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A Study on the Short and Long Run Determinants of Purchasing Power Parity in Malaysia

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Abstract: Purchasing Power Parity (PPP) concept is founded on the law of one price; which is the idea that in the absence of transaction costs, identical goods will have the same price in different markets. This concept is particularly prominent in three ways; one (1) it theorizes the exchange rate determination; two (2) it can provide a reference point against which the current exchange rate can be deemed to be "under or over-valued" relative to its PPP level; and three (3) irrespective of whether PPP will ever occur in the real world, deviations from it must be taken into account in making cross-regional comparisons of productivity. The basic idea of this study revolves around determining whether or not short- and long-run causality relationships exist between the PPP and the selected macro variables in the Malaysian context. Using annual time-series data ranging from 1977 to 2009, a time-series analysis methodology was conducted by regressing the values of PPP against four macro variables namely; Real Exchange rate, Consumer Price Index, Interest Rate and Money Supply. The study had discovered that all of the explanatory variables were related to PPP in the long-run, in which the PPP was negatively related to the Real Exchange Rate and Money Supply and positive in the case of Consumer price Index and Interest Rate. In addition to that, the PPP was also found to be Granger-caused by the Real Exchange Rate, Interest Rate and Money Supply. However, no such relation was found for Consumer Price Index. Since all of the variables were found to significantly influence the PPP, future studies could also incorporate other macro variables such as economic growth and net export into the model.

Key words: Purchasing Power Parity · Macroeconomic variables · Malaysian economy · Time series analysis

INTRODUCTION

The concept of purchasing power parity (PPP) has been the subject of plentiful studies, many of which have been unable to prove conclusively this core principle of international finance. According to [1], although industrialized countries have received most of the attention, studies that focus on less-developed and transition economies have also obtained mixed results. A study by [2] stated that the purchasing power parity or PPP theory has a long history in economics, dating back several centuries, but the terminology was introduced in the years after World War 1, concerning the appropriate level for nominal exchange rate among the major industrialized countries due to the large scale pre- and post-war inflation.

The basic theory asserts that the prices of common goods between two currencies should be equal once prices have been converted to a common currency. According to [3], in the fundamental form, purchasing power parity is a ratio that demonstrates the relative price level difference between two countries for similar products or group of products. The concept of PPP is also fulfilled when "the equilibrium rate of exchange equalizes the purchasing power of a currency in a country, with what it might buy in the exterior if it was converted into a foreign currency".

Neary argued that PPP is important in international economics for at least three reasons. First, it provides a simple theory of exchange rate determination: it predicts that, if the relative price of two currencies is flexible, then it will adjust to equal the ratio of their price levels. Second,

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if this kind of adjustment does not take place, the ratio of price levels can still provide a reference point against which the current exchange rate can be deemed to be "under- or over-valued" relative to its PPP level. Finally, irrespective of whether PPP will ever occur in practice, deviations from it must be taken into account in making international and interregional comparisons of real income [4].

A research by [5] aims to expand PPP literature by two fold. First, the performance of conventional linear PPP model (OLS) was compared with nonlinear PPP (GARCH). Secondly, the researchers revisited the PPP by using more recent data for the currencies of five leading members of the Association of Southeast Asia nations (ASEAN-5), including Malaysia. The researchers proved that exchange rate has significant relationship with the PPP model. A study by [6] presents an empirical analysis of purchasing power parity for 10 emerging market economies using cointegration technique. Evidences of nonstationarity between nominal exchange rate and CPI were found. Furthermore, a research by [7] in Pakistan using 28 observations from 1980 to 2008 stated that the consumer price index (CPI) as the measurement of price level has a significant effect towards PPP. CPI also has the advantage of providing a comprehensive measure of changes in competitiveness as it is based on a large group of goods and services. Another advantage is that almost every country publishes fairly reliable data on CPI, thus enhancing the accuracy of the results.

