Deviation from Purchasing Power Parity: Evidence from Malaysia, 1973–1997

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Deviation from Purchasing Power Parity: Evidence from Malaysia, 1973–1997*

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This paper presents an empirical test of Purchasing Power Parity (PPP) applied to the Malaysia ringgit for the period from 1973 (CPI) and 1984 (WPI) to 1997. Consistent with other research findings, it is detected that real exchange rate follows a random walk. Using multivariate cointegration methodology for the long-run relationship between real exchange rate and certain macro-economic variables, the study provides evidence supporting a long-run relationship between the real exchange rate and the current account balance and government spending, the last two variables have been not included in previous studies of this economy. The causality test between real exchange rate with the current account balance and government spending, however, does not receive support from the error-correction model. This suggests that both government spending and current account balance are not adequate to explain the changes in ringgit real exchange rate. The puzzle still remains unsolved.

I. Introduction

The literature, both theoretical and empirical, on Purchasing Power Parity (PPP) is voluminous. In its simplest form, the absolute version of PPP theory states that in the absence of trade restrictions and transportation costs, the exchange rate between two currencies should be equal to the ratio of the corresponding price level in the two countries. The theory predicts that, in the long run, the only overriding factor affecting movements in the exchange rate between any two currencies is the price level. PPP has a long history of being used as a theory for formulating policies and practices despite dubious support in empirical

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verification. It is also one of the most extensively tested hypotheses in the area of open-economy macroeconomics. This paper focuses on exchange rate behaviour in a relatively small open emerging economy such as Malaysia. Studies pertaining to this economy have produced conflicting results and this paper is a modest attempt to resolve the conflicting results in the literature.

There is meagre but significant empirical evidence available supporting the PPP theory. For instance, McNown and Wallace (1989), and Su Zhou (1997) showed evidence supporting PPP in high-inflation countries.[1] Abuaf and Jorion (1990), Kim (1990), Becketti et al. (1995) and Glen (1992) using relatively long-horizon data; Pippenger (1993) using post-Bretton Woods data, observed evidence supporting PPP. On the other hand, studies rejecting the PPP propositions are abundant: a few of them are Frenkel (1981), Edison (1987), Corbae and Ouliaris (1988), Taylor (1988), Meese and Rogoff (1988), Ballie and Patrick (1989), Gan (1991), Flynn and Boucher (1993), Chowdhury and Sdogati (1993) as well as Zubaidi and Ariff (1997) for five Southeast Asian countries including Malaysia where there was no support found for the theory.[2] All these studies holds that exchange rates in the long run can better be described as a random walk, thus, not supporting PPP.

This mixed bag of empirical findings has, time and again, inspired researches to resolve the conflicts through identification of confounding variables in the PPP – exchange rate relationship. Some studies attempted to explain the failure of PPP by looking at the assumptions underlying the theory such as transportation costs, trade barriers and non-tradable goods. Some other studies suggest that the failure of PPP is due to certain macro-economic variables such as technology, government spending largely on non-tradables, and productivity growth differentials that alter equilibrium relative prices between tradable and non-tradable goods and so cause changes in exchange rates and deviation from PPP. The Samuelson-Balassa hypothesis, for instance, identified productivity differentials between tradable and non-tradables as the determinant of relative price and the exchange rate. (Balassa, 1964; Samuelson, 1964). Rogoff (1992), on the other hand, accounted for high persistence in the real exchange rate by innovations in productivity and government spending. Asea and Mendoza (1994) have presented theoretical arguments that productivity differentials determine international differences in non-tradable relative prices and deviation from the PPP which reflect differences in relative prices.

Bahmani (1992) made the empirical observation that in the case of countries such as Italy, Japan and the United Kingdom, productivity differentials make a major contribution to exchange rates deviating from the PPP theory-suggested equilibrium exchange rate. Selahattin (1996) using quarterly data and the US dollar as base currency for industrial countries such as Germany, Italy and Japan

1. It is argued that for countries with a high rate of inflation, monetary factors rather than the real factor, would be expected to dominate exchange rate variation.
2. For a comprehensive survey of empirical studies in the PPP literature, see Rogoff (1996).

found evidence that such variables as productivity, government spending and real world oil price may explain deviations from the PPP equilibrium. Gan (1991), on the other hand, detected that changes in the relative price of tradable goods and the external terms of the trade also failed to explain the long-run swing in the real effective exchange rate of Malaysia's currency, the ringgit. Consequently, the results relating to Malaysia may have led to the null hypothesis of no relation between some market fundamental and exchange rate being accepted in Gan's study because some other pertinent confounding variables were not controlled in the tests. This study has sought to examine current account balance and government spending as two confounding variables that could explain the deviation from PPP equilibrium in Malaysia.

