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Exchange Rate Misalignment, Volatility and Import Flows in Malaysia

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ABSTRACT

This paper investigates the effect of real exchange rate misalignment and volatility on Malaysian import flows during 1991:Q1 to 2003:Q4. A measure of the quantitative proxy of the real exchange rate misalignment is constructed using the Natural Real Exchange Rate (NATREX) equilibrium model, whereas the volatility of real exchange rate is generated from the GARCH model. This paper differs from existing literature as the effects of exchange rate misalignment significantly hastened the level of Malaysian imports for period of the study. The empirical results also show that the exchange rate volatility has merely promoted the Malaysian imports during the crisis period. This suggests that the exchange rate misalignment and volatility are important determinants in inspiring Malaysian import flows, especially during the 1997 Asian financial crisis.

Keywords: Real Exchange Rate Misalignment, Volatility, Asian Financial Crisis and ARDL Bounds Test

INTRODUCTION

Over the past decade, issues related to exchange rate and international trade poses a number of questions and challenges. According to Moosa (2000), international trade is habitually affected by the exchange rate variability, which is known as exchange rate misalignment and volatility. Exchange rate misalignment can be defined as the deviation of the real exchange rate from its long run equilibrium path, which can distort comparative advantages, that is, the basis of the Ricardian international trade; while exchange rate volatility is commonly referred as a short-term exchange rate fluctuation measured by the conditional variance of the exchange rate, which believed may inhibits the growth of trade.

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Any remaining errors or omissions rest solely with the author (s) of this paper.

The East Asian financial crisis that occurred in mid-1997 has motivated policy makers in the region including Malaysia to prompt further studies about the potential causes and impacts of temporal exchange rate misalignment and volatility on trade flows. Sekkat and Varoudakis (2000) pointed out that mismanagement of economic policies in developing countries has led to exchange rate misalignment and volatility, which may have been damaging for international trade as well as decelerate economic performance. It can therefore be alleged that the avoidance of a variable that represents the influence of exchange rate risks such as exchange rate volatility in studies of traditional trade determinants can lead to biased results, which are potentially misspecified (Arize, 1995).

This has attracted debates among policy makers and researchers on how to deal with exchange rate misalignment and volatility influence on the volume of trade specifically the import flows as there is little attention devoted to assessing the extent of such exchange rate misalignment and volatility on import flows. It is encouraging to exclusively analyze the impact of exchange rate misalignment and volatility on Malaysian import flows during 1991 – 2003, which span the years of development of the foreign exchange market, and trade liberalization program as well as the 1997 – 1998 financial crises. So far, however, no definite result has emerged, either from the theoretical or empirical perspectives. Although, a generally accepted conclusion is that the effect of exchange rate misalignment have a substantial influence on international trade in which an overvalued exchange rate promotes imports while an undervalued is believed to deteriorate the demand for imports. This implies that with an overvalued exchange rate, the imported goods and services will become more competitive in international market, which added considerably to the growth of domestic demand for imported goods and services as foreign currency is now turn out to be less costly. In contrast, an undervalued exchange rate leads to decrease the demand for imports, indicating imported goods and services become increasingly less competitive, which is currently considered to be pricier.

On the other hand, the traditional argument for the effects of exchange rate uncertainty on trade suggests that higher volatility of exchange rate will act to deter the volume of trade as profits to be earned from international trade transactions seemed to be uncertain (see for example, Hooper and Kohlhagen, 1978 and Gotur, 1985). Sercu and Vanhulle (1992) showed that increased exchange rate volatility will lead to a decline in the risk-adjusted anticipated profits from international trade, implying that traders are risk-averse, where hedging is expensive or impossible. Furthermore, some authors do find support for the benefiting effects of exchange-rate volatility on trade such as Giovannini (1988) and Baron (1976), which exchange rate volatility significantly hastened trade flows. Based on De Grauwe (1988) the impact of exchange rate volatility on trade would rely on the degree of risk aversion, depending on the dominance of income effect or substitute effect. If the income effect is dominant over the substitution effect, the relationship between exchange rate volatility and trade will be positively related as market participants are sufficiently risk-averse. Meaning, those market participants who are very risk averse may import more as risks are higher due to the belief that the expected revenue will be declined. Beside that, the risk of exchange rate volatility could offset if traders may anticipate the changes in exchange rate better than the average participant in the foreign exchange market and gains from this knowledge (Bailey and Tavlas, 1988). Hence, price affecting information may appear to be limited and valuable in any fast changing business environment to which traders are likely to have proprietary access to some of it.

