Pakistan Economic and Social Review
Volume 44, No. 2 (Winter 2006), pp. 235-243

TESTS OF PURCHASING POWER PARITY FOR SOUTH ASIAN COUNTRIES

SAEED ANWAR JANJUA and EATZAZ AHMAD*

Abstract. Using monthly data on CPI, WPI and the nominal exchange rates for the period 1984 to 2002, this paper applies tests of purchasing power parity on the basis of mean reversion hypothesis and Engle-Granger co-integrating relationship for four South Asian countries. The results of mean reversion hypothesis indicate that PPP does not hold in any of the countries. The results of co-integration analysis indicate that PPP holds in the weaker form only in case of Pakistan. The evidence for India and Sri Lanka is weak, while there is strong indication of the lack of PPP for Bangladesh.

I. INTRODUCTION

Purchasing Power Parity (PPP) is one of the most important conditions in international finance because many models of exchange rate determination are based on the assumption that it holds in one form or another.[1] However, it is well known that PPP, as an exact relationship, holds only under strict conditions. Many real life complications, such as the presence of transactions cost, trade frictions and government policy interventions in foreign exchange markets, can lead to the failure of the PPP. Though the literature shows that PPP performs poorly in the short run (for example, Nelson, 1990; Wu, 1996; Parikh and Williams, 1998), many economists still believe that over the long run, relative prices move in proportion to the change in the nominal exchange rate so that the real exchange rate (RER) will revert to its long run equilibrium position (Bhatti, 1996; Lothain and Taylor, 1996).

---

*The authors are, respectively, Ph.D. student and Professor at the Department of Economics, Quaid-i-Azam University, Islamabad (Pakistan).

[1]For models based on the PPP assumption, see *e.g.* Dornbush (1976), Frenkel (1976), Mussa (1982), Edwards (1989), Nelson (1990), Wu (1996), and Parikh and Williams (1998).

Recent developments in time series econometrics, such as unit root tests, co-integration analysis and their extensions have provided appropriate tools for testing of the PPP proposition and numerous empirical studies have applies these techniques in their empirical analyses (for example, Nelson, 1990; Bhatti, 1996; Lothain and Taylor, 1996). The new econometric techniques typically require long series of low-frequency data. For example, Lothain and Taylor (1996) using data for two centuries concluded that in the long run RER shows mean reverting behaviour. Similarly Wu (1996) using a panel of 18 countries during the post-Bretton Woods era is able to reject the hypothesis that RER have a unit root, thereby concluding that PPP holds in the long run.

Although the concept of RER is very useful for economic analysis, there exists disagreement regarding the definition of real exchange rate in the literature. The exact definition of RER also depends on the purpose for which RER is computed. If the RER is to serve as a measure of international competitiveness of a country against its trading partner(s) then the appropriate concept of RER will be the one proposed in Edwards (1994), whereby RER is the price of tradable goods relative to the price of non-tradable goods, both expressed in a common currency. The usual practice is to multiply the price of tradable goods denominated in foreign currency by the nominal exchange rate and then divide by the price of non-tradable goods denominated in home currency. On the other hand, if the RER is to serve as an indicator of the validity of PPP proposition then the appropriate measure of RER is the ratio of foreign price denominated in foreign currency multiplied by nominal exchange rate and divided by domestic price denominated in home currency.

The objective of the present study is to examine whether real exchange rate series exhibit stable underlying processes in a selection of SAARC countries, namely Bangladesh, India, Pakistan and Sri Lanka. The study is based on monthly data for the period January 1984 to December 2002 and it uses the second concept of RER, which is used to determine validity of the PPP proposition as explained above.

In particular the study determines whether the series of RER are stable or not, that is, whether the series are mean reverting or not. There are two approaches in answering this question and we employ both. The first approach is based on the unit root tests, while the second approach is based on tests of co-integration between nominal exchange rate and the relative price.

The paper is organized as follows. Section II describes data, while the two approaches along with the empirical results are discussion in Section III and Section IV. Finally, Section V concludes the paper.

II. DATA AND VARIABLE CONSTRUCTION

The focus of our analysis is on the sample of four major countries of the SAARC region: Bangladesh, India, Pakistan and Sri Lanka. The USA is foreign country in each case and all nominal exchange rates are expressed in terms of US dollar. In total, 228 monthly observations from January 1984 to December 2002 are used in our analysis. The sample for Bangladesh consists of 198 monthly observations from January 1984 to June 1999. All the data are taken from *Monthly International Financial Statistics* (IFS) of the IMF.

