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An Empirical Analysis of Malaysian Ringgit Equilibrium Exchange Rate and Misalignment

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Following the reinstatement to managed floating exchange rate regime in July 2005, the real effective exchange rate (REER) of Malaysian ringgit (RM) has been fluctuating, albeit, slightly, which raises the question whether the current trend is consistent with the economic fundamentals. This paper attempts to ascertain the degree of misalignment of the ringgit by estimating the long run equilibrium real effective exchange rate of the currency. Based on Johansen vector cointegration technique, we have identified productivity, government consumption expenditure, and trade openness as important determinants of the ringgit long run equilibrium value. Results suggest that the ringgit was persistently overvalued prior to the 1997 crisis. After the crisis, the ringgit fluctuates around its long run equilibrium and the misalignments are eliminated over a relatively short period.

Field of Research: International Economics, Macroeconomics

1. Introduction

With the recent sub-prime mortgage crisis in the US that precipitates into a worldwide banking crisis, the global phenomenon of high food prices and volatile commodity prices, the issue of currency misalignment has again become relevant. Kaminsky et al. (1998) suggest that overvalued currency is one of the leading indicators of an incoming crisis. Furthermore, an overvalued currency can also aggravate the impact of a crisis. In the standard macroeconomic literature, exchange rate misalignment has become an acceptable indicator for a country's price or cost competitiveness (Rogoff, 2005; Candelon et al., 2007; Guergill and Kaufman, 1998). This study examines the equilibrium exchange rate path and misalignments between the actual and the equilibrium exchange rate from 1991:Q1 to 2008Q1. A formal model based on the behavioural equilibrium exchange rate (BEER) is developed along with other fundamental variables derived from Edwards (1994) and El-Badawi (1994) theories.

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The identification of fundamental factors affecting the exchange rate is vital since they reveal the channels through which adjustments take place. Essentially, this study aims to measure the degree of misalignment and to examine whether the disequilibrium is temporary or prolonged in nature, hence, leading to different policy implications. Furthermore, this study imparts an in-depth analysis on both the long and short run behaviour, so as to further ensure robustness and consistency in the estimates. Malaysia provides an interesting case since the period of study encompasses two different exchange rate regimes and covers the period where the 1997 Asian currency crisis took place. Eventually, this study is intended to offer an updated measure of misalignment that could be used in other studies such as its exports or foreign direct investment competitiveness.

The next section reviews the relevant literature on exchange rate equilibrium followed by the theoretical framework. A preliminary examination on the real effective exchange rate is provided to give background insights. Next, the relevant methods on long run analyses are discussed followed by the results and discussion. The last section summarizes the study and provides the conclusion.

2. Review of Literature

Theories of equilibrium exchange rate are voluminous and can be categorized into two major strands: price based theories and model based theories. Price based theories originate from the purchasing power parity theory (PPP), and later spawn into uncovered interest parity model (UIP) and to some extent, the monetary model (see for example, Husted & MacDonald, 1999; Cuaresma et al., 2008). We shall only briefly explain the major model based theories since the price based theories are often criticized for being static, inappropriate for developing countries and unable to capture time-varying equilibrium (Melecky and Komarek, 2007; Montiel, 1999; Egert, 2003).

Given the inadequacy of the price based theories, researchers move to model based theories to allow time-varying measures of equilibrium exchange rate. Model based theories can be categorized into three distinct models: the macroeconomic balance approach, external-internal sustainability approach, and the equilibrium real exchange rate approach (ERER). Although neither of the three dominates, the most popular approach is a direct estimation based behavioural equilibrium exchange rate (BEER). These models and their estimation techniques differ in their treatment of the dynamic aspect and the time frame they intend to study. The advantages of model based approach is that they provide more reliable predictions for medium and long run equilibrium exchange rate and are capable of dealing with variation in terms of consumer preferences, product differentiation and imperfect competitions (Driver & Westaway, 2004). The external-internal sustainability approach and the macroeconomic balance approach originate from the concept of fundamental equilibrium exchange rate (FEER).

The equilibrium real exchange rate (ERER) is based on the theoretical model developed by Edwards (1994), Elbadawi (1994) and Baffes et al. (1997). This approach is theoretically sound and can easily incorporate other fundamental variables to suit country specific factors. The fundamental variables are the terms of

trade, productivity, trade openness, and government consumption. This approach is similar to Williamson's macroeconomic balance approach since the long run equilibrium real exchange rate is defined as the level that is consistent with simultaneous achievement of internal and external balance. The model identifies a set of fundamental variables that determines the internal and external balance. Upon identification of the fundamental variables, a reduced form is then constructed to estimate the equilibrium real exchange rate (RER). Unlike the FEER approach, no normative judgments are needed since the variables are endogenously determined in the system. Further extensions of the model are presented in Montiel (1999) and Elbadawi (1998). The most attractive feature of this method is the reduced form approach which allows a comprehensive range of factors as well as *ad hoc* factors that can possibly affect the exchange rate. This feature is vital to capture country or regional specific effects. Elbadawi (1998) for example, modified the variables to suit developing countries. Giannellis & Papadopoulos (2007) added oil price to estimate the misalignment for Poland, Slovak, Hungary and Malta. Otero (1999) uses the original Edwards model to assess misalignments in Colombia.

Later studies comprise a fusion of different theoretical models and statistical approaches. Cashin et al. (2002) posit a close link between commodity prices and the equilibrium real exchange rate. Since then, there emerge a line of studies, especially of commodity dependent countries that include commodity prices such as oil price as a determinant of ERER (see *inter alia*, Zalduendo, 2006; Saayman, 2007; Giannellis & Papdopoulos, 2007; DeBroeck and Slot, 2006; Koranchelian, 2005; MacDonald & Ricci, 2003). Melecky and Komarek (2007) include net foreign income, foreign direct investment and real interest differential into the existing model to study the case of Czech Republic whilst Iossifov and Loukoianova (2007) study on Ghana adds fiscal stance and capital account balance as the fundamental variables. Giannellis and Papadopoulos (2007) incorporate the price of oil to capture external shocks. Zalduendo (2006) stresses the importance of oil as one of the determinants of real exchange rate movements in Argentina. In a vector cointegration (VEC) framework and using parallel market exchange rates rather than the conventional real effective exchange rate, he shows that oil price booms are associated with appreciation pressures but will subside as the price of oil declines. Regardless of the differences in the theoretical models, the basic fundamental variables such as productivity, interest differential, terms of trade, net foreign asset, and government consumption are always included.

