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# Real Exchange Rates and Purchasing Power Parity in South Asia

**Abdullah M Noman**
American International University Bangladesh
Dhaka-1213, Bangladesh
E-mail: amnoman@aiub.edu

**Tamanna Z Khan**
Southeast University
Dhaka-1213, Bangladesh
E-mail: z_tamanna@hotmail.com

**Ishtiaque Arif**
Southeast University
Dhaka-1213, Bangladesh
E-mail: ishtiaquearif@yahoo.com

**Abstract**—*The paper investigates time series properties of real exchange rates of seven south Asian currencies. It employs two alternative unit root tests, namely, the Augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) tests, to check whether these real exchange rates follow unit root process using 35 years of annual data ranging from 1972 to 2006. The ADF test statistic rejects the unit root null in 2 out of 21 cases only, while the PP test statistic rejects only 2 cases too. The overall results count against the stationarity of the South Asian currencies. The findings suggest that the Purchasing Power Parity (PPP) does not hold in South Asia vis-à-vis USA, the major trading partner of South Asian countries.*

**Keywords and Phrases:** Purchasing power parity, real exchange rate, South Asia, unit root tests.

**JEL Classification:** F31.

## 1. INTRODUCTION

The Purchasing Power Parity (PPP) postulates that changes in bilateral nominal exchange rate is proportionately explained by the price differentials of those countries. This version of PPP is also known as Absolute PPP (APPP). Empirically, it is very hard to get support in favour of the APPP. However, another version of PPP, known as the Relative PPP (RPPP), only requires that the changes in nominal exchange rate be proportional to the changes in the relative price levels of the two countries. The nominal exchange rate between two currencies gives us the price of one currency in amount of the other. It does not take into account, however, the price differential between those two countries concerned, which is considered in the real exchange rate, where the changes in the nominal exchange rates are adjusted through any changes in the relative price levels. The real exchange rate then implies a measure of the competitiveness

between two countries. The competitiveness of a currency, however, will now be corrected by the development in the relative prices (see Taylor 2003).

In connection with the PPP hypothesis, researchers have extensively studied the time series properties of real exchange rates. Stationarity of real exchange rates would mean a long term equilibrium value of national currency vis-à-vis a numéraire currency, e.g. US dollar. On the other hand, if a real exchange rate is found to be nonstationary, it indicates that the currency has no long run equilibrium value to revert to and it would meander towards an unknown value. Nonstationarity of real exchange rate would invalidate the PPP which is normally assumed to hold in most of the monetary models of exchange rates determination. In addition, this has implications for trade and balance of payment (BoP) position of a country. Therefore, investigation in the stationarity of real exchange rates has both theoretical and policy implications.

The current paper aims to test the validity of PPP in the SAARC regions. More specifically, it investigates the time series properties of the real exchange rates of seven SAARC nations, namely, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. It excludes the only other member, Afghanistan, which has joined the regional organisation very recently. The principal contribution of the paper is that it applies the unit root tests to the real exchange rates of SAARC nations, which remain largely impoverished despite huge potential. Although the relevant literature is vast, there are extremely few papers that have investigated the real exchange rate and PPP of the SAARC countries. The paper is organised as follows. Section 2 touches upon the existing literature on testing for PPP through stationarity of real exchange rates. Section 3 outlines the methodology and section 4 reports the findings. The section 5 concludes the paper.

## 2. A Brief Review of Empirical Literature

There have been numerous studies that investigate the stationarity of the major currencies of the world (see Sarno and Taylor 2002). The investigations have actually never stopped, rather were carried out again and again, often with newer econometric techniques being employed. An upshot of the use of recent econometric techniques has been increased acceptance of the PPP hypothesis in different studies which would not have been possible without advancement in time series econometrics. The literature on testing for PPP through stationarity of real exchange rates is also voluminous. Early researchers focused on regressing bilateral nominal exchange rate on the price differential of the relevant countries. They often found support in favour of PPP (e.g. Frenkel 1978). However, these studies did not take into account of the fact that both residuals and regression variables were potentially $I(1)$ processed. This resulted in spurious regression problem which overvalued the relationship between bilateral nominal exchange rate and price differential.

