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# EXCHANGE RATE DETERMINATION IN PAKISTAN: EVIDENCE BASED ON PURCHASING POWER PARITY THEORY

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**Abstract**. This paper presents the empirical evidence on purchasing power parity (PPP) for Pak-rupee vis-à-vis US-dollar exchange rate using Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration and bound testing approach to cointegration (Pesaran *et al.*, 2001) over the period 1982Q2-2005Q4. We find a considerable support for the existence of long-run PPP. Furthermore, the results of error-correction suggest that nominal exchange rate plays an important role in eliminating deviations from long-run PPP. The results further suggest that there is high degree of foreign exchange and goods markets integration. One major policy implication derived from the findings of this study is that the monetary authorities should contain money supply growth in order to stabilize prices and reduce balance of payments deficits.

## I. INTRODUCTION

In the era of globalization and financial liberalization, exchange rate plays an important role in international trade and finance for a small open economy like Pakistan. This is because movements in exchange rates affect the profitability of multinationals and increase exchange exposure to enterprises and financial institutions. A stable exchange rate may help enterprise and financial institutions in evaluating the performance of investments, financing and hedging and thus reducing their operational risks (Nieh and Wang, 2005; Rahman and Hossain,

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2003). Fluctuations in the exchange rate may have a significant impact on the macroeconomic fundamentals such as interest rates, prices, wages, unemployment, and the level of output. This may ultimately results in a macroeconomic disequilibrium that would lead to real exchange rate devaluation to correct for external imbalances (Parikh and Williams, 1998). Purchasing power parity (PPP) is the most fundamental and controversial hypotheses in international finance through which the long-run equilibrium exchange rate can be explained. It serves as a benchmark for computing equilibrium exchange rate and assessing whether shocks to the real exchange rate dampen over time. This makes the PPP theory as an attractive theoretical and empirical tool for understanding the fluctuations in exchange rate over time.

PPP theory enjoys significance in the literature and has far-reaching implications at the theoretical, empirical and policy levels. For example, PPP theory constitutes one of the fundamental building blocks in modeling the theories of exchange rate determination.[1] At policy level, it provides an important theoretical basis for the financial stabilization and structural adjustment policies sponsored by the International Monetary Fund and World Bank. It also plays an important role in the choice between money and inflation targeting in the design of monetary policy (Boyd and Smith, 1999). PPP is also sets the criterion for judging whether the exchange rate is overvalued or undervalued in relation to its long-run equilibrium path. Omerbegivic (2005) has noted that:

> the appropriateness of the exchange rate is determined by the criteria whether the current level of the exchange rate that is associated with the equilibrium situation, which is defined in terms of goods and labour market equilibrium and the external balance being sustainable, which on the other hand is determined by the condition of the real economic variables found in equilibrium.

Hence, a proper understanding the determinants of exchange rate helps the policy-makers to design appropriate exchange rate policy in achieving the long-run sustainability of the balance of payments.

PPP theory was originally advanced by Cassel (1916, 1918), asserts that under the conditions of free trade[2] the nominal exchange rate between two countries is equal to the ratio of the two countries price level. PPP theory assumes that equilibrium real exchange rates remain constant over time and therefore, movement

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[1]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).

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

in nominal exchange rates tends to offset relative price movements.[3] It also postulates that adjustments to parity are made via nominal exchange rate movements.[4] This theory basically relies on the law of one price (LOP)[5] in an integrated and 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]

The behaviour of exchange rate in the adjustment process assumes significance for Pakistan, which recently shifted from managed float exchange rate regime to a market-based exchange rate regime.[8] Besides changes in exchange rate regime, trade and financial liberalization and loosening of restrictions on capital flows in Pakistan during the past one and half decade has reduced many distortions. These structural changes may forces the parity condition to converge towards the long-run equilibrium path.

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), Cooper (1994), Corbae and Ovliaris (1988), Arderi and Lubin (1991), Dornbusch (1988) and Moosa and Bhatti (1996). These studies investigated the validity of PPP theory for the Post-Bretton Woods floating

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[3]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 from its mean values.

[4]Under the fixed exchange rate adjustments to parity are made through the movements in domestic price level, while in floating exchange rate regime PPP reversion takes place via nominal exchange rate movements (Kohli, 2002).