The key attraction of BEER is its relative ease in computation for single country real exchange rates. Unlike FEER, the relationship between the real exchange rate and its fundamental variables are explicitly spelt out. The fundamental variables in BEER are derived from the standard theory of the ERER. It differs from other methods in the way it defines the concept of equilibrium where the equilibrium is determined by a set of explanatory (fundamental) variables. The notion is that the actual RER is said to be in equilibrium in a behavioural sense if the exchange rate movements reflect changes in economic fundamentals in a well-defined statistical sense.

In practice, this equilibrium real exchange rate is estimated using the BEER approach which calls for the use of conventional econometric techniques such as Johansen and Juselius (1990) cointegration and vector error correction techniques which can easily be integrated into the model to estimate the real exchange rate. If

the real exchange rate and the fundamental variables are cointegrated, there exists a systematic co-movement amongst them in the long run. In other words, the real exchange rate has a mean reversion property in the long run and the mean can be viewed as the equilibrium rate. The derived cointegrating equation is used to approximate the ERER and later, to gauge the misalignments from this equilibrium path. Examples of studies in this category include Egert and Lahreche-Revil (2003) and Feyzioglu (1997). In recent years, the fundamental variables derived from this model are estimated using the BEER method (Yajie, 2007; Melecky & Komarek, 2007; Giannellis & Papadopoulos, 2007; Iossifov & Loukoianova, 2007; Zalduendo, 2007; Paiva, 2006; Oomes, 2005; MacDonald and Wojcik, 2004).

Studies on equilibrium exchange rate that include Malaysia and country specific study on Malaysia include Edwards (1989), Montiel (1989), Tan (1995) and Mohamed (2003); all of which uses annual data (1962-1984; 1960-1994; 1975-1987; 1965-1998 respectively) and share similar fundamental variables namely terms of trade, government spending and a measure of capital inflows. Other variables, however, are starkly different from each other since the focuses of these studies are different. Both Edwards and Montiel conclude that real exchange rate responds to both fundamental and nominal variables in the short run. Nominal devaluations for example, only have short run impacts but are neutral in the long run. Tan (1995) concludes that there has been no deliberate policy of undervaluation since neither sustained undervaluation nor overvaluation is apparent during the study periods. There were no major episodes of misalignments detected. Likewise, Mohamed (2003) identifies undervaluation in the mid 1980s which lends support for rapid growth in exports. Using NATREX model, Naseem et al. (2008) shows persistent overvaluation in the early 1990s.

3. Theoretical Framework

This study is based on Clark and MacDonald (1998, 2004) BEER approach with the fundamental variables derived from the ERER theories purported by Edwards (1994) and Elbadawi (1994). The economic fundamentals that are most likely to introduce systematic variability are as follows:

Productivity differential (+)
The Balassa-Samuelson effect hypothesizes that the internal price ratio describes the divergence of productivity levels in a country's non-tradable and tradable goods. A rise in productivity (positive shock) in the tradable sector raises wages in both tradable and non-tradable sector. A positive productivity shock improves trade balance which requires the real exchange rate to appreciate to keep the balance of payment at equilibrium (Feyzioglu, 1997). On the other hand, if the internal price ratio falls, the real effective exchange rate of a country is said to be undervalued and vice versa. Studies by Dibooglu and Kutan (2001) and Choudhri and Khan (2004) provide empirical support that productivity differential is an important determinant of real exchange rate.

Government consumption (+/-)
The effect of government consumption on the exchange rate is ambiguous. If substitution effect dominates, an increase in public consumption raises the demand for non-tradables since the share of non-tradable goods in public consumption is

higher compared to private consumption. Consequently, the domestic price level will rise, inducing an appreciation of the real exchange rate. The income effect is generated through improvement in trade balance which raises the income of the domestic economy. Higher income leads to higher demand for non-tradable goods. To restore internal equilibrium, the real exchange rate needs to depreciate. The overall impact of the income and substitution effects depend on the elasticity of demand for imports and exports. On a different note, Balvers and Bergstrand (2002) find empirical evidences that large government expenditure are associated with an exchange rate appreciation in the medium run through the resource withdrawal and consumption-tilting channels.

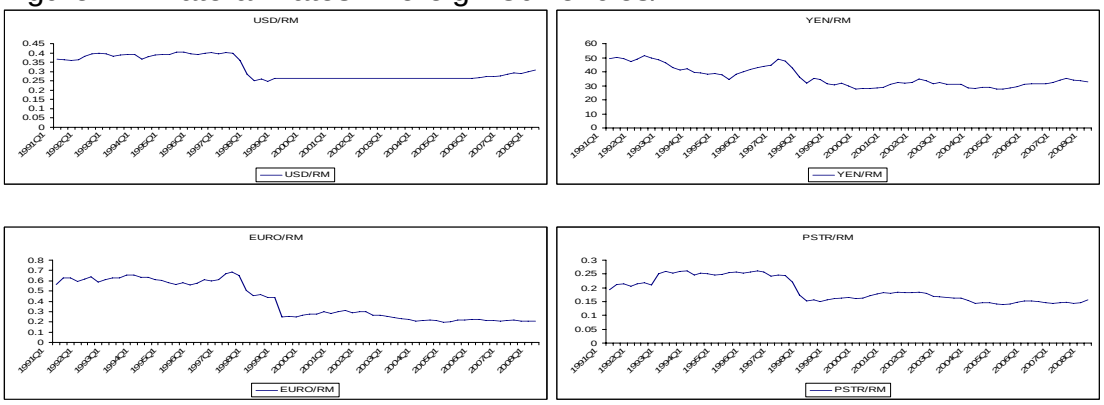
Openess (+/-)
If changes in openness are dictated by economic growth due to increase trade activities, less reliant on protectionism and undistorted external account (Maeso-Fernandez, 2006; Miyajima, 2007), then real exchange rate will appreciate. Edwards (1994) and Elbadawi (1994) show that greater openness to foreign trade may lead to real depreciation since tariff on imports and taxes on exports are lower. Openess can also be taken as a proxy for trade liberalization in time series framework (Egert, 2003; Saadi-Sedik and Petri, 2006).

Net foreign assets (NFA) (+/-)
Net foreign asset is subjected to two contrasting interpretations. First, this variable reflects the external position of a country. Higher borrowing or inflow of foreign direct investment can worsen a country's net foreign asset position. This requires the currency to depreciate which indirectly promotes international price competitiveness of a country's exports. Second, NFA also captures the impact of capital flows into a country. Capital inflow has a positive effect on the real exchange rate as supported by a study on Mexico by Dabos and Ramon, 2000. MacDonald (1998) suggests that NFA captures the effect of fiscal policy on the real exchange rate and other factors associated with private sector savings such as demographic. Therefore, the ambiguity of how these fundamental variables affect the ringgit warrants empirical research.

