Purchasing Power Parity in South Asia: A Panel Data Approach

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1. Introduction

Ever since the Gustav Cassel's (1921) seminal paper was published, Purchasing Power Parity (PPP) has been successful in attracting researchers' as well as policy maker's interest. PPP postulates that the same good should be selling for the same price in two different countries once prices are adjusted to reflect the foreign exchange rate between those two countries. This parity between purchasing power across countries assumes an environment known as the perfect capital market (PCM) that is void of all frictions, including taxes, tariffs and transaction costs. In addition, PPP is valid only when goods are exactly identical across boarders. In real world, however, these stringent conditions are difficult to meet and therefore the validity of PPP is often questioned. Numerous papers have been written testing for PPP in different countries and regions using various techniques and methods.

The idea of Purchasing Power Parity is based on the Law of One Price (LOP) which suggests that once adjusted for currency exchange rate, homogenous goods should sell for the same price in two geographically separate markets. The most cited example to illustrate this concept is the McDonald's Hamburger that is sold in many courtiers. *The Economist* regularly publishes McDonald's Hamburger prices around the world that shows that we do not live in a PCM world and the Law of One Price does not hold.

The objective of this paper is to test for PPP in a South Asian panel that comprises the following countries: Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. These countries are all members of the South Asian Association for Regional Cooperation (SAARC). The only other member is Afghanistan that has recently joined SAARC. The paper uses real exchange rates of these countries which expressed in terms of US dollars and applies two panel unit root tests, namely, the IPS and the CIPS test to detect nonstationarity in the panel.

The principal contribution of the paper is application of panel unit root tests in the South Asian foreign exchange rates. Other contribution includes investigation into the validity of PPP in the developing countries and addition to the ongoing literature that enquire the panel data techniques and that deal with cross section dependence due mainly to unobserved factors and other spatial or spill over effects (Baltagi and Pesaran, 2007)

The paper is organised as follows. Section 2 briefly reviews the relevant literature while section 3 outlines econometric methodology of panel unit root tests that we employ in this paper, namely, IPS and CIPS. Section 4 reports findings and section 5 concludes the paper.

2. Literature Review

The literature on purchasing power parity (PPP) is rather voluminous. It has developed alongside the econometric literature. More often than not, researchers have applied newly developed techniques in econometrics to test for PPP. Empirical avenues investigated include cointegration studies, long data span studies, panel data studies, and nonlinear econometric studies. Although the econometric techniques applied to test the validity of PPP, we can categorize the whole literature in a consistent way.[1]

Most of the early tests of PPP failed to get support in favour of it. The only exception is Frenkel (1978), where evidence in favour of PPP was found. However, Frenkel did not take into account the possibility of the regressors and residuals being nonstationary. Hence, the standard inferences were not appropriate in this case. Later researchers inclined to testing the real exchange rates for unit roots. They applied Augmented Dickey-Fuller (ADF) tests to detect unit root. If the real exchange rate of a country contains a unit root, it means that there is no equilibrium for the exchange rate in the long run sense, so PPP does not hold. Another distinct approach

[1]For comprehensive review of the literature, see Sarno and Taylor (2004) and Taylor and Taylor (2004).

has been cointegration analysis in which researchers looked into exchange rate series and price differential between two countries as potential I(1) processes cointegrating with each other. This approach allowed for long run relationship between exchange rate and relative price level meaning support for PPP.

In general, early studies found little evidence of PPP, but more support for PPP in high inflation countries and inter-war years. The recent works in PPP however are able to garner increasing support in favour of PPP than before even using post Bretton woods data. It was found, however, that the tests applied to examine the long run stability of the real exchange rate suffered from low power. In other words, in those tests, it was difficult to reject the null hypothesis even when it is false. Conversely, researchers were unable to reject the null of unit root in the series, even when there was indeed long run stability in the real exchange rate. The reason is that the mean reversion rate in the real exchange rate is so slow that traditional methods proved to insufficient to identify it which resulted in rejection of PPP.

As a solution to poor power problem in inferences of PPP regression, researchers have used long span data. For example, Frankel (1986) used a long span exchange rate data with large T and a single N ranging from 1869 to 1984. Using this long period approach, Lothian and Taylor (1996) gets evidence in favour of PPP. This approach is, however, not free from criticism. One major problem is that long span data are more likely to suffer from structural break and multiple exchange rate regimes. A second approach to solving is to use panel data. Dealing with panel data enables us to gather more information than either a single time or a single cross-section series. This additional advantage in the use of panel data will permit us to restrict ourselves to post-Bretton Wood exchange rate regime and hence avoid structural breaks.

