Fundamentals and the Equilibrium of Real Exchange Rate of an Emerging Economy: Estimating the Exchange Rate Misalignment in Malaysia

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ABSTRACT

To evaluate the existence of possible over and under valuation of exchange rate for Malaysia, the study examines the nature of misalignment in the equilibrium real exchange rate (RER) and its systemic and structural changes in the fundamentals. We account for structural breaks in the data generating process to determine the appropriate order of integration. Based on the suggestion of the weak exogeneity and unit vector analysis, the study estimates the equilibrium and sustainable equilibrium RER (SERER) based on the behavioural equilibrium exchange rate model using multivariate Johansen cointegration and dynamic ordinary least squares techniques. The result reveals that variation in the SERER is collectively accounted by the real capital formation, government consumption expenditure, capital flows and degree of openness. Furthermore, the study identifies changes in the final consumption expenditure as the major factor that leads to persistent variation in the RER. Nevertheless, the SERER consistently appreciates slightly throughout the sample period with little forms of neutralized depreciation. The consistency in the SERER appreciation is accounted for by the increase in real capital formation. Moreover, the finding on misalignment shows three episodes; the relative sustainable equilibrium with slight evidence of fluctuation; a bit undervaluation with trivial adjustment and the episodes of overvaluation. The policy implication of the study is that, policymakers should focus on fiscal policies that work towards greater import substitution strategies; inter-temporal substitution effect of close substitute of non-tradable commodities and monetary policies that reduce capital outflows.

Keywords: Exchange Rate, Dynamic Ordinary Least Squares, Misalignment, Consumption Expenditure
JEL Classifications: C43, G01

1. INTRODUCTION

The real exchange rate (RER) is a key to relative price in an economy and understanding of their dynamics is particularly important for developing and emerging economies as the volatility of exchange rates tend to be higher for these economies than developed economies (see Hausmann et al., 2006). Justification for studying the behaviour of the RER is provided by the fact that a misalignment of the RER significantly affects the resource allocation process in the economies by altering the relative profitability of tradable and non-tradable activities. The term misalignment in this study refers to the difference between actual or observed RER and the equilibrium or sustainable RER (SREER) in the long term.

However, the SERER is not observed so it must be estimated. It is noted that measuring the degree of misalignment is difficult, as it requires measuring an unobservable variable i.e., equilibrium RER (Elbadawi, 1994). Nevertheless, Isard (2007) puts forward six methodologies to carry out the estimation: The purchasing power parity (PPP), the PPP adjusted for productivity differentials, the macroeconomic balance approach, the focus of spreads in the competitiveness sector for tradable goods, the behavioural models of the RER (BEERS) and general equilibrium (FEERS) models. In addition to the models in his classification, there are various filters or other statistical methods that have been used to estimate the RER trend.

Theoretically, the misalignment could be divided into three components: (i) The gap between the observed exchange rate

and the short term RER equilibrium (STRER) attributed to the effects of speculative or bubble that occurs in the short term, (ii) The gap between the STRER and long term equilibrium RER (STRER-LTRER), which arises from the slow adjustment of the predetermined variables, and (iii) The gap between the LTRER and desired equilibrium RER (LTRER), which arises from inappropriate policies.

The misalignment that we refer to is the gap between the actual or observed RER and the desired equilibrium of the RER. To do this we assume that the optimum level of the policy is equal to its sustainable level. However, the relevance of the misalignment of the equilibrium RER has been called into question by different schools of economic thought, as described in Isard and Faruqee (1998), and Montiel (1999). Briefly, there are two basic criticisms to the concept of the RER: The exchange rate is always in equilibrium, so there is no gap. According to this approach, the RER may drift but never significant because it tends to reflect economic fundamentals. The gap may exist but it is impossible to measure in practice.

Montiel (1999) argues, with respect to the first criticism that although the RER may be in "equilibrium" but it is not always in long-run equilibrium. That is, such "equilibrium" may be a short-run equilibrium and unsustainable in the long term. In the second criticism, Montiel argues that there is an empirical challenge to the measure of the RER equilibrium. Previous research has focused on finding out if the RER was in equilibrium at some point of time and/or measures the degree of misalignment.

The RER is greatly discussed in both academic and economic policy. The possible existence of overvaluation or undervaluation exchange rate among others is one of the facts that needs further discussion. In general, it is said that a currency is overvalued (or undervalued), in real terms, if the current RER is below (or above) the RER equilibrium. In terms of policy, a significant negative gap is a leading indicator of a crisis of balance of payments, while a pronounced positive gap is usually indicative of higher future inflation. However, we believe that many differences in the points of view are actually due to the differences in concepts.

Nevertheless, the paper presents discussion about the overvaluation or undervaluation of the Malaysian currency, ringgit. To answer this question, at least in theory, three approaches are adopted: (1) PPP, (2) estimating an equation of the determinants of the RER, and (3) the decomposition of the series of the RER in constant and cyclical components, where the constant is interpreted as the equilibrium. Therefore, the study represents an analysis of the nature of misalignment of the RER and its link to structural and systematic changes in the fundamentals. It examines to what extent the current RER is consistent with economic fundamentals. In terms of policy discussion relative to the equilibrium RER, much has been emphasized on the concept of fundamental equilibrium of exchange rates, which is based on the concept of internal and external balance. Given the complexity of determining such exchange rate, a full specified structural model is required.

In this study the estimate of the equilibrium real exchange is based on BEER model[1] following Baffes et al. (1999) specification. The BEER approach uses econometric methods to establish a link to explain the RER with the main economic variables that explain it. Here, the estimation of the REER is based on its reduced form using time series methods, in which the RER (RER) is related to its fundamentals.

The remainder of this paper is organized as follows: In Section 2 a review of the literature is presented, Section 3 provides the theoretical aspects of RER, Section 4 outlines the characteristics of the database and methodology that are employed, while Section 5 presents and interprets the results of the estimates. Finally, we present some evaluative considerations in Section 6.

2. REVIEW OF LITERATURE

In this section we review the previous studies that applied the BEER[2] models to establish long-term relationships between the RER and its fundamentals.

The reviewed studies differ in the number of the potential fundamentals used. Similar statistical approach is applied to determine the long term relationship with RER. Baffes et al. (1999) estimate the REER for Burkina Faso and Côte d'Ivoire. In both cases the estimations are performed based on vector error correction model (VECM). For Burkina Faso annual data for the period of 1970-93 were used and the fundamentals were the output per worker relative to that of OECD countries, the degree of openness measured as the ratio of imports to GDP and resource balance as a percentage of GDP. Similarly, for Côte d'Ivoire the period of estimation spanned 1967 to 2003 and the fundamentals that were statistically significant were the last three reported for Burkina Faso and the investment-GDP ratio. The study provides guidelines for conducting empirical estimates of the BEER models that guide this study.