For the measurement of price level, the common practice is to use consumer price index (CPI), wholesale price index (WPI) or GDP deflator. CPI is a more frequently used indicator of price level since it reflects changes in the costs of a fixed basket of goods for the average consumer. CPI also has the advantage of providing a comprehensive measure of changes in competitiveness as it is based on a large group of goods including services. Another advantage is that almost every country publishes fairly reliable data on CPI. However, it is likely that PPP will be violated more often for the RER based on CPI than for the RER based on WPI because the international trade, the main channel of price arbitrage to establish PPP, occurs at wholesale, rather than retail level. In this study CPI and WPI are used alternatively to construct the RER series. Since monthly data on GDP deflator are not available, this measure is not used in the analysis. The data on WPI for Bangladesh are not available in the monthly IFS. Therefore, for Bangladesh the real exchange rate is constructed only on the basis of CPI.

According to Cassel's (1916) theory of Purchasing Power Parity (PPP), the real exchange rate is defined as $RER = S P^f / P^h$, where S, P^f and P^h stand for nominal exchange rate, foreign price level and domestic price level respectively. Taking natural logarithm on both sides, we obtain:

$$\ln (RER) = \ln (S) + \ln (P^f) - \ln (P^h) \qquad (1)$$

III. MEAN REVERSION IN THE REAL EXCHANGE RATE

In this section mean reversion properties of real exchange rate series are investigated. Unit root tests on nominal exchange rate and price levels usually reveal the presence of non-stationary processes at levels. But their combination in the real exchange rate could be stationary. Different tests with the null hypothesis of a unit root are applied to see whether, in general,

real exchange rate as defined follows a stable path or exhibits random walk or any other similar behaviour. The unit root test is based on the general specification of the following form that includes intercept and trend:

$$(RER)_t = \alpha_0 + \alpha_1 (RER)_{t-1} + u_t \quad (2)$$

Or

$$\Delta (RER)_t = \alpha_0 + \beta_1 (RER)_{t-1} + u_t \quad (3)$$

where u_t is a white noise error term and $\beta_1 = \alpha_1 - 1$. Under the null hypothesis RER series has a unit root, that is, $\alpha_1 = 1$ and hence $\beta_1 = 0$, while in the alternative hypothesis the series of real exchange rate is stationary, therefore, $\alpha_1 < 1$ or $\beta_1 < 0$. Thus, PPP will hold in the long run if the null hypothesis of unit root is rejected. We use the standard Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips-Perron (PP) test (Phillips and Perron, 1987). ADF test assumes that the error term is white noise otherwise the test results could be biased. One possible solution is to apply PP test, which does not assume that the error term is white noise. Alternatively one can include sufficient lag first difference terms in the above specification to make the error term white noise. That is to assume the following specification:

$$\Delta (RER)_t = \alpha_0 + \beta_1 (RER)_{t-1} + \lambda (k) \Delta (RER)_t + u_t \quad (4)$$

where k is the lag operator and $\lambda (k)$ is a polynomial of order p in lags k with co-efficient.

The studies based on short spans of data find it difficult to prove that there is any mean reversion in real exchange rate series (*e.g.* Parikh and Williams, 1998 and Wu, 1996). This problem is not likely to arise as we have a sufficiently long time series of 228 observations. We apply the test on real exchange rate using alternatively CPI (consumer price index) and WPI (wholesale price index). The test results are reported in Table 1.

All the test statistics fall in the acceptance range indicating that all the real exchange rate series are non-stationary. The real exchange rates of Pakistan and Sri Lanka calculated on the basis of WPI show some evidence of stationary at 5% significance level. But when we increase the lag length up to 4, these real exchange rates also support the hypothesis of unit root at levels.

On the basis of the results of ADF tests, we conclude that RER series are non-stationary at levels but they are stationary at first differences for each of the country in our sample. Hence, we can say that PPP does not hold in the short run for each of the country in our analysis.

