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Exchange Rate Misalignment in Pakistan: Evidence from Purchasing Power Parity Theory

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1. INTRODUCTION

Exchange rate provides a key link between the domestic and world markets for goods and assets. Therefore, a proper and detailed analysis of the behaviour of exchange rate is required. There is also growing agreement that prolonged and substantial exchange rate misalignment can create severe macroeconomic disequilibria and the correction of external balance will require both exchange rate devaluation and demand management policies. Thus the policy-makers have used PPP theory as a guide to represent the external competitiveness of a country, and as a benchmark against which floating exchange rates are judged to be misaligned. Developments in 1990s and 2000s show that cost associated with exchange rate misalignment is very high. Hence, the analysis of exchange rate determination in the presence of exchange rate misalignment is crucial for the policy purpose because of its role as a component of an early warning system [Berg, *et al.* (2000)].

It is not easy to set nominal exchange rate in its intended path. There are conceptual and empirical issues that what exactly the value of long-run equilibrium exchange rate. In the literature, there are at least three broad definitions of misalignment [Williamson (1994); Miles-Feretti and Raziun (1996) and Hinkle and Monteil (1999)]. *First*, Price-based criteria, such as purchasing power parity (PPP) and its variants. *Second*, model-based criteria, based on the formal models of nominal exchange rates. *Third*, solvency and sustainability-based criteria, which make reference to trends in the current account and the external debts to GDP ratio. It turns out that the economic relevance of each criterion is inversely related to the difficulty of implementing it. Price-based criteria are relatively easy to implement

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and has strong operational advantages.[1] Therefore, in this study a more modest goal of implementing the price-based criteria is set forth.

Purchasing power parity constitutes one of the fundamental building block in modeling the modern theories of exchange rate determination.[2] This theory was originally advanced by Cassel (1916, 1918), asserts that under the conditions of free trade[3] the nominal exchange rate between two countries is equal to the ratio of the two countries price level. This approach assumes that equilibrium real exchange rates remain constant over time and therefore, the nominal exchange rate movement tends to offset relative price movements.[4] The PPP hypothesis postulates that exchange rates adjust to price differentials in open economies to restore international commodity market equilibrium. Basically, PPP theory relies on law of one price (LOP)[5] in an integrated, competitive product market with an implicit assumption of a risk-neutral world. The concept is based on a flow theory of exchange rates[6] where the demand for currency is to pay for exports and the supply is to pay for imports. Despite the fact that the theory has been known for centuries, PPP remains controversial as ever.[7]

An extensive research has been carried out, *inter alia*, by Taylor (1988); Giovannetti (1989); Patel (1990); Nachane and Chrissanthaki (1991); Crowder (1992); Sarantis and Stewart (1993); MacDonald (1993); Cooper (1994); Corbae and Ovliaris (1988); Ardeni and Lubin (1991); Dornbusch (1988) and Moosa and Bhatti (1996) investigating the validity of PPP theory during the current system of floating exchange rates. But these studies have not found evidence in support of the

[1]The implementation of model-based and sustainability-based criterion requires more detailed analysis. Especially, the sustainability-based measures are very difficult to calculate, as they require a fully fleshed out macroeconomic model. PPP-based analysis can be used to make initial diagnoses and for identifying hypothesis for analysing more detailed models.

[2]The flexible-price monetary exchange rate model developed by Frenkel (1976) and Bilson (1978) presumes that PPP hold continuously, the Dornbusch's (1976) Sticky-price and the Frankel (1979) real interest rate differential models assumes that PPP hold in the long-run only. However, the poor performance of these models required the analysis of their underlying components, including PPP, to be tested for validity [Bhatti (1996)].

[3]Transaction costs, capital flows and speculative expectations are absent.

[4]Although the assumption of free trade, absence of transport costs and speculative flows are unrealistic in the real world and the exchange rate may deviate from its PPP level and real exchange rate from its mean values.