In an attempt to avoid dealing with nonstationary nominal exchange rates and price differentials, researchers inclined towards testing real interest rates for stationarity. If a real exchange rate series is stationarity, then it has a long run equilibrium value to revert to and hence, support for long PPP is obtained (Sarno and Taylor 2002). In order to investigate the time series properties of the real exchange rates, unit root tests have been extensively applied. The most popular

among all univariate unit root tests is the Augmented Dickey–Fuller (ADF) test. The test is well-known for its poor power. Therefore, other unit root tests like, Phillips–Perron (PP) test and Ng–Perron tests are also utilised. As a measure of overcoming the poor power problem of some unit root tests, long span data were used by the researchers. The reason is straightforward to understand. If a shock to the real exchange rate persists for long, it would die out very slowly over a long period of time. So, a tendency of mean reversion can be detected only by using long span data, rather than using high frequency data (Shiller and Perron, 1985). Studies that used long span data to test for PPP include Frankel (1986), Edison (1987), Abuaf and Jorion (1990), Glen (1992), Cheung and Lai (1994) and Lothian and Taylor (1996).

Although there exists a vast empirical literature that focus on time series properties of major international currencies, studies that look into South Asian currencies are scarce. Enquires that deal with the Asian real exchange rates have generally concentrated on the Asian Pacific, East and Southeast Asian Countries. The current research attempts to fill in this gap in the existing empirical literature.

## 3. Data and Methodology

### *3.1 Data*

The paper uses annual bilateral real exchange rates of seven SAARC countries with the US dollar as the numéraire currency. The paper uses US dollar as the numéraire currency for two reasons. First, all major databases contain real exchange rates of South Asian countries vis-à-vis US dollar only, and second, the US is the major destination of exports of these countries.

The data span over 35 years from 1972 through 2006. 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. Data for our investigation have been collected from the International Macroeconomic database maintained by the US Department of Agriculture. All data have been converted into natural logarithm.

### *3.2 The Unit Root Tests*

The paper applies two popular unit root tests on the real exchange rates series under investigation. The tests are the Augmented Dickey–Fuller (ADF) test and the Phillips–Perron (PP) test. The purpose of applying two different unit root tests is to check robustness of the results. Finding an $I(1)$ real exchange rate implies there is no long run equilibrium level for real exchange rates. In such case, there is no long run mean that the series reverts to and variance is time dependent, tending to infinity as $t$ increases. Alternatively, if a real exchange rate series is stationary, it exhibits mean-reversion (i.e. fluctuates around a long-run mean) with finite variance.

First, we conduct ADF test (Dickey and Fuller 1981) in order to detect nonstationarity in our data. Unit root tests are, however, sensitive to the number of included lags and inclusion of constant and trends. So it is likely that some of the results will indicate the presence of unit root while others will not. We use three different equations of ADF tests. First, without a constant term as follows,

$$\Delta y_t = \beta\ y_{t-1} + \sum_{i=1}^{m} \alpha_{i+1} \Delta y_{t-1} + u_t;\ \ t = 1,2,3.....T \tag{1}$$

second, with a constant term as follows,

$$\Delta y_t = \alpha_1 + \beta\ y_{t-1} + \sum_{i=1}^{m} \alpha_{i+1} \Delta y_{t-1} + u_t;\ \ t = 1,2,3.....T \tag{2}$$

and third, with both constant and trend terms as in the following equation,

$$\Delta y_t = \alpha_1 + \beta\ y_{t-1} + \gamma t + \sum_{i=1}^{m} \alpha_{i+1} \Delta y_{t-1} + u_t;\ \ t = 1,2,3.....T \tag{3}$$

where, $y_t$ the time series of interest, $t$ is trend variable, $m$ is number of lags required to get rid of autocorrelation problem from the data, and $u_t$, is white noise with zero mean and $\sigma^2$ variance.