The theoretical argument reflects the developments in the empirical ground that are correspondingly indecisive and limited. In this regards, Ghura and Grennes (1993) discovered that imports is impeded by the overvaluation of exchange rate. This does not support the hypothesis that an overvalued exchange rate has a positive influence on import flows. Contrarily, a recent analysis by Bouoiyour and Rey (2005) established evidence that supports the assertion, which an overvalued exchange rate persuades import flows. With respect to the relationship between exchange rate volatility and import flows, Kenen and Rodrik (1986) advocated that volatility of exchange rate appears to depress the volume of import flows[1]. Cushman (1988) and McKenzie (1998) further corroborated that higher volatility of exchange rate deters import flows. Conversely, Mckenzie and Brooks (1997) provided evidence that exchange rate volatility has a positive effect on import flows, which implies that a rise in exchange rate volatility hastens import flows. Besides, Arize (1998) showed that an increase in exchange rate volatility may have mutually positive and negative insinuations on import flows, based on the products' and countries' cases. Indeed, these cannot be seen as definite conclusion because there are also studies that failed to establish significant relationship between exchange rate volatility and import flows (see for example, Medhora, 1990; Belangar *et al.* 1992 and Siregar and Rajan, 2004).

Given the limitations of empirical studies on area of imports effect of exchange rate misalignment and volatility, especially in the region of ASEAN countries, this study is deemed to be timely in order to bridge the gap by empirically inspecting for comparatively small stock of evidence on the effects of exchange rate misalignment and volatility on the volume of Malaysian imports. The purpose of this study departs from previous studies in two novel ways. First, this study leads to endeavor in estimating the impacts of exchange rate misalignment and volatility on Malaysian import flows across different exchange rate regime. In particular, Malaysia has switched from a flexible regime to a pegged regime under the risk management

[1] Mackenzie (1999) documented that most of the empirical studies concluded that exchange rate volatility appears to depress the volume of international trade, which favor of the existence of a negative and statistically significant relationship between exchange rate volatility and trade flows.

during the 1997 – 98 Asian financial crises[2]. Second, since the study period span over the financial crisis, the sample period is divided into pre-crisis and crisis period to disentangle the impact of exchange rate misalignment and volatility on Malaysian import flows before and after the currency crisis. Thus, the findings obtained in this study will bring a new dimension to the literature.

The remainder of this paper is organized as follows. Section 2 explains the empirical model, econometric methodology employed and the sources of the data collected. Section 4 reports the estimated results and Section 5 concludes the findings.

EMPIRICAL MODEL, METHODOLOGY AND THE DATA

Exchange Rate Misalignment: The NATREX Model

For the purpose of this study, the real equilibrium exchange rate is measured based on the theoretical framework, so-called the **Nat**ural **R**eal **Ex**change Rate (NATREX) equilibrium model developed by Stein (1994, 1996). The NATREX model permits to generate an equilibrium benchmark using prevailing real economics fundamentals that determined the misalignment of exchange rate. Indeed, the NATREX approach is different from Purchasing Power Parity (PPP) model, where the NATREX will vary over time responding to the changes in the fundamentals (Stein and Lim, 2002). In addition, the NATREX approach does not require that the observed REER and the real equilibrium exchange rate be stationary (Edwards and Savastano, 1999)[3]. The general form of the NATREX model that depends upon a vector of real equilibrium exchange rate can be illustrated using the following single-equation econometric model:

$$NATREX = f(\Phi_t) \quad (1)$$

$$RER = \alpha_{1t} + \sum_{i=0}^{r} \alpha_{2i} RGC_{t-i} + \sum_{i=0}^{r} \alpha_{4i} TOT_{t-i} + \sum_{i=0}^{r} \alpha_{5i} PROD_{t-i} + \varepsilon_{1t} \quad (2)$$

where $NATREX_t$ represents the real equilibrium of long-run exchange rate *(RER)*, while vector Φ consists of the real economic fundamentals (*RGC*, *RIRD*, *TOT*, *PROD*). The *RER* is the Malaysian real exchange rate (ringgit against the US dollar), *RGC* is the ratio of government consumption to *GDP* deflator, *RIRD* is

[2] Friedman (1953) noted that the main advantage of flexible exchange rate regime is due to the less costly to operate, which means it is not as much of regulation dependencies. On the other hand, Mundell-Fleming-Dornbusch model, stressed that fixed exchange rate is superior as it can effectively reduce uncertainties of trade and investment.

[3] 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).

real interest rate differential between domestic *(i_{mas})* and world *(i^*)* real interest rate[4], *TOT* is the terms of trade (ratio of the export price index to the import price index) and *PROD* is the productivity index[5]. The model is set up with the intention to capture open economy properties such as international trade *(TOT)* and cross border capital flow *(i_{mas}, i^*)* as well as domestic economic performance, that is, high productivity *(PROD)* and government consumption *(RGC)*. This set of selected exogenous fundamental variables is consistent with the nature of the Malaysian economy, which has been quite frequently used in the literature on the determination of equilibrium real exchange rates generated from the NATREX model (Edwards and Savastano, 1999; Edwards, 2000; Siregar and Har, 2001; Rajan and Siregar, 2002; Rajan *et al*., 2004 and Bouoiyour and Rey 2005).

