DOES RINGGIT MISALIGN? AN EMPIRICAL INVESTIGATION, 1991 – 2003

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Abstract
A currency overvaluation seems to be the prominent explanations of 1997 – 98 Asian financial crises, albeit the issue is still on-going and doubtful. Based on the theory of equilibrium real exchange rate, this paper estimates the NATREX equilibrium exchange rate and the resulting misalignment in Malaysia. The empirical results point out evidence of prolongs persistent misalignment of Malaysia ringgit throughout the study period. The ringgit showed a sharp u-turn from an overvalued during the pre-crisis (1993 – 1997) to an undervalued in the post-crisis (1997 – 2003) period. This corroborated the hypothesis that an overvaluation leads to a currency crisis to which followed with a substantial currency devaluation.

Keywords: Asian crisis; Real exchange rate misalignment; NATREX model; Malaysia.

JEL Classification Codes: C32; F31; F41.

1. Introduction

In the history of development economics, the concern about exchange rate misalignment, either undervalued or overvalued has been thought of as a key factor especially for emerging economies, namely Malaysia. Over the past decade, Malaysia was developed by a clear story in terms of macroeconomic fundamentals and strong financial sector until the 1997-98 financial crisis. In the 1990s, Malaysia exhibited strong economic performance where inflation rate was low, unemployment was below 3 percent, the exchange rate remained stable around RM 2.50 per US dollar, the current account was improved and international reserves remained high. All these factors had led to an impressive economic growth around 8 percent a year of real GDP, which is several time faster than the US and other western industries countries (Lee et al., 2002). This reflects that Malaysia is a well managed country either in terms of economic development or political stability. However, in mid-1997 Malaysian economy was caught in a financial crisis that arose from a regional contagion effect. This sweeps Southeast Asia countries into dramatic currency chaos and had forced ringgit to depreciate from about RM2.50 to RM4.50 per US dollar. In defeating the crisis, Bank Negara Malaysia (BNM) had pegged the ringgit against the US dollar at RM3.80 per US dollar. The continual shackled of the dollar has led to 38.1 percent depreciation of ringgit[1].

The rise of ringgit depreciation that caused by the regional crisis can be interpreted as a disequilibrium phenomenon, suggesting that ringgit is somehow severe to exchange rate misalignment. Based on the most structured definition of misalignment, real exchange rate misalignment can be defined as the deviation between the actual and the equilibrium real exchange rate (Zhang, 2001). An exchange rate misalignment arises when there is a degree of fixity in exchange rate in terms of managed or fixed exchange rates or in the situation where floating markets are not efficient (Leape et al., 1997). In addition, Bouoiyour and Rey (2005) highlighted that the fixed exchange rate system allows serious misalignment of exchange rate. This implies that the Malaysian exchange rate arrangement is at risk of somehow misleading, upon which it would distort a comparative advantage from the basis of the Racardian theory of international trade. Meaning that the Malaysian economy will experience severe difficulties as Malaysia relies on its external sector as the main engine of economic growth[2]. It is

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[1] See Economic Report (1998/1999), for further explanation regarding the depreciation of ringgit.
[2] If the ringgit were to remain shackled to the dollar, depreciating ringgit will cause the cost of imports to rise significantly; fuelling the domestic inflationary pressures and export competitiveness will suffer (MIER, 2005).

acknowledged that a major source of slow growth in Africa and Latin America was due to chronic misalignment in real exchange rate (World Bank, 1984 and Gulhati et al., 1985).

Although, Stein and Lim (2004) noticed that a dramatic currency devaluation or depreciation is the most likely outcome result from a currency crisis that is generated by an "overvalued" exchange rate. This supports the hypothesis that an overvaluation of exchange rate is a vital determinant, which is very costly and has been caused of a most recent currency or balance of payments crisis (Kaminsky and Reinhart, 1999; Goldfajn and Valdes, 1999; Edwards and Savastano, 1999; Chin, 2000 and Edwards, 2000). In general, there are two type exchange rate misalignments. First, ***"macroeconomic induced misalignment"*** that occurred due to the discrepancies between the macroeconomic especially monetary policies and the official nominal exchange rate system. Second, "***structural misalignment"*** that occurred when there is changes in the real determinants of the real equilibrium exchange rate, which are not translated in short run into actual changes of the real exchange rate (Edward, 1987)[3]. In the literature, the real exchange rate misalignment is label to be an overvalued (undervalued) when the actual real exchange rate below (exceeds) the equilibrium real exchange rate (Richaud et al.; 2000). Up to now, this paper seeks to review the source and consequence of the 1997 Asian financial crisis on the Malaysian economy, which whether the failure of the real exchange rate to be aligned with its fundamental determinants precipitated the crisis, foremost to a great catastrophe of exchange rate misalignment.