[5]Law of one price states that when measured in a common currency, free traded commodities should cost the same everywhere under perfect market setting assumption (i.e. no transaction costs, no tax, homogeneous goods and complete certainty). If the prices deviate from each other, then the commodity arbitragers would capitalise by buying in one market and selling in another until the profitable opportunities cease to exist.

[6]PPP is called the flow model since it traces the flow of goods and services through the current account to determine the exchange rate.

[7]Much of the theory is reviewed and discussed by Officer (1984); Dornbusch (1988) and Levich (1998).

hypothesis as a long-run hypothesis.[8] As far as Pakistan is concerned, Bhatti (1996); Liew, *et al* (2004); Tang and Butiong (1994) and Ahmed and Khan (2002) found supportive evidence while Chishti and Hasan (1993) found evidence, which does not support the PPP hypothesis.

The main objective of the study is to test the validity of PPP theory of exchange rate determination and to evaluate whether PPP is valid criteria for calculating misalignment in Pakistan for 1982Q2 to 2002Q4. The study is organised in the following manner. In Section 2, the price-based measure of misalignment is described. Section 3 discusses the theoretical model of PPP. Data, econometric methodology and empirical evidence are discussed in Section 4. Exchange rate misalignment is calculated in Section 4, while some concluding remarks are given in the final section.

2. PRICE-BASED CRITERIA OF EQUILIBRIUM EXCHANGE RATE

Purchasing power parity theory of exchange rate determination asserts that the exchange rate between two currencies over any period of time is determined by the changes in the two countries price levels. This theory signals out changes in price levels as the overriding determinant in the determination of exchange rate. According to this theory, exchange rate may diverge from its PPP level in the short-run. There are several reasons that why deviations from PPP occur. *Firstly*, there may be restrictions on trade and capital movements, which will distort the relationship between home and foreign prices. *Secondly*, speculative activities and official intervention may create a PPP disparity. *Thirdly*, the productivity bias when there is a relatively faster productivity growth in the tradable sector than the non-tradable sector will result in systematic divergence of internal prices [Balassa (1964) and Chinn (2000)]. *Fourthly*, the prices are sticky and do not move rapidly enough to offset frequently changes in nominal exchange rates. *Lastly*, the apparent non-stationarity of real exchange rate will be consistent with prevalence of real shocks in the economy. Moreover, an important shocks during the past two decades include large commodity price changes, innovations in the financial sector, imbalance in government budget, differentials in productivity growth among major industrial countries, etc. [Arndt and Richardson (1987)] also generate short-run deviations from PPP.

3. PURCHASING POWER PARITY: THEORETICAL MODEL

The purchasing power parity theory serve as equilibrium condition in the theory of exchange rate determination and in exchange rate policy. This theory is

[8]It must be noted that the majority of studies conducted to data have been on developed countries and a limited number on high inflation developing countries.

still frequently used to determine the link between exchange rate and relative prices.[9] The building block of PPP is the law of one price. For any good, in the absence of quotas, tariffs and other impediments to trade, trade and effective arbitrage in goods markets should ensure identical price across countries. The law of one price is stated as:

$$P_i = S.P^*_i \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Here P_i is the price of good i expressed in domestic currency, P^*_i is the price of good i expressed in foreign currency and S is the nominal exchange rate expressed in unit of local currency per one unit of foreign currency. When aggregated over all goods, the law of one price yields the purchasing power parity, which is stated as

$$P_t = S_t.P_t^* \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Here P is the price level in the home country and P^* is the price level in the foreign country. Equation (2) is known as absolute PPP. It is known that transportation costs, tariffs and non-tariff barriers will entail market segmentation and create a wedge among price across countries. However, if these factors remain constant over time, PPP can be restated, using a positive constant B[10], as:

$$P_t = B(SP^*)_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

In logarithmic form it can be expressed as

$$p_t = \beta_0 + s_t + p^*_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Rearranging Equation (4) gives the strong or absolute form of the PPP

$$s_t = \beta_0 + (p - p^*)_t + \mu_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

[9]Many countries undertake corrective measures of their exchange rates based on inflation differentials with partner countries. While fundamental equilibrium exchange rates (FEERs), derived from medium term internal/external macroeconomic balance conditions, are becoming more and more attractive for detecting misalignment in a country's real exchange rate [Clark, *et al.* (1994)], PPPs remain much easier to compute. Moreover, deviations between FEERs and PPPs have not yet been analysed in empirical studies.