Results by [8] concluded that the interest rate parity is one of the methods developed to explain exchange rate movements which are purchasing power parity. The study focuses on explaining exchange rate movements using interest rate parity condition to the purchasing power parity. The result shows that there is a relationship between both variables. [9] Stated that the increases in domestic prices in the high-growth country would increase the PPP. Similarly, [10] findings reveal that the East Asian countries are returning to some form of PPP-oriented rule as a basis for their exchange rate policies due to the very small persistence of PPP deviations. Due to its' importance, this study focuses on how the PPP theory works in Malaysia and its' performance indicator, whether is weak or strong by determining the economic factors that can influence it. The economic factors like real exchange rate, consumer price index, real interest rate and money supply are introduced in this study.

Methodology: A model to predict the performance of PPP in Malaysia is laid down as follows. This model attempts to quantify the contribution of different determinants of PPP. This study incorporates a time series dataset ranging from 1977 to 2009 consisting of one dependent variable and four independent variables. The identified model hypothesizes PPP rate as a function of real exchange rate, consumer price index, real interest rate and money supply.

$$PPP = F(RER, CPI, INT, MS) \quad (1)$$

Where, PPP represents the Purchasing Power Parity rates in Malaysia (RM/USD); RER represents monthly real exchange rate; INT represents real interest rate; MS represents money supply and t-sign represents the time trend. A multivariate model is underlined as follows:

$$\ln(PPP_t) = \alpha + \beta 1 \ln(RER_t) + \beta 2 \ln(CPI_t) + \beta_3 \ln(INT_t) + \beta_4(MS_t) + \mu_t \quad (2)$$

Because there are four(4) variables in the equation, there can be more than one co-integration vector. In this context, the variables in Equation 2 may feature as part of several equilibrium relationships governing the joint evaluation of the variables. The model is derived into log-log model as the result can be used to determine the elasticity of each variable.

Using STATA statistical package, a time-series hypothesis testing methodologies was employed in three stages involving the tests for; one(1) stationarity (or unit root-tests; to determine whether the individual time series data is stationary or non-stationary using the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) Tests); two(2) cointegration test (carried out after all variables are stationary at first difference, with a purpose to examine the long-run relationship between the dependent variables and independent variables using Johansen test and VECM); and three(3) Granger causality test to investigate the short-run dynamic causality.

Unit Root Tests: A study by [11] stated that the main purpose of the unit root tests is to make sure that the data used for the study is stationary, which means that the trends need to be smoothened in order to avoid running a spurious regression. Both Augmented Dickey Fuller and Phillip Perron tests was conducted at the level and first difference values to determine the series order of integration which makes the series stationary. Both tests set the null hypothesis of non-stationary series (existence of unit root) against the alternative of stationary series (no unit root).

Augmented Dickey Fuller (ADF) Test: The ADF test is based on the regression equation with the inclusion of a constant and a trend:

$$\Delta Xt = \beta 0 + \mu t + \delta Xt\text{-}1 + \Sigma \alpha i \, \Delta Xt\text{-}i + \varepsilon t \qquad (3)$$

Where Xt = Variables of interest in the logarithm forms at time trend t, ΔXt-i expresses the first differences with k lags, ε is the white noise residual of zero mean and constant variance. The coefficients {β0, δ, μt, α1,..., αk} are parameters being estimated. The unit root hypothesis can be rejected if the t-test statistic from these tests is negatively less than the crucial value tabulated.

Phillips-Perron (PP) Test: An alternative strategy is known as the Phillips-Perron (PP) unit root test which deals with potential serial correlation in the errors by employing a correction factor that estimates the long-run variance of the error process with a variant of the Newey-West formula. Similar to ADF, PP test requires specification of a lag order; in the latter case, the lag order designates the number of lags to be included in the long-run variance estimate.

Cointegration Test: The cointegration test can be applied in several ways according to the nature of the equation. If it is a single system, the Engle Granger method is used; if it is a multivariate system, the Johansen Approach is applied. However, the multivariate cointegration technique proposed by [12] is said to be superior to determine the existence of the long run relationship among the variables.

Johansen and Juselius Cointegration: [13] stated that this method sets out a maximum likelihood procedure for the estimation of the co-integrating vectors' presence in a Vector Autoregressive (VAR) model. There are two test statistics that can be used in identifying the number of cointegrating vectors (r) which are the maximum eigenvalue and trace statistics. A rank of zero means that there is no cointegrating relationship. If the rank is one there is one, if it is two there are two and so on.

