Testing the Power of Exchange Rate to Equalize Prices

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Although already been tested numerous times thus far, researchers are still fascinated by the purchasing power parity (PPP) hypothesis due to its implication for international trade and financial flows, which stipulates that the exchange rate between any two currencies changes to equalize the price levels (purchasing power) in the two countries. This hypothesis has been tested by mainly testing the stationarity of the real exchange rate between any two currencies of interest. But we use a different approach. Our model is based on the long-term relationship between the official exchange rate and the relative inflation rates between two countries. According to our model, the validity of the PPP hypothesis is based on the non-rejection of the null hypotheses that the intercept term in the regression of the official exchange rate on the relative inflation rate is equal to zero and that the coefficient associated with the relative inflation rate is equal to one. We applied our test on a panel data from five BRICS countries. Our results rejected both null hypotheses at 5% significance level. Thus our findings invalidate the PPP hypothesis.

INTRODUCTION

The purchasing power parity hypothesis is one of the most tested yet one of the most controversial theories in international economics. While this hypothesis has been tested in various forms and with mixed findings, it is still fascinating researchers as the world economies are getting increasingly integrated. In its absolute form, the purchasing power parity stipulates that the exchange rate between two currencies equalizes the purchasing power (the price levels) in the two countries. In other words, the exchange rate between two currencies is equal to the ratio of price levels in the two countries. There are two reasons why the hypothesis has generated so much interest among researchers – first, if the purchasing power parity holds, the exchange rate between two currencies tend to equalize the price levels across nations thereby eliminating comparative cost advantage and, for that matter, a nation's competitiveness in global trade. Second, a quick adjustment in exchange rates in response to a change in relative price (price ratio) is also an indication of a change in the real interest rates between two countries causing the capital flows from the country with a lower real interest rate to the one with a higher. Moreover, many macroeconomic theories are based on the assumption that purchasing power parity holds and it's failing, therefore, invalidates those theories.

One-to-one correspondence of exchange rates with relative prices implied by the PPP hypothesis has prompted researchers to mostly use several variations of the unit root test on the real exchange rate (the relative-price-adjusted exchange rate) for the validity of the PPP hypothesis. Typically the null hypothesis is that the real exchange rate follows a random walk process along with the alternative hypothesis that it is a stationary process. If the null hypothesis is rejected, the researchers would conclude that the real

exchange rate series is stationary and, that the PPP holds in the long run. This long-run relation implies that even if the PPP does not hold in the short run due to the factors such as the presence of non-traded goods and transportation costs, any shock affecting currencies only has its effect in the short run and that the real exchange rate is mean reverting. So, the PPP hypothesis is only validated if the real exchange rate is a stationary process (Meese and Rogoff, 1988; Mark 1990; and Ardeni and Lubian, 1991). However, the argument that the misspecification of the deterministic component of the real exchange rate series may bias the result in favor of the null hypothesis (Perron and Phillips, 1987; and West, 1988) prompted many researchers (Darne and Hoarau, 2008; and others) to apply unit root tests with structural changes with the findings that invalidated the PPP hypothesis. Recently researchers have become increasingly interested in applying unit root test on panel data (Wu, 1996; Papell and Theodoridis, 2001; Papell, 2002). One group of researchers has used nonlinear specification of deterministic components in testing PPP and found evidence in its support (Cuestas and Regis, 2008; and Bahmani-Oskooee, Kutan, and Zhou 2007). While models used by previous researchers mainly focused on testing the stationarity of the real exchange rate with linear and nonlinear specifications, our model is different in many respects – first, in order to test the validity of PPP hypothesis, we estimate a model with official exchange rate as the dependent variable and the relative inflation rate as independent variable. Second, we apply cointegration test on the variables involved and base our conclusion on the estimates of the cointegrating equation. Third, we use panel data on five BRICS countries and the United States. The reason for our choice of the BRICS members is their relative importance in the world economy as they contribute to about 20 percent of the world gross domestic product. These countries are getting more and more integrated through trade and other financial flows. Some have even decided to use their own currencies as a means for payment instead of using U.S. dollar or any other vehicle currency. Such increasing economic and financial integration should have strong bearing on the validity of the PPP hypothesis.