In this regards, the determinants of exchange rates or the misalignment of exchange rate poses a number of questions and challenges among policy makers and researchers to deal on how to measure misalignment of equilibrium exchange rate. The 1997 turmoil effect is believed to be the onset that has led to cause and impact on temporal ASEAN exchange rate misalignment. The generalisability of much published research on this issue is problematic and assorted. Among previous studies that have dealt on such matter includes; Furman and Stigliz (1998) and Sazanami and Yoshimura (1999) that measured real exchange rate misalignment using the purchasing power parity (PPP) in long-run averaging (stylized facts based period) and mean reverting as base period, respectively, discovered that Malaysian ringgit was overvalued on the eve of the currency crisis. Moreover, Husted and Macdonald (1999) who estimated the equilibrium exchange rate via panel cointegration in the unrestricted version of flexible monetary model, corroborated that Malaysian ringgit was experienced an overvalued at the end of 1996.

In other major studies, Chinn (1998), Chinn and Dooley (1999) and Chinn (2000) employed a long-run PPP model, a productivity-based model and a monetary model of the nominal exchange rate to gauge Asian currencies overvaluation. The results found were conflicting. In a long-run PPP framework, the ringgit appeared to be overvalued, on the one hand, the productivity-based model revealed that ringgit was undervalued, on the other, the monetary model signified that misalignment of the ringgit is small or do not imply much deviation from short-run equilibrium at the eve of the currency crisis. Later, Kwek and Yoong's equilibrium real exchange rate model (2002) established that ringgit was undervalued before the eruption of 1997 Asian currency crisis. A recent study by Lee and Azali (2005) reports that by utilizing sticky-price monetary exchange rate model, Malaysian ringgit emerged to be overvalued on the eve of the crisis. In the respect of the NATREX equilibrium model, Stein and Lim (2004) measured the Malaysian real exchange rate misalignment that may serve as warning signals to predict crisis. The result found showed evidence of misalignment but not prolonged, where Malaysia ringgit seems to be depreciated.

Given the limitations of empirical studied on area of currency misalignment, particularly in the region of ASEAN countries, this study attempts to bridge the gap as well as to shed some light by assessing this issue based on concepts from a theoretical framework using the most existing methodology. Therefore, this study leads to the measurement the of real exchange rate misalignment of Malaysian ringgit vis a vis the US dollar across different exchange rate regimes from 1993:2 to 2003:4. The NATREX equilibrium model is used to estimate whether there is any currency misalignment for the ringgit's observed real exchange rate with the underlying macroeconomic fundamental of the

[3] For instance, when a country's international terms of trade worsen, it will affect equilibrium *RER* to change because relatively higher price of tradable are required in order to maintain economy equilibrium. As a result, real exchange rate misalignment will take place, as the changes are not accompanied by a change in the actual real exchange rate (Edward, 1987).

Malaysian economy that may serve as a warning signal for currency crises. Furthermore, the Average Total Sum of Squares Error (ATSSE) is employed to compute and disentangle the degree of exchange rate misalignment across different exchange rate regimes. This is due the action taken by Malaysia to switch from a managed floating to a conventional pegged arrangement under a risk management in the midst of the 1997-98 Asian financial crises. Hence, the findings obtained in this study will bring new dimensions to the literature in at least three important respects. First, this study leads to measure the Malaysian real exchange rate misalignment based on the NATREX equilibrium model. The estimation process is carried out by incorporating the macroeconomic fundamentals in the form of economics theories and econometric perspectives. Second, this was the first endeavor of estimating the exchange rate misalignment throughout the pre-and post-crisis in the case of Malaysia ringgit. Third, the ATSSE technique is applied to discern the misalignment effect across the two exchange rate regimes.

The remainder of this paper is organized as follows. Section 2 explains the development of Malaysian exchange rate arrangement while Section 3 describes the NATREX equilibrium model that used to estimate the real exchange rate misalignment. An econometric formulation and cointegration analysis are carried out in Section 4. Section 5 reports the empirical results obtained from the econometric analysis and Section 6 concludes the findings.

2. Malaysian exchange rate arrangement: the development of ringgit

An overview, Malaysia had implemented two different exchange rate regimes from 1970s to the present, as shown in Table 1. Malaysia adopted the managed floating system with the intervention of government via the open market operation from 1978 to September 1998 before decided to peg its currency to the US dollar as the outcome of 1997 Asian financial crisis. In July 2005, Malaysia has switched back to the managed floating system to further boost the economic growth.

Table 1: Official exchange rate policy for Malaysia

Periods	Regime
September 1978-September 1998	Managed Floating
September 1998-July 2005	Conventional Pegged Arrangement (Pegged to U.S dollar)
July 2005-present	Managed Floating

Source: IMF International Financial Statistics and Exchange Arrangement and Exchange Restrictions, several issues.

In addition, the series of Malaysian real exchange rate (RER) is illustrated in Figure 1. It seems that the RER has turned 180 degrees as the outbreak of the 1997-98 Asian financial crisis. The co-movement of exchange rate was relatively stable under managed floating in the 90s. A rising trend in the RER is apparently observed from 1996:2 to 1997:3, indicating an appreciation of the ringgit. This signifies that the value of ringgit is now increasing faster than the US dollar. Later, the eruption of the regional financial crisis had led the RER becomes volatile in 1997:3 before dwindling in 1998:3 where ringgit is then tighten up against the US dollar at RM 3.80. This can be deduced as depreciation of the RER. The conjointly of the RER appreciation and depreciation may lead to a sign of the exchange rate alignment.

