Does the purchasing power parity theory hold for Malaysia ?

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Abstract: Originally propounded by the sixteenth-century scholars of the University of Salamanca, the concept of purchasing power parity (PPP) was revived in the interwar period in the context of the debate concerning the appropriate level at which to re-establish international exchange rate parities. Broadly accepted as a long-run equilibrium condition in the post-war period, it was first advocated as a short-run equilibrium by many international economists in the first few years following the breakdown of the Bretton Woods system in the early 1970s and then increasingly came under attack on both theoretical and empirical grounds from the late 1970s to the mid 1990s. This study is also embarking on the same quest to check for the purchasing power parity between Malaysia and US using a monthly data over 12 years. To look at the relation between Domestic Price in Malaysia, Foreign Price of the US and Exchange Rate between the Ringgit and the Dollar from these two nations, a standard time series technique was applied. Empirical results tend to indicate that there is a cointegrating relationship among exchange rates, Malaysia price level and US price level and that the PPP holds in that the three variables adjust to equilibrium in the long run. The implication for the policy makers is that the movement should have no effect on the relative competitive position of domestic or foreign firms, as competitiveness will depend on the real exchange rate.

Keywords: PPP, VECM, VDCs, Malaysia

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1.0 INTRODUCTION

The general idea behind purchasing power parity is that a unit of currency should be able to buy the same basket of goods in one country as the equivalent amount of foreign currency, at the going exchange rate, can buy in a foreign country, so that there is parity in the purchasing power of the unit of currency across the two economies.

The question of how exchange rates adjust is central to exchange rate policy, since countries with fixed exchange rates need to know what the equilibrium exchange rate is likely to be and countries with variable exchange rates would like to know what level and variation in real and nominal exchange rates they should expect. In broader terms, the question of whether exchange rates adjust toward a level established by purchasing power parity helps to determine the extent to which the international macroeconomic system is self-equilibrating.

This paper makes an attempt to test purchasing power parity (PPP) of the Malaysian Ringgit against the US dollar and see if there is any theoretical relationship between domestic price level (in Malaysia), foreign price level (in the US) and exchange rate (Ringgit vs Dollar). We performed a variety of test using times-series regression: first of all we test the stationarity of varaibles, then Philips Peron Test to transform non-stationary variables into stationary one, then Johansen and Engle Granger for cointegration and so on.

We tested the purchasing power parity for the exchange rate between the Malaysian Ringgit and the US Dollar from 2001 to 2012.

2.0 OBJECTIVE OF THE STUDY

Literature suggests that the root cause of the PPP puzzle lie in the different speeds of convergence for nominal exchange rates and prices (Cheung et al., 2004) therefore this study want to test for the validity of the theory using Malaysia as a case study. Most long span studies have been undertaken for developed countries instead of developing countries, therefore our interest is to study Malaysia considering it being a successful developing country and is forging ahead to become a developed nation in its own frame.

The issue here is that some study argued that PPP holds in the long run while some proved otherwise. At the same time, other studies argued that PPP does not hold in the short run while others argue it does. However, this paper will examine if the PPP of Malaysia in relative to United States, whether it hold in the long run or not, as this study will be using monthly data for the period of twelve years (2001 – 2012).

In the long run, just a change in real income or financial innovation bring about trend changes in pace that destroy the one to one relationship between the money supply and prices, there are also trend deviations from PPP: productivity growth differentials between countries for example, lead to trend changes in real exchange rates.

3.0 LITERATURE REVIEW

Under the Bretton Woods agreement that was signed after World War II, the U.S. dollar was tied to the price of gold, and then all other currencies were tied or "pegged" to the U.S. dollar. Malaysia was not an exception. However, in 1971 President Nixon ended the convertibility of the U.S. dollar to gold and devalued the dollar relative to gold. After the failure of attempts to restore a version of the Bretton Woods agreement, the major currencies of the world began floating against each other in 1973.