In another study, Broner et al. (1997) use two fundamentals: The relative price of non-tradable to tradable and net foreign assets, in their study on the RER for Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela for the period 1960-1995. Meanwhile, Ades (1996) used quarterly data for Mexico, South Africa and Indonesia using terms of trade, openness, external capital flows and foreign interest rate as fundamentals for RER.

In his paper, Montiel (2007) performs an estimation of REER for Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay using annual data for the period 1969-2005. For each case, the study utilized VECM. For Bolivia and Uruguay it is established that the fundamentals of the RER are the terms of trade and relative productivity. As for Chile, the relative productivity is the only fundamental, while for Brazil the fundamentals are an index of relative productivity and the international investment position as

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1   Additionally, two statistical methods, Hodrick-Prescott and modified Hodrick-Prescott filters were used for estimating the real exchange rate.
2   A review of the various methodologies for estimating the real exchange rate equilibrium can be found in Edwards and Savastano (1999). The studies conducted here emphasize empirical applications of BEER models.

a percentage of GDP. In addition to the last two, Paraguay, the degree of openness proved to be a basis of the RER.

For Chile, Soto and Valdes (1998), use quarterly data from 1978 to 1997, they find evidence of a long-term relationship between the RER and the relative productivity of the tradable with respect to non-tradable sector, the net foreign asset position and public spending. The terms of trade are not significant. In another study Céspedes and De Gregorio (1999) use quarterly data for the period 1977 to 1998. They employ the co-integrated VAR estimation methodology and dynamic least squares (DLS) in their estimations. According to their study, the fundamentals of RER are the terms of trade, the ratio of net foreign assets to GDP, the ratio of government spending to GDP differentials and the difference in average labor productivity in the tradable sector relative to average labor productivity in the non-tradable sector.

Meanwhile, Calderón (2004) estimates the REER trajectory using both VECM and dynamic least squares, with quarterly data for the period 1977-2003. In particular, the result reveals that the depreciation of the Chilean peso in the eighties is mainly explained by higher net domestic borrowing of the country and a lower level of government spending. In turn, the appreciation during the nineties is attributed to an increase in the relative productivity of the tradable sector and an improvement in the external asset position.

In case of Colombia, two studies made by Oliveros and Huertas (2002) to estimate REER using VECM, using annual data from 1958 to 2001. They establish that the statistically significant of the RER fundamentals in the long run are net foreign assets, the interest rate differential with the U.S. and productivity relative to the U.S. In another estimate using quarterly data from 1980 to 2002 they found that the RER fundamentals are net foreign assets and productivity relative to the United States. Echavarría et al. (2005) obtain the result for Columbia that the fundamentals of the RER are the productivity differential between Colombia and the United States, the terms of trade, net foreign assets and government spending both as a percentage of GDP. These authors use annual data from 1962 to 2004.

Werner (1997) in his study of the RER in Mexico used quarterly data from 1979Q1 to 1997Q1. This author uses an extensive list of fundamentals among which are oil prices, government spending, tariffs, the interest rate of foreign debt, the capital account, the money supply and the interest rate differential relative to the U.S. Aboal (2002), uses quarterly data for the period 1986-2000. The result shows that the fundamentals for RER in Uruguay are the ratio of the total average productivity of the economy over the average productivity of the industry, the ratio of total consumption of the economy to GDP, and the ratio of consumption expenditure to GDP.

This methodology also been applied to the case of two African countries. For the economy of Botswana, Iimi (2006) estimates a VECM using relative price of non-tradable to tradable, capital inflows, terms of trade, the risk premium and the interest rate differential with respect major trading partners as the fundamentals

of RER. For South Africa, MacDonald and Ricci (2003) using the same estimation technique on the fundamentals of the REER that are GDP and the interest rates differential relative to major trading partners, an index of prices of major commodities exported by South Africa deflated by the export price index of industrial countries, the degree of openness of the economy measured as the ratio of the sum of imports and exports relative to GDP, the fiscal balance and net foreign assets.

Finally, Amuedo-Dorantes and Pozo (2004) and Lopez et al. (2007) explore the relationship between RER and remittances from migrant workers. The estimations use unbalanced panel approach due to the fact that there are not enough data on the series for any country, and the wide variability in length between countries. The estimation method is based on the fixed effects and instrumental variables. It should be noted that neither of these two studies estimates a REER.

Meanwhile, Lopez et al. (2007) also use a database that includes a broader low-and middle-income spectrum, among which they include 20 countries in Latin America and the Caribbean: Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic and RB Venezuela. Their main results are that there is a statistically significant relationship between RER and remittances and that this ratio is higher in Latin America.

3. GENERAL THEORETICAL FRAMEWORK

The exchange rate is defined as a relative price. The nominal exchange rate is the price of one currency in terms of another currency. From this perspective, the RER is the relative price of a basket of goods over another. The question is what kind of goods? There exist conceptual differences associated with theories of RER. The conceptual differences differ precisely in the components of these baskets of goods, and also on the theoretical and policy conclusions which rely on terms of international competitiveness, relative returns of the tradable sector, equilibrium levels, among others.

The concept of exchange rate begins with PPP hypothesis. It hypothesized the constancy of the REER so that it is not affected by changes in the relative productivity of the economy relative to its trading partners, terms of trade or changes in factor of endowments. If there is evidence of market forces with the RER at a constant long-term value, then this value cannot be at equilibrium. However, it is noted that since the late 70s the base models have failed to explain these fluctuations in RER (Meese and Rogoff, 1983) and numerous studies have established that the weak form of the PPP is true and the adjustment however is really slow. Nonetheless, the strong form (absolute) of PPP with relatively quick adjustments is only obtained when a very long series of exchange rate is used (Frenkel, 1978; 1981).

The key to understand these results is to understand the forces that keep the nominal exchange rate deviates from equilibrium which is in accordance with the theory of PPP. One element relates to

sticky prices when there are nominal shocks while others relate to the impacts of real shocks. Following MacDonald (1998), we consider the possible sources of variation in the RER in its augmented version which is based on its decomposition and further extend the short run version of the exchange rate level to the long term level based on uncovered interest parity which incorporates real interest rate differential (IRD) and fundamentals other than the interest rate differential.

In terms of policy discussion, relative to the equilibrium RER, much emphasis has been placed on the concept of fundamental of exchange rate equilibrium, which based on the concept of internal and external balance. Given the complexity in determining the exchange rate we proceed to use the behavioral methods of time series. It relatively eases to apply and allows us to observe the "bindings" of the fundamentals or determinants which the RER are based.