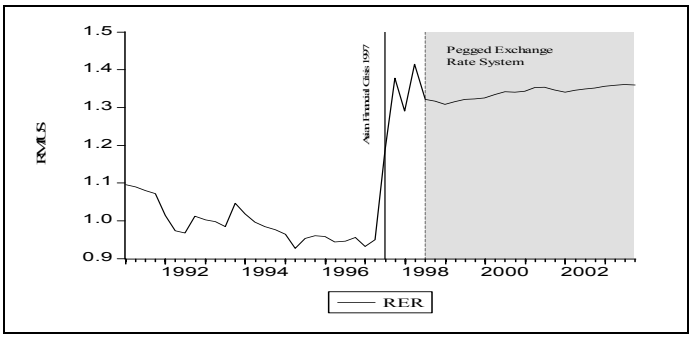

Figure 1: The Malaysian real exchange rate

Note: RER is The Malaysian Real Exchange Rate, ringgit against the US dollar.

3. Measurement of misalignment: determination of equilibrium exchange rate

It has long been argued on the measurement of the real exchange rate misalignment as it engages with an unobserved variable, the real equilibrium exchange rate [4]. Much of previous studies have relied on a measure based on the so-called purchasing power parity (PPP) model. Although, the PPP model is debatable as the real equilibrium exchange rate varied over time based on the movement of the economic fundamental variables, but it is not static at any point of time[5]. On the other hand, the poor empirical performances of the monetary models (the flexible and the sticky-price models) particularly underpinned by the fact that the monetary model is hardly beat a random walk (Meese and Rogoff, 1983) and the lack of micro-foundations (Obstfeld and Rogoff, 1995), had led to other theoretical development. This limitation brings to a major breakthrough of a new dimension in estimating the real equilibrium exchange rate using real economic fundamentals, which originates from the Stockman's real equilibrium model[6]. In particular, the real equilibrium exchange rate is derived from a more sophisticated alternative that has been received considerable interest in assessing misalignment is the increasingly influential "fundamentals approach" (Nurkse, 1945; Edwards, 1989; Williamson, 1994; Faruqee, 1995; MacDonald, 1996; Baffes et al., 1997; Zhang, 2001 and Lommatzsch and Tober, 2004). The consistency of the real equilibrium exchange rate is driven by the underlying macroeconomic variables through a set of steady-state values of supply-side, demand-side and policy variables (e.g. terms of trade, productivity and investment). Traditionally, the real equilibrium exchange rate is defined as the rate that is consistent with the simultaneous achievement of internal and external balances (Williamson, 1985). Then, the misalignment is expressed in terms of a country's actual real exchange rate deviates from its long-run equilibrium. Among others the family of fundamental approach that estimates the long-run real equilibrium exchange rate is Fundamental Equilibrium Exchange Rate (FEER), Behavior Equilibrium Exchange Rate (BEER) and Natural Real Exchange (NATREX), which mainly based on the analysis of the goods and services market.

An overview of the NATREX model

In line with the development, this study employs the **Na**tural **R**eal **Ex**change Rate (NATREX) model developed by Stein (1994, 1996) to estimate the equilibrium RER. The NATREX model permits to generate an equilibrium benchmark using prevailing real economics fundamentals that determined the misalignment of exchange rate. According to Stein and Paladino (1998), the NATREX rate relies on the attempt of micro agents that make private savings, investment, exports and imports decision to optimize in presence of a significant uncertainty. The NATREX model is positive and not normative as it takes government policies as given and does not assume that the policy is welfare optimizing. As practiced, the equilibrium rate of NATREX is the real equilibrium exchange rate that associated with both internal equilibrium (production is postulated as reaching its potential) and external equilibrium (evenness of the current account balance).

In addition, the NATREX model can be defined as a medium- and inter-cyclical real equilibrium exchange rate, implying the interaction between medium-term determinant factors of both capital flows and the current account balance as well as the stability of both the net external position and capitalistic intensity. Based on Stein and Lim (2002), the NATREX is a moving equilibrium exchange rate, which its varies over time responding to the changes in the current real macroeconomic fundamental variables. Indeed, the NATREX approach does not require that the observed REER and the real equilibrium exchange rate be stationary (Edwards and Savastano, 1999). Therefore, the NATREX model will be an appropriate measurement to acquire a good fit for the exchange rate misalignment as it takes into account real economic activities that comprised all adjustment made by the underlying real macroeconomic fundamentals of their respective economies, (Edwards, 2000). This makes it easier to consider NATREX as a real equilibrium exchange rate[7].

[4] For a more detailed discussion, please refer to Cheng and Orden (2005).

[5] The failure of PPP could be due to the existence of tariff and non-tariff barriers, transport cost, menu cost and imperfect information. But, in order for PPP to hold, the consumer baskets should be identical, all commodities produced should be equivalent and tradable; and have the same consumer preferences across countries.

[6] See Stockman (1980 and 1988).

[7] This study merely focuses on an operational of the NATREX model as the theoretical background discussion on the NATREX model has been widely explained (see Stein, 1994 and 1996; and Stein and Paladino, 1998).