4. Real Exchange Rate Movements

Before indulging into any form of statistical analyses, it is informative to examine the behaviour of the bilateral and real effective exchange rate (REER) of the ringgit. The REER shows an upward movement in the early 1990s but dived abruptly following the Asian financial crisis and imposition of capital and exchange control in 1997 and 1998 (Figure 2). Currency speculation which trigger the 1997 financial crisis resulted in a sharp depreciation of the ringgit against major currencies especially the USD, Yen, Pound Sterling, DM, Hong Kong dollar and Singapore dollar (Figure 1).

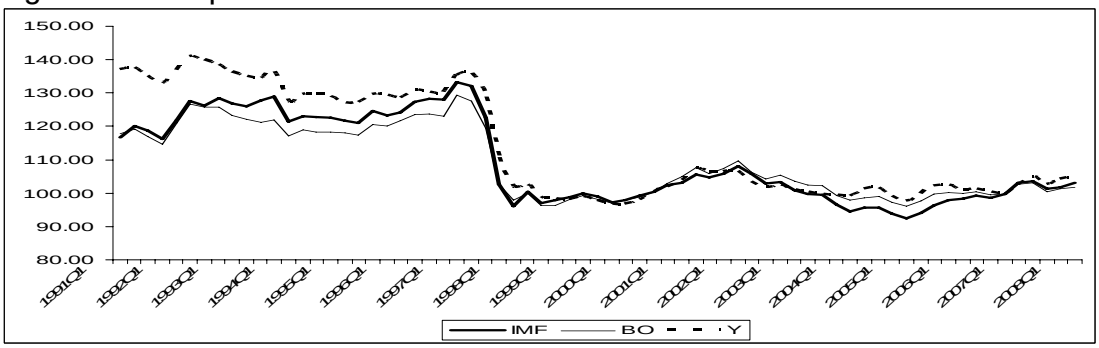
Figure 1 : Bilateral Rates –Foreign Currencies/RM



Sources: IMF (various issues), Bank Negara Malaysia Monthly Statistical Bulletin (various issues).
Note: Prior to 1999Q1, EURO/RM is represented by DM/RM. An increase(decrease) represents appreciation (depreciation)

In this study, we provide two alternative methods of calculating the REER based on Yusoff and Bahrumshah (1993) and Bahmani-Oskooee and Mirzai (2000) to complement the REER calculated by the IMF.

Figure 2 : Comparison of the REERs



Sources: IMF is the REER derived from the estimates provided by the IFS; BO denotes the REER based on Bahmani-Oskooee (2000) and Y is based on Yusoff (1993) methods respectively.

Figure 2 clearly shows that the Malaysia's REER had generally appreciated in the early 1990s. Sharp depreciation is evident during the 1997 crisis and since then, only minor fluctuations prevail. Overvalued ringgit vis-à-vis these major currencies prior to the crisis had been dubbed as one of the factors that contributed to the crisis (see Yusoff and Majid, 2000). The pegged exchange rate regime saw an overvaluation the REER during the early years of implementation but the situation began to reverse by mid-2002. The REER began to appreciate again following the reinstatement of *de facto* managed float regime in July 2005.

5. Methodology

Prior to deciding on the use of time series method, we test for the unit root. Regression analysis based on time series data assumes that the underlying variable series are stationary. Variables that are stationary indicate that the mean variances and auto-covariances of the variable are time-invariant at various lags. Hence, the

standard procedure of unit root testing by employing the Augmented Dickey Fuller (ADF) test is followed. However, since the ADF test is often criticized for low power, we complement this test with the Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test.

The ADF and PP tests offer three variations of random processes, namely trend and intercept, intercept only and no intercept and trend. This study experiments all the three variations and yield similar outcomes except for government spending proxies (GOV, GOVC and GOVD). Based on Table 1, all variables appear to be stationary at first difference except for GOV. The tests for GOV yield inconclusive results where these variables are *I(1)* according to ADF test but are *I(0)* based on PP test with intercept but is *I(1)* if intercept and trend are excluded. The KPSS test indicates that GOV, GOVC and GOVD are *I(1)*. Therefore, government spending is included on the basis that they passed unit root tests with no trend and intercept and the KPSS test.

Table 1: Augmented Dickey Fuller (ADF), Phillips and Perron (PP) and KPSS tests for autoregressive unit roots

	ADF		PP		KPSS	
	Level	First Difference	Level	First Difference	Level	First Difference
RER	-1.7298	-5.8286*	-1.3731	-5.7223*	0.8005*	0.0871
LCPIPPI	-1.5122	-7.8750*	-1.3640	-8.0667*	0.7903*	0.0910
LGDPPC	-1.3550	-7.3640*	-1.3756	-7.3691*	0.6072	0.1173
OPEN	-1.7641	-7.4179*	-1.8232	-7.4048*	0.7458*	0.1987
GOV	-2.4327	-3.7837*	-0.7789	-33.1153*	0.2163**	0.1073
GOVC	-1.0497	-14.6670*	-7.2197*	-27.9200*	0.9724*	0.2289
GOVD	-0.1539	-14.0344*	-6.0723*	-17.5727*	1.2135*	0.2135
NFA	-1.9171	-7.2243*	-1.9930	-7.1682*	0.6339**	0.1587
COM3	-0.7758	-7.2590*	-1.0024	-7.3006*	0.7474*	0.0769

*Notes: *, ** and *** denote significance at 1%, 5% and 10% significant level. p-values are in parentheses.*

Given that the variables are *I(1)*, this study proceeds to cointegration technique to test for long run relationships. In the literature of cointegrated time series, individually non-stationary variables at level, becomes stationary when combined together through linear combinations with other variables. Thus, the presence of cointegration implies that it would be possible to model a time varying equilibrium of the real exchange rate as a function of a range of fundamental variables.

In the context of this study, cointegration analysis tests for the existence of an equilibrium relationship amongst the real exchange rate and fundamental variables that involved a systematic co-movement among them in the long run. The existence of cointegration implies that the real exchange rate and its fundamental variables are related to each other in a systematic way, i.e. the real exchange rate has a mean reversion property in the long run, where the mean is viewed as the equilibrium rate. Hence, the cointegrating equation captures the steady state relationship between the actual values of the real exchange rate and the fundamental variables.