We lay out our model in section 2, detail the methodology of this study in section 3, describe the data source in section 4, present our empirical findings in section 5, and finally conclude the study in section 6.

THE MODEL

The purchasing power parity condition with no transportation costs, tariffs, and other trade restrictions can be laid as,

$$R_t = \frac{P_t}{P_t^*} \tag{1}$$

That is, the exchange rate between the currencies of any two countries is equal to the relative price level in the two countries. Here R_t is the exchange rate of the domestic currency (e.g. U.S. dollar) with a foreign currency – expressed as number of domestic currency units needed to purchase one unit of the foreign currency – P_t is the domestic price level (e.g. U.S. price level), and P_t^* is the price level in the foreign country – all in time period t. If equation (1) holds for time period t, it also holds for time period t+1, that is,

$$R_{t+1} = \frac{P_{t+1}}{P_{t+1}^*} \tag{2}$$

Suppose, R changes by e%, P changes by π% and P* changes by π*% from one period to the next. Equation (2) can be rewritten as,

$$R_t(1+e) = \frac{P_t(1+\pi)}{P_t^*(1+\pi^*)} \tag{3}$$

Substituting the value of R_t from equation (1) into equation (3) yields,

$$1 + e = \frac{1+\pi}{1+\pi^*} \text{ Or } e = \frac{1+\pi}{1+\pi^*} - 1 \quad (4)$$

The above equation with a time subscript can be written as,

$$e_t = \frac{1+\pi_t}{1+\pi_t^*} - 1 \quad (5)$$

METHODOLOGY

We will test the purchasing power parity condition laid out in equation (5) using the following statistical model:

$$e_t = \alpha_0 + \alpha_1 \left(\frac{1+\pi_t}{1+\pi_t^*} - 1\right) + u_t \quad \text{or}$$
$$e_t = \alpha_0 + \alpha_1 z_t + u_t \quad (6)$$

where, $z_t = \frac{1+\pi_t}{1+\pi_t^*} - 1$. If the null hypotheses:$\alpha_0 = 0 \; and \; \alpha_1 - 1 = 0$ cannot be rejected and u_t turns out to be stationary, then the expected form of equation (6) will be the same as that of equation (5) and purchasing power parity hypothesis is validated. But if variables e_t and z_t are non-stationary the error term, $u_{t,}$ cannot be stationary. However, even if variables e_t and z_t are found to be non-stationary, the error term, $u_{t,}$ can still be stationary if e_t and z_t are integrated of the same order. Therefore, an ADF test will be conducted to see if variables e_t and z_t contain a unit root. If they are both found to have a unit root and integrated of the same order, then a cointegration test will be conducted to see if there exists a cointegrating vector for which e_t and z_t are cointegrated. If such a vector is found to exist, then we can safely conclude that the error term, $u_{t,}$ is stationary and test the null hypotheses.

DATA

We use a panel data on the exchange rate between U. S. dollar and the currencies of five BRICS countries – Brazil, Russia, India, China, and South Africa – and the inflation rates in the U. S. and in the BRICS countries for the years, 1996-2014. The data on exchange rates and inflation rates were obtained from the World Development Indicators, 2015.

EMPIRICAL FINDINGS

We applied the ADF test to see if our dependent variable, e_t, and independent variable, z_t, contain a unit root. As shown in the Appendices, the probabilities of the ADF test statistic for both e_t and z_t are zero, which rejects the null hypotheses that these variables have a unit root. This finding allows us to use ordinary least square technique to estimate equation (6). We obtained the following results from the estimation:

$$e_{it} = \underset{(0.015616)}{-0.023319} + \underset{(0.135767)}{1.547295} z_{it} \quad (7)$$

The numbers in parentheses are standard errors. The t-statistic for the null of $\alpha_0 = 0, is \; \frac{-0.023319}{0.015616} = -1.4933$, and for the null of $\alpha_1 = 1, is \; \frac{1.547295-1}{0.135767} = \frac{0.547295}{0.135767} = 4.0311$. The t-statistics, thus, reject the null of $\alpha_1 = 1$ but cannot reject the null of $\alpha_0 = 0$ indicating that no purchasing power parity exists.