The recent studies that use panel data to test for PPP include, among others, Coakley and Fuertes (1997), Pedroni (2001), Breitung and Candelon (2005) and Coakley, Kellard and Snaith (2005) and Drine and Rault (2007). Pedroni (2001) tests for strong PPP in a cointegrated panel for the post-Bretton Woods data and reports rejection of the hypothesis. Breitung and Candelon (2005) investigate the stationarity of real exchange rate in a panel of 10 different countries of Asia, and South and Latin America that suffered currency crisis in the last quarter of the 20th century. They develop a panel unit root test that is robust to structural breaks due to currency crisis. They find that the long run PPP hold for the Asian countries, whereas the PPP relationship breaks down for countries of South and Latin America. While Coakley and Fuertes (1997) employ the IPS test only, Coakley, Kellard and Snaith (2005) apply IPS and CIPS (which takes the cross-sectional dependence into account) tests on two panels (CPI and PPI) of 15 OECD countries. Their results reject the PPP for the CPI panel, but for the PPI panel, PPP is not rejected. On the other hand, Drine and Rault (2007) apply panel cointegration technique to test for PPP. They form various panels, such as, OECD, African, Asian, Middle East and North Africa (MENA), Latin American, and Central and East European panels. They report favourable evidence for strong PPP in OECD panel and for weak PPP in MENA panel. For other panels, their study shows that PPP does not appear to characterise the long run behaviour of real exchange rates.

3. Econometric Methodology

3.1 The IPS test

The Im, Pesaran and Shin (IPS) test (Im *et al.*, 2003) is one of the popular panel unit root tests. It allows for residual serial correlation and panel heterogeneity, but does not offer a proper treatment for cross-sectional dependency (CSD). The null and alternative hypotheses of this test can be expressed as

$$H_0 : \beta_i = 0 \qquad \forall\ i$$

$$H_1 : \beta_i < 0 \quad \forall\ i = 1,\ldots\ldots\ldots\ldots N_1; \qquad \beta_i = N_1 + 1,\ldots\ldots\ldots, N$$

The IPS test statistic is given by

$$IPS(N,T) = \frac{\sqrt{N}\left\{ tbar_{NT} - \frac{1}{N}\sum_{i=1}^{N} E\left[t_{iT} \middle| \beta_i = 0\right]\right\}}{\sqrt{1/N \sum_{i=1}^{N} Var\left[t_{iT} \middle| \beta_i = 0\right]}} \overset{T,N}{\Rightarrow} N(0,1) \tag{1}$$

where, $tbar_{NT} = \sum_{i=1}^{N} t_{iT}$ and t_{iT} denotes the t-ratio of the individual ADF regression for cross-section i. More specifically, t_{iT} to form the IPS *tbar* is garnered by taking the t-ratio of the least squares estimate of β_i from the following ADF regression:

$$\Delta y_{it} = \gamma_i + \beta_i y_{i,t-1} + \sum_{j=1}^{m} \alpha_{ij} \Delta y_{i,t-j} + u_{it} \tag{2}$$

Lastly, the normalization terms, obtained from the Table 3 of (Im *et al.*, 2003) are $E[t_{iT} | \beta_i = 0]$ and $E[t_{iT} | \beta_i = 0]$.

3.2 The CIPS test

The CIPS test is a modified version of the IPS test that takes into account the problem of Cross–Sectional Dependence (CSD). This is done by further augmenting the ADF regression as in the IPS test based upon the common correlated estimator approach (CCE) (Pesaran, 2003). The CIPS test statistic, which is a generalized version of the IPS test, is given by

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i(N,T) \tag{3}$$

where $t_i(N,T)$ is the t-ratio given by the ADF regression on cross-section i. The cross-sectional augmented ADF equation (also referred to as CADF) is given by

$$\Delta y_{it} = \gamma_i + \beta_i y_{i,t-1} + c_i \bar{y}_{t-1} + \sum_{j=0}^{m} d_{ij} \Delta \bar{y}_{t-j} + \sum_{j=1}^{m} \alpha_{ij} \Delta y_{i,t-j} + e_{it} \tag{4}$$

where, $\bar{y}_t$ is the cross-sectional mean of y_{it}. The critical values for the CIPS test are contained in the paper.

4. Empirical Findings

4.1 Data

The paper uses real exchange rates of seven South Asian countries, namely, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan and Sri Lanka. These countries are all members of SAARC. The data are of yearly frequency and span the years between 1971 and 2006, 35 years altogether. Data ranging long period of time have been used in order to capture mean reversion tendency in the real exchange rates of currencies of our interest. The real exchange rates have been constructed using the formula $q_t = s_t + \left(p_t^* - p\right)$, where, q_t is the real exchange rate at time t and s_t is the nominal bilateral real exchange rate. p_t^* and p_t are price indices of foreign and home countries, respectively. Data for our investigation have been collected from the International Macroeconomic database maintained by the US Department of Agriculture. Real exchange rates are calculated from nominal exchange rates and consumer price index (CPI) of the member countries of SAARC. Figure 1 in Appendix B exhibit the time plots of the real exchange rates of the seven South Asian currencies. These plots show clear upward trends in all cases.

4.2 Results and Findings

4.2.1 Univariate Unit Root Tests

Table 1 (Appendix A) presents results of the Augmented Dickey–Fuller (ADF) tests. The null hypothesis is the presence of unit root. As for the removal of serial correlation from the data, appropriate lags have been selected using the Schwarz–Bayesian Information Criterion (BIC) and reported in the second column. While the ADF test without a constant term fails to reject presence of unit root in all cases, it is able to reject the unit root null only in few cases when constant and trend terms are included. The overall results, however, witness the presence of unit root in SAARC currencies. This indicates to the fact that these currencies do not seem to have a long run equilibrium value to revert to. Another implication is that PPP does not hold in this set of countries with the US dollar as numéraire currency.