The theoretical literature of the expected sign of the coefficient estimates for the selected real economic variables is briefly highlighted based on theory. The *Real Government Consumption (RGC)* is disproportionately devoted to nontradable goods. A rise in *RGC* leads to a real exchange rate appreciation as the price for nontradable goods increased so α_{2i} is expected to be negative. Regarding the *Real Interest Rate Differential (RIRD ($i_{mas} - i_{us}$))*, the investor will tend to shift their portfolios 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 exchange rate appreciation, so α_{3i} is expected to be negative. Besides, the *Terms of Trade (TOT)* may have positive or negative impact on real exchange rate, depending on the relative importance between substitution and income effects[6]. An improvement in the terms of trade leads to reduce the cost of imported inputs in the production, generating real exchange rate depreciation through the substitution effect and hence, α_{4i} is expected to be positive. For Productivity (PROD), the Balassa-Samuelson theory indicates that the boost in the national productivity will lead to a real appreciation of exchange rate, so, α_{5i} is expected to be negative.

Exchange Rate Volatility: The GARCH Model

The Generalized Autoregressive Conditional Heteroscedastic (GARCH) model developed by Bollerslev (1986) was constructed in order to parameterize the conditional variance of exchange rate. This due to the capability of the - to capture the unexpected volatility and the time-varying conditional variance as a parameter generated from a time series model of the conditional mean and variance of the exchange rate. Bollerslev (1986) has extended the ARCH model by including a

4 $(i_{mas} - i^*) = (i_{mas} - i_{us})$, where i_{mas} is the Malaysian interest rate while ius is the US interest rate.

5 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).

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

lagged value of the conditional variance and specifying the conditional variance to be a linear combination of *p* lags of the square residuals from the conditional mean equation and *q* lags of the conditional variance. If the error process be such that $\varepsilon_t = v_t \sqrt{h_t}$ where $\sigma_v^2 = 1$, then the residual series is modeled as a GARCH (*p,q*) process as demonstrated below:

$$\varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t) \tag{3}$$

$$ht = \theta + \sum_{i=1}^{p} \beta_i \varepsilon_{t-i}^2 + \sum_{t=1}^{q} \alpha_i h_{t-i} \tag{4}$$

where θ β and α are restricted to be positive $(\alpha > 0, \beta > 0, \theta > 0)$ to ensure the possibility of conditional variance (h_t) is positive. Beside that $N(0,h_t)$ indicates that the conditional density through zero mean and variance, *h*. Therefore, this model allows the conditional variance of ε_t to be an ARMA process.

Import Demand Model

The model adopted in this study relies on the standard import demand equation augmented by including the term "volatility effect", which is an uncertainty of exchange rate. This model is similar to the one used by Mckenzie and Brooks (1997), Mckenzie (1998), Arize (1998) and Siregar and Rajan (2004). In addition, the import demand model is further extended by incorporating the 'misalignment effect', which is the exchange rate deviation from its long-run equilibrium. Among those that measured the impact of exchange rate misalignment to import flows are Ghura and Grennes (1993) and Bouoiyour and Rey (2005). That is, the import demand model is a function of income, price, volatility and misalignment and can be derived as follows:

$$IM_t = f(DI_t, PIM_t, MIS_t, VOL_t) \tag{5}$$

$$IM = \gamma_0 + \gamma_1 \ln DI_t + \gamma_2 \ln PIM_t + \gamma_3 \ln MIS_t \gamma_4 \ln VOL_t + \varepsilon_t \tag{6}$$

where IM_t is the real imports of goods and services (the total import in domestic currency deflated by GDP deflator), DI_t is the real domestic income (proxied by Malaysian industrial production index, IPI), PIM_t is the price of import (the ratio of the home import price to the world import price), MIS_t is the misalignment of exchange rate, VOL_t is the volatility of real exchange rate, ε_t is the disturbance term and *t* refers to time period. All variables are in natural logarithm except for MIS_t and VOL_t.

The standard demand theory indicates that the demand for imports is primarily determined by the real income of domestic economy. An increase in domestic income would rise in the volume for imports, suggesting more foreign goods will be purchased as distribution of income is unchanged (Arize, 1998). As such, DI_t is expected to be positive[7]. For price of import, the higher the price, the lesser the demand for imports, so PIM_t is expected to be negative. Regarding the effect of exchange rate misalignment on imports, an overvalued of exchange rate leads to increase in the demand for imports, so MIS_t is expected to be negative and vice versa. As discussed earlier, the impact of exchange rate volatility on imports demand is indeterminate, where it may be positive or negative, so VOL_t is expected to be ambiguous.

Econometric Methodology

This section discusses the properties of time series and the econometric methodology used to estimate the exchange rate misalignment and volatility as well as to examine their impacts on Malaysian import flows in the pre-crisis and crisis periods across different exchange rate regimes.

The vector autoregressive (VAR) model of the multivariate cointegration test is employed to gauge the NATREX model. This is to test for existence of an equilibrium relationship between exchange rate and its determinants. As a prelude to the cointegration test, the integration order for all time series variables are verified through the Augmented Dickey-Fuller (1981) and the Kwiatkowski *et al.* (KPSS, 1992) test. Conditionally on the outcome of the stationarity test, the cointegration test developed by Johansen (1988) and Johansen and Juselius (1990) is utilized. This method has been widely applied in empirical economic model to scrutinize the presence or absence of long-run equilibria among the variables. It is based on two likelihood ratios (LR) test statistics, which are the trace and maximum eigenvalue (λ-max) statistics that identify the number of unique cointegrating relationship between the variables. The trace statistics confirms the null hypothesis of at most *r* cointegrating relationship, against a general alternative hypothesis while the null hypothesis of λ-max statistic is *r* cointegrating vectors, against the alternative of *r+1* cointegrating relationship. The critical values for both tests are tabulated in Johansen and Juselius (1990).