Manzur and Ariff (1995) applied Theil's Divisia index, or traded index of prices to concurrently test the PPP of five Southeast Asian countries (including Malaysia) and the results indicated that PPP holds poorly in the short run but quite well in the long run.

The present study, however, has sought to provide an insight into how far the PPP hypothesis can be expected to be crucial in the case of a small open economy such as Malaysia. The study aimed at testing the PPP hypothesis: whether real exchange rate of the ringgit (which is not used by Zubaidi and Ariff) follows a random walk. It also probed into the extent of the role played by the current account balance and government spending in causing the deviations from PPP in the case of Malaysia.

The paper is organized as follows. Section II briefly explains the test of PPP and the Augmented Dicky Fuller (ADF) test on real exchange rate. The results of the ADF tests are reported in this section along with possible explanations for deviation from PPP. Section III discusses several macroeconomic variables affecting the equilibrium relative price between tradable and non-tradable goods that might have caused deviation from PPP. In Section IV, Johansen's cointegration methodology is applied to find out whether the real exchange rate is cointegrated with the macroeconomic economic variables. Section V presents estimates from applying the Error-Correction Model and draws inferences, particularly causality between real exchange rate and macroeconomic variables. The findings of the paper are summarized in Section VI.

II. Testing for PPP

PPP implies a linear relation between nominal exchange rate of a currency to the ratio of the domestic and foreign price level. The real exchange rate is defined as the nominal exchange rate adjusted for changes in the domestic and foreign price levels. The real exchange rate can be expressed as:

$$e_t = P_t - P_t^* \tag{1}$$

$$r_t = e_t + P_t^* - P_t \tag{2}$$

where, e_t is the logarithm of the nominal exchange rate measured as the domestic price of one unit of foreign currency, r_t is the real exchange rate of the domestic currency against one unit of foreign currency, P_t and P_t^* are the logarithm of the of domestic and foreign price level with t being time intervals $t = 1, 2, \ldots, T$. In cointegration literature, PPP will be said to be hold in the long run if we find these series, e_t, P_t and P_t^* are individually non-stationary but integrated of the same order with the existence of a linear combination of them, which would be integrated of order zero. An alternative method of testing for a long-run PPP relation is to test whether the real exchange rate follows a random walk. If the real exchange rate follows a random walk, there will be no tendency for the nominal exchange rate and the relative price levels to converge even in the long run. This implies that PPP is not holding for our set of data from this emerging economy.

The price level is usually represented by the wholesale price index (WPI), consumer price index (CPI), or GDP deflator. The use of WPI is usually favoured as a measure of PPP because conceptually, WPI is heavily weighted with tradable goods compared to CPI, which measures price changes in both tradable and non-tradable items. However, as noted by Officer (1978), CPI has the advantage of being a base-weighted index designed to measure changes in the price level of an average basket of commodities in an economy. In our study, therefore, we used both WPI and CPI since quarterly data for these two types of price index are available in Malaysia.[3] Besides, this allows us to examine whether the choice of the price index matters much in the PPP analysis in the case of Malaysia. The data needed for these tests are taken from IMF International Financial Statistics, CD-ROM. The quarterly sample period for the CPI is from 1973.1 to 1997.2, while the sample period for the WPI is from 1984.1 to 1997.2.[4] We use the US dollar as the base currency.[5]

We began with univariate unit root tests for the two real exchange rates for the ringgit: CPI-based and WPI-based real exchange rates. Figures 1 and 2 are plots of both series. Both plots indicate that the currency experienced a real depreciation with no tendency to revert to a long-run mean. The ADF test involves regressing the first difference of the real exchange rate on a constant, and its first lagged level and K-items of lagged first differences as in

$$\Delta r_t = \beta_0 + \beta_1 r_{t-1} + \sum_{i=1}^{k} \gamma_j \Delta r_{t-i} + \varepsilon_t \tag{3}$$

3. The WPI is officially referred to as Producer Price Index (PPI) in the US and Malaysia for all practical purposes.

4. For the want of time and data, the analysis is confined up to the second quarter of 1997. The constraint is posed by the non-availability of PPI data for the third and fourth quarters of 1997 from the IMF's international Financial Statistics, CD-ROM.