4. DATA AND METHODOLOGY

The database that is used in the study contains annual data of the RER and its possible fundamentals. The set of the possible fundamentals includes relative trade openness (OPEN), investment (GFCAPF), government consumption (GOVEXP), terms of trade (TOT) and capital flows (FLOW, TB6MSD). Data in the study are sourced from the World Bank and IMF databases. The sample period spans from 1960 - 2012.

4.1. Model
Edwards and Savastano (1999) detail the direction taken by previous research on the RER. First, studies have been conducted based on an equation that represents a reduced form model. Earlier studies of this type were performed to check whether the theory of PPP was met. Then comes an alternative approach that rejects the implementation of the PPP on the basis that there are several internal and external shocks that structurally modify the economy and the level of dynamic equilibrium of the RER. The new conditions associated with changes in productivity; terms of trade; trade, financial and fiscal reform; and international interest rate, are among others could establish new levels of equilibrium of the RER. This approach emphasizes the test on the effect of economic fundamentals on the equilibrium RER.

A second generation of estimates of the equilibrium RER is based on structural models. In this group we have two classes: Partial equilibrium models based on the estimation of trade elasticity, and computable general equilibrium models, which is based on calibration techniques and simulation model with microeconomic foundations.

4.2. Single Equation Model
4.2.1. Estimates of PPP
According to the theory of PPP price levels of tradable goods of all countries should be equal when expressed in the same currency. However, in practice, the existence of transportation costs and transaction costs, among other possible barriers to trade, prevent the price equalization. The relative version of the PPP however includes trade barriers that solve the described problem. According to Froot et al. (1995), the early estimates were made on the following PPP equation (Equation 1) in its reduced form.

$$e = a_0 + a_1 p + a_2 p^* + u \qquad (1)$$

The earlier studies, based on the estimates of ordinary least squares (OLS), that requires the realization of the symmetric condition $(a_1 = a_2)$ and homogeneity $(a_1 = a_2 = 1)$. That is in compliance with the absolute version of the PPP. These estimates obtained favorable results of PPP only in situation of high inflation.

Second generation of study applies unit root tests on RER. It shows that the variable is stationary only for over long periods. Finally, in the third generation of study the cointegration tests are applied between e, p, p*. The results obtained indicate a long-term relationship only over very long periods and rejecting the conditions of symmetry and homogeneity.

4.2.2. Estimates based on fundamentals (BEER)
The results of the estimates of the equilibrium RER based on the PPP indicate that this theory is not fulfilled due to the effect of other factors that are not included[3]. These factors are associated with important variables in determining the equilibrium of the economy and their effect on RER. In this regard, the study is to identify these factors that are called fundamentals and relate directly to the RER.

In econometric terms we can conclude that the estimates based on the PPP show systematic deviations from equilibrium, which could be associated with the fundamentals of the economy that are not stationary. Therefore, this study follows sought to relate directly in a single equation model, between the RER and its fundamentals. This approach involved a direct econometric analysis of the behavior of the RER equilibrium known as Behavioral Effective Exchange Rate (BEER).

Many authors developed theoretical models (including the inter-temporal frameworks, representative agents, price flexibility, etc.) which are derived from a reduced form. The reduced form relates the RER to a set of variables called fundamentals. These fundamentals are usually the terms of trade, growth (or productivity differential), openness (opening the country to international trade), capital flow, import tariffs and government spending.

4.3. Single-equation Estimation of the BEER
This section presents the estimation of the behavior equilibrium of RER for Malaysia based on a single equation model of exchange rate fundamentals. The BEER approach assumes that the economic fundamentals that determine the behavior of the RER are at sustainable levels or equilibrium.

The BEER rests on a standard theoretical model for a small open economy. Various economic fundamentals governed the determination of the long-run equilibrium RER in such an

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3   The estimated results are readily available from the author upon request.

economy. The typical model we postulate states that, in the long run, the RER is determined by:

RER=f (OPEN, GFCAPF, FISCAL, TOT, FLOW)

Where RER is the multilateral RER, TOT denotes the terms of trade, OPEN is the degree of openness of the economy, FISCAL refers to variables such as government consumption, the government revenue, public investment, or a combination of both, as a percentage of GDP, PROD is the relative productivity, represented by GFCAPF and FLOW is the flow of capital.

4.4. Steps in Estimating BEER

First, we analyse the characteristics of the time series of each variable included in the functional form, and classifies them either as stationary series (which revert to its mean) or non-stationary. This followed with the test on co-integration. The Johansen-Julius co-integration test on the set of the variables, allow us to determine if there is a long-term relationship between the variables. The next stage is to estimate the vector of the long-run coefficients of the VECM using the specification determined in the Johansen co-integration test.

The next step is to estimate using the method of dynamic OLS (DOLS) developed by Stock and Watson (1993). The choice of this methodology is based on evidence from Stock and Watson's Monte Carlo showing that DOLS estimator is superior to many other estimators used in small samples. For example, DOLS procedure allows both stationary and non-stationary variables in a long-term relationship, taking into account feedback effects in model regressors (endogenous) and problems facing in small samples, including advanced (lead) and lagged values of changes in non-stationary variables. This point can be illustrated by the following regression (this not final):

$$
\begin{aligned}
LRER_t = & const + \beta_1 LOPEN_t + \beta_2 LGOVEXP_t \\
& + \beta_3 LGFCAPF_t + \beta_4 LTB6MSD_t + \beta_4 LTOT_t \\
& + \sum_{j=-K}^{j=+K} f_j \Delta LOPEN_{t-j} + \sum_{j=-K}^{j=+K} \gamma_j \Delta LGOVEXP_{t-j} \\
& + \sum_{j=-K}^{j=+K} \eta_j LGFCAPF_{t-j} + \sum_{j=-K}^{j=+K} \varphi_j \Delta LTB6MSD_{t-j} + \\
& \sum_{j=-K}^{j=+K} \lambda_j \Delta LTOT_{t-j} + \varepsilon_t
\end{aligned}
\tag{2}
$$

Where long-term elasticities are given by βs the terms associated with levels. In this paper the cyclical or short term influences of the fundamentals are filtered as much as possible in the estimates of the long-run equilibrium RER.

5. EMPIRICAL RESULTS

5.1. Unit Root Analysis

The stationarity of the series is investigated using five different statistical techniques; Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Kwiatkowski-Phillips-Schmidt and Shin (KPSS), Zivot and Andrews (ZA) and Lee and Strazicich (LS) with one

break lagrange multiplier (LM) tests. We employ the augmented Dickey and Fuller (1979) test assuming that shocks are temporal and do not have long run effect on the series (Glynn et al., 2007). The estimates of the ADF unit root test on LRER, LOPEN, LGFCAPF, LGOVEX, LTOT and LTB6MSD are presented in Table 1.