The volatility of exchange rate is measured through the GARCH (*p,q*) model. The Akaike Info Criterion (AIC) and Schwartz Criterion (SC) are employed to select the optimal ARMA (*p,q*) process. Bollerslev *et al.* (1992) documented that most of the financial and economic series are sufficient with the combination of $p = q = 1$. It is also assumed that the GARCH (*p,q*) model to be $\alpha_1 + \beta_1 < 1$, which indicates stationary properties of GARCH (*p,q*) model.

[7] The sign on the income coefficient is often predicted to be positive. However, the sign can be negative if the imported good has a relatively close domestic substitute (Magee, 1975).

Bounds Testing Approach

The newly autoregressive distributed lag (ARDL) bound test proposed by Pesaran *et al.* (2001) is used to estimate the import demand model. One of the advantages of using ARDL bounds test is that it is applicable regardless of the stationary properties or irrespective of whether the regressors are purely $I(0)$ or $I(1)$, or mutually cointegrated. This proposes a useful approach that bypasses the need for pre-testing the integration order of variables which the potential biased associated in the unit root test can be avoided[8]. Moreover, the bounds test approach is robust for cointegration analyses with small sample study (Pesaran *et al.*, 2001). Given that the sample period is divided into two sub-samples, the sample size is limited and considered as a small sample size with a total of 21 observations for pre-crisis (1992:Q2 - 1997:Q2) and 26 observations for crisis period (1997:Q3 – 2003:Q4), which performing the bounds test seems to be appropriate. Mah (2000) stated that as small sample size, the conventional cointegration tests such as the Engle and Granger (1987) or Johansen and Juselius (1990) appear to be unreliable. According to the bounds test procedure, is essential to model equation (6) as a conditional ARDL as follows:

$$\begin{aligned}\Delta \ln IM_t = {} & \theta_0 + \delta_1 \ln IM_{t-1} + \delta_2 \ln DI_{t-1} + \delta_3 \ln PIM_{t-1} + \delta_4 \ln MIS_{t-1} \\ & + \delta_5 \ln VOL_{t-1} + \sum_{i=1}^{n} \lambda_1 \Delta \ln IM_{t-i} + \sum_{i=0}^{n} \lambda_2 \Delta \ln DI_{t-i} \\ & + \sum_{i=0}^{n} \lambda_3 \Delta \ln PIM_{t-1} + \sum_{i=0}^{n} \lambda_4 \Delta \ln MIS_{t-1} + \sum_{i=0}^{n} \lambda_5 \Delta \ln VOL_{t-i} + \varepsilon_t\end{aligned} \quad (7)$$

where Δ is first difference operator and ε_t is a white-noise disturbance error term. The long-run relationship between the concerned variables can be conducted based on the Wald test (F-statistic) by imposing restrictions on the estimated long-run coefficients of one period lagged level of the variables equal to zero, that is, *Ho:* $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$. Then, the computed F-statistic is compared to the critical value tabulated in Pesaran *et. al* (2001) and Narayan (2005)[9]. The lower bound values assumed that the explanatory variables x_t are integrated of order zero, or $I(0)$, while the upper bound values assumed that x_t are integrated of order one, or $I(1)$. Therefore, if computed F-statistic falls below the lower bound value, $I(0)$, the null hypothesis of no cointegration cannot be rejected. Conversely, if the computed F-statistic exceeds the upper bound value, $I(1)$ then it is concluded that imports and its determinants are moving together to a long-run equilibrium.

[8] For further explanation, see Pesaran and Pesaran (1997).

[9] This approach is analogous to the one applied in Narayan and Narayan (2005). The appropriate critical values are extracted from Pesaran *et al*. (2001) and Narayan (2005), Table (C1.iii), Case III: Unrestricted intercept and no trend. The structural lags are determined by using minimum Akaike's Information Criteria (AIC).

Besides, if the computed *F*-statistic falls within the bound values, a conclusive inference cannot be made.

Once a cointegration relationship has been ascertained, the long-run and short-run parameters of the cointegration equation are then estimated. The long-run cointegration relationship is estimated using the following specification:

$$IM_t = \gamma_0 + \sum_{i=1}^{q} \gamma_1 \ln IM_{t-i} + \sum_{i=0}^{q} \gamma_2 \ln DI_{t-i} + \sum_{i=0}^{r} \gamma_3 \ln PIM_{t-1} + \sum_{i=0}^{s} \gamma_4 \ln MIS_{t-1} + \gamma_5 \sum_{i=0}^{v} \ln VOL_{t-i} + u_t \quad (8)$$

However, due to the speed of adjustment back to equilibrium may not immediately adjust, the demand for imports is most likely to be varied from its actual level of imports. This could be caused by the adjustment process and lags in perceiving changes in any of the imports' determinants. Hence, the speed of adjustment of the imports demand model can be captured through the estimation of the error correction model as expressed below:

$$\Delta \ln IMt = \beta 0 + \sum_{i=1}^{q} \beta_1 \Delta \ln IM_{t-i} + \sum_{i=0}^{q} \beta_2 \Delta \ln DI_{t-i} + \sum_{i=0}^{r} \beta_3 \Delta \ln MIS_{t-1} + \sum_{i=0}^{s} \beta_4 \Delta \ln MIS_{t-1} + \sum_{i=0}^{v} \beta_5 \Delta \ln VOL_{t-i} + \beta_6 \varepsilon_{t-1} + u_t \quad (9)$$

where ε_{t-1} is the error correction term of one period lagged estimated from the equation (9) while the coefficient (β_6)measures the speed of adjustment of the model's convergence to equilibrium.