5. Although Malaysia formally pegs her currency, ringgit, to a basket of currencies, most of the trade and finance transaction between Malaysia and others countries are in US dollars terms. Apparently, the movement between ringgit and US dollars is crucial in Malaysian exchange-rate policy.

Figure 1 CPI-based Real Exchange Rate

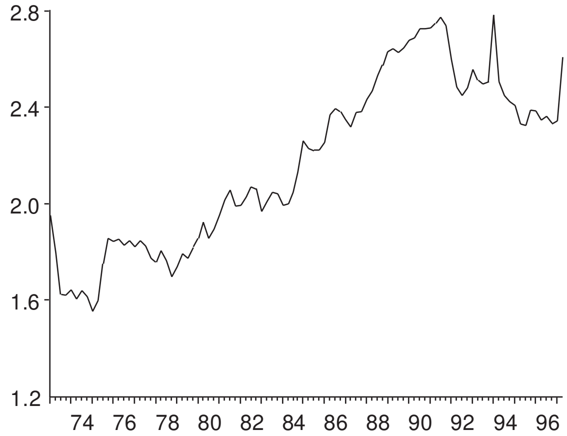
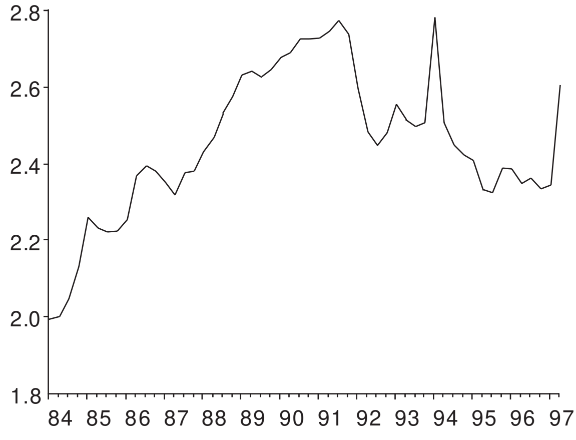


Figure 2 WPI-based Real Exchange Rate



We started with $k = 4$, since the data are quarterly based, and the insignificant lags were progressively deleted to whiten the residuals based on the Box-Pierce Q-test. The white-noise errors are necessary to get valid t-statistics. The ADF equations for the tests above on the real exchange rate include a time trend term to allow for deterministic trend in the series. The critical values for the t-statistics for the ADF equations are based on MacKinnon (1991). The ADF results are reported in Table 1. These indicate that the null hypothesis of a random walk for the real exchange rate is not rejected either in the case of CPI-based real exchange rate series or the WPI real exchange rate series. This finding is consistent with the results of other researchers especially Gan (1991) who found a unit root in the real effective exchange rate.

Table 1 Unit Root Test Results

Variable	t-*statistic*/ (ρ)	Q*(20)/prob*
$r(T)$ (CPI-based)	−2.64(1)	10.98(0.95)
$r(T)$ (WPI-based)	−2.31(0)	8.6226(0.98)

Note: (T) means a constant and a time trend are included, (ρ) means the chosen lag length to include in each series. $Q(20)$ refers to the Q-statistic with 20 degree of freedom. Prob refer to the probability level at that degree of freedom. The 5% critical value of $Q(20)$ is 31.41. The MacKinnon (1991) t-critical values for the sample size of 50 are 1% −4.15, 5% −3.50, 10% −3.18 and for a sample size of 100 are 1% −4.04, 5% −3.45, 10% −3.15.

There are two possible reasons why one may fail to reject the null hypothesis of non-stationarity in real exchange rate. First, it has been pointed out by Edison et al. (1997) that small sample size has very low power to reject a random walk model of real exchange rate. They argued that if the PPP deviations damp sufficiently slowly, then it requires many decades of data for one to be able to reject the existence of a unit root in real exchange rate. One must, therefore, look for a longer data set. The second possible reason is that there are some macroeconomic disturbances, perhaps shocks in the forms of current account and government spending, that caused deviations from PPP in this case. Our next attempt is to identify such disturbances affecting the equilibrium relative price between tradable and non-tradable goods that may have caused deviations from PPP.