The result indicates that all the series are not stationary at level under both intercept and intercept with trend models except for terms of trade, LTOT. The LTOT series is found stationary at level under the intercept without trend model at 10% level of significance. The result is similar to that of KPSS unit root test on the same variables[4]. However, the ADF and KPSS tests reject the null hypothesis that the series have unit root at first difference.

To check the sensitivity of the ADF result, we further apply Phillips and Perron (1988) test. The PP test results depicted in Table 1 as well, also indicate that the series are not stationary at level with the exception for LGOVEX which is found stationary at level, at 10% level of significance under the intercept and trend model. However, the PP result also shows that the test rejects the null hypothesis that series are I(2).

Nevertheless, it has been argued that presence of structural break leads to size distortion and spurious conclusion in the traditional ADF and PP models (Lee and Strazicich, 2003 and Perron, 1989). Thus, in addition to the traditional ADF and PP tests, this study employs Zivot and Andrews (1992) (ZA)[5] and LS LM with one structural break to account for structural shocks and further check the stationarity of the variables. The LS test is break point nuisance invariant under both null and alternative hypotheses. It is associated with neither size nor location dependence and unaffected by incorrect estimation in the presence of structural break (Lee and Strazicich, 2013).

The result of the LS with one structural break is presented in Table 2. The break points are mostly significant under model C (intercept with trend). The LS test results are in line with the ADF counterpart where LTOT variable is found significant at 10% level under intercept model. The result does not differ between the one break and two breaks[6] LM test. However, based on the LS one break unit root test, LRER and LTB6MSD are also found stationary. The LRER is significant at 10% and 5% levels under intercept and intercept with trend models respectively for both one and two breaks tests. The LTB6MSD variable is also stationary at 5% and 1% levels of significance under the trend model for one and two breaks respectively. Thus, the LS result establish a mixture of I(1) and I(0) order of intergration. The integration order of the variables is determined to be I(1) for all the series except for real effective exchange rate, terms of trade and US tresury bill 6 months discount which are determined to be I(0)[7]. The break points are

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4   The KPSS test results are available from the authors based on request.
5   The result of the ZA test shows that none of the series is stationary at level without structural break. The result of the tests reveals that the series are stationary at first difference therefore, integrated at I(1) order. The result of the ZA test is available upon request.
6   The result of the LS with two breaks LM test are available from the authors upon request.
7   Results of the first difference LS test are available upon request.

mostly found statistically not significant under the intercept model. This implies that the data generating process is characterized by structural breaks in the trend.

5.2. Cointegration Analysis

The study empirically tests for the validity of sustainable equilibrium RER (SERER) model for Malaysia using modified cointegration technique. This allows for applying Johansen Maximum likelihood test for cointegrating vectors even in the mixture of cointegrated series provided that at least two or more of the series are cointegrated after first difference (Dennis et al., 2006). The test investigates the influence of permanent changes in exchange rate fundamentals in relation to changes in the RER and show whether RER and a vector of its nonstationary fundamentals are having a stable relationship in the long run. The rejection of the null hypothesis of no cointegration indicates the existence of error-correction in the model (Chin et al., 2007). The reduced form of the cointegrating vector is referred to as the SERER (Montiel, 2007).

In this study, we highlight some issues in cointegration analysis. It is pertinent to note that both long and short runs inferences are sensitive to the appropriate choice of cointegrating ranks. This is traditionally, inappropriately approximated when structural break exist and a dummy variable is used especially for small sample size (Dennis et al., 2006). This study employs the underlying empirical data to simulate new asymptotic critical values for testing the rank of the trace test statistics using bootstrap simulation. The simulation is considered important to avoid size distortion due to the anticipated weak exogeneity of some variables and existence of structural break as evident from the weak exogeneity and LS tests respectively.

The cointegration ranks result presented in Table 3 indicates the existence of five and four common trends as well as two and three cointegrating vectors based on asymptotic and simulated test statistics respectively. The simulation was conducted based on the underlying data. The result implies that there exist long run

Table 1: Augmented Dickey-Fuller and Phillips Perron unit root tests

Series	Constant without trend				Constant with trend			
	ADF		PP		ADF		PP	
	Level	First different	Level	First different	Level	First different	Level	First different
LRER	−1.195	−4.934***	−1.046	−5.296***	−3.051	−4.893***	−2.384	−5.314***
LOPEN	−0.110	−4.910***	−0.023	−6.292***	−2.451	−4.985***	−2.525	−6.404***
LGFCAPF	−1.416	−4.672***	−2.036	−5.154***	−1.858	−4.794***	−1.746	−5.284***
LGOVEX	−1.998	−5.685***	−2.440	−8.285***	−3.050	−5.702***	−3.475*	−8.358***
LTOT	−2.898*	−4.615***	−2.553	−5.882***	−3.098	−4.583***	−2.693	−5.896***
LTB6MSD	−0.941	−4.492***	−0.464	−4.086***	−1.707	−5.142***	−0.341	−4.586***

***, ** and * represent significance level at 1%, 5% and 10% respectively (Dickey and Fuller, 1979; Phillips and Perron, 1988). The figures are the t-statistics for testing the null hypothesis that the series has unit root. The lag length is determined and fixed as one based on Schwert (1987). The ADF critical values for intercept without trend are −3.562, −2.919 and −2.597 whereas, for intercept with trend the values are −4.146, −3.499 and −3.178 for 1%, 5% and 10% respectively. Whereas, The PP critical values for intercept without trend are −3.560, −2.918 and −2.596 whereas, for intercept with trend the values are −4.142, −3.497 and −3.177 for 1%, 5% and 10% respectively. ADF: Augmented Dickey-Fuller, PP: Phillips-Perron

Table 2: LS one-break LM unit root tests

Variables	Model A					Model C				
	$\hat{k}$	$\hat{T}_B$	$\hat{t}_{\gamma j}$	Test statistic	Critical value break points λ	$\hat{k}$	$\hat{T}_B$	$\hat{t}_{\gamma j}$	Test statistic	Critical value break points λ
LRER	1	1985	−2.200**	−3.384[c]	−0.044	1	1986	−3.657***	−4.860[b]	−0.073
LOPEN	1	1974	−2.963***	−1.311	−0.059	1	1988	2.724***	−2.493	0.054
LGFCAPF	1	1998	0.746	−2.340	0.015	1	2000	−3.318***	−3.743	−0.066
LGOVEX	1	1971	2.003**	−1.475	0.040	1	1971	−3.337***	−3.139	−0.067
LTOT	1	1995	−0.437	−3.496[c]	−0.009	1	1996	−2.358**	−3.853	−0.047
LTB6MSD	1	2002	−0.084	−2.784	−0.002	1	1994	0.690	−4.766[b]	−0.014
Critical values	1%	5%	10%							
Model A	−4.239	−3.566	−3.211							
Model C	−5.110	−4.500	−4.210							