The NATREX equation estimation

The general form of the NATREX model that depends upon a vector of real equilibrium exchange rate can be demonstrated via the following single-equation econometric model:

$$NATREX_t = f(\Phi_t) \tag{1}$$

where $NATREX_t$ represents the real equilibrium of the long-run exchange rate, while vector Φ consists of the real economic fundamentals $(RGC, RIRD, TOT, PROD)$, which are real government consumption *(RGC)*, real interest rate differential *(RIRD)*; domestic and world real interest rate *(i_{mas}, i^*)*, terms of trade *(TOT)* and productivity *(PROD)*. The model is set up with the intention to capture 'open economy' and 'domestic economy' properties of countries. This is customized especially for small-open economies, such as Malaysia that heavily depended on international trade *(TOT)* and cross border capital flow *(i_{mas}, i^*)* as well as the domestic economic performance of high productivity *(PROD)* and government consumption *(RGC)*. This set of selected exogenous fundamental variables has also been quite frequently used in the literature on the determination of real equilibrium exchange rates (Edwards and Savastano, 1999; Edwards, 2000; Siregar and Har, 2001; Rajan and Siregar, 2002; Rajan et al., 2004 and Bouoiyour and Rey 2005).

As the NATREX cannot be observed and due to the difficulty to have some data, this study attempts to estimate the following set of equation[8]:

$$RER_t = \alpha_{1I} + \sum_{i=0}^{r} \alpha_{2i} RGC_{t-i} + \sum_{i=0}^{r} \alpha_{3i} RIRD_{t-i} + \sum_{i=0}^{r} \alpha_{4i} TOT_{t-i} + \sum_{i=0}^{r} \alpha_{5i} PROD_{t-i} + \sum_{i=0}^{r} \alpha_{6i} DUM_{t-i} + \varepsilon_{1t} \tag{2}$$

The equilibrium of the RER is acquired using the coefficient estimates from Equation (2) that best fit to the RER on the country's pertinent real economic fundamentals. The variables used are briefly described in Table 2.

Table 2: Description of variables

Variables	Description
RER	Real Exchange Rate of Malaysian ringgit against the US dollar: $RER = [NEX_{MYR/US}] * [CPI_{US}/CPI_{MAS}]$ where CPI is the consumer price index and NEX is the nominal exchange rate. An increase in RER indicates a real depreciation of ringgit against the US dollar.
RGC	Real Government Consumption (RGC): = Ratio of government consumption to GDP deflator = Government consumption/GDP deflator
RIRD *($i_{mas} - i_{us}$)*	Real Interest Rate Differential: i_{mas} = Malaysia Treasury bill three months rate i_{us} = US Treasury bill rate
TOT	Terms of trade (TOT): = (export unit value indices)/(import unit value indices)
PROD	Productivity index (proxy as Malaysia GDP Per Capita)
DUM	A crisis dummy variable. The crisis dummy equals one from 1997:Q2 to 1997:Q4 and zero otherwise. This is purposely to capture the sudden impact of the 1997 Asian financial crisis.

Note: *($i_{mas} - i_{us}$) = ($i_{mas} - i^*$)*. The series of real GDP per capita is employed due the lack of data to proxy the productivity index (Siregar and Har, 2001; Rajan and Siregar, 2002 and Rajan et al., 2004).

[8] The selected fundamental variables are consistent with the nature of the Malaysian economy, which is generated from the NATREX model.

Expected sign of coefficient

The theoretical literature of the expected sign of the coefficient estimates for the selected real economic fundamental variables is briefly highlighted based on theory[9].

(a.) *Real Government Consumption (RGC)*: The government consumption is disproportionately devoted to tradable goods that are composed of importable and exportable goods, which will shift the external balance[10]. A rise in RGC will lead to an incipient trade deficit, which in turn tends to deteriorate balance of payment that requires a real depreciation, so α_{2i} is expected to be positive.

(b.) *The Real Interest Rate Differential (RIRD; ($i_{mas} - i_{us}$))*: The investor will tend to shift their portfolio from abroad to local assets when the return is dominated in terms of local currency. Ultimately, the rise in the local real interest rate will lead to a real appreciation of exchange rate, so α_{3i} is expected to be negative.

(c.) *Terms of Trade (TOT)*: The impact of shock to the terms of trade on real exchange rate may be positive or negative, depending on the relative importance between substitution effect and income effect[11]. An improvement in the terms of trade leads to reduce the cost of imported inputs, generating real depreciation of exchange rate through the substitution effect, so, α_{4i} is expected to be positive.

(d.) *Productivity (PROD)*: An increase in productivity leads to an incipient trade surplus, so a real appreciation, as proposed by the Balassa-Samuelson model. This is because the capacity to generate higher export revenues increases through cost efficiency. Thus, α_{5i} is expected to be negative.

Hence, the real equilibrium exchange rate (NATREX) can be obtained. The rate of misalignment is then estimated through the deviation of a currency from its equilibrium rate, implying a difference between the actual real exchange rate (RER) and the real equilibrium exchange rate (NATREX). The deviations indicate a currency is misaligned; either overvalued or undervalued that occurs at any point of time. That is, the observed real rate can no longer be justified by the existing fundamentals in the economy.