III. Deviation from PPP: Model and Methodology

To demonstrate that deviation from PPP is influenced by the changes in the equilibrium relative price between tradable goods, P^T and non-tradable goods, P^{NT}; following Selahattin (1996) and Strauss (1999), we assumed that the PPP hold only for traded goods. Thus

$$e_t = P_t^T - P_t^{T*} \tag{4}$$

where e is already defined, P^{T*} denotes the foreign tradable goods price. The general price level in the domestic and foreign economies is comprised of traded goods, P^{T*}, and non-traded goods, P^{NT} and P^{NT*}. The contributions of traded and non-traded goods to the general price level are assumed to be constant. That is

$$P_t = (1 - \beta)\, P_t^T + \beta\, P_t^{NT} \tag{5}$$

$$P_t^* = (1 - \beta^*)\, P_t^{T*} + \beta^*\, P_t^{NT*} \tag{6}$$

where β and (1 − β) represent the share of traded and non-traded goods in both economies. Real exchange rate is defined in Equation (2) as $r_t = e_t + P_t^* - P_t$.

Substituting Equations (3) to (6) into Equation (2) yields real exchange rate as a function of domestic and foreign relative prices of tradable and non-tradable goods. Thus

$$r_t = -\beta(P_t^{NT} - P_t^T) + \beta^*(P_t^{NT*} - P_t^{T*}) \tag{7}$$

Equation (7) states that the real exchange rate is a function of the relative price of tradable and non-tradable goods in the domestic and foreign economy, respectively. For example, an increase in the domestic relative price of a non-tradable decreases *r*. That is real exchange rate appreciating.

Rogoff (1996) in a survey of PPP literature mentioned that deviation from PPP can be accounted by three factors, viz: (1) productivity differential as suggested by Balassa (1964) and Samuelson (1964), (ii) government spending and, (iii) current account balances. The Balassa-Samuelson hypothesis implies that an increase in the productivity of traded goods but not in the non-traded goods leads to an increase in the relative price of non-tradables, which causes the real exchange rate to appreciate.

Productivity differentials are only one of several contributing factors in explaining permanent change in the real exchange rate. The persistent change in the real exchange rate can arise from a change in government consumption spending that falls largely on the non-traded sector. Suppose a government expands its spending, allowing government revenue, nominal exchange rate and price of tradable goods to remain constant, the price of non-tradable goods would increase and thus cause the real exchange rate to appreciate. Froot and Rogoff (1991) sought to find out the extent to which increases in government spending could explain significant shifts in real exchange rates over the EMS period. They regressed real CPI exchange rates against various measures of productivity differentials and government spending. They observed that the government spending variable consistently entered with correct sign in all the individual country regressions, and was strongly significant in pooled time series cross-sectional regression. They attributed this to the fact that the governments tended to spend more heavily on non-tradable goods. Therefore, a rise in government spending leads to an increase in the real exchange rate.

Another explanation for deviation from PPP is that the real exchange rate changes are due to imbalances of the current account. Theoretically, substantial current account (CA) deficits are associated with long-run real exchange rate depreciation. Krugman (1990) argued that CA deficits are likely to induce significant exchange-rate changes because different countries tend to exhibit different spending patterns. This implies that the residents of a country having a current account deficit spend more on tradable goods than non-tradable goods, this will cause a decrease in the domestic relative price of non-tradable and the real exchange rate depreciates. Implicitly this would mean that the causality is from CA balance to the real exchange rate. Edwards (1999), in a theoretical analysis, also emphasised that current account dynamics will affect real exchange rate behaviour, specifically, current account deficit will be associated with a temporary real exchange rate depreciation, and vice versa. One may, therefore, tend to assume unicausality from CA balance to the real exchange rate; though the possibility of causality the other way round, from real exchange rate to the CA may not necessarily be ruled out.