Vector Error Correction Model (VECM): If cointegration has been detected, this already suggests the existence of a long-term equilibrium relationship. Thus, VECM is applied to evaluate the long run properties of the cointegrated series. In VECM, the cointegration rank shows the number of cointegrating vectors. For instance, a rank of two indicates that two linearly independent combinations of the non-stationary variables will be stationary.

Granger Causality Test: The purpose of Granger Causality test is to find out any short-run causality relationships among the variables. The test helps to verify whether changes in any series can be explained by the other series. A verdict of unidirectional causality occurs between two variables if either null hypothesis of the cross pairs is rejected. Bidirectional causality exists if both null hypotheses are rejected and there is no causality if both null hypotheses fail to be rejected.

RESULTS AND DISCUSSION

Trends of Variable: Based on figure 1, no absolute trend can be seen as the movements of PPP levels were quite normal. In 1977, the PPP level was recorded at RM1.60 before it experienced a slight increase in the next three years before gradually appreciating (decreasing in value) until 1987. From that point, the PPP levels began to pick up before settling at RM1.80 in 2009. The growths in values were quite small and the PPP rates were also behaving in a non-volatile manner, which signifies the stability of the exchange rates. The real exchange rate's movement did not exhibit a clear and steady trend, but it can be said that the movements took place in small values from 1977 until mid-90. However, a very sudden hike in the rate took place in 1998 due to the Asian currency speculative attack.

On the other hand, a continuously increasing trend was vividly seen involving the CPI variable. It means that the price levels in Malaysia had moved in an increasing order throughout the years and that the prices of goods and services had been steadily appreciating. The highest point was recorded in 2009 when the country's CPI surged to the level of 140 points. Contrary to that, the real interest rate movements saw a steady decline starting mid-80s until 2009 which might be in response to the ever-increasing inflation rate as explained in the above subsection. Since the real interest rate is obtained by subtracting the nominal interest rate with the inflation rate, the real interest rate level will fall as the counterpart rises. The level of M2 money supply had also been steadily increasing except that there have been small ups and downs between the year of 1997 and 2000. In theory, the level of money in circulation is negatively related to the interest rates prevailing in the nation.