TABLE 1

Unit Root Tests for the Real Exchange Rates

Country	Sample	Series	ADF test (Lag 0)	ADF test (Lag 4)	PP test (Lag 0)	PP test (Lag 4)
Bangladesh	1984:1 to 1999:12	ln RER1	–1.26	–1.22	–1.49	–1.79
		ln RER2	–	–	–	–
India	1984:1 to 2002:12	ln RER1	–1.09	–1.01	–1.11	–2.02
		ln RER2	–1.06	–1.06	–1.12	–2.62
Pakistan	1984:1 to 2002:12	ln RER1	–2.68	–1.52	–2.69	–3.57
		ln RER2	–3.85	–3.06	–3.42	–3.91
Sri Lanka	1984:1 to 2002:12	ln RER1	–3.04	–2.15	–2.85	–3.42
		ln RER2	–3.05	–2.90	–2.90	–3.09

NOTE: ln RER1 and ln RER2 stands for natural logarithm of RER calculated on the basis of CPI and WPI respectively.

IV. CO-INTEGRATION AND ERROR CORRECTION MECHANISM

Engle and Granger (1987) co-integration technique is employed in this section to see whether there is nay long run relationship between nominal exchange rate and relative price level or not, that is, whether the PPP holds in the long run or not. We test co-integration between nominal exchange rate and relative price level for this purpose. Note that all the variables are in natural logarithm. Steps of the procedure are as under:

Step 1 Pretest each variable to determine its order of integration. Co-integration technique requires that the variables should be integrated of the same order. If the variables are integrated of different order, it is possible to conclude that they are not co-integrated. Moreover, if the variables are stationary at level then there is no need to proceed. The Dickey-Fuller, Augmented Dickey-Fuller and Phillips-Perron test can be used to infer the number of unit roots (if any) in each of the variables.

Step 2 If the results of the first step indicate that the variables are integrated of same order, the next step is to estimate the long run relationship in the form:

$$\ln (S_t) = \alpha + \beta \ln (\pi_t) + v_t \quad (5)$$

where π_t is the ratio between foreign price level (P^f) and domestic price level (P^h), S_t is the nominal exchange rate and v_t is the white noise disturbance term. If the sequence of residuals from this regression is stationary, the sequences $\{S_t\}$ and $\{\pi_t\}$ are said to be co-integrated of order (1, 1) and the PPP holds. On the other hand, if these residuals are non-stationary at levels, we conclude that PPP does not hold. There is no long run relationship between nominal exchange rate and relative prices and hence RER will not revert to its parity. It means that the behaviour of RER is non-mean reverting.

TABLE 2

Unit Root Tests for the Nominal Exchange Rates, Consumer Price Index and Wholesale Price Index

Country	Sample	Series	ADF test (Lag 0)	ADF test (Lag 4)	PP test (Lag 0)	PP test (Lag 4)
Bangladesh	1984:1 to 1999:12	ln S	–3.39	–2.04	–3.51	–2.19
		ln CPI	–2.78	–3.01	–3.06	–3.44
		ln WPI	–	–	–	–
India	1984:1 to 2002:12	ln S	–0.55	–0.61	–1.09	–1.45
		ln CPI	–0.39	–0.38	–0.87	–0.97
		ln WPI	–0.56	–0.79	–1.24	–1.55
Pakistan	1984:1 to 2002:12	ln S	–0.45	–0.23	–1.12	–1.36
		ln CPI	–1.39	–1.22	–1.45	–1.57
		ln WPI	–0.97	–0.62	–1.51	–1.48
Sri Lanka	1984:1 to 2002:12	ln S	–0.47	–0.67	–1.13	–1.59
		ln CPI	–0.77	–0.95	–1.01	–1.31
		ln WPI	–0.86	–1.23	–1.78	–2.02

NOTE: ln S stand for the natural logarithm of nominal exchange rate, ln CPI stands for natural logarithm of consumer price index and ln WPI stands for natural logarithm of producer price index.

We first conduct standard ADF and PP tests for a unit root for each individual series. Table 2 presents the results of unit root tests. The

regressions are run without a time trend and the lag length is set equal to 4 for each of the individual series. Other lag lengths are used and the tests are also conducted with a time trend. The results are qualitatively the same and are not reported. Table 2 shows that the null hypothesis that all individual series contain unit root cannot be rejected at conventional significance levels in general. The only exception is the nominal exchange rate of Bangladesh for which the null hypothesis is rejected at 5% significance level, but when we increase lag length up to 4 it also supports the hypothesis of unit root. All variables are non-stationary at level but they are stationary at first difference, that is, they are integrated of order one.