The above discussion leads us to examine whether any one of these factors contributes to the deviation from PPP in the case of Malaysia. In this respect, we considered two variables, namely, government spending and current account balance in the Malaysian context.[6]

It is commonly believed that the rapid growth in government expenditure in the 1980s was an important determinant of the relative prices of non-tradable goods in Malaysia. Government expenditure as a percentage of the GDP rose from an average of 17% in the late 1950s to a peak of 37% in the early 1980s. In both the recessionary periods (1983–85 and 1998), the government appeared to be adopting the Keynesian remedy, i.e. to increase government spending in order to boost the economy. A current account deficit was considered to be a grave problem only in the 1980s on account of the global recession. In 1982, which marked the end of the commodity price boom on which Malaysia progressed, the CA deficit was about 14% of total GNP. The rapid economic recovery after 1987 substantially improved the CA balance. However, the high growth beginning in the 1990s, an investment boom without a corresponding increase in the domestic saving rate and rapid appreciation of real exchange rate, has led to high CA deficits since 1993, with the highest deficit recorded in 1995 at 9.8% of GDP. The CA deficit with a slowing of foreign capital inflows had provided opportunity for speculation on a depreciation of the ringgit which was heavily pegged to the US dollar in 1997.

If the observed deviation from PPP in Malaysia or the non-stationarity in the real exchange rate of the ringgit is caused by the government spending and the current account balance, then the ringgit real exchange rate can be expected to be cointegrated with these two variables. Following Selahatin (1996), we considered domestic and foreign government spending that fell largely on the non-traded sector. The specification of the testing equation is

$$r_t = \beta_0 + \beta_1(g_t - g_t^*) + \beta_2 CA_t + \mu_t \tag{8}$$

where, r_t is the logarithm of the CPI or WPI real exchange rates with US dollar, g_t and g_t^* are nominal Malaysian and US government spending on non-tradable goods and CA_t is the current account balance in Malaysia. If Equation (8) represents an equilibrium for the exchange rate in the long run, then r_t, $(g_t - g_t^*)$ and CA_t must be cointegrated. We used the multivariate cointegration methodology proposed by Johansen (1988) and Johansen and Juselius (1990). The Johansen maximum likelihood allows testing of the multivariate framework and avoids some of the drawbacks of the Engle and Granger (1987) cointegration methodology.

6. We did not include the Balassa – Samuelson model since quarterly data on productivity traded and non-traded sectors are not available in Malaysia.

The Johansen maximum likelihood procedure, which is based on the vector error-correction model, is of the following form

$$\Delta Y_t = \sum_{i=1}^{\rho-1} \alpha_i \Delta Y_{t-i+1} + \Pi Y_{t-1} + \varepsilon_t \tag{9}$$

where, Y_t is the 3×1 vector of all $I(1)$ processes r_t, CA_t, $(g_t - g_t^*)$. Y_{t-1} is the 3×1 vector that contains the first lag of the variables r_t, CA_t, $(g_t - g_t^*)$. The long-run relation in the data set is captured in the Π matrix. The rank of Π is w, equals the number of cointegrating vectors which is tested by the maximum eigenvalues and trace statistics; with critical values from Osterwald and Lenum (1992). The ε_t is a vector of white noise process.

IV. Data and Results

The relevant data are obtained from IMF's International Financial Statistics, CD-ROM. Since it is not possible to decompose government expenditure into spending on tradable vs. non-tradable goods, we have used general government expenditure in national account as a proxy for government spending on non-tradable goods. The quarterly data on the CA balance are not available, hence, we use trade balances as a proxy for the CA balance. Two models have been tested in this context. Model 1 is based on the CPI real exchange rate with data from 1973.1 to 1997.2. Model 2 is based on the WPI real exchange rate for which the data begin from 1984.1 onwards. All variables are measured in logarithms.

A precondition for the cointegration test is whether the individual series to be regressed on r_t, i.e. CA_t, or $(g_t - g_t^*)$, has a common order of integration. The test results based on the ADF test are shown in Table 2, which presents evidence that each series is integrated of order one; that is, each series is I(1). The ADF test on $(g_t - g_t^*)$ series includes an intercept and time-trend term. In testing for unit root in the first differences, only the intercept is included in all series. Each test equation includes four lags, where the adequacy of the lag length (as indicated in Table 2) is checked with tests for serial correlation using the Box-Pierce Q-test.