[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 capitalized 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 trace 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).

[8]Pakistan has opted managed floating exchange rate system in January 1982. In July 2000, the exchange rate policy shifted from managed float to free flexible exchange rate policy. These changes in exchange rate regime imply that deviations from parity might be eliminated through different processes. Adjustment to parity are made through the movements in domestic price level in fixed exchange rate, while in case of managed floating exchange rate regime parity reversion take place through the movements in exchange rates (Froot and Rogoff, 1995).

exchange rates system and failed to produce supportive evidence for long-run PPP.[9] The empirical evidence associated to Pakistan on this issue is still sparse (Chishti and Hasan, 1993; Bhatti, 1996, 2000; Liew *et al.*, 2004; Tang and Butiong, 1994; Ahmed and Khan, 2002; Qayyum *et al.*, 2004 and Junjua and Ahmed, 2006). All these studies found supportive evidence, while Chishti and Hasan (1993) found evidence which does not support the PPP hypothesis. This study attempts to extend the body of empirical literature by re-examining the validity of PPP using quarterly data over the period 1982Q2-2005Q4. The present study significantly differs from earlier studies conducted on this issue in Pakistan. *First,* unlike previous studies we have estimated PPP as a cointegration-based error-correction model that encapsulate short-run dynamics and the long-run response of the exchange rate to changes in relative prices. *Second,* we check the robustness of the results by using autoregressive distributed lag (ARDL) approach to cointegration. *Third*, the data used in this study is more recent and cover a wide span of time from 1982Q2-2005Q4.

The rest of the paper is organized as follows: section II deals with the theoretical model of purchasing power parity. The possible sources of deviations from the PPP are also discussed in section III. Section IV discusses data, methodology and empirical results, while concluding remarks along with policy implications are given in the final section.

## II. PURCHASING POWER PARITY: A THEORETICAL MODEL

PPP is generally attributed to Cassell's writings in the 1920s, although its intellectual origins date back to the early writings of the 19th century British economist David Ricardo (1821). The basic concept underlying the PPP theory is that goods market arbitrage equalizes prices internationally once the prices of goods are measured in the same currency (Pilbeam, 1998). PPP continuously serves as an equilibrium condition in the theory of exchange rate determination and in exchange rate policy and frequently used to determine the link between exchange rate and relative prices.[10] The building block of PPP is the law of one price (LOP) which simply states that in the absence of a competitive market structure and the absence of transport costs, quotas, tariffs and other trade impediments, trade and effective arbitrage in goods markets should ensure identical price across countries. The LOP

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

[10]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), PPP remain much easier to compute. Moreover, deviations between FEERs and PPP have not yet been analyzed in empirical studies.

is based on the idea of perfect goods arbitrage. Arbitrage occurs where economic agents exploit price differences to provide a riskless profit. The proponents of PPP argue that the exchange rate must adjust to ensure that the LOP holds internationally for identical bundle of goods (Pilbeam, 1998). The testable version of absolute PPP is given by:

$$s_t = \beta_0 + \beta_1 (p - p^*)_t + u_t \tag{1}$$

Where $s$, $p$ and $p^*$ are the natural log of nominal exchange rate, domestic and foreign price indices respectively while $u_t$ is the error term. This version of PPP states that the price of a common basket of goods in the two countries will be the same at all time because of costless spatial arbitrage. In equation (1), $\beta_0$ is the logarithm of the exchange rate observed in the base period. The presence of constant term $\beta_0$ is justified by Krichene (1998) on two grounds. *First*, the transportation costs, tariff and non-tariff barriers lead to market segmentations and create a wedge among prices across countries. *Second,* the use of constant is also necessary when prices are in terms of indices.

The absolute PPP theory states that an increase in the domestic price level due to monetary expansion or unrestrained credit expansion should result in equi-proportionate depreciation of the nominal exchange rate. This proposition holds true only when $\beta_0 = 0$ and $\beta_1 = 1$. Furthermore, real factor also affect the common basket of goods measured in a common currency. However, $\beta_0 = 0$ is often relaxed due to the presence of transportation costs, official intervention in the foreign exchange markets and other possible impediments to trade. The restriction $\beta_1 = 1$ can also be relaxed due to the measurement errors.[11] In addition, national price levels and the nominal exchange rates are generally found to be non-stationary so that the estimated coefficients in equation (1) are biased and do not have a usual $t$-distribution. For these reasons, cointegration tests of PPP do not usually impose restrictions on the values of the coefficients appearing in equation (1).