Sources of Data

This paper employed quarterly data that covers the period from 1991 to 2003 for the case of Malaysia. The data is primarily gathered from various issues of IMF that included exchange rates (RM/USD), government consumption, interest rate, consumer price index, GDP deflator, world import price indices, imports of goods and services and industrial production index. For the real GDP per capita and the 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 Gandolfo (1981) to facilitate the utility of the system.

EMPIRICAL RESULTS

Result of Unit Root Tests

Table 1 shows the results of ADF and KPSS unit root tests. The results clearly show that all variables tend to be nonstationary at level. 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. At first difference level, the ADF test has well rejected the null hypothesis of unit root at 1 percent significant level whilst the KPSS test refused 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 determinants. These results are consistent with the findings that most macroeconomic variables follow an I(1) process (Baharumshah *et al*., 2003)[10].

Table 1 Result of unit root tests

Variable	ADF		KPSS	
	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: Figures in parenthesis ( ) represents the number of lag length used, which are selected based on Akaike Information Criterion (AIC) for the ADF test and Fixed Spectral OLS AR for the 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

Given each of the series is considered to be $I(1)$ process, the Johansen multivariate cointegration is subsequently designed to scrutinize the existence of cointegration

[10] In order to costume the ARDL model, the real imports variable (as the dependant variable) of the pre-crisis and crisis periods are tested for the order of integration. The results found to be satisfactory of $I(1)$ or integrated of order one. These results are available upon request.

relationship between exchange rate and its determinants. The estimated results show that the null hypothesis of non-cointgerating vector is rejected at 1 percent significant level as reported in Table 2. This indicates the presence of one cointegration relationship for the NATREX equilibrium model, suggesting 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)*.

Table 2 Result of Johansen and Juselius 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 that rejection at the 1% critical value. 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.

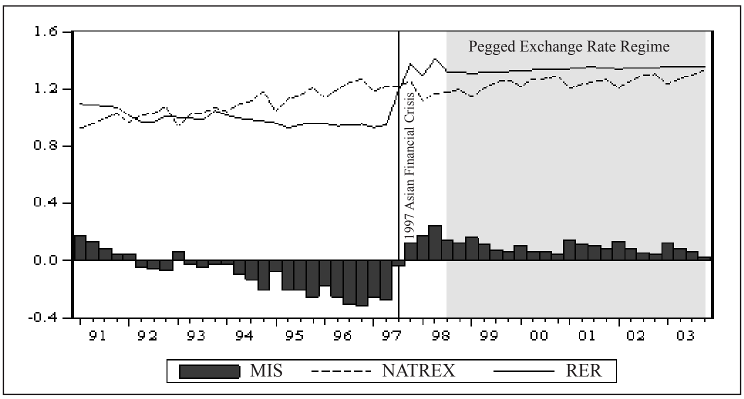
The estimated cointegrating vector is summarized in Table 3. By normalizing on the RER*,* the estimated cointegrating vectors which reflect long-run relationship are obtained. This normalized equation is obtained by dividing each cointegrating vector by the negative of the estimated RER coefficient, together with their respective *t*-values. The normalization process yielded estimates of long-run equilibrium parameters. The results in Table 3 show that all fundamental variables have significant and theoretically consistent coefficient estimates at 1 percent and 10 percent level. The estimated coefficients revealed that an increase in the RGC, RIRD and PROD has negative impact on the RER, which indicates any elevation in these fundamental variables will cause an appreciation of the real exchange rate. In contrary, the TOT has positive influence on the RER, implying an increase in TOT leads to a depreciation of the real exchange rate.

The rate of misalignment (MIS) is demonstrated in Figure 1. The Malaysian real exchange rate is said to be misaligned in term of overvalued or undervalued as its real exchange rate (RER) is lower or higher than its natural real equilibrium exchange rate (NATREX), which is either negative or positive, (RER – NATREX). The results discovered that the real exchange rate of Malaysian ringgit had practiced an undervalued scenario from 1991:Q1 to 1992:Q1 and was mildly overvalued until 1992:Q4. The Malaysian real exchange rate had further experienced an overvalued scenario between 1993:Q2 to mid-1997. This finding is consistent with Furman and Stigliz (1998) who documented the overvaluation of Malaysian real exchange rate at the end of 1996. In addition, Husted and Macdonald (1999) and Sazanami and Yoshimura (1999) further corroborated that the Malaysian real exchange rate 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 appeared to be undervalued commencing from 1997:Q3 to 2003:Q4. This can be deduced that the regional crisis seemed to be an important utensil in switching the direction of Malaysian real exchange rate from an overvalued in the per-crisis to an undervalued in the crisis period.