$\hat{k}$ is the optimal number of lagged first-difference terms included in the unit root test to correct for serial correlation. $\hat{T}_B$ denotes the estimated break points. $\hat{t}_{\gamma j}$ is the t value of DT_{jt}, for j=1,2. See Lee and Strazicich (2003) Table 2 for critical values. a, b and c indicate significance of the LM test statistics at 99%, 95% and 90% critical level, respectively. While *, ** and *** indicate the two-tailed significance level of the break date at 99%, 95% and 90% respectively. (Lee and Strazicich, 2003, 2013) LS: Lee and Strazicich, LM: Lagrange multiplier

Table 3: Johansen Maximum likelihood test for cointegrating vectors

Hypotheses	Eigenvalues	Asymptotic critical values		Simulated critical values	
		Trace statistics	5% critical	Trace statistics	5% critical
r=0	0.787	191.544**	146.131	191.544**	127.257
r≤1	0.656	128.509**	113.303	128.509**	96.630
r≤2	0.602	83.377	84.216	83.377**	70.668
r≤3	0.410	42.937	58.932	42.937	48.471
r≤4	0.226	19.023	37.263	19.023	30.332
r≤5	0.125	6.556	18.765	6.556	14.816

The reported trace statistics are the corrected small sample size statistic, ** represents significance at 5% level of significance. Source: Author's computation

relationship among the variables irrespective of using asymptotic and simulated critical values although there tend to be an element of size distortion when asymptotic critical values are employed. This is evident from the difference that arise when the alternative critical values are simulated. Furthermore, the adequacy of the model is assessed to meet the assumptions governing the appropriate choice of the asymptotic results. This is carried out using three mechanisms; graphical inspection of series, residual misspecification tests and constancy of parameters of the model.

The residuals of the changes in RER depicted in Table 4 reveals that the cointegrating ranks of the model are not affected by autocorrelation based on the LM one and two tests, not affected by heteroscedasticity and non-normality.

However, the univariate test indicates that changes in the 6 months US Treasury bill is associated with heteroscedasticity whereas, changes in the RER and gross capital formation are affected by non-normality of residuals[8]. Nevertheless, these are only related to univariate series which do not spill over and affect the overall model.

The standardized residuals shows high negative changes in the exchange rate around 1997 to 1998 which reflect the Asian financial/currency crises. The economy absorbed the structural shock in relation to other competing economies. This is evident by the positive residual increase in 1999-2000. The root of comparison matrix also indicates that the model follows I(1) process[9]. The graph also shows three roots close to unity whereas, other roots are all embedded within the unit disc of the comparison matrix graph.

The argument for inclusion or otherwise of the shift dummy is investigated using likelihood ratio (LR) test. The results of the LR test in the subset of β restriction indicates that the shift dummy should not be excluded in the estimation of the model. We also presented the result of the beta (β) over identifying restriction[10] to investigate joint stationarity in cointegrating relationships. The estimates show that the three cointegrating relationships are independent stationary. The test in the unit vector in alpha (α) (which measures speed of adjustment or factor loading) indicates that cumulative shocks in the exchange rate fundamentals lead to common trends thereby having effect on the stationarity of the RER of Malaysia.

Table 5 presents variable diagnostic tests to further ensure the appropriateness of the cointegrating ranks. We test for the variables exclusion and found that only the 6 months US Treasury bill can be excluded in the model. This result is relevant irrespective of using ranks of two or three cointegrating vectors. However, to measure competitiveness of a given economy in terms of flows of capital such a variable plays a vital role and that justify the difference between economic and statistical significance. The table also depicts the test of stationarity of the series. The result

8   The diagnostic results for each variable are presented in Table 5.
9   The graph is readily available from the author.
10   See Table 4 for the test result. It represents the vector of the cointegration coefficients.

Table 4: Residual diagnostic tests

Test	χ^2 statistic	P
Autocorrelation		
LM1	35.524	0.491
LM2	27.668	0.839
ARCH Effect		
LM1	461.466	0.242
LM2	942.415	0.077
Normality	18.439	0.103
Shift dummy restriction	48.754	0.000
Over identification restriction	16.277	0.001
Unit vector restriction	20.739	0.000

The normality test is based on Doornik-Hansen test. See Doornik and Hansen (2008). Source: Author's computation. LM: Lagrange multiplier

reveals that no single variable in the model is stationary by itself except for the log of openness. The stationary of the openness variable itself seized to exist at 12 percent level of significance which is reasonable enough and not far from the conventional 10 percent significance level. Moreover, cointegration can be established once there exist at least two series that are integrated of order one I (1) (Dennis et al., 2006). The study further tests for the weak exogeneity of the series. The result indicates that only the 6 months US Treasury bill can be considered weakly exogenous in the model. In contrast to the joint test of unit vector in α (test for the adjustment speed or factor loading), the univariate test indicates that none of the variables disturbances enter into a common trend in the model. However, the non-zero coefficients in the estimates of the alpha vector in raw one to three as determined in this study suggest the use of multivariate Johansen cointegration techniques rather than the single equation of Engle-Granger estimation procedure.

The study estimates the SERER using the reduced form of the cointegrating relationship. This shows how the vector of the non-stationary series derives the behaviour of the RER over time. In this model, the test for variable exclusion indicates that structural break dummy and trend should also be included in the estimation process. The statistical significance and predicted theoretical compliance of the non-stationary fundamentals explain the sustainability of the RER equilibrium (Montiel, 2007).

Table 6 presents the estimates of the sustainable RER equilibrium for Malaysia. The first model (model 1) in the table indicates the long run estimates of the RER and its non-stationary fundamentals in the baseline case without eliminating the transitory components of the series. The second model (model 2) takes account of the transitory components of the data by filtering the variables using the widely method of series de-trending, Hodrick-Prescott filter. The predicted estimates of the filtered series are the real coefficients of the SREER. The result of the model shows that the competitiveness of the Malaysian traded good sector is affected by numerous factors other than the productivity effect of the Balassa-Samuelson hypothesis. This is evident from both models 1, 2 and 3 of Table 6.