However, in the real world the equilibrium price of a good may not be the same when converted into a common currency. The reason for this includes the wedge between price levels across countries is created because of transport costs, asymmetric information and the distorting effects of tariffs and other forms of protectionism, which reduce the effectiveness of arbitrators.[12] In addition, the presence of non-traded goods can prevent arbitrators from responding to profitable investment opportunities. The non-traded neutrality of money in the short-run can

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[11] 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.* $\beta_1 \neq 1$).

[12] Furthermore, in real world, different baskets are used for constructing price indexes in different currencies because their tastes and needs are different.

generate price differences in similar goods across countries. This price heterogeneity does not imply the market failure, but it may simply reflect the inability to shift the commodities costlessly and instantaneously from one location to the other. It is argued that a weaker form of PPP ─ known as relative PPP ─ can be expected to hold even in the presence of such distortions. The testable version of relative PPP is given by:[13]

$$\Delta s_t = \alpha_0 + \alpha_1(\Delta p - \Delta p^*)_t + \varepsilon \tag{2}$$

Where $\Delta$ is the first difference operator. For the relative PPP to hold the coefficient restrictions $\alpha_0 = 0$ and $\alpha_1 = 1$ must not be rejected. If these restrictions hold then relative PPP argues that the rate of change in exchange rate is equal to the inflation differential among two countries (Cassel, 1918).

The absolute PPP in equation (1) shows comparative prices in different currencies in a given location and common basket of identical goods. Due to the fact that the PPP hypothesis is regarded as a theory of exchange rate determination, hence, its validity may be depends on the degree of the exchange rate flexibility. The absolute PPP cannot be tested empirically due to the non-availability of comparable data, particularly, on the price levels across countries.[14] However, Bhatti (1996) has pointed out that the distinction between absolute and relative PPP becomes practically impossible because the domestic and foreign price levels are inevitably measured in relative terms by assuming unit price in some base year.

Cointegration analysis is useful for testing the PPP hypothesis as a long-run relationship. Many economists still hold the view that over the long-run, relative prices may move in proportion to the changes in the nominal exchange rate, so that the real exchange rate will revert to parity. If the variables entering in equation (1) are non-stationary, then PPP is tested first by testing the cointegration between *s* and $p - p^*$ and then testing the coefficient restrictions. If $s \sim I(1)$ and $(p - p^*) \sim I(1)$ then the necessary condition for absolute PPP to hold is that $u_t \sim I(0)$, while the sufficient condition is that $(\beta_0, \beta_1) = (0, 1)$.

The next step is to estimate error-correction model based on long-run relationship between nominal exchange rate and relative prices to examine the short-run dynamics. The theory underlying the error-correction model is that a proportion of the deviations from PPP in the initial period are corrected in the subsequent periods. The error-correction model takes the following form:

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[13]The lack of absolute price data constructed for an internationally standardized basket of goods to test the absolute PPP is often enforces researchers to retreat to the testing of relative PPP (Rogoff, 1996). Further, the relative or weak form of PPP relaxes the restriction that $\beta_0 = 0$, and often defines the evolution of exchange rates in growth rate form.

[14]See, for example, Junge (1984), Pippenger (1993) and Bhatti (1996).

$$\Delta s_t = \gamma + \sum_{i=0}^{k} \psi_i \Delta s_{t-i} + \sum_{i=0}^{k} \delta_i \Delta (p - p^*)_{t-i} + \rho EC_{t-1} + v_t \quad (3)$$

Where $\rho$ is the speed at which the deviations from the PPP are corrected. $\rho < 0$ would indicate a reduction in the exchange rate in the current period. A negative and significant error-correction coefficient indicates the tendency for the exchange rate to revert to its long-run equilibrium path. $\rho = 0$ shows no statistical relationship between the exchange rate and the deviation from PPP. In this case there is no tendency for the exchange rate to revert back to its long-run equilibrium. While $\rho > 0$ would mean that the exchange rate is greater than its long-run equilibrium path. Under such situation one would expect that adjustments in exchange rate will take place in the next period and the movements in the price level will produce tendency in restoring long-run equilibrium.