Once the cointegrating relationship has been established, the next step is to estimate the error correction model. Although Engle and Granger (1987) two-step error correction model can be applied in a multivariate context, we choose VECM, a

full information maximum likelihood estimation model, since it yields more efficient estimators of the cointegrating vectors. VECM permits testing for cointegration in a whole system of equation in one step and without requiring a specific variable to be normalized. Another advantage of VECM is the non-requirement for a prior assumption of endogenity or exogenity of the variables. Given that real exchange rate is cointegrated with the selected fundamental variables, there exists a vector error correction model which describes the short and long run adjustment processes. It is a restricted vector autoregression designed for non-stationary series that are known to be cointegrated at least of *I(1)*. VECM forces the endogenous variables to converge to their long run cointegrating relationships while allowing for short term adjustment dynamics.

6. Results

We use five different models using different proxies to come up with the best model as well as to test the sensitivity of the estimates. Prior to that, given that all the variables are *I(1)*, this study proceeds to test for cointegration relationship. Johansen-Juselius (1990) cointegration test is known for its sensitivity towards the choice of lags (Maysami and Koh, 2000). To circumvent this problem, we first estimate the optimal lag length based on Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criteria (SC) and Hannan-Quinn Criterion (HQ). Results, however, are mixed. Due to the inconclusive results, we proceed to examine the residuals of VAR and all variables are collectively stationary at six lags for models 1 and 4 and, the optimal lags for Models 2, 3 and 5 is four.

Table 2: VEC Lag Exclusion Wald Test

	Model 1	Model 2	Model 3	Model 4	Model 5
Lag =1	143.5640*	258.7009*	70.1006*	161.5370*	112.7487*
Lag =2	87.9464*	36.5232	72.4986*	97.7502*	88.1944*
Lag =3	68.0504*	36.0639	79.8736*	82.4866*	65.9048*
Lag =4	89.1943*	136.1107*	54.2983**	79.6175*	60.4848*
Lag =5	54.9968*	-	-	56.0859**	-
Lag =6	146.5817*	-	-	167.3712*	-

Note: For joint coefficients, H_0: Lag's coefficients are jointly non-significantly different from 0 (i.e. can be excluded) if probability value is larger than the chosen significant level.

Table 3: Johansen-Juselius test for multiple cointegrating vectors

	Model 1	Model 2	Model 3	Model 4	Model 5
	Trace Statistics				
r=0	**89.4343**	**118.2608**	**104.6312**	**118.2552**	**92.5468**
	(69.8189)	(95.7537)	(95.7537)	(95.7537)	(69.8189)
r=1	33.9346	69.4988	67.2286	**73.9751**	40.4445
	(47.8561)	(69.8189)	(69.8189)	(69.8189)	(47.8561)
r=2	12.6762	38.1218	36.6759	38.4700	17.3493
	(29.7971)	(47.8561)	(47.8561)	(47.8561)	(29.7971)
r=3	3.1590	18.4848	18.9655	18.5109	4.4461
	(15.4947)	(29.7971)	(29.7971)	(29.7971)	(15.4947)
	Max. Eigenvalue Statistics				
r=0	**55.4992**	**48.7619**	37.4026	**44.2801**	**49.8522**
	(33.8769)	(40.0776)	(40.0776)	(40.0776)	(33.8769)
r=1	21.2584	31.3770	30.5527	**35.5051**	23.0952
	(27.5843)	(33.8769)	(33.8769)	(33.8769)	(27.5843)
r=2	9.5173	19.6370	17.7104	19.9590	12.9033
	(21.1316)	(27.5843)	(27.5843)	(27.5843)	(21.1316)

r=3	3.1453	13.4440	11.9605	11.8528	0.1291
	(14.2646)	(21.1316)	(21.1316)	(21.1316)	(14.2646)

Note: 5% critical values are in parentheses. The trace and eigenvalue coefficients have been corrected based on Ahn and Reinsel (1990).

To confirm this selection we employ the VEC lag exclusion Wald test which tests whether the variables are jointly significant at each lags. Based on Table 2, all six lags are jointly significant for models 1 and 4 and four lags for Model 3 but lags are rather inconclusive for model 2. Despite the contrasting results, this study chooses to adhere to the number of lags based on the residuals of VAR. Next, the Johansen-Juselius test for cointegration results are presented in Table 3. All models show one cointegrating relationship except for Model 4 after the adjustment for small sample size. Given that the variables are cointegrated, this study proceeds to estimate the long run equilibrium for the real effective exchange rate.

Table 4 : Long run Cointegrating Equation (Normalized log REER) and Coefficients of Error Correction terms

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
lcpippi	2.3113	2.9204	3.2018	1.6547	-
	(0.3457)	(0.4546)	(0.6822)	(0.6086)	
	[-6.6854]*	[6.4243]*	[-4.6940]*	[-2.7189]*	
open	0.8018	1.1344	1.1914	0.8850	0.3635
	(0.1230)	(0.1575)	(0.2118)	(0.1879)	(0.0813)
	[-6.5172]*	[-7.2011]*	[-5.6241]*	[-4.7102]*	[4.4713]*
gov	-3.1996	-0.0049	-3.8849	-2.5582	-2.0731
	(0.72071)	(0.3222)	(1.4191)	(1.0654)	(0.5242)
	[4.4396]*	[-0.0152]	[2.7376]*	[2.4011]*	[-3.9549]*
govd	-	1.1361	-	-	-
		(0.7641)			
		[1.4868]			
nfa	-0.3365	-0.4126	-0.4505	-0.4556	-0.3324
	(0.0465)	(0.0593)	(0.0700)	(0.0680)	(0.0414)
	[7.2428]*	[-6.9592]*	[6.4353]*	[6.7015]*	[-8.0363]*
lwt	-	-	-0.0351	-	-
			(0.1085)		
			[-0.3235]		
com3	-	-	-	-0.0892	-
				(0.0333)	
				[2.6801]*	
lgdppc	-	-	-	-	0.5108
					(0.1370)
					[3.7280]*
constant	-0.3610	-5.8089	-1.5925	0.8373	-3.4061

*Notes: *, ** and *** represent 1%, 5% and 10% significant levels. Standard errors and t-statistics are parentheses and brackets respectively.*

A crisis dummy is included to account for the 1997-1998 crisis period. Table 4 shows the estimated coefficients of VECM. The coefficients of the cointegrating vector are all significant, of the correct signs and plausible when compared to other similar studies. All four major macroeconomic variables correspond to the theoretical construct. Specifically, trade policy is captured by openness, the

domestic supply factor which captures the B-S effects is proxied by the price of tradables and non-tradables, fiscal policy is represented by government expenditure, net capital inflows encapsulate net portfolio and equity investment and, net foreign asset in the banking and monetary sector. An increase in B-S effect and openness lead to appreciation of the real effective exchange rate whilst an increase in government spending and net foreign asset have depreciating effects on the real effective exchange rate.