The level of exchange rate misalignment: The ATSSE technique

This study attempts to discern the degree of the exchange rate misalignment across the two exchange rate regimes between managed floating and pegged exchange rate regimes throughout the study sample. The flexible exchange rate system permits to avoid misalignment but in return the fixed exchange rate system leads to serious misalignment of exchange rate, (Bouoiyour and Rey, 2005). For this purpose, a technique of average total sum of squares error (ATSSE) is applied as formulated in the Equation (3) below.

$$ATSSE = \frac{\sum_{i=1}^{n} e_i^2}{n} \tag{3}$$

where e_i^2 is the error between the actual RER and NATREX whilst n is the number of observations.

[9] Detail discussion concerning the anticipated sign of the coefficient estimates for these selected relevant exogenous economic fundamentals consult Hinkle and Montiel (1999), Balvers and Bergstrand (2002), Lommatzsch and Tober (2004) and Cheng and Orden (2005). This suggests that the effects of these real fundamental variables will depend upon the proportion of falling on nontradable and that falling on tradable sectors.

[10] Based on the methodology build by Dwyer (1992) and Knight and Johnson (1997), the descriptions of tradable goods can be defined as follows: Tradable goods or services are those that enter into international trade and satisfy the law of one price or at an appropriate variation in relative prices could do so, which correspond to importable and exportable goods. For the nontradable goods, it works in an opposite manner that accounts other goods in the economy excluding importable and exportable goods.

[11] It is highlighted that the effect of terms of trade on real exchange rate seems to be ambiguous (Elbadawi and Soto, 1994).

4. Methodology

This section discusses the properties of time series and the econometric methodology used to estimate the real equilibrium exchange rate and the measure of misalignment that may serve as a warning signal for currency crises, explicitly the impacts across different exchange rate regimes.

The VAR model of multivariate cointegration test is employed to estimate the NATREX model with the intention to inspect the equilibrium of exchange rate towards the computation of exchange rate misalignment. As prelude to test for cointegration, the unit root test is necessary to verify the order of integration for all time series variables involved in this analysis. In order to determine the integration order of each series, the unit root tests of Augmented Dickey-Fuller (1981) test and the Kwiatkowski et al. (1992) test are used. Conditional on the outcome of the tests, the cointegration test is then applied on the variables that integrated of the same order. For this purpose, the Johansen's Maximum-Likelihood procedure developed by Johansen (1988) and Johansen and Juselius (1990) is employed. This concept has been widely applied in empirical economic model to estimate the presence or absence of long-run equilibria among the variables. This test utilizes two likelihood ratios (LR) test statistics, namely the trace and the maximum eigenvalue (λ-max) statistics. The cointegration test is still performed even those variables are in different integration. According to Masih and Masih (1999), the different integration must be between *I*(0) or mixture of *I*(0) and *I*(1). Although, Pesaran et al. (2000) pointed out that, *I*(0)s is treated as exogenous variables that enter the system in level form.

5. Data and empirical results

Data analysis

This paper employed quarterly data that covers the period 1991:1 to 2003:4 for the case of Malaysia. The data is primarily gathered from various issues of IMF that includes of exchange rate (MYR: USD), government consumption, GDP deflator, interest rate, consumer price index. For real GDP per capita and terms of trade, the data are extracted from various issues of Malaysian Economic Statistic: Time Series, Department of Statistic, Malaysia and The Malaysian Economy Figures, Economic Planning Unit, Prime Minister's Department; Malaysia, respectively. However, due to the unavailability of quarterly base data, these variables (real GDP per capita and terms of trade) have been interpolated from yearly to quarterly base using Gandolflo (1981) in order to facilitate the utility of the system. All variables in the data set are transformed into natural logarithm form.

The unit root tests results

Table 3 shows the results of ADF and KPSS unit root tests. The results clearly stated that all variables tend to be nonstationary in their levels. The ADF test failed to reject the null hypothesis of nonstationary while the KPSS test has successfully rejected the null hypothesis of stationary at 1 percent significant level. In first difference or *I(1)*, the ADF test has well rejected the null hypothesis of unit root at 1 percent significant level whilst the KPSS test refuse to reject the null hypothesis of stationary. This implies that these variables are integrated of order one or *I(1),* suggesting the existence of cointegrating relationships among the series of exchange rate and its real economic fundamental variables. These results are consistent with the findings that most macroeconomic variables follow an *I(*1) process (Baharumshah et al., 2003).