## III. SOURCE OF DEVIATIONS FROM PPP

The possible sources of deviations of PPP from the long-run equilibrium can be explained at theoretical and empirical levels. At theoretical level, PPP may have deviations from its long-run equilibrium in either 'structural' or 'transitory'. *First*, the structural changes may have been a trend deviation from PPP. For instance, a productivity growth differential between countries leads to trend changes in the real exchange rate. A rise in the domestic productivity would give real appreciation of domestic currency against foreign currency. Shifts in technology, tastes, commercial policies and labour force growth will bring changes in the national productivity and hence real exchange rate. Real factors such as, real income, factor endowments, productivity level, etc. will introduce systemic departure from PPP (Hoontrakul, 1999). *Second*, the transitory deviations from PPP occur as a result of disturbance through which the economy adjusts with differential speeds in goods and asset markets. This may be due to the price stickiness and imperfect competition in the product market. In addition, capital flows and divergent fiscal-monetary policies also generate significant deviations from the PPP. Dornbusch (1976) argued that if capital markets are highly integrated and goods markets exhibit slow price adjustment, then there can be substantial prolonged deviations of the exchange rate from PPP.

At empirical level, the conflicting evidence supporting absolute and relative PPP caused by the statistical difficulties (Plibeam, 1998).[15] Most evidence shows the sign of large persistent deviations from PPP for several reasons.[16] *First*, it is difficult to find accurate price index to measure the inflation rate for the countries being studied. Different commodity baskets in different countries cause PPP not to

[15]To test absolute or relative PPP, the data requirement usually is one time series of exchange rate and two time series of price indexes from the corresponding countries.

[16]See discussions on long swings in foreign exchange rate fluctuations by Engle and Hamilton (1990).

hold (Frenkel, 1978), a bias in PPP calculation using the consumer price index (Genberg, 1978). Perhaps non-tradable items such as (*i*) immovable property, (*ii*) perishable goods, and (*iii*) services can allow departure from PPP to persist when one measure inflation only from conventional market-bundle price indexes. Hence, given the different economic structures, the essence of PPP could be vastly different. The economies of the developing countries including Pakistan are heavily dependent on the international trade;[17] inflation and PPP are relevant to exchange rate especially in the medium to long-run for these economies. *Secondly*, obstacles to find support for PPP may be due to the statistical procedure (Pippenger, 1986). The problem of simultaneous determination of prices and foreign exchange rate is noted by Levi (1976) and Hakkio (1984), while the errors in measuring inflation differential were found by Levi (1977). The main results of these studies indicate that PPP does not hold in each and every period, since adjustment time must be allowed. *Third*, after using a cointegration test, Pippenger (1993) concludes that relative PPP holds in the long-run and that nominal exchange rate follows a random walk. Becketti *et al.* (1995) conclude that PPP holds in the long-run. Micheal *et al.* (1997) has pointed out that transaction costs such as, purchase of foreign exchange, forward cover, payments of tariffs and import licensing fees, and transportation costs may generate small deviations from PPP and will not be corrected through the process of commodity arbitrage. Frenkel (1981) argued that PPP holds better when the countries concerned are geographically close and trade linkages are high. Larger discrepancies are expected to be mean-reverting such that speed of adjustment is increasing function of the discrepancy. Furthermore, official interventions in the foreign exchange market when the nominal exchange rate movements are asymmetric and price stickiness are also responsible for nonlinear adjustment of real exchange rates.

Thus, the importance of PPP as a guide for policymakers remains meaningful element of macroeconomics for open economy as a benchmark for overvaluation or undervaluation of the domestic currency. In short, neither forms of PPP holds in the short-run, while there is some evidence favouring the validity of relative PPP in the long-run.

## IV. DATA, METHODOLOGY AND EMPIRICAL RESULTS

The data set used in this study consists of quarterly observations covering the period from 1982Q2 to 2005Q4. The exchange rate ($s_t$) is the average market rate measured in terms of unit of Pak-rupee per US-dollar. Relative prices $(p - p^*)_t$ were

[17]Pakistan is small open economies, which rely heavily on imports because the exports of Pakistan are import oriented.

calculated on the basis of wholesale price index.[18] All the data were obtained from the International Financial Statistics (IFS) CD-ROM (2006).