[10]In contrast, relative PPP refers to the relationship between relative change in nominal exchange rate and the differential in relative changes in price levels, that is, $\frac{\Delta s}{s} = \frac{\Delta p}{p} - \frac{\Delta p^*}{p^*}$, or in logarithmic form

$$\Delta s = \Delta p - \Delta p^* .$$

Where s_t, p_t and p_t^* are the natural log of nominal exchange rate, domestic and foreign price indices respectively while μ_t is the error term.[11] This version of PPP is based on the law of one price, which states that the price of a common basket of goods in the two countries, measured in a common currency will be the same at all time because of costless spatial arbitrage.

The testable version of PPP is expressed as:

$$s_t = \beta_0 + \beta_1 (p - p^*)_t + \mu_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Where β_0 is the logarithm of the exchange rate observed in the base period. In Equation (6), the presence of a constant term β_0 is justified by Krichene (1998) on two grounds. *First*, since transportation costs, tariff and non-tariff barriers entail markets segmentation and create a wedge among prices across countries. *Second*, the use of a constant also necessary when prices are in terms of indices.

PPP holds in the long-run if the restrictions $(\beta_0, \beta_1) = (0,1)$ cannot be rejected. Moreover, an equilibrium relationship exists when exchange rate and relative prices are cointegrated. Further, if exchange rate changes over time but is stationary *ARIMA* (*p, q*) process, then the deviations from parity are largely temporary and are expected to disappear through time. Although, one-to-one proportionality restrictions seem to be implausible and unrealistic in practice when transport costs, other trade impediments and measurement errors are allowed. Taylor (1988) and Sercu, *et al.* (1995) demonstrates that in the presence of transport costs and measurement errors in the price variables, the proportionality may still hold, but it will not necessarily equal to unity (i.e. $\beta_1 \neq 1$).

4. DATA, ECONOMETRIC METHODOLOGY, AND EMPIRICAL EVIDENCE

We utilised quarterly data ranging from 1982Q2-2002Q4. The exchange rate (s_t) was the end of period nominal rate measured in terms of units of domestic currency per US dollar. Data on relative prices $(p - p^*)_t$ were calculated on the basis of wholesale price index[12] and were obtained from the IFS CD-ROM. Before conducting the analysis of long-run relationship between exchange rate and relative prices, we first test the order of integration of the stochastic variables by employing the augmented Dickey-Fuller (1979) unit root tests. Table 1 reports the augmented Dickey-Fuller test results.[13]

[11]Logarithm of constant *B* is β_0.

[12]We used (WPI) whole sale price indices (1995=100) for both Pakistan and U.S. because the relative prices based on the consumer price indices (CPI) seems to be *I* (2) i.e. $(p-p^*)_t \sim I$ (2) while the exchange rate $s_t \sim I$ (1).

[13]These unit root test results carried out by including linear trend and constant and constant only.

Table 1

Unit Root Tests

Series	Log-Level		Log-first Difference	
	C	C & T	C	C & T
s_t	–0.4692(0)	–2.443(0)	–8.485(0)**	–8.432(0)**
$(p-p^*)_t$	–0.7231(3)	–1.502(3)	–3.743(2)**	–3.570(2)*
		Critical Values		
1%	–3.52	–4.08		
5%	–2.90	–3.47		

** and * indicate significant at 1 percent and 5 percent levels respectively.
C&T are respectively represents constant and trend.

These results indicate that the series s_t and $(p-p^*)_t$ are I (1) in their log-level and I (0) in their log-first difference. Since both series, which would enter the PPP formulation, are integrated of the same order, hence it is possible to test for the presence of cointegration.