TABLE 3

Unit Root Test with Intercept Term only
on the Residuals of Regression S_t on π_t
(v_1 and v_2 stands for residuals of the regression
of S_t on π_t using CPI and WPI respectively)

Country	Residuals	ADF test at Lag 0	ADF test at Lag 1	ADF test at Lag 2	Decision
Bangladesh	v_1	–1.26	–1.32	–1.19	No co-integration
	v_2	–	–	–	–
India	v_1	–2.24	–2.12	–2.34	No co-integration
	v_2	–2.74	–2.89*	–3.15*	Co-integrated
Pakistan	v_1	–3.77**	–3.29*	–2.95*	Co-integrated
	v_2	–3.96**	–3.54**	–3.16*	Co-integrated
Sri Lanka	v_1	–3.59	–3.71**	–3.32*	Co-integrated
	v_2	–3.16	–2.55	–2.42	No co-integration

NOTE: The statistics significant at 5% and 1% levels are indicated by * and ** respectively.

Table 3 shows that no long run relationship exists between nominal exchange rate and relative price levels for Bangladesh. The evidence of co-integrating relationship for India and Sri Lanka is also quite weak. For India co-integration hold for the WPI only and that too with the lag lengths 1 and 2. Likewise for Sri Lanka co-integration holds for CPI only at the lag lengths 1 and 2. Only in case of Pakistan the evidence of co-integrating relationship between nominal exchange rate and relative price is significant and robust

both with respect to the price index used (CPI or WPI) and the lag length. Thus, we can conclude that PPP holds in the long run only in case of Pakistan.

V. CONCLUSION

The objective of the present study has been to examine whether real exchange rate series exhibit stable underlying processes in a selection of SAARC countries, namely Bangladesh, India, Pakistan and Sri Lanka. The study is based on monthly data for the period January 1984 to December 2002. In particular the study determines whether the series of RER are stable or not.

The tests of PPP indicate that PPP does not hold in the sense that the real exchange rates are not stable over time. The paper then explores the possibility of the existence of PPP in a weaker form by examining the stability of a proportional relationship between nominal exchange rates and the relative prices. The results show that this weaker form of the PPP holds only in case of Pakistan.

We can thus come to the following conclusion with regard to the empirical relevance of the PPP theory. First, we except the PPP not to work well at the aggregate basket of goods (which include many non-traded goods), that is, with respect to the general price level, though it might work for the highly traded individual commodities such as wheat or steel of particular grade. Second, for any level of aggregation, PPP does not hold over the short period, despite the tendency towards parity over the long run. These conclusions are important not only for the relevance of PPP theory itself but also because PPP theory occupies a central position in the monetary and in the asset market or portfolio balance approaches to the Balance-of-Payments and exchange rate determination.

REFERENCES

Bhatti, R. (1996), A correct test of PPP: The case of Pak Rupee exchange rates. *The Pakistan Development Review*, Volume 35(4), pp. 671-682.

Bhatti, R. (1997), Do expectations play any role in determining Pak Rupee exchange rates? *The Pakistan Development Review*, Volume 36(3), pp. 263-273.

Cassel, G. (1916), The present situation of the foreign exchange. *Economic Journal*, Volume 26, pp. 62-65.

Dornbush, R. (1976), Expectations and exchange rate dynamics. *Journal of Political Economy*, Volume 84, pp. 1161-1176.

Enders, Walter (1995), *Applied Econometric Time Series*. New York: John Willey & Sons Inc., pp. 331-336.

Engle, R. F. and C. W. J. Granger (1987), Co-integration and error correction: Representation, estimation and testing. *Econometrica*, Volume 55, pp. 251-276.

Lothian, J. and M. Taylor (1996), Real exchange rate behaviour: The recent float from a perspective of the last two centuries. *Journal of Political Economy*, Volume 104(3).

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

Parikh, A. and G. Williams (1998), Modeling real exchange rate behaviour: A cross-country study. *Applied Financial Economics*, Volume 8, pp. 577-587.

Sebastian, Edwards (1989), Exchange rate misalignment in developing countries. *Research Observer*, Volume 4(1).

Wu, Y. (1996), Are real exchange rates non-stationary? Evidence from a penal data test. *Journal of Money, Credit and Banking*, Volume 28, pp. 54-63.