The coefficients of the sustainable fundamental values conform to the theoretical anticipation of the RER equilibrium. The gross real capital formation enters the model with negative coefficient

Table 5: Variable diagnostic test

Variable	Variable exclusion	Variable stationarity	Weak exogeneity	Unit vector
LRER	21.818 (0.000)	17.973 (0.000)	20.191 (0.000)	20.739 (0.000)
LOPEN	33.320 (0.000)	5.464 (0.141)	24.252 (0.000)	18.731 (0.000)
LGFCAP	25.737 (0.000)	38.355 (0.000)	19.461 (0.000)	26.637 (0.000)
LGOVEXP	25.871 (0.000)	10.568 (0.000)	28.166 (0.000)	27.371 (0.000)
LTOT	40.057 (0.000)	20.179 (0.000)	37.928 (0.000)	13.667 (0.003)
LTB6MSD	2.163 (0.539)	22.440 (0.000)	3.842 (0.279)	19.617 (0.000)
BREAK	27.738 (0.000)	-	-	-
TREND	16.265 (0.001)	-	-	-

The test is conducted based on likelihood ratio test. 7.815 is the critical value of the variable diagnostic tests. The values in parentheses represent the corresponding probability values of the tests. Source: Author's computation

Table 6: Estimates of the cointegrating equation

Series	Johansen cointegrating equation		Dynamic OLS
	Model 1 (basic equation)	Model 2 (sustainable REER)	Model 3 (sustainable REER)
LGFCAP	−1.096*** (−5.020)	−0.080** (−0.034)	−0.073* (−0.030)
LOPEN	0.194** (2.157)	0.765*** (0.158)	1.518*** (0.097)
LGOVEXP	−0.680*** (−4.158)	0.550** (0.015)	0.708*** (0.137)
LTOT	0.047*** (8.965)	−1.420 (1.367)	−0.724 (1.065)
LTB6MSD	0.974 (1.221)	0.046*** (0.013)	0.227*** (0.041)
ECT$_{t-1}$	-	−0.094** (−0.046)	-
Centered R^2	-	97%	99%

The values in parentheses are the t-statistics for model 1 and standard errors for models 2 and 3 respectively. ***, ** and * represent 1%, 5% and 10% respectively. The ECT$_{t-1}$ is the ECT. Source: Author's computation. SREER: Sustainable equilibrium real exchange rate, RER: Real exchange rate, ECT: Error correction term, OLS: Ordinary least squares

in line with Balassa-Samuelson effect. The result shows that 1% increase in LGFCAP leads to a decrease in LRER by 0.080%. The possible reason is that increase in the productivity of tradable commodities leads to increase in the real wage equilibrium due to increase demand for labour in the tradable sector. This expands (contracts) tradable (non-tradable) goods sector leading to excess demand in the non-tradable commodities. Therefore, restoring domestic equilibrium level induces decrease in the RER. The other variables such as government final consumption expenditure, the US 6 months discount Treasury bill, openness and trend are all positively related to real effective exchange rate.

The result reveals that increase in LGOVEXP by 1% leads to increase in LRER by 0.550 percent. It is expected that increase in government expenditure on final consumption usually leads to crowding out effect hereby reduction in private wealth and their respective demand for non-tradable goods. This causes depreciation in the equilibrium exchange rate. Furthermore, a percentage increase in LTB6MSD causes an increase in LRER by 0.046 percent. This is because, in a small open economy like Malaysia, increase in international interest rate is associated with liberalization of capital account effect. The non-convergence of domestic and international real interest rate leads to postponement of consumption of non-tradable goods to future period. This lowers not only the prices of the non-tradable goods but also their demand. This implies negative income effect which leads to steady exchange rate depreciation. In other words, the increase usually causes excess capital outflow for foreign investments. This also leads to high exchange rate relative to foreign currencies. The trade policy variable proxied by openness shows that a percentage increase in the degree of openness leads to 0.765% increase in LRER. The implication is that the importable goods in Malaysia are complementary to the domestic non-tradable goods. Therefore, the inter-temporal substitution effect will generate

increase in the RER thereby depreciation in the Malaysian RER. The positive relationship is in line with Zhang (2001) for China. The result further reveals that terms of trade is negatively related to LRER but statistically not significant. The non-significance of terms of trade is similarly reported in Soto and Valdes (1998) for Chile. However, this analysis only holds for the sustainable real equilibrium exchange rate (SREER) model.

Moreover, the DOLS model (depicted in model 3 of Table 6) is estimated with two fixed lag and leads specification based on annual data frequency. The standard errors used in the model are based on Newey and West (1986) which are robust for small sample size like in this study. The SERER result based on the DOLS is also similar to that of the SERER (estimated based on Johansen long run equation in model 2 of Table 6) and statistically significant. However, the magnitude of the coefficients vary except for terms of trade which is equally found not significant. This is a further indication that the identified factors are the real determinants of SERER in Malaysia except the terms of trade. Furthermore, the validity of the DOLS model is assessed using the test for serial correlation and normality of residuals. The tests reveals that the model is not affected by serial correlation and non-normality of residuals. Therefore, the model does not violate the assumptions of standard error.

The study quantifies the dynamics of adjustment by estimating the error correction representation of the SREER. This shows the extent to which the long run relationship explains the determination of the SREER. The error correction term (ECT) measures how meaningful the SERER can be and how the theoretical prepositions are empirically justified. The negative sign and significance of the ECT indicates the existence of the long run misalignment and explain how changes in the adjusted exchange rate fundamentals affect the SREER. Despite the fact that the ECT coefficient is very

low, about 9.4 percent which indicates slow adjustment process of sustainable RER to equilibrium, the centred R^2 explains a significant greater percentage in the changes in SERER resulting from the changes in the fundamentals. The estimated variables empirically reveal the level of misalignment that arise from the fundamental factors that affect SERER in Malaysia. The values and graph that shows the magnitude of the misalignment are presented in Table 7 and Figure 1 respectively.

The possible explanation of the slow adjustment to proper exchange rate condition relative to the prevailing fundamental exchange rate values, is the existence of structural break in the data generating process. This can be seen in Figure 1 where the misalignment is plotted to justify the existence of the structural changes (see the shaded areas) which constitute the outrageous deviations from the equilibrium level. However, the reported model indicates that movement of exchange rate in Malaysia is mainly driven by the exchange rate fundamentals at least for the sample period. The result is not surprising for Malaysia because of the country's prolong manage floating of exchange rate and relative political and general macroeconomic stability.