Table 2 presents the results of the Phillips–Perron (PP) tests. The Newey–West truncation parameter is used to determine appropriate lags and reported in the second column. Similar to the ADF test, we report tests statistics based on three different models without a constant term, with a constant term and with both constant and time trend respectively. The null hypothesis is again that a series is nonstationary (i.e. contains a unit root). We are unable to reject the null in all except in two cases as reported in the third column. The results found here reinforce results reported in the previous table.

4.2.1 Panel Unit Root Tests

Table 3 reports the IPS test results that is based on the methodology described earlier. Panel unit root tests have greater rejection power as compared to univariate unit root tests, e.g. the ADF test. The critical values at different levels of confidence are also reported in the table. The IPS test statistic is unable to reject the null of unit root in the real exchange rates of the panel of our interest in both the cases, with and without a time trend. The results obtained here go in favour of results that are obtained earlier in case of univariate unit root tests.

Table 4 presents the CIPS test results. As explained earlier, the particular test takes into account the problem of cross-sectional independence in the data that might be induced due to use of common numéraire currency and price index. The CIPS test, with a constant but no time trend, rejects the null of unit root at all conventional levels of significance. However, when a time trend is added to the test equation in addition to a constant, the results are reversed and the null is accepted at all levels of significance. This part of the results reinforces findings reported in the previous tables.

The overall empirical findings lean towards the failure of the unit root null in this paper. This means that the real exchange rates in our panel are nonstationary, i.e. follow a unit root process. The findings have further implication that PPP does not seem to characterise the long run real exchange rate movements in South Asian countries.

5. Concluding Remarks

The paper set out to test for the validity of PPP in a South Asian panel that includes seven member countries of SAARC. In particular, it investigates whether the real exchange rates of the panel are unit root process by employing a battery of unit root tests. We apply two univariate unit root tests, namely, the ADF and the PP test to check for nonstationarity in the individual real exchange rates. These tests, however, suffer from the so-called problem of the poor power to reject the null hypothesis when it is, in fact, false. Therefore, we also apply two panel unit root tests that are designed to have increased power. These tests are known as IPS and the CIPS tests, where the latter takes into account the presence of cross–sectional dependence (CSD) in the panel data.

The two univariate unit root test results show that the seven real exchange rates mostly follow unit root process and have no long run mean to revert to. This finding is reinforced in the IPS test as well. The only case where we are able to reject the null is in the CIPS test with a constant only. However, when a time trend is added in addition to the constant, the test statistic again fails to reject the null of unit root. The overall finding of this paper is that real exchange rates of the South Asian panel are nonstationary. This finding has particular implication that PPP does not seem to be valid proposition in this region. Therefore, any foreign exchange modelling of this region must take into account the fact that PPP does not characterise the long run relationship between foreign exchange rates and price differentials in the South Asian countries.

6. References

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Appendix A

Table 1: The Augmented Dickey–Fuller (ADF) Test Results

	ADF Tests			
	Lag	**Without Constant**	**Constant**	**Constant and trend**
1. Bangladesh	3	1.463	– 4.421*	–2.952
2. Bhutan	1	0.997	–0.735	–1.954
3. India	1	1.305	–0.974	–1.758
4. Nepal	1	1.585	–1.093	–1.507
5. Pakistan	2	1.311	–0.313	–2.950
6. Maldives	1	0.079	–1.607**	–3.323**
7. Sri Lanka	1	1.097	–2.583	–1.556

* (**) denotes rejection of unit root null at 5% (10%) level of significance.

Table 2: The Phillips–Perron (PP) Test Results

	PP Tests			
	Newey-West Lag	**Without Constant**	**Constant**	**Constant and trend**
1.Bangladesh	3	1.888**	– 2.149	–1.307
2. Bhutan	3	0.885	–0.591	–2.786
3. India	3	1.321	–0.718	–2.059
4. Nepal	3	1.720**	–0.839	–1.791
5. Pakistan	3	1.523	–1.565	–2.786
6. Maldives	3	–0.158	–1.569	–3.171
7. Sri Lanka	3	1.071	–2.180	–1.249

(**) denotes rejection of unit root null at 10% level of significance. There is no rejection of the null at 5% level of significance.

Table 3: IPS Test Results

	Constant	Constant and Trend
IPS Test Statistic	**–1.675**	**–2.286**
1% Critical values	–2.290	–2.900
5% Critical values	–2.070	–2.680
10% Critical values	–1.950	–2.570

Table 4: CIPS Test Results

	Constant	Constant and Trend
CIPS Test Statistic	**–2.877**	**–2.539**
1% Critical values	–2.550	–3.060
5% Critical values	–2.330	–2.840
10% Critical values	–2.210	–2.730

Appendix B

Figure 1: Time–Plots of South Asian Real Exchange Rates