The test for the presence of cointegration is performed using Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration method. Two lags were selected for VAR following the Likelihood ratio statistic adjusted for degrees of freedom. Moreover, the VAR model includes restricted intercepts and no trend. Table 2 reports the maximal eigenvalue ($\lambda-\max$) and trace ($\lambda-trace$) statistics of the underlying VAR.

Table 2

Cointegration Analysis of the PPP Hypothesis Series $[s_t, (p-p^*)_t]$ *and Lags = 2*

Eigenvalues	0.31534	0.050444
Hypothesis	r=0	r<=1
$\lambda-\max$	31.06(0.000)**	4.24(0.388)
$\lambda-trace$	35.31(0.000)**	4.24(0.389)
$\lambda-\max(T-nm)$ +	29.55(0.000)**	4.04(0.418)
$\lambda-trace(T-nm)$ +	33.59(0.000)**	4.04(0.419)
Panel B: Standardised Eigenvector (β')		
S_t	1.0000	–0.85630
$(p-p^*)_t$	–1.1031	1.0000
Constant	–3.9206	3.0597
Panel C: Standardised Adjustment Coefficient (α)		
S_t	–0.072218	0.050583
$(p-p^*)_t$	–0.026476	–0.046840

** Indicate 99 percent level of significant. The critical values are taken from Pesaran, *et al.* (2000).
+ The $\lambda-\max$ and $\lambda-trace$ are maximum eigenvalue and trace statistics, adjusted for degrees of freedom.

It may be noted that the exchange rate and price series reveal strong evidence of cointegration using either of the two statistics. The results also indicate the existence of a unique cointegrating vector. The presence of a single cointegrating vector confirms the long-run relationship between the nominal exchange rate and relative prices over the sample period 1982Q2-2002Q2. Thus, we set a considerable support for the so-called weak-form PPP, which purports that exchange rate, and price levels are cointegrated to produce stationary residuals. In order to examine the strong form of PPP, the maximum likelihood estimates of the normalised cointegrating vector was obtained by imposing exactly-identifying restrictions on the identified cointegrating vector. Moreover, imposing over-identifying restrictions on the parameters has also tested the proportionality restriction.[14] The results are presented in Table 3.

Table 3

Testing for Coefficients Restrictions

$(s_t = \beta_0 + \beta_1(p - p^*)_t + \mu_t)$

Panel A: Coefficients and Coefficient Restrictions			
β_0			3.9206
			(0.0615)
β_1			1.1031
			(0.0844)**
Log-likelihood Ratio			393.5807
χ^2 ($\beta_0 = 0$)			4.4805**
χ^2 ($\beta_1 = 1$)			0.9134
χ^2 (β_0 , β_1) = (0, 1)			4.8021
Panel B: Coefficient Restrictions and Weak Exogeneity			
(Standardised β' eigenvectors and $\alpha = A\theta$ coefficients)			
	s_t	$(p - p^*)_t$	constant
β'	1.0000	–1.0000	0.0000
α	–0.0061597	0.0000	0.0000
	(0.0014462)**		
LR-Test of Restrictions, Rank=1: χ^2 (3)= 16.316 (0.0010)**			

** Indicate significant at the 99 percent level. Figures in parentheses indicate standard errors.

[14]These restrictions have been tested by employing Johansen (1988, 1991) maximum likelihood ratio test.