At this time the dominant approach to determination of exchange rates was called the "monetary approach." This approach assumed that the PPP exchange rate held continuously (Frenkel, 1976; Taylor, 1995; Frankel and Rose, 1995). Advocates of this approach argued that since the exchange rate is the relative price of two monies, that relative price should be determined by the relative balance of supply and demand in the respective money markets in an asset market equilibrium. Exactly how percentage changes in relative money supplies translated, other things equal, into exactly matching exchange rate movements was not immediately obvious, however, unless one resorted to the earlier argument based on goods arbitrage: that is, changes in the relative money supply affect relative prices, including relative traded goods prices, which then leads to international goods arbitrage.

A wave of empirical studies in the late 1970s tested whether continuous purchasing power parity did indeed hold, as well as other implications of the monetary approach to the exchange rate and the initial results were encouraging (Frenkel and Johnson, 1978). With the benefit of hindsight, it seems that these early encouraging results arose in part because of the relative stability of the dollar during the first two or three years or so of the float (after an initial period of turbulence) and in part because of the lack of a long enough run of data with which to test the theory properly.

Towards the end of the 1970s, however, the U.S. dollar did become much more volatile and more data became available to the econometricians, who subsequently showed that both continuous PPP and the simple monetary approach to the exchange rate were easily rejected. One did not have to be an econometrician, however, to witness the "collapse of purchasing power parity" (Frenkel, 1981): one could simply examine the behavior of the real exchange rate.

In the late 1980s, a more sophisticated econometric literature on long-run PPP developed, at the core of which was the concept of a "unit root process." If a time series is a realization of a unit-root process, then while changes in the variable may be to some extent predictable. The idea that PPP may hold because of international goods arbitrage is related to the so-called Law of One Price, which holds that the price of an internationally traded good should be the same anywhere in the world once that price is expressed in a common currency, since people could make a riskless profit by shipping the goods from locations where the price is low to locations where the price is high (i.e., by arbitraging). If the same goods enter each country's market basket used to construct the aggregate price level—and with the same weight—then the Law of One Price implies that a PPP exchange rate should hold between the countries concerned. Possible objections to this line of reasoning are immediate. For example, the presence of transactions costs—perhaps arising from transport costs, taxes, tariffs and duties, and nontariff barriers—would induce a violation of the Law of One Price. Engel and Rogers (1996), for example, looked at the price differentials between similar goods in cities across the U.S. and Canada and reported evidence broadly in support of this: they found that the volatility of the price differential tended to be larger the greater the distance between the cities concerned, and increased substantially when prices in cities in different countries were compared (the so-called "border effect").

4.0 DATA AND METHODOLOGY

Monthly data from 2001:1 to 2012:11 which was collected from the Thomson Reuters, Data-stream data service will be utilized for this study. In total there is 143 observations.

There are three variable being used for this study, first is the exchange rate of Malaysia to USD which was peg from September 1998 – July 2005, and after that it operates under a free float system, thus this study covers some of the pegged period (2001 – July 2005). The second variable is domestic price level of Malaysia, therefore we chose to use Producer Price Index (PPI) as an indicator of price. Although other indicator like consumer price index can be used but we choose to test with PPI as we encountered difficulties getting the CPI data. The third variable is foreign price level, which is the price level of USA, in which we choose to use PPI as well.

Precisely, Producer Price Index (PPI) is used since it was argued in Taylor's (2004) paper that since PPP is based on traded goods, it might be more usefully tested with producer price indices that tend to contain the prices of more manufactured tradable, rather than consumer price indices, which tend to reflect the prices of relatively more non-tradable, such as many services.
We will be using "Time series techniques" to test our data. Masih and Algahtani (and Masih, Al-Sahlawi and De Mello (2010) mentioned about the dilemma of testing non-stationary variables. On one hand, testing the 'level' form of non-stationary variables will invalidate conventional stationary tests (i.e. R^2, t). On the other hand, if the variables were differenced to make it stationary, we will lose long-term information contained in the trend element. Fortunately, the development of time series techniques manages to overcome the above shortcoming inherent in traditional regression.