An alternative test to detect unit a root is known as the Phillips–Perron (1988) (PP) test. The PP test is based on equations similar to the ADF equations but without the lagged difference terms as follows,

$$\Delta y_t = \alpha_1 + \beta\ y_{t-1} + \gamma t + u_t;\ \ t = 1,2,3.....T \tag{4}$$

Unlike the ADF test, the PP adopts a nonparametric approach to correct for autocorrelation. The PP test generally has enhanced power as compared to the ADF test as suggested by some Monte Carlo studies. Similar to the ADF test, the PP test can take three different forms as outlined above.

## 4. Results and Findings

Figure 1 presents (see the Appendix) time plots of the data. The plots suggest that all real exchange rates series have a clear tendency to trend upward. Therefore, unit root tests that accommodate a time trend are included in our study. Table 1 shows the summary statistics of the data. The Ljung–Box $Q$ statistics for lags up to 6 and 12 indicates the presence of autocorrelation in our data. So, we apply augmented versions of unit root tests that account for serial correlation in the data under consideration. On the other hand, The Kolmogorov-Smirnov (K–S) test results show that some of the time series do not conform to theoretical normal distribution.

Table 2 presents results of the 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 Information Criterion (SIC) and reported in the second column. The last three columns of Table 2 show ADF test statistics on the basis of equations (1-3). 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 a single case each when constant and trend terms are included. The overall results, however, witness the presence of unit roots 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 vis-à-vis US dollar as numéraire currency.

**Table 1.** Summary Statistics of SAARC Foreign Exchange Rates

| | Bangladeshi (Taka) | Bhutan (Ngultrum) | Indian (Rupee) | Maldives (Rufiyaa) | Nepalese (Rupee) | Pakistani (Rupee) | Sri Lanka (Rupee) |
|---|---|---|---|---|---|---|---|
| Mean | 4.2737 | 4.1925 | 4.1533 | 4.2815 | 4.2050 | 4.3406 | 4.2185 |
| S.D. | 0.47865 | 0.34716 | 0.36893 | 0.27092 | 0.34402 | 0.40252 | 0.21337 |
| $Q$ (6) | 76.788* | 137.235* | 138.954* | 145.300* | 134.188* | 63.465* | 107.379* |
| $Q$(12) | 80.419* | 159.939* | 151.455* | 168.566* | 157.611* | 64.765* | 113.575* |
| K–S | 1.769* (0.004) | 1.244** (0.091) | 0.710 (0.694) | 1.156 (0.138) | 1.038 (0.231) | 2.177* (.000) | 0.658 (0.780) |

Notes: Q(q) is the Ljung–Box Q statistic for testing q–order joint serial correlation, which distributes as a chi–square with q degrees of freedom. * (**) Indicates significance at 5% (10%) level. The Kolmogorov–Smirnov (K–S) statistic tests for normality in the data. Values below the K–S test statistics and within parentheses are the associated p–values.

**Table 2.** The Augmented Dickey–Fuller (ADF) Test Results

| | | ADF Tests | | |
|---|---|---|---|---|
| | Lags | 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 |

Notes: The table contains the ADF test statistics. * (**) denotes rejection of unit root null at 5% (10%) level of significance.

Table 3 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). One is unable to reject the null in all except in two cases as reported in the third column. The results found here reinforce those reported in the previous table.

**Table 3.** 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 |

Notes: The table contains the PP test statistics. (**) denotes rejection of unit root null at 10% level of significance. There is no rejection of the null at 5% level of significance.