Table 3: Unit root tests

	ADF		KPSS	
Variable	No Trend	Trend	No Trend	Trend
		Level		
RER	-0.786(0)	-2.189(0)	27.97(3)*	0.889(3)*
RGC	0.785(3)	-0.963(3)	7.356(2)*	4.509(3)*
RIRD	-1.439(1)	-1.237(1)	0.761(2)*	0.651(2)*
TOT	-0.771(4)	-1.061(4)	55.38(3)*	1.515(3)*
PROD	1.920(1)	-2.167(1)	87.70(2)*	3.392(2)*
		First Difference		
RER	-6.451(0)*	-6.420(0)*	0.086(3)	0.063(3)
RGC	-23.19(2)*	-23.35(2)*	0.130(4)	0.052(4)
RIRD	-5.038(0)*	-5.108(0)*	0.210(4)	0.106(4)
TOT	-6.756(3)*	-6.564(3)*	0.068(3)	0.041(3)
PROD	-3.856(3)*	-4.260(3)*	0.071(3)	0.001(3)

Notes: ( ) represents the number of lag length included which is selected based on Akaike Information Criterion (AIC) for ADF test and Fixed Spectral OLS AR for KPSS test. The asterisk (*) denotes the

statistically significant at 1% level. These values are provided by the EVIEWS output based on Kwiatkowski-Phillips-Schmidt-Shin (1992) and Mackinnon (1996).

Estimation results of the exchange rate misalignment

Indicative of each series is integrated of the same order of *I(1)*, the Johansen multivariate cointegration technique is then utilized in order to scrutinize the cointegrating relationship for the NATREX equilibrium model. The estimated results show that the null hypothesis of non-cointgerating vector is rejected at 1 percent significant level as reported in Table 4. Meaning that the null hypotheses of $1 \leq r$, $2 \leq r$, $3 \leq r$ and $4 \leq r$ cannot be rejected in favor of the alternative hypotheses of $2 = r$, $3 = r$, $4 = r$ and $5 = r$, respectively. This indicates the presence of one cointegration relationship for the NATREX equilibrium model, implying a long-run equilibrium relationship among real exchange rate (*RER*), real government consumption (*RGC*), real interest rate differential (*RIRD*), terms of trade (*TOT*) and productivity (*PROD*)[12].

Table 4: The Johansen multivariate cointegration test

The Optimal Lag = 1					
(H_o)	(H_A)	Trace Statistic	Critical Value 1%	λ-Max Statistic	Critical Value 1%
r = 0	*r = 1*	82.17*	76.07	55.44*	38.77
r ≤ 1	*r = 2*	26.73	54.46	20.91	32.24
r ≤ 2	*r = 3*	5.82	35.65	3.58	25.52
r ≤ 3	*r = 4*	2.24	20.04	1.30	18.63
r ≤ 4	*r = 5*	0.93	6.65	0.94	6.65

Notes: *r* indicates the number of cointegrating vectors. The (*) denotes the rejection at the 1% critical values. The statistics are computed with linear trend in the VAR equation. The crisis dummy is included in the cointegration regression equation to restrain the impact of the 1997 financial crisis (one from 1997:Q2 to 1997:Q4 and zero otherwise). The system optimal lag length is determined through the Akaike Information Criterion (AIC). The diagnostic test conducted for normality, serial correlation, and heteroscedasticity were found to be satisfactory, suggesting the estimated model is adequately specified. These results are available upon request.

The estimated cointegrating vector is explained in Table 5. Through normalizing on the RER, the estimated cointegrating vectors reflect long run elasticities. This is the normalized equation that is obtained by dividing each cointegrating vector by the negative of the estimated RER coefficient, together with their respective *t*-values. The normalization process yield estimates of long-run equilibrium parameters.

Table 5: The estimated cointegrating vector

	RER	C	RGC	RIRD	TOT	PROD
	-1.000	20.836	1.626	-0.277	5.036	-3.555
s e			0.170	0.064	2.820	0.949
t-ratio			9.589	-4.306	1.786	-3.746

Note: *t*-ratio critical values: at 1% = 2.704, at 5% = 2.021 and at 10% = 1.684. C is constant. s e denotes standard deviation.

The results in Table 5 report that all fundamental variables are statistically significant at 1 percent level in the cointegrating vector, except terms of trade *(TOT)*, which is weakly significant at the 10 percent level. Indeed, the results obtained from the estimation are also theoretically consistent coefficient estimates. The estimated coefficients point out that the government consumption *(RGC)* and the terms of trade *(TOT)* have positive influence on the real exchange rate (*RER*), implying an increase in *RGC* and *TOT* will lead to a depreciation of the real exchange rate, as it is a direct quote in Malaysia ringgit against the US dollar. This is likely in Malaysia due to acceleration of exports may increase imports capacity that lead to a domestic growth especially in the expansion of industrial sector in the 1990s[13].

[12] Rajan et al. (2004) in their empirical study in examining misalignment on Thailand Baht through the same economic framework discovered that a long-run relationship among the variables for the country in their sample for the period from 1981:Q1 to 1999:Q3.

[13] The fact is that Malaysia has maintained a high import portion on capital and intermediate goods that accounts for more than 83 percent of its total imports. The high imports is greatly demanded to produce high-quality export and re-export products to further stimulate economic growth, see The Second Outline Perspective Plan 1991-2000.

On the other hand, the real interest rate differential *(RIRD)* displays a negative sign, indicating that higher local interest rate caused capital inflows, which leads to a real appreciation. For the variable *PROD*, the result implies a negative impact that a rise in productivity appreciates the real exchange rate. This associates with the buoyant export revenue that appreciation of the exchange rate could be due to the large returns on the exports growth.