VECM restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short run adjustment dynamics. This cointegration term is known as the error correction term such that the deviations from the long run equilibrium are corrected gradually through a series of partial short run adjustments. Hence, the use of this technique allows for the identification of the variable(s) responsible for the short run adjustment dynamics. The error correction term is negative (-0.1584) and significant which indicates that if the real effective exchange rate is overvalued, it will adjust downward, and vice versa. Any deviations will be forced back towards the long run equilibrium under this dynamic error correction model.

The short run adjustments are generally insignificant except for government spending which marginally surpasses the 5 percent critical values. In this case, government spending carries the burden of adjustment of real effective exchange rate towards its equilibrium in the short run. As shown in Table 7, an increase in government spending is likely to depreciate the real effective exchange rate in the short run by approximately 7.5 percent in each quarter in the absence of shocks. In the long run, increase in government spending is also associated with a depreciation of the equilibrium exchange rate. Hence, government spending has a depreciating effect on the equilibrium exchange rate in both short and long run where the income effect dominates the substitution effect. The estimated error correction term suggests that almost 16 percent of the disequilibrium is eliminated in the following quarter. In the absence of further shocks, half-time back to equilibrium is around 3 ½ quarters or 0.78 years.

The residuals in the VEC model are diagnosed (Table 5) to examine whether all the variables retain their long run cointegrating relationships. The estimated long run equilibrium exchange rate satisfies a number of post diagnostic tests for skewness and no autocorrelation in the residuals. The hypothesis that the residuals have a normal distribution is rejected due to excess kurtosis. However, Parulo, 1997 (cited in MacDonald and Ricci, 2003) argues that non-normality as a result of excess kurtosis does not affect Johansen's results. For the remaining analyses, this study concentrates on Model 1 on the basis that it performs better in terms of the long run estimates and residual test statistics, and to ensure parsimony in modelling. In addition, the linear restriction test based on Johansen-Juselius (1990) reports that all the selected variables belongs to the cointegrating space (Table 6).

Table 5: VEC Joint Tests for Skewness, Kurtosis and Normality of Residuals and Other Diagnostic Tests

	Model 1	Model 2	Model 3	Model 4	Model 5
Skewness	0.0970	7.5217	15.9155*	0.4833	22.1582*
Kurtosis	77.8351*	40.8397*	66.9483*	98.9676*	86.8753*
Normality	77.9321*	48.3614*	82.8638*	99.4508*	109.0335*

Autocorrelation	26.7185	30.4328	62.0933*	44.0015	44.1358*

Skewness, kurtosis and hetroscedasticity is based on chi-squared test values whilst autocorrelation is based on LM test.

Table 6: Johansen-Juselius (1990) Linear Restriction (LR) Test for Model 1

Variable excluded	**r**	**Test Statistics**
REER	1	56.28
LCPIPPI	2	66.89
OPEN	2	65.02
GOV	1	49.15
NFA	1	43.10

Notes: r is the number of cointegrating vectors. Critical values for r=1 and r=2 are 6.63 and 9.21 at 1% significant level. LR test is based on χ^2 *statistics.*

Table 7: Temporal Causality and Block Exogeneity Test Results Based on VECM for Model 1

Dependent Variables	∆REER	∆LCPIPPI	∆OPEN	∆GOV	∆NFA	ect
∆REER	-	8.1389 (0.2281)	27.6690 (0.0001)*	19.2028 (0.0038)*	23.7911 (0.0006)*	-0.1584 (0.0322) [-4.9238]**
∆LCPIPPI	10.3209 (0.1118)	-	3.0602 (0.8013)	5.8230 (0.4433)	4.2774 (0.6392)	-0.0420 (0.0660) [-0.6365]
∆OPEN	7.6881 (0.2619)	7.7473 (0.2572)	-	5.4941 (0.4822)	13.0997 (0.0415)	0.5603 (0.2273) [2.4646]
∆GOV	11.3930 (0.0770)	8.6602 (0.1936)	11.8263 (0.0660)	-	13.2012** (0.0399)	-0.0742 (0.0364) [-2.0388]**
∆NFA	8.7444 (0.1885)	5.0064 (0.5430)	2.7933 (0.8343)	4.5177 (0.6070)	-	-0.2326 (0.6996) -0.3326]-

*Notes: * and ** represent 1% and 5% significant levels. Standard errors and t-statistics are in brackets and parentheses respectively.*

To further comprehend the adjustment process, causality is examined in a multivariate VECM framework. The advantage of using this framework is that it distinguishes both short and long run causality. Also, given the long run cointegrating relationship, there exists a corresponding error correction representation where changes in the REER are a function of the level of disequilibrium in the cointegrating relationship along with changes in other fundamental variables (Engle and Granger, 1987). Table 7 shows that in the short run, REER is Granger-caused by openness, government spending and net foreign assets. The direction of causality is unidirectional.

In the long run, changes in all the fundamental variables are responsible to correct any deviations from the equilibrium cointegrating relationship. This is clearly reflected by the significant error correction term (Table 7). These results reiterate the importance of LCPIPPI, GOV, OPEN and NFA in affecting changes in REER in the long run. Moreover, all the fundamental variables clear the disequilibrium arising in GOV in the long run.

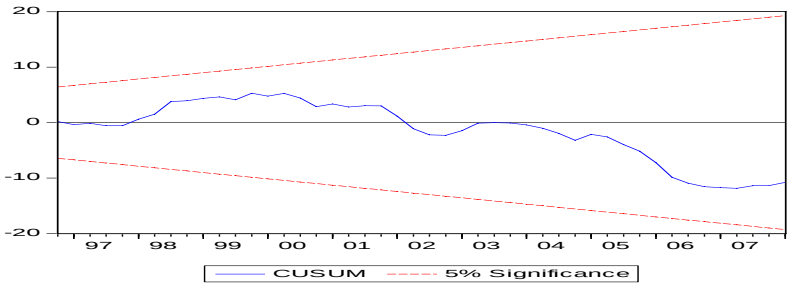
In the short run, the VECM results (Table 8) suggest that all the fundamental variables are important determinants of the REER in various short term horizons. LCPIPPI is marginally significant in the second quarter whilst OPEN is highly significant up the fourth quarter. The negative sign entails depreciation effect of trade openness in the short run. This depreciation may result from protectionism or distorted external account which tends to be rigid until trade negotiations and adjustments of the external account is undertaken. In the long run, when protections are removed and current account liberalized, trade openness dictated by economic growth will appreciate the exchange rate. Capital account liberalization in Malaysia has undergone various phases (Jomo, 1998), and with the recent global financial meltdown, the government will continue to liberalize the economy. One of the most apparent way of trade liberalization include free trade agreements that has been actively promoted through Ministry of International Trade and Industry (MITI) since early 2000 (Malaysia Industrial Development Authority (MIDA), 2007) and the gradual implementation of AFTA that suppresses tariff within the participating ASEAN countries.