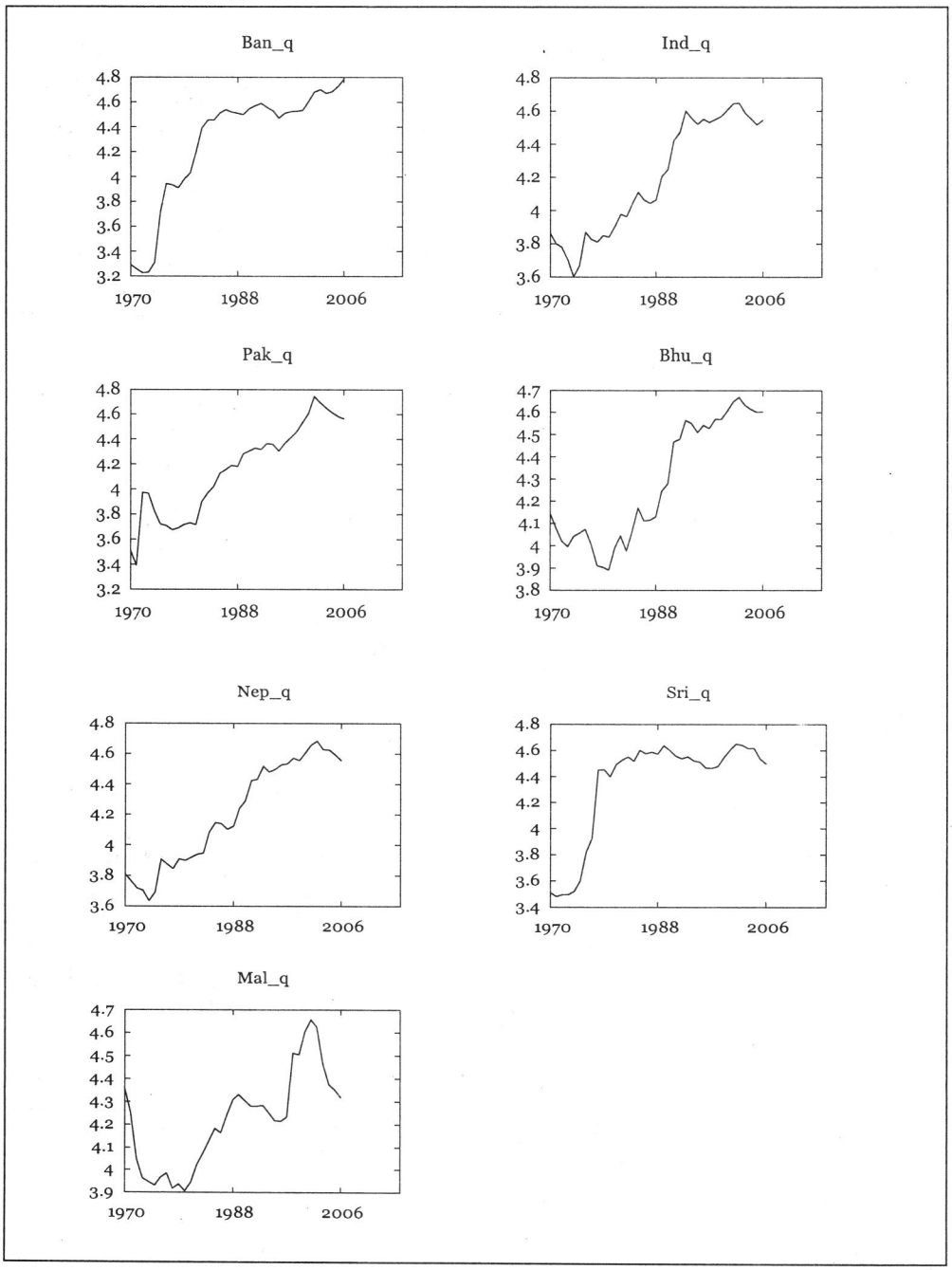


**Figure 1.** Time–Plots of South Asian real exchange rates ($q$)

## 5. CONCLUDING REMARKS

The paper aims at examining whether real exchange rates of seven South Asian countries follow a mean-reversion or a random walk process. To this aim,

two different unit root tests, namely the ADF test and the PP test are applied. Apart from few exceptions, the paper fails to reject the unit root null in the data for both of the tests. The findings overwhelmingly indicate towards the fact that exchange rates of these countries contain unit root and are indistinguishable from $I(1)$ process. In other words, any shock to the real exchange rate movement is permanent and does not die away even in the long run.

The findings of this paper have several implications. The prime implication is that PPP does not seem to hold valid for these South Asian countries. Therefore, macroeconomic models that assume validity of PPP would not be appropriate for South Asian economies. A similar connotation of these results is that any economic study involving real exchange rates (e.g. the Fisher hypothesis) of these South Asian nations has to consider their nonstationary time series properties. So, models that require stationarity of real exchange rates could not be applied on them.

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