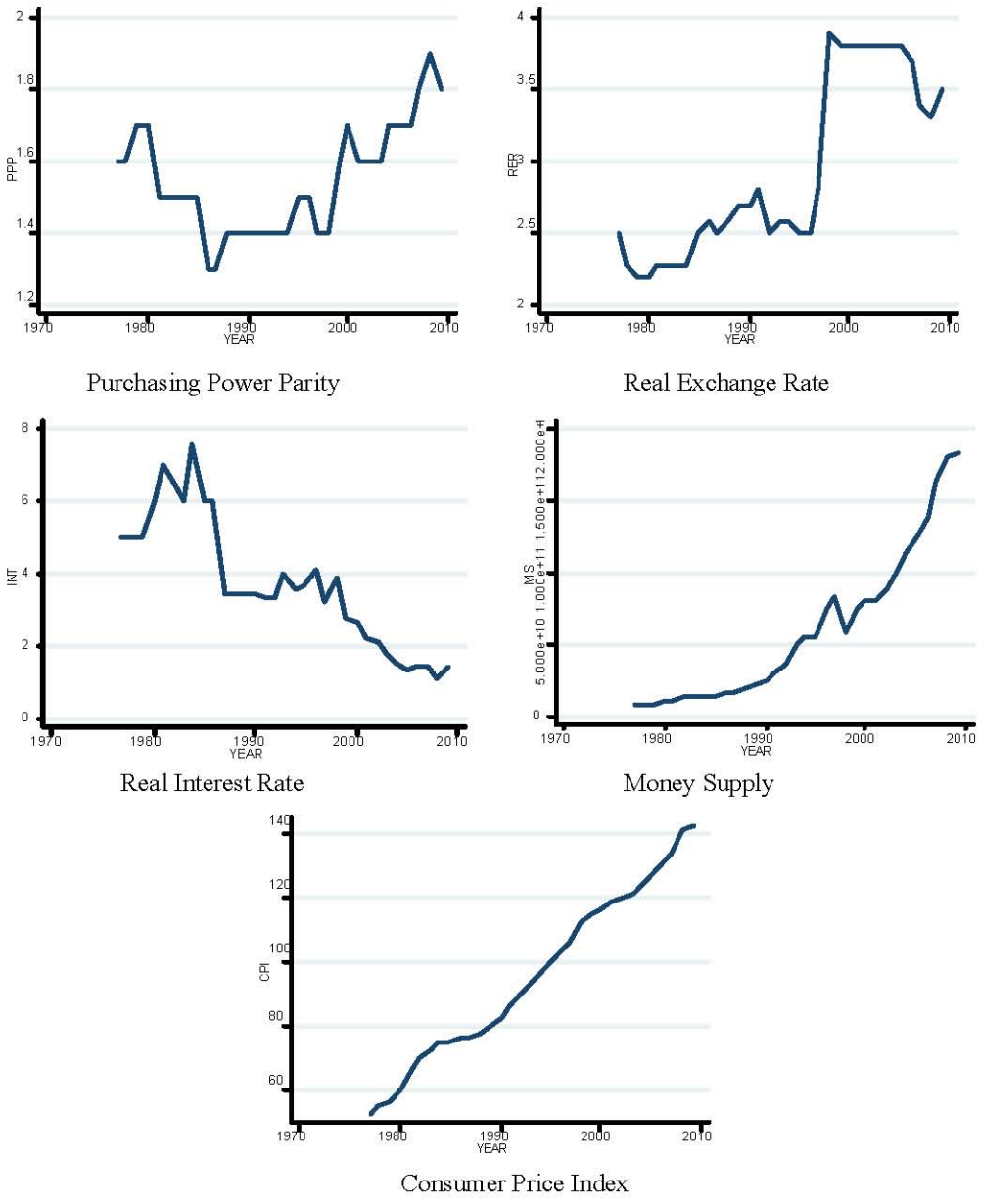

Fig. 1: Trends of the variables' dataset

Unit Root Tests

At Level: The result of unit root tests (ADF and PP tests) on the level values of the series is given in the Table 1. In all cases for both unit root tests on the level, the absolute value of P-value was larger than significant level of 0.05, suggesting that the null hypothesis of the presence of unit root could not be rejected and that all of the series were non stationary in their level forms.

At First Difference: Upon generating the first-difference values of the variables and running the ADF unit root test again, the researcher found out that all null hypotheses were successfully rejected. There was no longer any presence of unit root and therefore, all of the variables were stationary at first difference level in Table 2. Next, the PP test was also conducted to verify the results of the ADF test above. Consistent to the ADF test result, the PP test yielded a result that all of the variables were stationary in their first-differenced form. All of the respective null hypotheses were well-rejected at 5% significant level. Therefore the researcher concluded that all of the null hypothesis of the series were rejected, implying that all them were I (1).

Table 1: Unit root tests at level

	Augmented Dickey-fuller Test	Phillip-perron Test
Test	---	---
Variables	MacKinnon approximate p-value for Z(t) (5% critical level)	MacKinnon approximate p-value for Z(t) (5% critical level)
PPP	0.6749	0.7575
RER	0.7919	0.7711
CPI	0.0900	0.2697
INT	0.9128	0.9267
MS	0.7969	0.7849

Table 2: Unit root tests at first difference

	Augmented Dickey-fuller Test	Phillip-perron Test
	---	---
Variables	MacKinnon approximate p-value for Z(t) (5% critical level)	MacKinnon approximate p-value for Z(t) (5% critical level)
PPP	0.0000	0.0000
RER	0.0001	0.0001
CPI	0.0367	0.0365
INT	0.0000	0.0000
MS	0.0000	0.0000