The series of the NATREX model that derived the real equilibrium exchange rate and the actual RER are illustrated in Figure 2. The ringgit is said to be misaligned in terms of overvalued or undervalued as its actual RER is lower or higher than its natural real equilibrium exchange rate (RER - NATREX), which is either negative or positive.

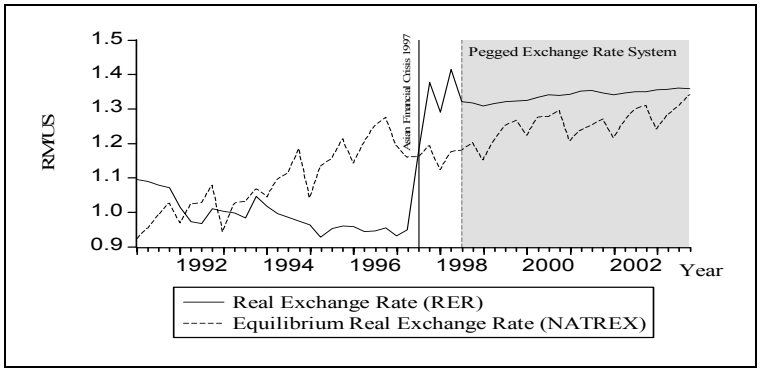

Figure 2: The real equilibrium exchange rate (NATREX) and real exchange rate (RER) for Malaysian Ringgit

An interesting pattern of misalignment rates of overvaluation and undervaluation are demonstrated in Figure 3 and summarized in Table 6. It is apparent that the Malaysian real exchange rate was distorted from vigorous "misalignment" throughout the study sample. From the observations, the Malaysian ringgit had practiced an undervaluation scenario between 1991:Q1 to 1992:Q1 and was mildly overvalued until 1992:Q4. The results further revealed that the ringgit had experienced a persistent overvaluation scenario from 1993:Q2 to 1997:Q2. This validates that the ringgit is severely deforms of an overvaluation before the eruption of 1997 Asian financial crisis, which is in line with Furman and Stigliz (1998), Chinn (1998), Sazanami and Yoshimura (1999), Husted and Macdonald (1999), Chinn and Dooley (1999), Chinn (2000) and Lee and Azali (2005) who noticed that Malaysia ringgit was overvalued on the eve of the currency crisis. However, due to the outbreak of the Asian financial crisis in July 1997, the Malaysian real exchange rate appears to be undervalued commencing from 1997:Q3 to 2003:Q4. This is in agreement with Sekkat and Varoudakis (2000) who stated that as periods of increasingly overvalued *RER* would be followed by large devaluations. This may further explained that a currency crisis which results from an overvalued exchange rate is most likely to face dramatic currency devaluation (Stein and Lim, 2004).

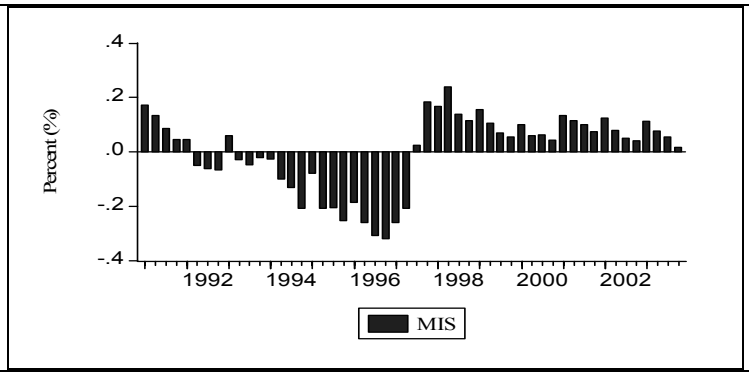

Figure 3: The Malaysian real exchange rate misalignment

Notes: MIS is The Malaysian Real Exchange Rate Misalignment, ringgit against the US dollar. The level of misalignment = [(RER – NATREX)/ NATREX] * 100, where a positive (negative) number implies an undervaluation (overvaluation).

Table 6: The misalignment rates of overvaluation and undervaluation

Rate of Misalignment	Sample Period				
Overvaluation		1992:3 - 1992:4	1993:2 - 1997:2		
Undervaluation	1991:1- 1992:1			1997:3 - 2003:4	
					[a] 1991:1- 2003:4
t-statistic	2.2272***	5.4878**	4.7693*	4.9917*	5.8826*
(probability)	(0.0899)	(0.0316)	(0.0002)	(0.0000)	(0.0000)

Note: *t*-statistic indicates the null hypotheses of overvaluation and undervaluation is significantly indifferent from zero. [a] denotes the rate of misalignment for the full study sample. The asterisks (*), (**), and (***) indicate the statistically significant at 1%, 5% and 10% levels, respectively.

The degree of Malaysian real exchange rate misalignment across the two exchange rate regimes are showed in Table 7. The results of the average total sum of square error (ATSSE) indicate that the degree of exchange rate misalignment had been reduced by 69 percent during the fixed exchange rate regime. This could be due to the selective capital control policy adopted by the Malaysian government since September 1998. It is also believed that the macro fundamentals were able to adjust to the pegged rate after the regime swift to which leads a reduction in the rate of misalignment. This indicates that ringgit has become less misaligned under the fixed exchange rate regime compared to the flexible exchange rate regime.