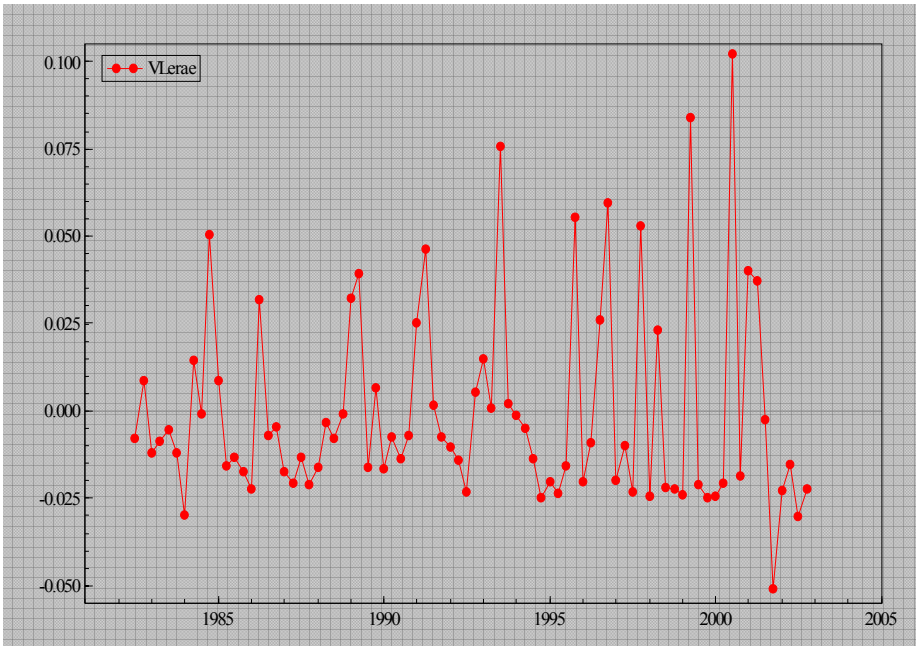
These results indicate that all the coefficients possess expected signs and are significant at the 5 percent level of significant. Furthermore, the results of the coefficient restrictions test reveal that PPP hold reasonably well; lend strong support for the validity of PPP hypothesis as a long-run relationship. Our results are consistent with the previous results obtained by Bhatti (1996) and Tang and Butiong (1994) for Pakistan. Further, the adjustment coefficients (panel C, Table 2) for nominal exchange rate and the relative price level are negative and significant, indicating that both variables adjust to correct the deviations from long-run equilibrium position. However, exchange rate is adjusted faster than the changes in relative prices towards the long-run equilibrium.

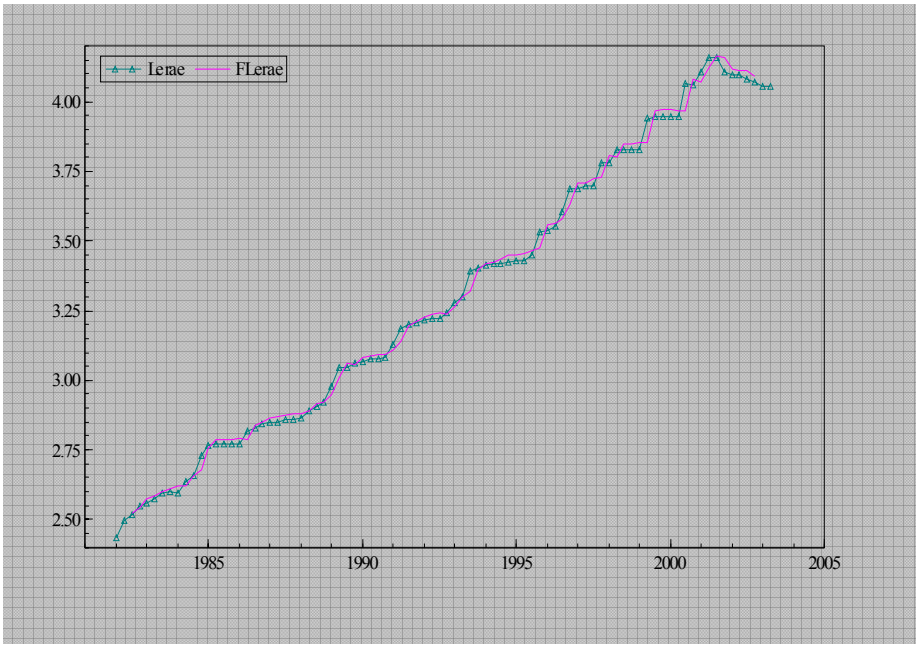
Panel B of Table 3 present the results of testing jointly the existence of a single cointegrating vector and long-run weak exogeneity of the variables s_t and $(p - p^*)_t$ for the parameters in the PPP equation, which are constrained for the long-run proportionality of the exchange rate and relative prices. This implies a single row in the β' matrix and a single column in the α matrix of the form (*, 0, 0). The restrictions do not accepted by the data at the 5 percent level of significant. This result implies that both variables adjust to correct the deviations from long-run equilibrium position.