Table 3: Lag order selection criteria

Johansen tests for cointergration

Trend: constant — Number of obs = 30

Sample : 1980-2009 — Lags = 3

Maxium rank	Parms	LL	Eigenvalure	Trace statistic	5% Citical
0	55	250.62571	.	112.5039	68.52
1	64	280.09795	0.85282	53.5594	47.21
2	71	293.33862	0.58634	27.0781*	29.68
3	76	299.98511	0.35796		
4	79	306.01175	0.33087	13.7851	15.41
5	80	306.87767	0.05609	1.7381	3.76

Table 4: VECM estimation result

Cointification equation

Equation	Parms	Chi2	P>Chi2
_Ce1	4	52.24923	0.0000

identification: beta is exaectly identified johanson normalization restriction imposed

_Ce1	Coef.	Std. Err.	Z	P>|Z|	[95% coff. Inteival]
Inppp	1	.	.	.	.
Inrer	-.3537827	.1267777	-2.79	0.005	-.105303
Incpi	1.070599	.3151394	3.40	0.001	1.68826
Inint	.1377887	.0572674	2.41	0.016	.2500308
InMS	-.211288	.0872665	-2.42	0.015	-.0402488
_Ce1	-.03448345	.	.	.	.

Table 5: Results for Granger Causality test

	Dependent Variables				
	$P > chi^2$				
Inde-pendent Variables	PPP	RER	CPI	INT	MS
PPP	-	0.7317	0.5080	0.0504	0.3604
RER	0.0000	-	-	-	-
CPI	0.0825	-	-	-	-
INT	0.0000	-	-	-	-
MS	0.0000	-	-	-	-

Cointegration Test: The Table 3 is the result obtained upon the application of Johansen cointegration test based on ECM. The results are going to interpreted based on the maximum eigenvalues and the trace test statistics.

The Johansen test is conducted using a lag length of 3 and a rank is obtained. The star (*) at the trace statistic was denoted at 2 which suggests a maximum rank of 2. Thus, the VECM can now be carried out using the rank of 2 to test for any long-term relationships between the variables. Table 4 contains the results for the VECM estimation:

It is now proven that there were significant long run relationships between all of the independent variables and the dependent variable since all of the respected p-values are significant at less than 5% critical level. The null hypotheses are hence rejected, which means that the Real Exchange Rate, Consumer Price Index, Real Interest Rate and Money Supply were significant in influencing the PPP performance in the long-run. The joint significance, as indicated by the p>chi2 is recorded at 0.0000, which means that the variables in togetherness could also effectively influence the movements of the PPP performance in the long-run. The null hypothesis is therefore well-rejected. Furthermore, to tackle the issues of elasticity (magnitude) and the direction of relationships, the results are extracted and expressed in the following cointegration equation:

$$PPP = -0.03483 - 0.3538\,RER + 1.0706\,CPI + 0.1378\,INT - 0.2113\,MS \quad (4)$$

PPP vs. Real Exchange Rate (RER): According to [14], the literature shows that purchasing power parity (PPP) performs poorly in the short run and many economists still believe that over the long run, relative prices move in proportion to the change in the nominal exchange rate. The result from this study is however, inconsistent with the available literature, since the real exchange rate is found to be negatively related to the PPP performance in the long run. Any 1% increase in real exchange rate will reduce the PPP by 0.3538%. Real exchange rate fluctuations are mostly due to different rates of inflation between the two economies. In other words, a devaluation in real exchange rate (happens when the rate increases), as the result of higher price levels will ultimately reduce the performance of PPP.

PPP vs. Consumer Price Index (CPI): According to [7], relative PPP refers to the changes in inflation rate. This proposition states that the rate of appreciation of a currency is equal to the difference in inflation rates between foreign and the home country. When a country's domestic price level is increasing (as in inflation), that country's exchange rate must depreciate in order to return to PPP. [15] also stated that the inflation rate could reduce the markup of profit-maximizing firms. From the result, the CPI is found to be positively related to the PPP performance. The elasticity is quite high as well, since any 1% increase in CPI would lead to a 1.0706% increase in the PPP value. Theoretically, the PPP is supposed to be negatively related to the level of inflation since inflation will reduce the value of money.