Table 7: The degree of real exchange rate misalignment

	Average total sum of square error between real exchange rate and equilibrium exchange rate (ATSSE)
Managed float (1991:Q1 - 1998:Q2)	0.028
Fixed exchange rate (1998:Q3 - 2003:Q4)	0.009

In order to verify the overall performance of the rate of misalignment, the stability of the Malaysian real exchange rate regime is assessed by judging the deviation between the actual *(RER)* and the real equilibrium exchange rate *(NATREX)*[14]. The results reported in Table 8 indicate that the ADF test statistic is significant at 5 percent significant level, rejecting the null hypothesis of nonstationary at its level. That is, the misalignment rate is stationary at level or *I(0),* implying that the misalignment of Malaysian real exchange rate was stable throughout the study period, 1991 – 2003.

Table 8: Stability test for misalignment

	ADF Unit-root test		*P*-value
Variables	*t*-statistic	Lag Length	
MIS[b]	-3.132**	0	0.0304

Notes: [b] denotes no trend at level. The lag length is selected based on Akaike Information Criterion (AIC). The asterisk (**) indicates the statistically significant at 5% level. The critical values at 1, 5 and 10 percent levels are -3.565, -2.920 and -2.598, respectively. These values are provided by the EVIEWS output based on Mackinnon (1996).

5. Conclusion

Based on the economic theory of equilibrium real exchange rate, this paper estimated the long-run equilibrium path for the real exchange rate in Malaysia using the NATREX equilibrium model that covers from 1991:Q1 to 2003:Q4. In this investigation, the systematic relationship between the actual real exchange rate and the economic fundamental variables is taken as the basic equilibrium concept, where the RER is in equilibrium when its movements reflect the economic fundamentals.

[14] The deviation is calculated as follows: $RER_T - NATREX_T = \varepsilon_T$. The real exchange rate is stable if its rate of misalignment, ε_t , is stationary at level or *I(0).*

Subsequently, the gap of misalignment rate is evaluated based on the comparison between the evolutions of the actual and the generated equilibrium real exchange rate.

The empirical findings based on Johansen multivariate cointegration analysis pointed out the presence of a unique long-run relationship of the NATREX equilibrium model, interpreting that the real exchange rate is communicated to the selected real fundamental variables throughout the sample study. The heart of the findings showed that the Malaysian real exchange rate was found to be an overvalued during 1993 – 1997. However, with the onset of the 1997 - 98 Asian financial crisis, the ringgit appeared to be undervalued in mid-1997 – 2003. This suggests that the regional crisis seemed to be an important utensil in switching the direction of misalignment from an overvalued in the per-crisis period, to an undervalued in the post-crisis period. The results provide empirical corroboration for claims in the literature about "an overvaluation leads to a currency crisis", implying to mean that the 1997 - 98 Asian financial crisis was due to the real exchange rate overvalued to which followed by a substantial currency devaluation or depreciation. The evidence indicates that exchange rate overvalued may hurt the exports sector and expose imports competing industries to fierce competition from foreign companies. This tends to lead current account deficits, severe decline in foreign direct investment and ends up with a chronics economic recession, which brings to a dramatic exchange rate undervalued.

The findings obtained advocate several policy implications. An important conclusion that can be drawn here is that the selected fundamental determinants can be used as stabilization policy in the country, where prudent exchange rate management policies are crucial towards the macroeconomics stabilization targets. The results revealed that the Malaysian real exchange rate relies more on domestic supply-side factors and fiscal policy. This signifies that government expenditures and national productivity played a major role in determining the real exchange rate in Malaysia to further stimulate economic growth. On the other hand, the international economic environment showed that the real interest rate differential (Treasury bills) captures the international interest rate arbitrage, where capital is highly mobile internationally and intersectorally. This suggests that the real interest rate parity holds. For terms of trade, the result found implies that as a small-open economy, Malaysia seems to be a price taker in the international market, indicating lack of necessary market power to influence terms of trade and other prices on the world market. On other matter, the shift to a fixed or pegged exchange rate system under a risk management sound superior especially for a small-open economy like Malaysia. It is always more effective to regulate the fixed rate rather than flexible rate, particularly during the time when the speculation activity might be very active.

As a summary, one can generalize that the policies under consideration should include an appropriate measure that leads to reduce the exchange rate fluctuations as well as to restore equilibrium of exchange rate. The fixed or pegged rate employed, however, has to be carefully determined based on the macroeconomic fundamental to ensure its efficiency. The floating exchange rate system, on the other hand could be not suitable for a small open country during the crisis, as it could deviate from its equilibrium value due to some speculative actions. This system, however, is more efficient comparatively when the economy is stable under the normal condition. This implies that a small country should relax the fixed system to a more flexible system when the economy is back on its normal and stable track. Therefore, action taken by the Malaysian government to unpegged its exchange rate in July 2005 is believed an opportune measure as the gap of misalignment may be widen when the economic fundamentals begin to strengthen.

Acknowledgments: The authors wish to thank Nikhat Niaz Ahmad for her kindness supports towards the successful completion of this paper.

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