5.0 EMPERICAL FINDINGS AND INTERPRETATIONS

5.1 Testing stationarity of variables

The first empirical test is to test for the stationary of our variables. Before we can proceed to other steps, we have to ensure all variables are I(1), meaning each variable has to be non-stationary in their level form and stationary in its difference form. To proceed with the testing, we create a difference form of each variables by taking difference of their log, and then conducted the Augmented Dickey-Fuller (ADF) test on each variable (in both level and differenced form). The result shows that all variables in its level form is non-stationary and stationary in its difference form, therefore we have an I(1) variables, and we can proceed with next step. The table below summarized the result we got for the ADF test. Actually, there is a conflicting value for LUSPPI where AIC is bigger than critical value but SBC is lower than critical value, therefore I consider SBC to AIC which gives a non-stationary variable.

Table 1: ADF Test

Level form			
Variables	T. ratio	Critical Value	Result
LMYPPI	-2.2980	-3.4430	Non-stationary
LUSPPI	-3.6727(AIC) -3.4130(SBC)	-3.4430	Non-stationary
LXR	-2.7364(AIC) -2.6199(SBC)	-3.4430	Non-stationary
Difference form			
DMYPPI	-5.1361(SBC) -4.4422(AIC)	-2.8827	Stationary
DUSPPI	-6.9437	-2.8827	Stationary
DXR	-9.2334(SBC)	-2.8827	Stationary

	-3.8237(AIC)		

Table 2: Philips Peron Test			
Level form			
Variables	T. ratio	P-Value	Result
LMYPPI	-0.59328	0.554	Non-stationary
LUSPPI	-0.30787	0.759	Non-stationary
LXR	-0.59162	0.555	Non-stationary
Difference form			
DMYPPI	-5.3156	0.000	Stationary
DUSPPI	-6.2621	0.000	Stationary
DXR	-8.9042	0.000	Stationary

5.2 Determination of order of VAR model.

Before we can test for the co-integration of variables, we need to determine the order of Vector Auto regression (VAR) in this step, which is determining the number of lag that need to be use. The table below shows the result of the VAR test, which indicates that AIC recommend order of 2 and SBC recommend order of 0.

Table 3		
	Result	
	AIC	SBC
Optimal order of lag	2	0

According to the VAR result, 2 lag should be used. Although there is a conflict between AIC and SBC, apparently we cannot go for lag lower than 2 in order not to encounter serial correlation problem. To address this we checked for serial correlation of variables. The result is shown below.

Table 4: Serial correlation test

Variables	Chi-square	Implication 5%
DMYPPI	0.707	No serial correlation
DUSPPI	0.811	No serial correlation
DXR	0.085	No serial correlation

Looking at the table above, it is shown by the test result that there is no serial correlation. We might take a higher lag and the disadvantage of taking a higher order is that we risk over-parameterization. However, in our case, given that we have a relatively long time series (144 observations), this is a lesser concern. Considering the trade-off of lower and higher orders, we decided to choose the higher VAR order of 2, hoping it will be appropriate and will give co-integration among the variables.

5.3 Testing co-integration

In the first two steps, we already confirm that the variables are I(1) and also determined the number of lags to be used from the second step. In this step, we will test for co-integration based on the order of lag determined earlier. Two method will be use to test for co-integration among the variables, the first one is Johansen method which use maximum likelihood and may identify more than one co-integrating vector. While the second method is Engle-Granger methods which can only identify one co-integrating vector.

When we test for co-integration with two lag, we couldn't get any co-integration. Therefore we keep increasing the number of lags, and we got co-integration with 5 lags (see appendix 3b-3d).

The co-integrating relationship indicates that the three variables are interdependent, meaning there is a common force that brings exchange rate, domestic price level and foreign price level together in the long run. Even If there is no co-integration then there is room for arbitrage between the two countries and it will eventually equates in the long run.