5. AN ESTIMATION OF EQUILIBRIUM EXCHANGE RATE

Recently, a huge literature has been developed around testing equilibrium exchange rate relationship [see Williamson (1994); MacDonald (1995); Hinkle and Monteil (1999) and MacDonald (2000)]. Increasingly, both practitioners and policy-makers have been using such relationship to address the issue of exchange rate misalignment. Chinn (2000); Husted and MacDonald (1999) and La Cour and MacDonald (2000) assessed whether some currencies are overvalued or undervalued against US dollar or Japanese Yen before the 1997 Asian crisis. In this study, the exchange rate misalignment is calculated as deviations of the nominal exchange rate from the level implied by PPP. If the actual rate is above (below) the level implied by PPP then the domestic currency is overvalued (undervalued). Figure 1 reports the implied misalignment for the period 1995Q1 to 2002Q4. These results indicate that throughout the period Pak-rupee appeared to undervalue against US-dollar. However, the magnitude of under-valuation varies over time and depending upon the estimation of equilibrium rate. As of 2002Q4, the Pak-rupee is seemed to be undervalued about 2.3 percent. The average percentage deviations over the period 1982Q2-2002Q4 are 0.08 percent, which means that the misalignment is corrected in about 3 years, while the maximum and minimum values of the deviations are respectively +10.2 percent and –5.11 percent.

Fig. 1. WPI-based Exchange Rate Misalignment ($(s_t - \hat{s}_t)$





6. CONCLUSIONS

In this study we have tested the validity of purchasing power parity hypothesis and exchange rate misalignment for Pakistan over the period 1982Q2-2002Q4. From the empirical analysis we can say that nominal exchange rate is cointegrated with WPI ratio. The cointegration coefficient between nominal exchange rate and the WPI-based price ratio is close to one. Furthermore, the coefficient restrictions are tested using maximum likelihood ratio statistic, lend support for the validity of the long-run PPP. Pakistan has been pursuing trade and exchange rate liberalisation policies from the late 1980s. Through these reforms, Pakistan has successfully eliminated most price controls and liberalised trade. These trade and exchange liberalisation policies allowed the law of one price to work more efficiently as shown by the supportive evidence of PPP. Moreover, the short-run deviation from PPP has frequently occurred, but the long-run validity of absolute PPP could not be rejected. The adjustment coefficient is negative and significant. However, the size of this coefficient is small indicating that the speed of adjustment is very slow. Even though long-run PPP holds, the speed of adjustment is rather slow, implying that misalignment is eliminated in the absence of shocks but only after a substantial period of time. The exchange rate remained undervalued *vis-à-vis* US dollar since the adoption of managed floating exchange rate system. Finally, the predictive power of these findings implies that exchange rate misalignment relative to PPP would eventually be corrected through commensurate movements in nominal exchange rates.

From the above discussions we can derive the following policy implications.

- *First:* macroeconomic and structural policies should help to converge along the same line as those of its partners. The economic reforms help to enhanced economic efficiency and trade. Moreover, the elimination of tariff and non-tariff barriers also helps to foster private sector development and enhance economic growth.
- *Second:* there is a close relationship between the monetary approach to the balance of payments and PPP. By managing real exchange rates and re-establish international competitiveness reversing losses in foreign exchange reserves and even rebuild these reserves to comfortable levels.
- *Third:* the findings tend to confirm the notion of WPI-based PPP as a long-term anchor; namely, nominal exchange rate will tend to adjust to inflation differentials. Hence, the apparent validity of long-run PPP might warrant testing more elaborate exchange rate models that allow for a well-specified role of main macroeconomic variables, including real income and money supply. In order to control the exchange rate misalignment, the authorities should take appropriate measures to contain the inflation rates.

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