GOV have significant positive impact in the first two quarters but are negative after the fifth quarter. This finding is similar to that of Balvers and Bergstrand (2002) where government spending appreciates the real exchange rate in the short (to medium) run. Initially, government expenditure leads to appreciation given that the income effect dominating substitution effect. This income effect is generated through improvement in trade balance in the short run as discussed in Yusoff (2007). Hence, in the medium to long term, the exchange rate will be forced to depreciate to restore equilibrium. In this study, these adjustment processes begin after the fifth quarter.

An increase in NFA will result in an appreciation of the ringgit throughout the six lags with exception of the fifth lag, similar to that of Mexico (Dabos and Ramon, 2000). However, in the long run, inflows of foreign direct investment worsen the country's net foreign asset, thus, forcing the real exchange rate to depreciate.

In Table 8, the diagnostic tests indicate that the VECM specification is adequately specified. The stability of the estimates is ensured via the CUSUM and CUSUM squared tests in Figure 3.

Figure 3: CUSUM and CUSUM squares test



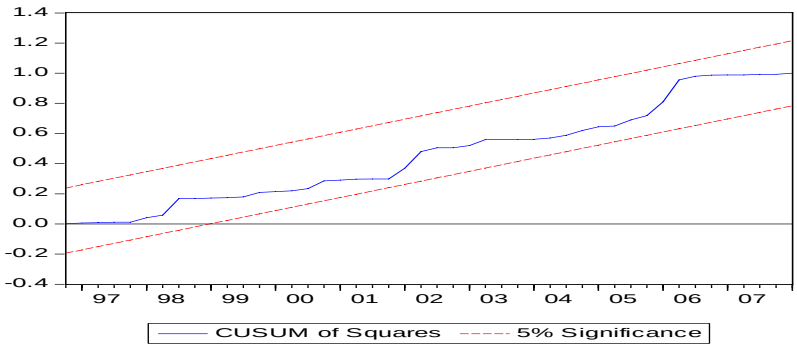


Table 8: Short run VECM results

Dependent Variable: REER							
		Coefficient estimates of					
Lag	**ECM**	**ΔREER**	**ΔLCPIPPI**	**ΔOPEN**	**ΔGOV**	**ΔNFA**	**CD**
	-0.1584						-0.0534
	(-4.9238)*						(-6.2419)*
1		-0.2546	-0.1869	-0.0807	0.5755	0.0268	
		(-1.5409)	(-1.5971)	(-2.4591)*	(3.5801)*	(2.2198)*	
2		-0.2934	-0.1999	-0.1089	0.5575	0.0359	
		(-2.1025)*	(-1.8952)	(-3.8569)*	(2.9806)*	(3.2171)*	
3		-0.5558	-0.0358	-0.0739	0.1547	0.0368	
		(-3.4335)*	(-0.3600)	(-2.7742)*	(0.8426)	(3.4440)*	
4		-0.4971	0.1175	-0.0856	0.0588	0.0197	
		(-3.2495)	(1.2306)	(-3.1580)*	(0.3131)	(1.8701)	
5		-0.3447	-0.0347	-0.0391	-0.3328	0.0026	
		(-2.3315)	(-0.3533)	(-1.3182)	(-1.6896)	(0.2731)	
6		0.0598	0.0088	-0.0013	-0.3663	0.0250	
		(0.4023)	(0.0915)	(-0.0480)	(-2.1713)*	(2.8581)*	

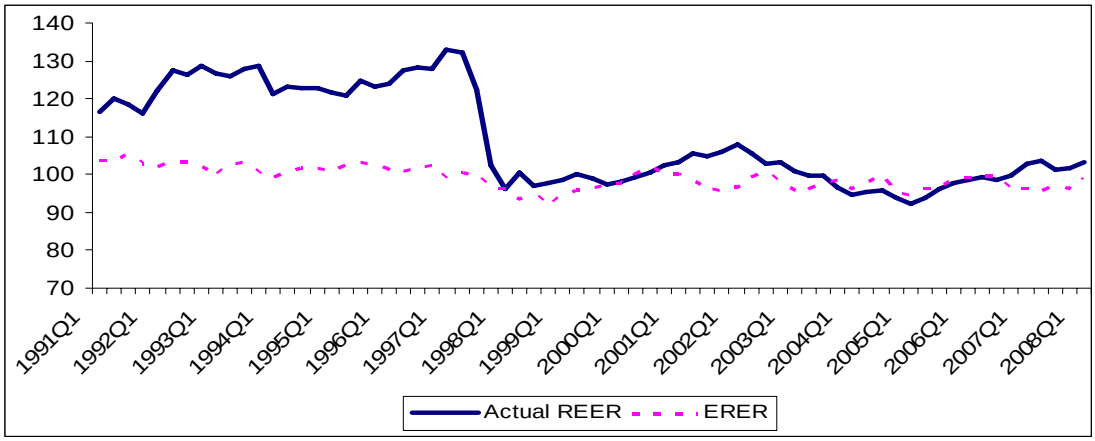
Diagnostic tests: R^2=0.8298, Normality test: JB, χ^2(2)= 9.2719[0.0097], LM: F(2,22)=2.1745 [0.1257], Hetroscedasticity: F(16,46)=0.9618 [0.5108], Chow: F(45,1)=6.5483 (0.3022)

*Notes: t-statistics and probabilities are in parentheses and brackets respectively. * and ** denote significance at 1% and 5%. CD denotes crisis dummy.*

7. Exchange Rate Misalignment

To ensure consistency in discussion, exchange rate misalignment is calculated based on Model 1. The long run relationship derived from the vector cointegration permits the estimation of the equilibrium exchange rate and hence, the degree of misalignment. Theoretically, the equilibrium exchange rate estimated based on the long run cointegrating coefficients is the real exchange rate that is consistent with the equilibrium values of the fundamental variables in the long run. As depicted in Figure 4, the estimated equilibrium exchange rate shows fluctuations over the specified period which confirms the fact that the equilibrium exchange rate is itself time-varying. The gap between the actual and the estimated equilibrium may be caused by temporary factors such as financial market pressures or because of the change in the fundamental variables that alters the equilibrium from time to time.