Table 5: Johansen Test

Ho	H1	Statistic	95% Critical Value	90% Critical Value
Maximum Eigen value Statistics				
r = 0	r = 1	28.0663	25.4200	23.1000
r<= 1	r = 2	6.8364	19.2200	17.1800
r<= 2	r = 3	3.8382	12.3900	10.5500
Trace Statistic				
r = 0	r = 1	38.7408	42.3400	39.3400
r<= 1	r = 2	10.6746	25.7700	23.0800
r<= 2	r = 3	3.8382	12.3900	10.5500

Table 6	
Criteria	Numbers of co-integrating vector
Maximal Eigenvalue	1
Trace	0
AIC	1
SBC	0
HQC	1

From the above table (Johansen), looking at the Maximal Eigenvalue, the test statistic for null of r = 0 is greater than the 95% critical value whereas for other null hypotheses, statistic is less than the critical values. For Trace, the null r = 0 cannot be rejected because the test statistics is less than 90 or 95% critical value. For AIC, SBC and HQC, the number of co-integrating vectors is obtained by locating the highest numbers, both the AIC and HQC indicate one co-integrating vector and SBC indicate no co-integrating vector. However, for the purpose of this study we will consider the Maximal Engen value, that is, at least one co-integrating vector. This result indicates that the variables in some combination result in stationary error term, and also implied that these variables (exchange rates and price level) move along in the long run and are theoretically related. To further confirm/test if our error term is stationary or nor, we run Engle and Granger co-integrating test. The result is shown in the appendix 3E.

5.4 Long run structural modeling

Using long run structural modeling, this step will focus on quantifying the theoretical relationship between domestic price level, foreign price level and exchange rate. One variable will be normalized against others, so our variable of interest is domestic price level (LMYPPI) which

is normalize against foreign price level (LUSPPI) and exchange rate (LXR). The result we get is as follows.

Table 7: Exact identification

Variables	Coefficient	Standard error	t-ratio	Result
LMYPPI	-	-	-	-
LUSPPI	-5.1270	1.7601	-2.91	Significant
LXR	-0.51676	0.39566	-1.31	Insignificant

The above result indicates that LUSPPI is significant and LXR is not significant. However we normalized the two other variables against the other and the result otherwise (See appendix). Never the less we will focus on LMYPPI as our interest variable. To confirm the above result, we subject the variables to over identifying restriction. The result is shown below.

Table 8: over identification

Variables	Chi-square/p-value	Result
LMYPPI	-	
LUSPPI	0.000	Significant
LXR	0.185	Insignificant

Table 9: Exact and Over identifying restrictions

	Panel A	Panel B
LMYPPI	1.000 (None)	1.0000 (*None*)
LUSPPI	-5.1270 (1.7601)*	-5.4920 (2.4849)
LXR	-0.51676 (0.39566)	0.0000 (*None*)
TREND	.0093394 (0.0046969)	.011404 (0.0071304)
CHI-SSQUARE	None	1.7607[.185]

However, after applying the over identifying restriction, the result still remain the same. Meanwhile the null hypothesis of LXR cannot be rejected, therefore the restriction is correct (still in significant). Notwithstanding, based on intuition, we believe that LXR is significant, considering the fact that exchange rate and price level move together based on co-integration test established earlier. Also in the theory, it is said that exchange rate depends on relative price levels, hence we go with intuition and theory based.

5.5 Vector error correction model

Based on the analysis done earlier, we established that the variables (MYPPI, USPPI & XR) are co-integrated, although LRSM indicates that XR is insignificant. Meanwhile, the causality wasn't established in the co-integration test, we only know they move together but couldn't indicate which variable lead or cause which. However, we are interested in knowing which variable is exogenous and which is exogenous. Therefore in this step, we will use vector error correction model to analysis and by decomposing the change in each variable to short-term and long-term components, we are able to ascertain which variables are in fact exogenous and which are endogenous. In the result, by examining the error correction term, et-1, for each variable, and checking whether it is significant, we found that all the three variables are endogenous. This indicates that in the adjustment process, no variable is leading or causing another, they are all followers be it in the short or long run. This result is consider puzzling as in the LRSM XR was found to be insignificant, meaning it wasn't consider to have an effect on other variables. Although the theory which this study is based on holds that exchange rate and price level have some degree of effect on each other especially in countries that are trade partners. The result is shown in the table below.

