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Purchasing Power Parity Theory from 1996-2016: Time Series Approach

Niri Martha Choji[1], Edna Manga[2]

[1]Department of Mathematics, Plateau State University, Bokkos, Nigeria
[2]Department of Mathematics University Jos, Nigeria

Abstract: **This paper applied time series tests in testing for the existence of Purchasing Power Parity for a group of five Asian countries for the period of 1996-2016 using monthly data. For this purpose, we applied both time series unit root and cointegration methods to test for Purchasing Power Parity. Firstly, we tested for the stationarity of the variables and found that the variables are non-stationary at levels but stationary at first difference. Secondly, we applied the cointegration test to see if our variables are stationary in the long-run. Results of the cointegration test rejected the null hypothesis of no-cointegration for four out of the five countries, meaning that we have enough evidence to support PPP in the long-run for these Asian countries over the period of 1996-2016. In other words, the rejection of null hypothesis implies a long-run relation between nominal exchange rates and relative prices.**

Keywords: **purchasing power parity, unit root tests, cointegration.**

1. INTRODUCTION

A time series is an ordered sequence of values of a variable at equally spaced time intervals. There are so many applications of time series data that exists in the literatures. One of those applications is in testing for purchasing power parity (PPP). The purchasing power parity is a very important area in the field of international finance. The theory of the purchasing power parity says that the nominal exchange rate between two currencies should be equal (be the same) as the ratio of aggregate price level between the two currencies, so that the unit of currency of one country will have the same power to purchase goods and services in a foreign country.

There are basically two types of the purchasing power parity; the absolute purchasing power parity and relative purchasing power parity. The absolute PPP holds when the purchasing power of a unit of currency is exactly equal in the domestic economy and in a foreign economy, once it is converted into foreign currency at the market exchange rate. This idea suggests that the exchange rate between two countries is identical to the ratio of the price levels for those two countries. While the relative PPP holds that the exchange rate adjusts to the amount of the inflation differential between countries. That is, changes in the exchange rate are equal to changes in the relative national prices.

Due to the importance of the theory of PPP so many researchers have worked and are still working on this theory. Those who have worked on this theory with diverse findings include: Wallace (2013), who used the approach of Im et al. (2008) cointegration test using stationary instrumental variables to test for the validity of PPP on the updated version of the Taylor data set (Rev Econ Stat 84(1): 139-150, 2002). They found evidence to support the validity of PPP using Taylor's data set. Also, Noman and Rahman (2010), used linear and nonlinear unit root tests (ADF and KSS (Kapetanios, Shin and Snell, 2003)) to investigate the validity of the Purchasing Power Parity for four Asian real exchange rates over the period of 1973-2007. Results of the linear unit root test indicate that PPP does not hold in any of the four (Bangladesh, India, Pakistan and Sri Lanka) countries while the results of the nonlinear unit root test found support in only one (Bangladesh) of the four countries. Thereafter, Acaravci and Ozturk (2010), examined the validity of PPP in 8 transition countries for monthly data from 1992:1 to 2009:1. While results from both the ADF and the KPSS unit root tests indicate that PPP does not hold for Bulgaria, Croatia, Czech Republic, Hungary, Macedonia (FYR), Poland, Romania and Slovak

Republic. In the presence of structural breaks, PPP holds only for Bulgaria and Romania but does not hold for the other 6 transition countries. Testing the stationarity of real exchange rate series by using four types of unit roots tests, the evidence suggests that real effective exchange rate is nonstationary and thus PPP doesn't hold for all 6 transition countries in the long run. All results emphasized that there is weak evidence about the long-run PPP hypothesis in transition countries and the validity of PPP remains a controversial and unsettled issue. Nonetheless, absolute rejection of the PPP was reported in the work of Baharumshah and Ariff (1997), used the Johansen and Juselius (1990) cointegration test to test for the long run validity of the PPP five Asian economies using data of over twenty years. They also used the ADF test and the PP test. Their empirical analysis failed to support the hypothesis of the purchasing power parity.