To run the Johansen cointegration test, we first tested the appropriate lag length since the results of the Johansen test can be quite sensitive to the lag length. The Sim's likelihood ratio tests were carried out.[7] Taking into account

7. The likelihood ratio test estimated by Sim is the following

$$LR = (T - c)\,(\ln|\Sigma r| - \ln|\Sigma u|) \sim \chi^2$$

where T is the number of observations in the unrestricted model, c the number of parameters used in the unrestricted model, $\ln|\Sigma r|$ the natural logarithm of the determinant of the restricted model, and $\ln|\Sigma u|$ the natural logarithm of the determinant of the unrestricted model.

Table 2 Unit Root Test Results

Variable	t-*statistics/ (ρ)*	Q*(20)/(prob)*
Model 1 (CPI-based real exchange rate, 1973.1–1997.2)		
$(g_t - g_t^*)$ (T)	−2.32 (1,2,3,4)	25.13 (0.19)
$CA(C)$	−2.87 (7,8)	17.69 (0.61)
$\Delta r(C)$	−8.10 (0)***	18.37 (0.86)
CPI-based		
$\Delta(g_t - g_t^*)$ (C)	−17.10 (1,3,4)***	23.82 (0.25)
$\Delta CA(C)$	−6.71 (1,7)***	19.33 (0.50)
Model 2 (WPI-based real exchange rate, 1984.1–1997.2)		
$(g_t - g_t^*)$ (T)	−2.84 (1,2,3)	24.80 (0.21)
$CA(C)$	−2.15 (0)	10.12 (0.92)
Δr(C)	−6.23 (0)***	7.02 (0.97)
WPI-based		
$\Delta(g_t - g_t^*)$ (C)	−26.22 (1,2)***	22.36 (0.32)
$\Delta CA(C)$	−5.91 (0)***	12.05 (0.91)

Note: *** significant at 1%; (c) means a constant is included; (T) means a constant and a time trend are included; (ρ) means the significance lags to include in each series. Q(20) refers to the Q-statistic with 20 degree of freedom. Prob refer to the probability level at that degree of freedom. The 5% critical value of Q(20) is 31.41. The MacKinnon (1991) t-critical values for the size sample of 100: (T) are: 1% −4.04, 5% −3.45, 10% −3.15; (C) are: 1% −3.51, 5% −2.89, 10% −2.58. The MacKinnon (1991) t-critical values for the size sample of 50: (T) are 1% −4.15, 5% −3.50, 10% −3.18; (C) are 1% −3.58, 5% −2.93, 10% −2.60.

that the data are quarterly, Vector Auto Regression models with 8, 6, 4 and 2 are specified for CPI-base real exchange rate model (6, 4 and 2 lags for WPI-based real exchange rate model), with common lags on all three variables in each model. The computed likelihood ratio statistics follow a chi-square distribution, with degrees of freedom equal to the number of variables omitted in the restricted model. The null hypothesis that all omitted lags in the restricted model have zero coefficients was tested for lags from 8 to 6, 6 to 4 and 4 to 2. The results of the test are presented in Table 3.

In Model 1, the χ^2 test statistics for lags from 4 to 2 are bigger than the critical value at the 1% level of significance, therefore, the null hypothesis is rejected. This implies that the lags from 4 to 2 are statistically significant. The χ^2 test statistics for the lags 6 to 4 and 8 to 4 are smaller than the critical value at the 1% level of significance, therefore, we fail to reject the null hypothesis. This means that best lag length for the CPI-based real exchange rate model is 4 lags. In Model 2, we also found that 4-lag specification was the best for the WPI-based real exchange rate model. Thus, we specified 4 lags for both models in Johansen tests. The result of the Johansen test is shown in Table 4. We included

Table 3 Likelihood Ratio Test

Lags	χ^2 *statistics*	*Conclusion*
Model 1 (CPI-based real exchange rate)		
4 to 2 lags	157.28	reject H_0 at 1% level of significance
6 to 4 lags	14.10	do not reject H_0 at 1% level of significance
8 to 4 lags	43.09	do not reject H_0 at 1% level of significance

Note: The degree of freedom for the lags from 4 to 2 and 6 to 4 are 18, from 8 to 4 are 36.
The χ^2 critical value for degree of freedom 18 are : 1% 34.80, 5% 28.87, 10% 25.98
36 are : 1% 63.69, 5% 55.75, 10% 51.80.