SUMMARY AND CONCLUSION

Although already been tested numerous times thus far, researchers are still fascinated by the purchasing power parity (PPP) hypothesis due to its implication for international trade and financial flows, which stipulates that the exchange rate between any two currencies changes to equalize the price levels (purchasing power) in the two countries. This hypothesis has been tested by mainly testing the stationarity of the real exchange rate between any two currencies of interest. But we use a different approach. Our model is based on the long-term relationship between the official exchange rate and the relative inflation rates between two countries. According to our model, the validity of the PPP hypothesis is based on the non-rejection of the null hypotheses that the intercept term in the regression of the official exchange rate on the relative inflation rate is equal to zero and that the coefficient associated with the relative inflation rate is equal to one. We applied our test on a panel data from five BRICS countries. Our results rejected both null hypotheses at 5% significance level. Thus our findings invalidate the PPP hypothesis.

REFERENCES

Ardeni, P. G. and D. Lubian (1991): "Is there a trend reversion in purchasing power parity", *European Economic Review*, vol. 35, pp 1035-1055.

Bahmani-Oskooee, Mohsen, A. M. Kutan, and S. Zhou (2007): "Testing PPP in the non-linear STAR framework", *Economics Letters,* Vol. 94, Issue 1, pp. 104-110.

Cuestas, J. C. and P. J. Regis (2008): "Testing for PPP in Australia: Evidence from unit root test against nonlinear trend stationarity alternatives", *Economics Bulletin,* vol. 3, No. 27, PP. 1-8.

Darne, O. and J. F. Hoarau (2008):"The purchasing power parity in Australia: Evidence from unit root test with structural break", *Applied Economics Letters*, vol. 15, pp. 203-206.

Meese, R. A. and K. Rogoff (1988): Was it Real the real exchange rate-interest differential relation over the modern floating-rate period", *Journal of Finance*, col. 43, pp. 933-948.

Mark, N. (1990): : Real and nominal exchange rates in the long run: An empirical investigation", *Journal of International Economics*, vol. 28, pp. 115-136.

Perron, P. and P. C. B. Phillips (1987): "Does GNP have a unit root? A reevaluation", *Economics Letters*, vol. 23, pp. 139-145.

Papell DH., Theodoridis H. (2001): The choice of numeraire currency in panel tests of purchasing power parity. *Journal of Money, Credit and Banking,* vol. 33, pp. 790-803.

Papell DH. (2002): The great appreciation, the great depreciation, and the purchasing power hypothesis, Journal of International Economics, vol. 57, pp. 51-82.

West, K. D. (1988): "Asymptotic normality when regressors have a unit root", *Econometrica*, vol. 56, pp. 1397-1418.

Wu, Y. (1996): Are real exchange rate stationary? Evidence from a panel data test, *Journal of Money, Credit and Banking*, vol. 28, pp. 54-63.

APPENDICES

Appendix-A

Null Hypothesis: E has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-6.083282**	**0.0000**
Test critical values:	1% level	-2.590910	
	5% level	**-1.944445**	
	10% level	-1.614392	

*MacKinnon (1996) one-sided p-values.

Appendix-B

Null Hypothesis: Z has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-8.028302**	**0.0000**
Test critical values:	1% level	-3.497727	
	5% level	**-2.890926**	
	10% level	-2.582514	

*MacKinnon (1996) one-sided p-values.

Appendix-C

Dependent Variable: E
Method: Least Squares
Date: 07/17/15 Time: 05:56
Sample (adjusted): 1996 2014
Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	**-0.023319**	0.015616	**-1.493274**	0.1388
Z	**1.547295**	0.135767	**11.39670**	0.0000

R-squared	0.582744	Mean dependent var	0.064795
Adjusted R-squared	0.578258	S.D. dependent var	0.203634
S.E. of regression	0.132244	Akaike info criterion	-1.187514
Sum squared resid	1.626419	Schwarz criterion	-1.133748
Log likelihood	58.40690	Hannan-Quinn criter.	-1.165788
F-statistic	129.8848	Durbin-Watson stat	1.289736
Prob. (F-statistic)	**0.000000**		