This paper found evidence in support of the PPP hypothesis in Philippines, Malaysia, Singapore and Thailand, but not in Indonesia.

2. DATA AND METHODOLOGY

Data:

In this paper, we used data collected from *Datastream*, Thomson Reuters. It is a set of monthly data for a group of ASEAN-5 countries starting from January, 1996 to March, 2016. The countries contained in our sample are; Malaysia, Indonesia, Thailand Philippines and Singapore. The data consist of the nominal exchange rate and price levels (local currency per 1USD). Consumer price index (CPI) for each country and CPI for the US. The US was used as the base currency.

Time Series Unit Root Tests:

ADF

Following Mccarthy (2015), the ADF test tests the hypothesis that a time series y_t is I(1) against the alternative that it is I(0) assuming that y_t is an ARMA process (and ARMA process has both autoregressive and moving average terms). To test for a unit root using the ADF test, one estimates the following model:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 t + \sum_{i=1}^{n} \alpha_i \Delta y_{t-1} + \mu_t \qquad (1)$$

Where the n lagged first differences approximate the ARMA dynamics of the time series, β_0 is a constant, and t is a trend. If the series has a unit root, $\beta_1 = 0$ and $\sum_{i=1}^{n} \alpha_i \Delta y_{t-1} = 1$. The ADF test is a test of the hypothesis that $\beta_1 = 0$ given n lagged first differences.

PP

Following Greasley and Oxley (2011) Phillips and Perron (1988) take a different approach to the potential effects of serial correlation – they use semi-parametric estimation of the long run effects of the short run dynamics. In particular, consider the auxiliary regression:

$$\Delta y_t = \mu + \alpha y_{t-1} + \gamma t + \eta_t \qquad (2)$$

where $\eta_t = \phi(L)\varepsilon_t, \varepsilon_t \sim iid\ N(0,1).$ If we define the residuals from the OLS

regression of y_t on a constant and t, the Phillips and Perron test statistic can be defined as:

$$z_t = \hat{\sigma}_{\xi} \hat{\omega}^{-1} t_{\alpha} - \hat{\lambda} \left[\hat{\omega} \left(T^{-2} \sum_{t=2}^{\hat{T}} D_{t-1}^2 \right)^{1/2} \right]^{-1}$$

Where ω^2 and λ are nuisance parameters consistently estimated by applying the Newey- West (1987) estimator. Under the null hypothesis of a unit root, z_t converges in the limit to the Dickey-Fuller distribution, although they may differ in finite samples.

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Phillips-Ouliaris Cointegration Test:

Following Ssekuma (2011), Phillips-Ouliaris introduced two residual-based tests namely: the variance ratio test and the multivariate trace statistics. These residual-based tests are used in the same way as the unit root tests, but the data are the residuals from the cointegrating regression. These tests seek to test a null hypothesis of no cointegration against the alternative of the presence of cointegration using scalar unit root tests applied to the residuals. Phillips-Ouliaris methods are based on residuals (differences between the observed and expected values) of the first order autoregression, AR(1), equation. The multivariate trace statistics has the advantage over the variance ratio test in that it is invariant to normalisation, that is, whichever variable is taken to be the dependent variable, the test will yield the same results (Pfaff, 2006).