Lags	χ^2 *statistics*	*Conclusion*
Model 2 (WPI-based real exchange rate)		
4 to 2 lags	79.37	reject H_0 at 1% level of significance
6 to 4 lags	20.69	do not reject H_0 at 1% level of significance

Note: The degree of freedom for the lags from 4 to 2 and 6 to 4 are 18.
The χ^2 critical value for degree of freedom 18 are: 1% 34.80, 5% 28.87, 10% 25.98.

H_0: All omitted lags in the restricted model have zero coefficients.

Table 4 Johansen Cointegration Test

	λ_{max}			λ_{trace}		
Model 1 (CPI-based real exchange rate)						
Null Hypothesis (H_0)	$w = 0$	$w = 1$	$w = 2$	$w = 0$	$w \leq 1$	$w \leq 2$
Alternative Hypothesis (H_1)	$w = 1$	$w = 2$	$w = 3$	$w > 0$	$w \geq 2$	$w \geq 3$
	10.31	5.73	0.90	16.94	6.63	0.90
Model 2 (WPI-based real exchange rate)						
Null Hypothesis (H_0)	$w = 0$	$w = 1$	$w = 2$	$w = 0$	$w \leq 1$	$w \leq 2$
Alternative Hypothesis (H_1)	$w = 1$	$w = 2$	$w = 3$	$w > 0$	$w \geq 2$	$w \geq 3$
	22.20*	9.88	3.36	35.45*	13.25	3.36

Note: The second column reports the λ_{max} statistics as number of observations multiplier $\ln(1 - \hat{\lambda}_i)$ where $\hat{\lambda}_i$ is the estimated values of the characteristic roots or eigenvalues obtained from the estimated π matrixs. The last column reports the λ_{trace} statistics as the summations of λ_{max} statistics. * denotes significance at 5%. The critical values for the λ_{max} at 5% significance level are 21.894 ($n - w = 3$), 15.75 ($n - w = 2$), 9.094 ($n - w = 1$). The critical values for the λ_{trace} at 5% significance level are 35.068 ($n - w = 3$), 20.168 ($n - w = 2$), 9.094 ($n - w = 1$) where n denotes the number of variables in the model, w denotes the number of cointegrating vectors.

an intercept and a linear trend in the data and no trend in the cointegrating equation when running the Johansen procedure. This is because the plot of data, $(g_t - g_t^*)$ showed a clear deterministic trend and the trend is significant in the ADF test.

The results shown in Table 4 are quite interesting. Using CPI as the base real exchange rate, the λ_{max} shows that we fail to reject the null hypothesis at the 5% significance level at $w = 1$. By using WPI as the base of real exchange rate, the λ_{max} test shows that we are able to reject the null hypothesis at the 5% significance level (but not at the 1% level) at $w = 1$ but not at $w = 2$. This confirms that there is only one cointegrating vector in Model 2. Using the λ_{trace} statistics, we again arrived at the same conclusion.

Even though we used a shorter time period for the WPI-based model than for the CPI-based model, we found that the cointegration results favoured the former rather than the latter. This again makes it clear that the CPI index, which gives a significant weight to non-tradable goods, is not a proper measure for testing PPP, at least, in the Malaysia case.[8]

V. Error-Correction Model

Cointegration is a necessary and sufficient condition for the representation of economic time series in an error-correction model (ECM) which combines both the short-run dynamics and the long-run equilibrium relations among the series. Short-run dynamics in the ECM are captured by the Error-Correction Term (ECT) and the conventional tests of causality are based on the significance of ECT and any significance of the lagged difference terms in the ECM. Since we found one cointegrating vector in model 2, namely the results using the WPI based real exchange rate, this allows us to proceed with the ECM to identify the causality among variables in the model. Table 5 reports the OLS regression estimates of WPI-based real exchange rate with CA and $(g_t - g_t^*)$ of the ECM in an restricted form. We allow lags from 1 to 4 on the differences of all variables, and then omit insignificant terms. These restricted ECM estimates pass a series of diagnostic tests using Box-Pierce Q test.