Table 3 Result of cointegrating relationship

Variable	RER	C	RGC	RIRD	TOT	PROD
Coefficient	-1.000	20.836	-1.626*	-0.277*	5.036***	-3.555*
t-statistic			-9.589	-4.306	1.786	-3.746

Note: The asterisks (*) and (***) denote the statistically significant at 1% and 10% levels, respectively.



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).

Figure 1 The Malaysian real exchange rate misalignment

Estimation Results of the Exchange Rate Volatility

The results of the GARCH (1, 1) model for the Malaysian real exchange rate are presented in Table 4[11]. The estimated coefficients of ARCH (ε^2_{t-i}) and GARCH

[11] The selection Results based on the Akaike Information Criterion (AIC) and Schwartz Criterion (SC) indicate that p = q = 1 is the best combination. These results are available on request.

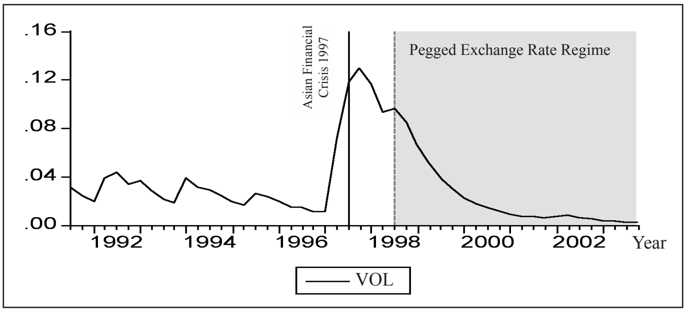
(h_{t-i}) are found to be statistically significant at 10 percent and 1 percent levels, respectively. This implies that the presence of the ARCH and GARCH effects throughout the sample period. The sum of the ARCH and GARCH coefficients approaches unity, signifying the persistence of shocks to volatility (conditional variance) is greater while the decay rate of the shock was slower (Choudhry, 2005)[12].

Table 4 Result of GARCH (1,1) model

$ht =$	$-$ 0.00000038	+	0.377 *** ε^2_{t-1}	+	0.581* h_{t-1}	+	0.005 *DUM*	+	ε_t
	[0.000011]		[0.224]		[0.0896]		[0.024]		
	(0.972)		(0.092)		(0.000)		(0.838)		
$\alpha_1 + \beta_1 = 0.958$,			Q(2) = 3.118 (0.210), Q(4) = 5.075 (0.280)						
			$Q^2(2)$ = 0.792 (0.673), $Q^2(4)$ = 1.103 (0.894)						

Notes: The standard errors are in [ ] and *p*-values are in ( ). DUM is the crisis dummy, includes to capture the effect of the 1997 financial crisis (one from 1997:Q2 to 1997:Q4 and zero otherwise). Q(k) is the Box-Pierce statistic and the figure in the associated parenthesis is the estimated residual of order k. The (*) and (***) denote the statistically significant at 1% and 10% levels, respectively. Residual based on vector test conducted for normality and heteroscedasticity were also found to be satisfactory. These results are available upon request.

In addition, the Box-Pierce statistic failed to indicate any serial correlation in both the standardized and standardized squared residuals at 2 and 4 lags. According to Giannopoulos (1995), the deficiency of serial correlation in the standardized squared residuals implies a lack of need to encompass a higher order ARCH process. The series of the Malaysian real exchange rate volatility is illustrated in Figure 2.



Note: VOL is The Malaysian Real Exchange Rate Volatility, the ringgit against the US dollar

Figure 2 The Malaysian real exchange rate volatility

[12] Engle and Bollerslev (1986) noticed that if $\alpha 1 + \beta 1 = 1$ in a GARCH (1,1) model, the future variance is conditioned as current shock persists indefinitely. Such a model is so-called the IGARCH or Integrated-ARCH model.

Estimation Results of the Import Demand Model

The estimated import demand models are displayed in Table 5. Panels A and B report the results for pre-crisis and crisis periods, respectively. The results of ARDL bounds testing to cointegration test indicate that the restricted null hypothesis of the long-run coefficient is rejected ($Ho: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$) at 1 percent significant level. This suggests that in the pre-crisis and crisis periods there is a cointegration relationship between imports, domestic income, price of import, misalignment and volatility.

The discussions of long-run relationship for the pre-crisis and crisis periods are based on the data in Panels A and B of Table 6. The results show that in the pre-crisis and crisis periods the estimated coefficients of the domestic income are positive and statistically determinant for imports demand, implying 1 percent increase in domestic income lead to rise in imports by more than 3.8 percent and 1.7 percent, respectively. This result is not surprising given that Malaysia has maintained a high import portion of capital and intermediate goods that accounts for more than 83 percent of its total imports in order to assist its export led growth strategy, especially in the expansion of industrial sector in the 1990s, where the imported inputs is believed to generate higher productivity in the future (see, Second Outline Perspective Plan 1991 – 2000). However, the volume of Malaysian imports has comparatively decreased with the onset of Asian financial crisis that arose in the midst of the 1997. This may be due to the defensive action taken by the government in reducing the ringgit outflows as well as to defeat the awful impacts of regional crisis[13].