3. RESULTS

Below are the results of our analysis. Table 1. Presents the outcome of the time series unit root tests from our analysis. The time series unit-root tests include the ADF (Said & Dickey 1984) and PP (Phillips & Perron 1987) for Indonesia, Philippines, Malaysia, Singapore and Thailand. The tests were conducted on the log values of all the variables. We conducted the tests on the log of the nominal exchange rate and its first difference (Lxrate and ΔLxrate), log of the domestic price and its first difference (Lcpi and ΔLcpi), and the log of the foreign price and its first difference (Lcpius and ΔLxrate). Results show that the null hypothesis of unit root is not rejected for Lxrate, Lcpi and Lcpius in all the tests for all the countries, implying that these variables are not stationary at levels. However, results show that the null hypothesis of unit root is rejected for ΔLxrate, ΔLcpi and ΔLcpius for all the tests in all countries, implying that the variables are stationary at first difference. Since all the variables for all tests and countries are nonstationary at levels, but stationary at first difference, we say that our variables are integrated of order one. Since all the variables are integrated of order one, we proceed with the cointegration. Table 2. Presents results of the cointegration test of Phillips and Ouliaris (1990). Results show that the null of no cointegration is rejected for Philippines, Malaysia, Singapore and Thailand but not for Indonesia, indicating the presence of cointegration in Philippines, Malaysia, Singapore and Thailand except for Indonesia. Which means that there is a long-run relationship between the nominal exchange rate and price levels (cpi and cpius) in Philippines, Malaysia, Singapore and Thailand but not for Indonesia.

TABLE 1. Time Series Unit Root Tests

Varible	Indonesia		Philippines		Malaysia	
	ADF	**PP**	**ADF**	**PP**	**ADF**	**PP**
Lxrate	0.9587	1.1988	1.4500	1.1180	0.6087	0.5097
ΔLxrate	-5.9819***	-11.5332***	-13.6470***	-14.0349***	-14.7519***	-14.8259***
Lcpi	-1.0656	-1.1106	0.7967	0.6154	0.0857	-0.0899
ΔLcpi	-12.4589***	-20.8158***	-13.6470***	-13.5051***	-14.1464***	-14.1508***
Lcpius	-1.2089	-1.4259	-1.2089	-1.4259	-1.2089	-1.4259
ΔLcpius	-10.0725***	-7.9067***	-10.0725***	-7.9067***	-10.0725***	-7.9067***

*** indicates significance at the 1% level

CONTINUATION OF TABLE 1.

Variables	**Singapore**		**Thailand**	
	ADF	**PP**	**ADF**	**PP**
Lxrate	-0.3430	-0.3316	0.4380	0.5130
ΔLxrate	-15.9426 ***	-15.9513***	-11.9127***	-11.8658***
Lcpi	1.1870	-1.1332	0.0079	0.0862
ΔLcpi	-14.7413***	-14.7568***	-14.7413***	-14.7568***
Cpi_us	-1.2089	-1.4259	-1.2089	-1.4259
ΔCpi_us	-10.0725***	-7.9067***	-10.0725***	-7.9067***

The table above shows the results of our time series unit root tests. The unit root t-statistic are displayed on the table with *** representing 1% significance level. ADF and PP, are Augmented Dickey-Fuller and Phillips-Perron time series unit root tests.

TABLE 2: Prob. Values and Z-Statistic of Phillips-Ouliaris Cointegration Test

Countries	Phillips-Ouliaris Cointegration Test
Indonesia	-17.9496
Philippines	-78.3563***
Malaysia	-134.3004***
Singapore	-33.4355***
Thailand	-126.6594***

The above table shows the Prob. values and Z-statistic for the Phillips-Ouliaris test of cointegration for the individual ASEAN-5 Countries with *** representing significance at 1% level.

4. CONCLUSION

This paper re-examined the purchasing power parity theory for five Asian countries using time series methods. Firstly, paper applies the ADF and PP time series unit root tests on Philippines, Malaysia, Singapore and Thailand and Indonesia to find out if the variables from these countries are stationary. Results show that all the variables are nonstationary at levels but stationary at first difference, implying that our variables are integrated of order one. Because our variables are integrated of order one, we proceed with the cointegration. We applied the cointegration technique of Phillips and Ouliaris (1990). Results of the cointegration show that there is a long-run relationship between the nominal exchange rates and the price levels (domestic and foreign prices) in Philippines, Malaysia, Singapore and Thailand but not for Indonesia. This shows that the theory of purchasing power parity is valid in Philippines, Malaysia, Singapore and Thailand but not in Indonesia

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