However, contrary results were found in this study. This might be due to the inflation rate differential between Malaysia and the United States. The theory states that the home currency should devalue as according to the extent of the difference between the home and foreign inflation rate. Therefore, even though the inflation rate in Malaysia is steadily hiking over the years, the Malaysian PPP rates could still climb due to the higher inflation rates recorded in the foreign counterparty. From 2005 until 2010, the average inflation rate in Malaysia was 2.77% against 3.38% in the US. Therefore, it is quite clear that the inflation in Malaysia is lower than in the United Stated. This could explain why the relationship was positive.

PPP vs. Real Interest Rate (INT): The Real Interest Rate moves in tandem to what is expected in the standard economic arguments. Real interest rate is the rate adjusted with inflation which is done by removing the inflationary element out of the nominal interest rate. This study found that the interest rate will positively affect the PPP, as any 1% increase in the real interest rate could boost the PPP rate by 0.1378%. Interest rate is normally associated with the price of money and the costs of borrowing. Thus, an increase in interest rate adds up to the costs, making the money relatively costlier to borrow. This will later translate into lower supply of money and lower inflation level in the economy thus strengthening the real exchange rate of the home currency. In effect the PPP rate will also appreciate to reflect the changes.

PPP vs. M2 Money Supply (M2): Theoretically, the expected relationship between money supply and PPP is negative, where the former is believed to diminish the PPP rate as it increases. From the results, when the level of money supply is swollen by 1%, it would lead to a 0.2112% reduction in the PPP rate. The elasticity is also small. This is still consistent with prior research results such as the one produced by [9] who stated that the increases in domestic prices, causing higher inflation will force the monetary authority to reduce the money in circulation, thus leading to an increase in PPP rate. Similarly, [16] stated that there is a negative relationship between money supply and purchasing power parity. Now based on the monetary approach, it is possible to figure out the expected form of time paths of price level and exchange rate follows a change in the money supply. If we assume flexible prices, where prices are responding immediately to the change in money supply, monetary expansion will lead to an increase in the price level, which in turn, depreciates the exchange rate.

Granger Causality

PPP vs. Real Exchange Rate (RER): It was found that the p-value of chi^2 for the causality between PPP and RER is 0.0000, indicating that the relationship is significant. Therefore, the null hypothesis was rejected, indicating that RER does Granger cause PPP in the short run. In the reverse, the causality between RER and PPP obtained a p-value of 0.7317 which means that the relationship is insignificant. The null hypothesis is thus not rejected. Since only RER cause PPP and not the other way around too, there was only a unidirectional short-run causality relationship between the pair.

PPP vs. Consumer Price Index: The result of Granger causality test involving PPP and Consumer Price Index (CPI) is presented in the table above. It can be seen that both of the pair did not show a significant property in one way or another, since both of the p-values are greater than 0.05. Thus, there was no causality (non-directional) relationship.

PPP vs. Real Interest Rate: On the other hand, between PPP and Real Interest Rate (INT), both of the p-values are significant as the p-value for the causality between is 0.0000 while the causality between Real Interest Rate and PPP is 0.0504, in which each are smaller than (or just about) the 0.05 significance level. Consequently, the null hypotheses can each be rejected which means that the both of the variables could cause one another in the short run. Strong causality relationships are present since a bi-directional relationship is observed. This suggests that the Real Interest Rate is a very important determinant of the PPP and any variation in the interest rate will trigger a very quick response in the PPP rate. The PPP, on the other hand, is also very influential to the changes in Real Interest Rate.

PPP vs. Money Supply: There is an evidence of a unidirectional causality between PPP and M2 Money Supply since the p-value of the pair is significant at 0.0000. Put in another word, the PPP rate is Granger caused by the M2 Money Supply in the short-run. In the opposite, PPP does not hold the any causality relationship onto M2 Money Supply since the p-value is recorded at 0.3604. Altogether, this is an evidence of a unidirectional relationship between this pair of variables.

CONCLUSION

To sum it up, all of the variables were found to be significantly related to the performance of PPP in Malaysia in the long run. Contradicting to that, only three variables influenced PPP in the short run. Since most of the variables were found to significantly influence the PPP, future studies could also incorporate other macro variables such as economic growth and net export into the model.

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