Table 5 Results of ARDL bounds test

	F-Statistic
Panel A: Pre-crisis period (1992:Q2 to 1997:Q2)	13.56
Panel B: Crisis period (1997:Q3 to 2003:Q4)	13.21

Critical Value	90 %		95 %		99 %	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Pesaran *et al*. (2001)	2.45	3.52	2.86	4.01	2.86	4.01
Narayan (2005)	2.75	3.99	3.35	4.77	3.35	4.77

Notes: Critical values are extracted based on Pesaran *et al*. (2001) and Narayan (2005), Table (C1.iii), Case III: unrestricted intercept and no trend. The structural lags are determined by using minimum Akaike's Information Criteria (AIC).

[13] On September 1998, Bank Negara Malaysia (BNM) had implemented provisional policy through the selective capital control which included foreign exchange restriction. The objectives were to eliminate transactions that close the offshore market, suspend ringgit credit to foreigners and reduce outflows as well as to insulate the domestic economy from the effect of short-term capital flows (Hood, 2001).

Table 6 Results of long-run relationship

Variables	Coefficients	t-Statistics
Panel A: Pre-crisis (1992:Q2 to 1997:Q2)		
DI_t	3.863*	4.495
PIM_t	0.821	0.260
MIS_t (Overvalued)	2.539**	3.660
VOL_t	0.899	0.233
Constant	-3.532**	-2.588
Panel B: Crisis period (1997:Q3 to 2003:Q4)		
DI_t	1.756**	3.182
PIM_t	-0.525	-1.502
MIS_t (Undervalued)	1.459*	4.081
VOL_t	0.749*	6.313
Constant	-6.034**	-2.807

Notes: *DI* = Domestic Income; *PIM* = Price of Import; *MIS* = Misalignment; *VOL* = Volatility. The asterisks (*) and (**) denote the statistically significant at 1% and 5% levels respectively.

The price of import, *PIM* found to be insignificant throughout the study samples. Based on Arize (1997) the insignificant price effects can be attributed to the use of unit-value indexes, where some aggregations has taken place in the computation process from observation units. But, if the composition of the unit remains the same or the net effect of such changes is insignificant the value obtained are accurate. Besides, price elasticity that is positive and/or insignificant can certainly be the result of poor data quality.

An appealing part of the results is that the exchange rate misalignment, which appeared to be an overvalued in the pre-crisis and undervalued in the crisis period found to have a significant positive impact on imports demand, albeit the size of the Malaysian imports has reduced due to the substantial undervalued exchange rate during the crisis period. This indicates that a 1 percent increase in the Malaysian exchange rate misalignment leads to promote imports in more than 2.5 percent and 1.4 percent in the pre-crisis and crisis periods, respectively. It can therefore be assumed that the Malaysia on the whole relies on its imports sector to further stimulate its economic growth by the invention of higher productivity through the imported inputs such as high technology equipments and machineries.

Another interesting aspect of the results is that the exchange rate volatility found to be statistically significant (with positive effect) on imports demand during the crisis period, signifying that a 1 percent increase in real exchange rate volatility induces approximately 0.7 percent elevate in Malaysian total imports in the crisis period. It can thus be suggested that prior to the crisis, Malaysian real exchange rate was relatively stable and less volatile, which does not cause to any impact on imports demand. However, the eruption of 1997 financial crisis had led to an increase in the uncertainty of exchange rate, which hastens the demand for imports. Hence, it could conceivably be hypothesized that Malaysian importers may imports more to avoid any reduction in revenues arising from increased in exchange rate risk as they are greatly risks averse[14]. This result is consistent with other previous studies that found the volatility of exchange rate beneficial imports (Mckenzie and Brooks, 1997).

The dynamic short-run results and diagnostic tests are summarized in Table 7. The reliability of the error correction model for both the pre-crisis and crisis periods is determined through a number of diagnostic tests such as Breusch-Godfrey serial correlation LM test, ARCH test, Jacque-Bera normality test and Ramsey RESET specification test. The diagnostic tests reveal that over the periods under consideration, the estimated models are well specified, which fulfilled the conditions of non autocorrelation, homoskedastic, normality of residual and zero mean of disturbance. The goodness of fit of the estimated models to the data are also found to be satisfactory, as indicated by the high values of *R*-squared and adjusted *R*-squared. Therefore, the estimated import demand models for the pre-crisis and crisis periods are sufficient and can be used to construct the subsequent explanation on the behavior of Malaysian imports.