The study presents the degree of exchange rate misalignment in Figure 2. The figure shows the variation between RER and SERER for Malaysia. The graph presented three scenarios; the relative sustainable equilibrium during the periods of 1960-1966 with a slight evidence of fluctuation; a bit undervaluation during the periods of 1966-1968, 1973-1975, 1982-1986, 1995-1998, 2001-2003 and 2007-2011 with a trivial adjustment and finally, the episodes of overvaluation for the rest of the sample period. Although the gaps between the SERER and RER is graphically observed not too wide but a separate graph (Figure 1) depicts how wide the degree of the misalignment can be visualised. Furthermore, the misalignment is also influenced by the prevalence of the structural breaks of the 1980s, 1990s and 2000s. This can further justify the relative slow speed of adjustment in the model.

The period of 1966 to 1968 coincides with the era of about 14.3% devaluation of Malaysian ringgit in relation to British pound sterling. The recovery from the shock leads to the persistent overvaluation of the Malaysian ringgit in the 1970s up until 1980s with noticeable undervaluation. The episodes of the 1995 resulted from the market oriented exchange rate strategy of free floating regime and later aggravated by the East Asian financial crisis. The central bank of Malaysia's decision to pegged the ringgit to the US dollar in September 1998 following the East Asian crisis further leads to disequilibrium in the sustainable RER. This scenario was associated with ringgit overvaluation in relation to US dollar. The later episodes could be justified by the 1997, 2001 and 2009 financial crises which leads to general depreciation in the value of ringgit in relation to the basket of its trading currencies. The conclusion is that the RER of Malaysia is associated with random misalignment at least for the greater part of the sample period. The true deviation of the RER from its sustainable values is depicted in Figure 1. The figure shows not only the prolonged sustainable deviation but also the influence of structural changes in the exchange rate management.

Table 7: Exchange rate misalignment

Year	RER	SREER	MIS	MIS (%)
1960	221.63	222.75	−1.12	−111.66
1961	220.72	219.73	0.99	99.47
1962	217.63	216.70	0.93	93.07
1963	217.63	213.65	3.97	397.28
1964	214.16	210.60	3.55	355.23
1965	206.52	207.60	−1.07	−107.31
1966	202.87	204.72	−1.84	−184.48
1967	205.44	202.04	3.40	340.35
1968	198.98	199.61	−0.63	−63.14
1969	190.16	197.53	−7.37	−737.17
1970	185.00	195.87	−10.87	−1087.18
1971	183.54	194.64	−11.11	−1110.56
1972	187.30	193.75	−6.45	−644.81
1973	204.38	192.97	11.41	1141.07
1974	208.98	192.03	16.95	1694.79
1975	200.52	190.78	9.74	973.67
1976	186.49	189.22	−2.73	−272.63
1977	184.49	187.45	−2.96	−295.89
1978	179.11	185.55	−6.45	−644.62
1979	178.67	183.58	−4.90	−490.36
1980	171.46	181.50	−10.04	−1004.23
1981	170.24	179.26	−9.02	−902.25
1982	180.32	176.70	3.62	362.36
1983	187.75	173.55	14.20	1420.13
1984	193.82	169.60	24.23	2422.64
1985	187.52	164.76	22.76	2275.71
1986	159.41	159.21	0.21	20.74
1987	149.23	153.33	−4.10	−409.76
1988	132.85	147.51	−14.67	−1466.78
1989	129.17	142.12	−12.96	−1295.90
1990	124.35	137.36	−13.02	−1301.62
1991	121.04	133.30	−12.27	−1226.53
1992	129.32	129.90	−0.57	−57.16
1993	130.58	126.96	3.62	362.00
1994	126.38	124.32	2.06	205.57
1995	128.37	121.83	6.53	653.33
1996	133.36	119.36	13.99	1399.26
1997	127.82	116.86	10.96	1096.23
1998	103.28	114.39	−11.12	−1111.84
1999	104.73	112.16	−7.43	−742.89
2000	106.90	110.25	−3.34	−334.42
2001	112.28	108.64	3.64	364.11
2002	112.34	107.33	5.01	501.16
2003	104.88	106.31	−1.43	−142.94
2004	99.75	105.64	−5.89	−588.84
2005	100.00	105.37	−5.37	−536.86
2006	104.02	105.48	−1.45	−145.34
2007	107.30	105.89	1.40	140.25
2008	108.56	106.54	2.02	201.97
2009	105.24	107.34	−2.09	−209.18
2010	111.68	108.24	3.44	343.95
2011	112.81	109.19	3.62	362.00

RER and SERER represent the actual and sustainable real exchange rate respectively, MIS and MIS (%) indicate misalignment, which is the difference between RER and SERER and its percentage respectively. Source: Authors' computation. SREER: Sustainable equilibrium real exchange rate, RER: Real exchange rate

The decomposition of the SERER estimated for Malaysia is presented in Figure 3. The variation in SERER is collectively accounted by gross capital formation, government final consumption expenditure, openness and 6 months US Treasury bill. The major factors that lead to the persistent variation in the RER in Malaysia can be related to changes in final consumption expenditure. The SERER consistently appreciate slightly

Figure 1: Exchange rate misalignment
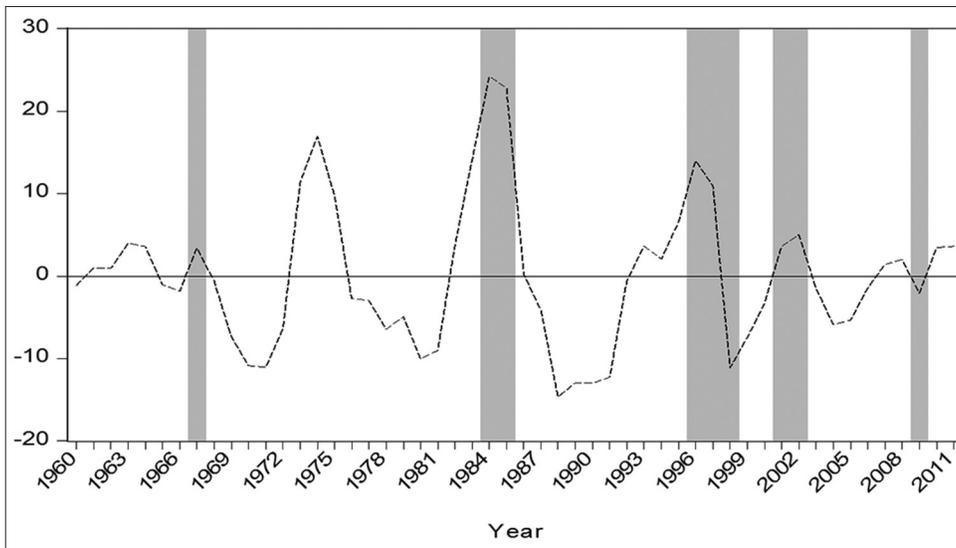
Source: Shaded areas are structural breaks