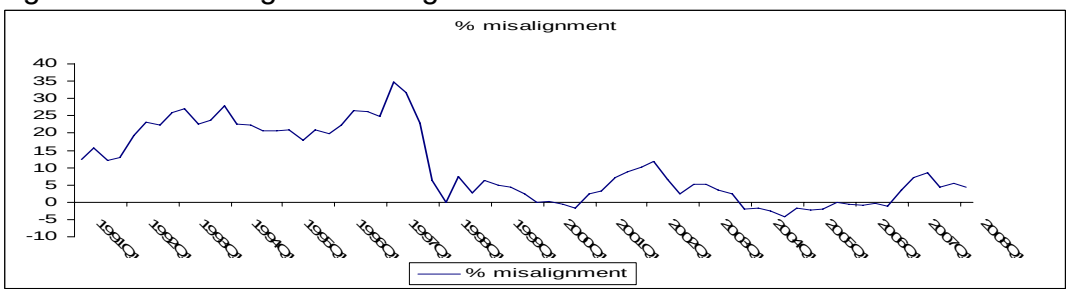
Figure 4: Actual REER and Equilibrium Real Exchange Rate (ERER)



Source: Author's estimation

Figure 4 shows the actual and estimated equilibrium exchange rates; and the pattern of misalignment is displayed in Figure 5. Generally, the actual real effective exchange rate was above the estimated equilibrium between 14.7 – 33 percent in the 1990s right through the third quarter of 1997 when the financial crisis sets in. This is consistent with Naseem et al. (2008) which uses a NATREX model. Literally, the ringgit was overvalued prior to the Asian financial crisis but has generally been close to the equilibrium after the crisis period. As expected, the ringgit peg to the USD has brought the REER of ringgit to sustainable values with minor misalignments. This is evident when misalignments were hardly more than 10% during the post 1998 period except for in 2001Q4 and 2002Q1 where misalignments were 10.3 and 11.8 percent respectively. There was also noticeable, albeit small, overvaluation period in 1998:Q2 to 2000Q1, 2001:Q2-2004:Q1 and between 2007:Q1-2008:Q1. No significant undervaluation is detected during the period of study. In general, the REER has remained intact despite changes in exchange rate regime since the pegged regime has suppressed the REER to its appropriate level that is consistent with the macroeconomic fundamentals. By the end of 2006 to date, the REER is again appreciating possibly due to rising oil, commodities and food prices.

Figure 5: Percentage of misalignment



Source: Derived from Figure 4.

8. Conclusion and Policy Implications

Based on the Edwards and El-Badawi equilibrium exchange rate theory, this study estimates the long run equilibrium path for the real effective exchange rate in Malaysia using the behavioural equilibrium exchange rate approach. In a behavioural sense, the real exchange rate is in equilibrium when its movement reflects the macroeconomic fundamentals to which it is related in a well defined statistical sense. Under this approach, the systematic relationship between the actual real exchange rate and the estimated equilibrium exchange rate is used to estimate misalignments via the concept of cointegration. The VEC estimates shows that the B-S effect, openness, government spending and capital inflows are important long run determinants of the equilibrium exchange rate in Malaysia.

The empirical results in this study indicate that there has been significant misalignment of the real effective exchange rate against major trading partners in the 1990s but this scenario has drastically changed especially after the 1997 crisis. The estimated coefficients of the VECM for long run relationship generally conform with the economic theory. Specifically, the relative price of tradables to non-tradables, net capital inflows, government expenditure and trade openness are important fundamental variables that have profound impact the real effective exchange rate movements. Based on the estimated model, it can be seen that increase in government spending could act as the major forces for the adjustment of ringgit in the near future. The findings points to the fact that currently, the ringgit has depreciated compared to the early 1990s which literally means that from that the Malaysian exports can still compete on the basis of price competitiveness but this may not be a sustainable strategy.

Despite robust statistical properties of the estimates and given the use of quarterly instead of annual data, care is needed when interpreting the results. It would be rather safe to conclude that the misalignment puzzle is not totally exhausted and certainly deserve additional empirical investigation using the macroeconomic balance and external sustainability approach, and perhaps, misalignment based on PPP. Furthermore, what constitutes an equilibrium in this complex world of real exchange rate is still debatable especially on the use of proxies. Thus, it is not easy to choose the ‘right’ benchmark.

Another important finding of this study is that following the conversion to managed float regime, the ringgit has moved closer to the estimated equilibrium level and began to show signs of future appreciation. From a policy perspective, relying on managed float with an intention to lower inflation would certainly raises some difficult policy dilemmas regarding the optimal level of the real exchange rate which would be consistent with stabilizing inflation and maintaining external balance, without hampering growth. This is especially the case when inflation fuelled by the recent global phenomenon of increase oil of prices since early 2007 and the surging food prices.

In ensuing export led growth, much attention was placed on enhancing competitiveness through various measures such as increase productivity, better infrastructure, removal of government red tapes and more attractive investment incentive packages. Contrary to expectations, Figure 2 vividly describes the REER

path which went through persistent appreciation in the early 1990s. As such, the REER has been overvalued prior to the 1997 crisis. Hence, appreciation may have contributed to the onset of the 1997 currency crisis. Similar contention is echoed in Yusoff and Abdul Majid (2000). At the peak of such appreciation, the REER index plummeted to as low 96.11 in the first quarter of 1998. Again, as depicted in Figure 4, the actual REER incessantly surpasses the hypothetical REER, and the difference between the two is interpreted as an overvaluation. This shows that the REER was inconsistent with underlying fundamentals which, in a way, led to the crisis. Our results are consistent with a study by Husted and MacDonald (1999) where traditional fundamental variables did not contribute to the financial crisis. In this study, we show that the REER was not in line with its equilibrium value, hence, providing ample avenue for currency attack. Hence, an important lesson for Malaysian policymakers is that prolong overvaluation endorses opportunity for currency attack which leads to other financial vagaries.