Table 10: VECM test result		
Variables	ECM (-1) P-Value	Implications
LMYPPI	0.007	Endogenous
LUSPPI	0.000	Endogenous
LXR	0.011	Endogenous

5.6 Variance Decompositions Model

Having established that all the variables are endogenous using VECM, in this step we will be able to identify which one is the most endogenous among the three by using variance decomposition model for analysis. By doing this, the VDC will decomposes the variance of forecast error of each variable into proportions attributable to shocks from each variable in the system, including its own. The least endogenous variable is thus the variable whose variation is explained mostly by its own past variations. Firstly we apply orthogonalized by forecasting 12, 20 & 32 months (short and long term) which give the following result.

Table 11: orthogonalized VDC			
Forecast at horizon monthly	MYPPI %	USPPI %	XR %
Relative variance in ΔMYPPI			
12	69.06	21.48	9.47
20	57.28	32.20	10.52
32	51.35	37.63	11.02
Relative variance in ΔUSPPI			
12	64.16	21.20	14.64
20	52.42	29.37	18.21
32	44.89	33.78	21.33

Relative variance in ΔXR			
12	2.552	19.02	78.43
20	2.231	22.10	75.67
32	1.798	23.41	74.79

From the above table, the rows is read as the percentage of the variance of forecast error of each variable into proportions attributable to shocks from other variables (in columns), including its own while the columns is read as the percentage in which that variable contributes to other variables in explaining observed changes and the highlighted part represent the relative endogeneity. Meanwhile, the ranking of this result (most endogenous) in which the variable can be explain by its own past will be depicted below.

Table 11: ranking	
No.	Index
1	XR
2	MYPPI
3	USPPI

However, there are some limitations in orthogonalized VCD, one of it is assuming that when a particular variable is shocked, all other variables are "switched off", and more importantly, orthogonalized VDCs do not produce a unique solution because the generated numbers are dependent upon the ordering of variables in the VAR, hence the first variable will give the highest percentage and is likely to be the most exogenous. In this case MYPPI comes first in the order of the variables is reported to be the least endogenous while is XR because is the last in ordering of VAR. anyways, the orthogonalized VDC is perceived to be biased, therefore the analysis will be done again using generalized which does not depend on the order of VAR and doesn't switch off other variables when one is shocked. To interpret the generalized result, we have to compute and

do the calculation manually because the numbers does not add up to 1 like orthogonalized. The result is depicted below.

Table 12: Generalized VDC			
Forecast at horizon	MYPPI **%**	USPPI **%**	XR **%**
Relative variance in ΔMYPPI			
12	68.70	4.210	27.09
20	61.73	7.367	30.91
32	58.08	08.53	33.38
Relative variance in ΔUSPPI			
12	50.48	26.28	23.24
20	44.30	27.10	28.59
32	40.21	25.63	34.17
Relative variance in ΔXR			
12	2.499	13.59	83.91
20	2.188	18.35	79.46
32	1.769	20.29	77.95

Table 13			
No.	Variables relative endogeneity		
	12months	20months	32months
1	XR	XR	XR
2	MYPPI	MYPPI	MYPPI
3	USPPI	USPPI	USPPI

Observing the above table, we notice that the ranking of endogeneity is stable across each horizon and it is consistent with the result from orthogonalized as well as across different time horizon. Hence, XR is the most endogenous or rather the least exogenous variable, which indicates that exchange rates adjust to the level of purchasing power parity. While USPPI is the least endogenous or the most exogenous variable. It can also be observe that the relative different between the most and least endogenous variable is substantial. In the case of XR and USPPI, the difference is 52.32% in week 32.

The above result will have the following plausible implications for the policy makers, that any country where domestic price level increases, its exchange rate must depreciates in order to stay in line with the PPP theory. Perhaps, this might be due to several reasons like transaction cost within trading countries, arbitraging and more, so considering the fact that Malaysia is under a managed floating currency system, therefore there is a minimum level MYR can depreciates and a maximum it can appreciates.