The major findings reported in Table 5 show that all the ECT tests are statistically significant. This implies that r, $(g_t - g_t^*)$ and CA are all adjusted to the long-run equilibrium with the CA adjusting the most with a coefficient of 0.33. It means that 33% of the disequilibrium in CA will be corrected in the next period. Indeed, the real exchange rate is adjusted least with a coefficient of just 0.007.

8. By estimating the normalizing equation of real exchange rate determination with respect to the explanatory variables, we have:

$$\underset{}{r_t = -2.855}\underset{(3.09)}{(g_t - g_t^*)} - \underset{(4.32)}{1.864CA_t} - 8.939$$

Parentheses represent the standard errors of each parameter. Since neither estimated coefficient is statistically significant, we will not address the economic implication.

Table 5 OLS estimates for the ECM

Dependent Variable	Δr	ΔCA	$\Delta(g_t - g_t^*)$
C	0.138(2.08)	−6.012(3.78)	−1.333(2.59)
$R(-1)$	0.007(2.01)	−0.333(3.74)	−0.075(2.61)
$\Delta CA\ (-3)$		0.481(2.02)	
$\Delta(g_t - g_t^*)(-1)$		0.993(3.84)	−0.800(9.59)
$\Delta(g_t - g_t^*)(-2)$		0.422(2.01)	−0.822(10.02)
$\Delta(g_t - g_t^*)(-3)$			−0.866(14.80)
$\bar{R}^2$	0.055	0.244	0.918
$Q(4)$/prob	1.30(0.861)	0.4980(0.974)	3.296(0.510)
$Q(8)$/prob	3.34(0.911)	3.5261(0.897)	7.324(0.502)
$Q(12)$/prob	10.442(0.577)	4.0449(0.983)	14.922(0.246)
$Q(20)$/prob	14.52(0.803)	7.5791(0.994)	24.743(0.211)

Note: R is the residual series from the OLS cointegrating regressions WPI-based r_t, $(g_t - g_t^*)$ and CA. $\bar{R}^2$ is the adjusted R-squared. $Q(n)$/prob is the Box-Pierce Q Statistics at n degree of freedom, prob is the level of probability. Parentheses represent the absolute values of t-ratios.

This may be attributed to the relatively low level of inflation in both Malaysia and USA during the tested period. Perhaps the managed exchange rate system is partly responsible, under which the country's exchange rate was managed within a band of ringgit 2.50 – 2.70 right up to the Asian Financial Crisis of 1997–8. The significant lagged difference in the ECM implies a causality relation among the variables. In Table 5, astonishingly, we found no causal relationship of r with CA nor with $(g_t - g_t^*)$. Furthermore, only a unidirectional causality from $(g_t - g_t^*)$ to CA is observed. Critically, there is no causality from exchange rate to the two variables. The causality test results, thus, imply that real economic shocks, if indeed these two variables (government spending and current account balances) indicate shocks to PPP equilibrium, are also not adequate to explain the changes in the real exchange rate in Malaysia.

VI. Conclusion

This study suggests that the Malaysia's real exchange rate follow a random walk contrary to the expectations of PPP equilibrium. It also confirms that the type of price index does matter in testing the PPP relation in this economy. The WPI index is perhaps more appropriate than the CPI index in this regard. In one of the test results, use of the WPI produced results consistent with the long-run equilibrium, which is consistent with Manzur and Ariff (1995), who used a trade-related index of prices.

Furthermore, in our study, the Johansen cointegration test indicates that a cointegrating relationship exists between current account balance, government spending and the WPI real exchange rate. This may facilitate correction of a possible modelling error in Gan (1991) and Zubaidi and Ariff (1997).

Our empirical findings are consistent with Melvin's (1997) proposition that only when there is a large increase in the domestic general price level using a longer time frame, can one find relative price between tradable and non-tradable goods changing the exchange rate. In view of the low inflation rate in Malaysia and also in the US, coupled with the short horizon over which the tests are done, one need not be surprised to see that these relative price effects between tradable and non-tradable goods may dominate the changes on the real exchange rate. Our results fail to identify the causality between the real exchange rate, the current account balance as well as government spending in this test case. As has been made clear the empirical part of this paper is limited to testing deviations from PPP and accounting for the select macroeconomic variables only. In particular, we investigated only two major sources of disturbance to the real exchange rate. The real exchange rate, however, may respond to a multitude of macroeconomic variables in the long run. Future research studies may need to focus on this point.

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