As shown in Panel A and B of Table 7, the estimated error correction term, $ECM_{t-1,}$ is negative and statistically significant, implying the imports demand models for the pre-crisis and crisis periods are cointegrated and the long-run equilibrium is attainable. The ECM coefficients term for the pre-crisis (-0.81) and crisis periods (-0.82) depicts that the speed of adjustment of the imports demand in perceiving changes in its determinants is very rapid before converging to its equilibrium level. This means that more than 80 percent of the disequilibria of the previous period's shock adjust back to the long-run equilibrium in the current year. Furthermore, the short-run tests for both the pre-crisis and crisis periods show that the changes in the domestic income and misalignment are positively related with the demand for imports while changes in the volatility merely exert positive impact on imports demand during the crisis period, in addition to their long-run effects. For the meantime, the price of import is insignificant by means of no effect with imports demand in the pre-crisis and crisis periods.

[14] De Grauwe (1988) highlighted that if market participants are risk averse amply, an increase in the exchange rate volatility will raise the expected marginal utility of trade revenue and therefore induce trade to increase.

Table 7 Results of dynamic short-run tests

Dependent Variable ΔIM_t			
Variables	**Coefficients**	**t-statistics**	**Summary Statistics**
Panel A: Pre-crisis period (1992:Q2 to 1997:Q2)			
ΔDI_t	1.790**	3.061	R2 = 0.909
ΔPIM_t	-0.656	-1.686	Adjusted R2 = 0.946
ΔMIS_t (Overvalued)	1.704*	6.625	AR(2) = 4.914 (0.303)
ΔVOL_t	-0.410	-0.335	ARCH(2) = 0.671 (0.530)
ECM_{t-1}	-0.806*	-5.246	JB = 0.379 (0.827)
Constant	-2.691**	-2.439	RESET = 1.066 (0.410)
Panel B: Post-crisis period (1997:Q3 to 2003:Q4)			
ΔDI_t	1.189**	3.194	R2 = 0.916
ΔPIM_t	0.154	0.835	Adjusted R2 = 0.795
ΔMIS_t (Undervalued)	1.146*	4.161	AR(2) = 2.916 (0.123)
ΔVOL_t	0.556***	2.370	ARCH(2) = 0.377 (0.771)
ECM_{t-1}	-0.820*	-5.590	JB = 0.966 (0.617)
Constant	-5.170*	-4.002	RESET = 0.812 (0.394)

Notes: The asterisks (*), (**) and (***) denote the statistically significant at 1%, 5% and 10% levels, respectively. *P*-values are shown in parentheses. AR(*i*) and ARCH(*i*) represent LM-type Breusch-Godfrey Serial Correlation LM and ARCH test at lag *i,* where i = 2. JB refer to Jarque-Bera Normality Test while RESET stand for Ramsey Regression Specification Error Test. The optimal lag-length is determined by the Akaike Information Criterion (AIC).

CONCLUSION

This study examines the dynamic relationship of exchange rate misalignment and volatility on Malaysian import flows that covers from 1991:Q1 to 2003:Q4. The inspiration of having two sub-samples is to portrait a better understanding on the issue, explicitly the pre-crisis (1992:Q2 to 1997:Q2) and crisis periods (1997:Q3 to 2003:Q4). The empirical results established that real imports, domestic income, price of import, exchange rate misalignment and volatility are cointegrated, implying these macroeconomic variables are not drifted far apart in the long run. It is also found that the selected macroeconomics variables are tie closely together in their short-run dynamics.

The findings obtained recommended several policy implications. First, the domestic income has a positive and elastic impact on import volumes in the pre-crisis and crisis periods, suggesting that strong domestic growth in Malaysia will induce higher demand for imports. If import growth outweighs export growth, it may worsen the balance of payment but lead to an appreciation of Malaysian ringgit through the export led growth policy, which improves the problems of balance of payment deficits. Second, the price of import is inelastic and has no significant effect on imports demand all over the study periods. This indicates that as a small open economy, Malaysia seems to be a price taker in the international market, where import prices are beyond the control of Malaysian policymakers. Third, the exchange rate misalignment either overvalued or undervalued exchange rate provides favorable condition to increase the demand for imports in both the pre-crisis and crisis periods. This implies that the performance of the import sector of Malaysian economy determines its export policy and most importantly the export-import policy of Malaysia in order to further generate its economic development. Fourth, exchange rate volatility appeared to favorably affect the demand for imports during the crisis period. This result may indicate that exchange rate volatility is not treated simply as a trading risk by most Malaysian importers to which there is only a little option for dealing with increased exchange rate risk, especially in a small economy like Malaysia.

To this end, different level of the exchange rate misalignment and volatility would have different effects on the allocation of output. The importers tend to be intensified by the exchange rate misalignment as well as exchange rate volatility. Hence, policymakers should rely on an import demand specification that includes the exchange rate misalignment and volatility as the omission of such variables could result omitted variables misspecification. Hence, acknowledgement of the exchange rate misalignment and volatility that affects imports flows is important for the design of exchange rate policy, which is vital in modeling any trade agendas, forecasting and policy formulation. As a consequence, one can generalize that the policies under consideration should include an appropriate measure to reduce the exchange rate fluctuations as well as to restore the exchange rate equilibrium. In conclusion, this study corroborated that a substantial divergence and instability in the exchange rate misalignment and volatility are significantly influenced the demand for imports, especially for a small open economy during the time when the economic is under pressure as in the 1997 Asian financial crisis.

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