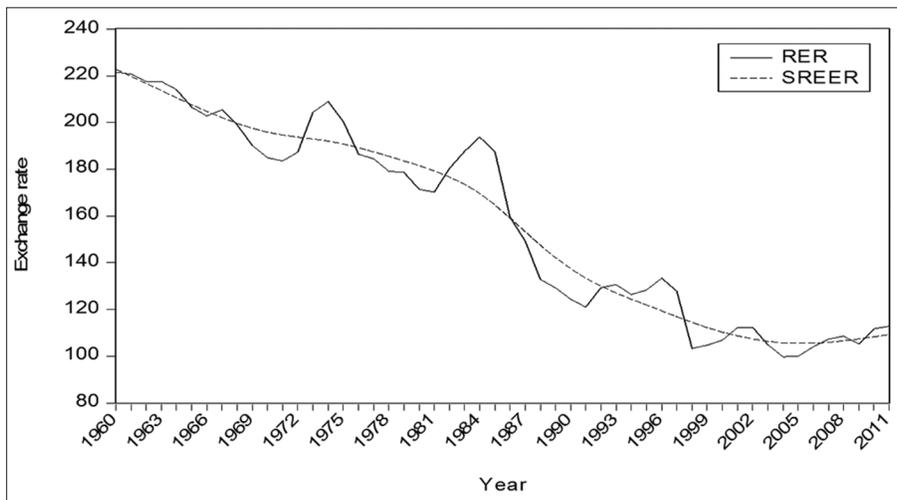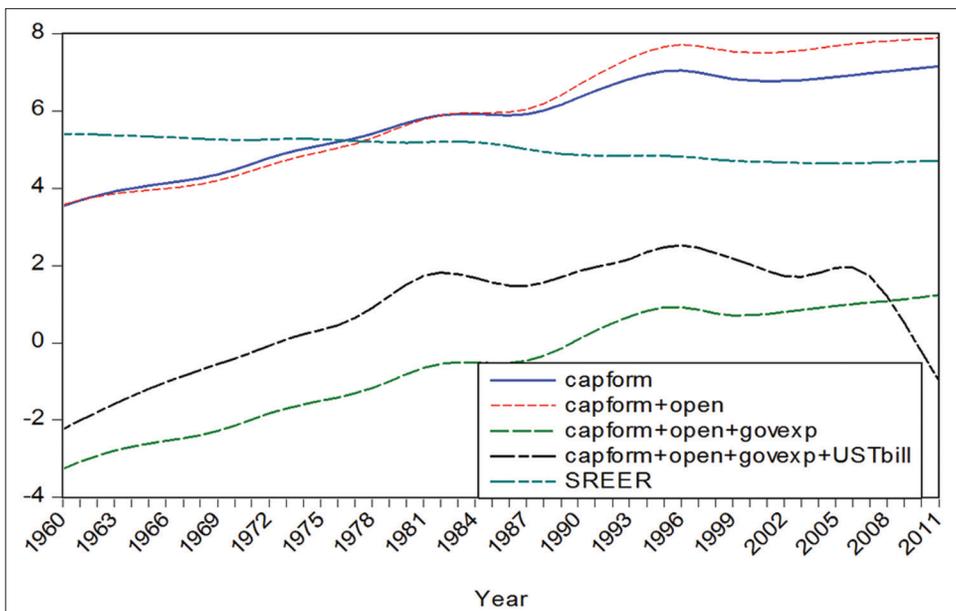**Figure 2:** Sustainable and actual equilibrium real exchange rate

Figure 3: Decomposition of the sustainable equilibrium real exchange rate

throughout the sample period with very little form of neutralised depreciation. The consistency in the appreciation of the SERER is explained by the increase in gross capital formation. The study decomposed openness on the gross capital formation. It is found that the degree of openness does not alter the pattern of the consistent increase in the level of capital formation. It rather increases the trend after 1986. This is an evidence that the Malaysian export has increased by about 10% compared to its performance in 1985. Although government expenditure on final consumer goods reduces the competitiveness of the RER however, the fluctuations in the level of government expenditure does not temper with the pattern of the movement. Similarly, the international interest rate shows less severe effect compared to government expenditure at least up until 2008. The effect became more severe after the investors' loss of confidence due to the 2008-2009 financial crisis. This leads to excess capital outflow by the investors in search for US based treasury bills as hedging strategy for the aftermath of the Asian financial crisis. The major implication of the episode is the persistent low demand for the domestic currency which affect the sustainable equilibrium level of RER.

6. CONCLUSIONS

This study employs the standard economic theory by estimating the BEER for Malaysia based on a single equation model of exchange rate fundamentals. Cointegration analysis and DOLS are used to determine whether the movement of RER in Malaysia reflects the identified factors related to the series. The finding of the study reveals that SERER for Malaysia is basically determined by the gross capital formation, government consumption expenditure, capital flows and degree of openness.

The study further estimates the Malaysian RER misalignment. The finding shows three scenarios; the relative sustainable equilibrium during the periods of 1960 to 1966 with a slight evidence of fluctuation; a bit undervaluation starting from the late 1960s and finally, the episodes of overvaluation. The former period corresponds with the era of Ringgit devaluation in relation to British pound sterling. The recovery from the shock leads to the persistent overvaluation of the Malaysian ringgit in the 1970s up until 1980s with noticeable undervaluation. The episodes of the 1995 resulted from the market oriented exchange rate strategy of free floating regime and later aggravated by the East Asian financial crisis. The policy of pegging ringgit to the US dollar in September 1998 is associated to overvaluation of *ringgit* in relation to US dollar. The later episodes could be justified by the 1997, 2001 and 2009 financial crises which leads to general depreciation in the value of ringgit in relation to the basket of its trading currencies. The conclusion is that the RER of Malaysia is associated with random misalignment at least for the greater part of the sample period. Furthermore, the misalignment is also influenced by the prevalence of the structural breaks of the 1980s, 1990s and 2000s. This can further justify the relative slow speed of adjustment in the model.

To ensure sustainable RER appreciation in Malaysia, the relevant policy makers should focus on first, fiscal policies that work towards greater import substitution strategies in order to increase the marginal propensity to consume of the non-tradable goods by public sector in relation to the private sector; second, inter-temporal substitution effect of close substitute non-tradable commodities with the imported goods and finally, monetary policies that reduce interest differential to enable transfer of future consumption of non-tradable goods to the present in order to generate positive income effect in the economy. Thus, the individual and collective functioning of these policies will work towards sustainable RER appreciation in Malaysia.

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