The next issue is the relationship between exchange rate and choice of exchange rate regime. The estimates indicate that the ringgit may have been overvalued over the early 1990s up to the crisis period but remained close to the equilibrium for the rest of the period. Despite being in a managed float regime, significant overvaluation was present especially during the early 1990s up to the pre-1997 financial meltdown. In the exchange rate regime literature, a few studies have categorized Malaysia as a fixed regime or following a certain moving band (for example Levy-Yeyati and Stuzennegar, 2001; Reinhart and Rogoff, 2002) instead of its *de jure* choice of regime. In similar veins, McKinnon and Schnabl (2003) show that more than 70 percent of trade invoicing was conducted in the USD. They suggest that the movement of ringgit is akin to the USD which necessitates that the ringgit follows the USD closely or it is at least the strongest currency in the currency basket. However, based on our estimation, trading with the US only accounts for 16.1%, 20.7% and 13.51% for 1991, 1998 and 2007. The pegged exchange rate regime which reigned between September 1998 to July 2005 has successfully brought the ringgit closer to its equilibrium, hence, securing price competitiveness of Malaysia's export.

Several policy implications can be inferred from the econometric results in the previous sections. One of the reasons for ongoing interest in this subject is that exchange rates may deviate long periods away from their fundamentals. If disequilibrium is temporary, policy makers may want to curtail further disequilibrium through short run policy measures that remedy the deviation as well as to promote faster convergence towards the equilibrium level. In the case of prolonged deviations, more rigorous policy undertakings should be introduced. Malaysia is an interesting case to consider. Indeed, this study has shown that prior to the crisis, there has been a prolong overvaluation and following the speculative attack on the ringgit, the government resorted to unorthodox methods of capital controls and exchange rate controls. These two measures, despite contradicting the '*impossible trinity*' has helped to revive the economy (Kaplan and Rodrik, 1999). After 1998, misalignment is less pronounced. The speed of convergence is approximately 16 percent per quarter, which is relatively fast but in line with previous estimates (Mohamed, 2003; Edwards, 1989). This implies that full adjustments towards the equilibrium exchange rate may take place in less than two years in the absence of further shocks. Hence, no radical policy actions should be undertaken to speed up the adjustment towards equilibrium unless an unexpected shock occurs.

Maintaining a stable macroeconomic environment with low inflation is vital to limit any potential real appreciation stemming from the increase in fuel prices and its spillover effects, especially in 2006-2007. In Malaysia's context, however, trade partners' appreciation is apparently more pronounced such that it offsets the potential appreciation due to skyrocketing oil price in 2007. Besides, Malaysia is also a net oil producer but imports oil for domestic consumption. In this context, more restrictive monetary and fiscal policies can be useful to help lower domestic inflation, at least below major trading partner countries' inflation, which could reduce potential overvaluation in the near future.

There has also been a popular belief that the dollar has strong influences on the ringgit such that the ringgit is bound to depreciate or depreciation along with the USD vis-à-vis other currencies especially during the pegged regime period. This can be viewed as a way to continuously maintain price competitiveness of exports by retaining an undervalued currency. It was indeed true despite the fact that Malaysia's trade with the US accounts for an average of 23 percent between 1991-2007 and the percentage has gradually decreased to 17-20 percent in recent years. From another perspective, pegging to the USD did reduce the extent of misalignment and can be considered as a tool to maintain price competitiveness. Furthermore, the role of foreign direct investment, portfolio and equity flows have significant effects in appreciating the equilibrium exchange rate. If these net inflows persist in the near future, appreciation of the ringgit becomes almost inevitable.

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APPENDIX I – Variable Description and Data Source

Real Exchange Rate
The real effective exchange rate will be used as a proxy for the real exchange rate. Source: IFS (various issues, CD-ROM).

Productivity (B-S effect)
Log of CPI/PPI over major trading partners CPI/PPI. Source: IFS (various issues, CD); Monthly Statistical Bulletin, BNM. Weights are calculated based on exports with major trading partners. Source: Direction of Trade Statistics (DOTS), IMF. GDP per capita is also used as an alternative proxy. Source: IFS (various issues, CD-ROM).

Openess
Ratio of the sum of export to import to GDP. Source: Department of Statistics, Malaysia.

Commodity Prices
Four main export commodities are selected – petroleum, rubber, palm oil and cocoa. The aggregation method is the weighted average of prices of four, three (petroleum, rubber and palm oil) and one (petroleum only) commodity (ies). The weights are normalized shares of these commodities in each year of the sample.

Table 8: Weights for Commodities

	Weights for Four (4) Commodities (com4)	Weights for Three (3) Commodities (com3)	Weight for One (1) Commodity (com1)
Petroleum	0.529	0.53 (0.529)	1
Palm Oil	0.375	0.38 (0.375	0
Rubber	0.095	0.09 (0.096)	0
Cocoa	0.001	0	0

Source: Department of Statistics, Malaysia. Base year =2000

Government spending (gov)
GOV is also divided into current and development spending (Source: Monthly Statistical Bulletin, BNM).

Net foreign asset (nfa)
Proxies used include net foreign asset in monetary and banking sector (Source IFS, various issues, CD). Net capital inflow, investment and debt are also used (Source: Monthly Statistical Bulletin, BNM). Variables are expressed as a ratio of GDP.

APPENDIX II - CALCULATION OF REER

Yusoff and Baharumshah (1993) computed the REER as follows:

$$REER_t = 100 \exp\left[\sum_{i=1}^{k} w_i \ln E_{it} - \sum_{i=1}^{k} w_i (\ln P_{it} - \ln P_{mt}\right]$$

where w_i, M_i , X_i, E_{it}, P_i, P_m and *k* denote weight, export and import to *i*-th Malaysian trading partner, the index of the price of ringgit in terms of currency *i* at time *t*, the consumer price index of *i*-th Malaysian trading partner, the consumer price index of Malaysia and the number major trading partners for Malaysia which consist of 15 major trading partners namely Australia, China, Hong Kong, Japan, Germany, France, Netherlands, India, Indonesia, Korea, Thailand, Philippines, Singapore, United Kingdom and United States. To ensure consistency in definition, this study inverts the calculated REER such that an increase in the index indicates appreciation.

Bahmani-Oskoee and Mirzai (2000) compute the REER as follows:

$$REER = \sum_{i=1}^{k} \alpha_{ji} \left(\frac{(P_j R_{ji} / P_i)_t}{(P_j R_{ji} / P_i)_{2000}} x100 \right)$$

where, *k* is the number of countries, $P_j (P_i)$ is the price level in country *j*(*i*), R_{ij} is the exchange rate defined as the number of country *i*'s currency per unit of *j*'s currency, and α_{ij} is the trade share of country *j*'s trade with country *i* such that $\sum \alpha_{ji} = 1$. In this study, *j* represents Malaysia and *i* denotes major trading partners. Unlike Bahmani-Oskooee and Mirzai (2000) who proxy import as trade share, we use both import and export shares to represent α_{ij}.