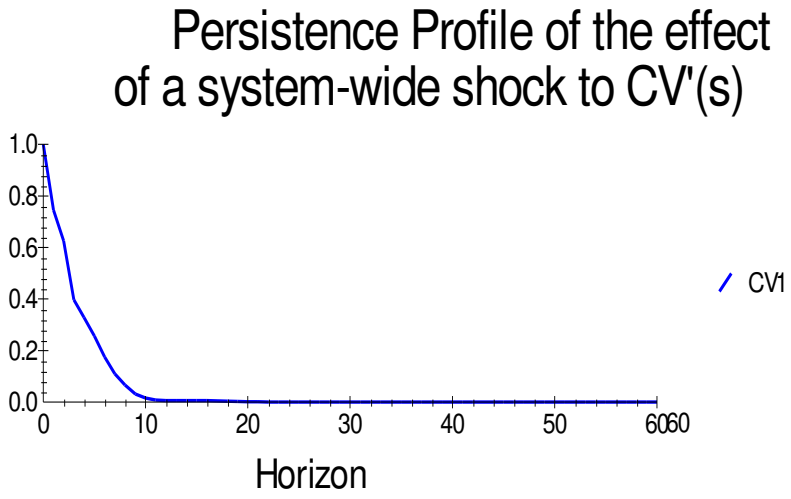
5.7 Impulse Response Function

The impulse response functions (IRFs) essentially produce the same information as the other test, except that they can be presented in graphical form. When we applied the Generalized IRFs and found that consistent with the earlier result. The graphical result can be seen in the appendix (Appendix 7A – 7F).

5.8 Persistence Profile

The persistence profile illustrates the situation when the entire co-integrating equation is shocked, and indicates the time it would take for the relationship to get back to equilibrium. Here the effect of a system-wide shock on the long-run relations is the focus unlike the variable-specific

shocks as in the case of IRFs). The chart below shows the persistence profile for the co-integrating equation of this study and the result shows that it takes 12 months for the co-integration relationship to return to equilibrium after a system wide shock.



6.0 CONCLUSION

This paper attempt to test empirically if the relative PPP holds in Malaysia and USA, meaning does the percentage change in the exchange rates of Malaysia to USA over a given period of time offset the difference in the inflation rates. Therefore, to do this we used the nominal exchange rates of Malaysia to USA, and also each country price level. Specifically, we choose to use producer price index as an indicator for price level instead of CPI because it is relatively more accurate as it captures more in terms of price level.

This empirical debate on PPP has been on for decades and yet is inconclusive as some empirical findings support the theory, while some did not. And the empirical studies are said to be biased based on the methodology/model used and also the length of time period examined. Meanwhile in this analysis, we investigate empirically whether prices or the exchange rate is the weakly exogenous/endogenous variable in the PPP relationship. As a parity or arbitrage condition, PPP does not imply any direction of causality, but as an exchange rate determination theory it clearly assumes exogenous prices. Contrary to most of the previous PPP empirical studies, we allow the endogeneity/exogeneity status to be evaluated statistically, rather than imposed a priori. Hence, it was revealing that there is no exogenous variables, they are all endogenous.

Explaining further, this result indicates that the Malaysia price level, domestic price level and exchange rate are co-integrated in the long run although it was indicated that exchange rate is not significant in this case. Hence, it implies that changes in exchange rate is being cancelled out by the changes in foreign price level relative to domestic prices, therefore it brings about equilibrium. This might be due to the fact that the first few years of our observation MYR was pegged to USD. Nevertheless, our main result shows that all the variables are adjusting to bring about equilibrium in the long run, hence it is concluded that purchasing power parity holds in

Malaysia. Considering this result, the implication for policy makers can be said that the movement should have no effect on the relative competitive position of domestic or foreign firms, as competiveness will depend on the real exchange rate. It can also be said that the behavior/effect of speculators and arbitrageurs will bring about equilibrium in the long run.

In summary, the theoretical framework of this study revealed something interesting to be looked at in depth in the future considering the usage of PPI instead of CPI, as most empirical study use CPI which was argued by Taylor (2004) to be inaccurate as it only reflects the prices of relatively more non-tradable, such as many services, while PPI tend to contain the prices of more manufactured tradable goods. The underlying theoretical aspect from various studies done previously may create a fundamental in analyzing the data ahead using PPI say for Asian countries, probably other continent and also including more sample size/time frame.

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