Before the implementation of the cointegration test, we first examine the order of integration of the individual variable by means of ADF unit root test. The results are reported in table 1. The ADF test suggest that real exchange rate ($q_t$) is non-stationary in terms of log-level and stationary at log-first difference implying no mean reversion of real exchange rate. Parikh and Williams (1998) and Wu (1996) argued that the studies based on short spans of data find it difficult to prove that there is any mean reversion in real exchange rate. Hence, we concluded that based on the *a priori* coefficient restrictions PPP does not hold in the short-run.

TABLE 1

Unit Root Test

| Series | Log-Level | Log-First Difference | Log-Level (with Dummies | Log-First Difference (with Dummies) | Decision |
|---|---|---|---|---|---|
| $s_t$ | –1.288 (1) | –6.618 (0)* | –1.264 (1) | –6.461 (0)* | I (1) |
| $(p-p^*)_t^{cpi}$ | –0.357 (4) | –1.711 (6) | –0.377 (3) | –1.602 (6) | I (2) |
| $(p-p^*)_t^{wpi}$ | –1.384 (3) | –3.940 (2)* | –1.381 (3) | –3.596 (2)* | I (1) |
| $q_t$ | –1.612 (2) | –6.769 (1)* | –1.547 (2) | –6.828 (0)* | I (1) |

**indicate significant at the 1 percent level of significance. Numbers in brackets indicate the lags used in ADF test.

The ADF test associated to $s_t$ and $(p-p^*)_t^{wpi}$ indicates that both series are I (1)[19] at their log-level and I (0) at their log-first difference. To capture the effects of seasonality we also used seasonal dummies in the ADF test, but this makes no difference in the results. Since both variables entered in the PPP formulation are integrated of order I (1), hence it is possible to test for the existence of cointegration.

For the presence of cointegration between exchange rate and the relative prices, Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration tests were performed. Two lags were selected for VAR following the Likelihood ratio statistic adjusted for degrees of freedom and Akaike Information Criterion (AIC).

[18]We used (WPI) whole sale price indices (2000=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.* $(p-p^*)^{cpi} \sim I(2)$ while the exchange rate $s \sim I(1)$.

[19]The relative prices based on CPI are I (2).

The VAR model includes restricted intercept with no trend, three unrestricted seasonal dummies and one intervention dummy $D_{00}$ representing shifts in exchange rate regime from managed float to free flexible in July 2000. Table 2 reports the maximal eigenvalue ( $\lambda - \max$ ) and trace ( $\lambda - trace$ ) statistics of the underlying VAR model.

TABLE 2

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

| | | |
|---|---|---|
| Eigenvalues | 0.1869 | 0.0430 |
| Hypothesis | $r = 0$ | $r <= 1$ |
| $\lambda - \max$ | 19.45 [0.011]* | 4.13 [0.405] |
| $\lambda - trace$ | 23.58 [0.015]* | 4.13 [0.405] |
| $\lambda - \max$ # | 18.62 [0.016]* | 3.95 [0.430] |
| $\lambda - trace$ # | 22.57 [0.022]* | 3.95 [0.430] |
| Panel B: Standardized Eigenvector ($\beta$ matrix) | | |
| $s_t$ | 1.0000 | –0.9453 |
| $p_t - p^*_t$ | –1.0775 | 1.0000 |
| Constant | –4.0073 | 3.4880 |
| Panel C: Standardized Adjustment Coefficient ($\alpha$ matrix) | | |
| $s_t$ | –0.1206 | –0.0162 |
| $p_t - p^*_t$ | 0.0153 | –0.0459 |
| Panel D: Vector Statistics | Test Statistics | p-value |
| Vector Portmanteau 10 lags | 42.83 | – |
| Vector AR 1-5 Test: F (20, 148) | 1.39 | 0.13 |
| Vector Normality test: Chi^2(4) | 39.07* | 0.00 |
| Vector Hetero test: F (24, 215) | 1.09 | 0.36 |
| Vector Hetero-X test: F (42, 202) | 1.10 | 0.32 |

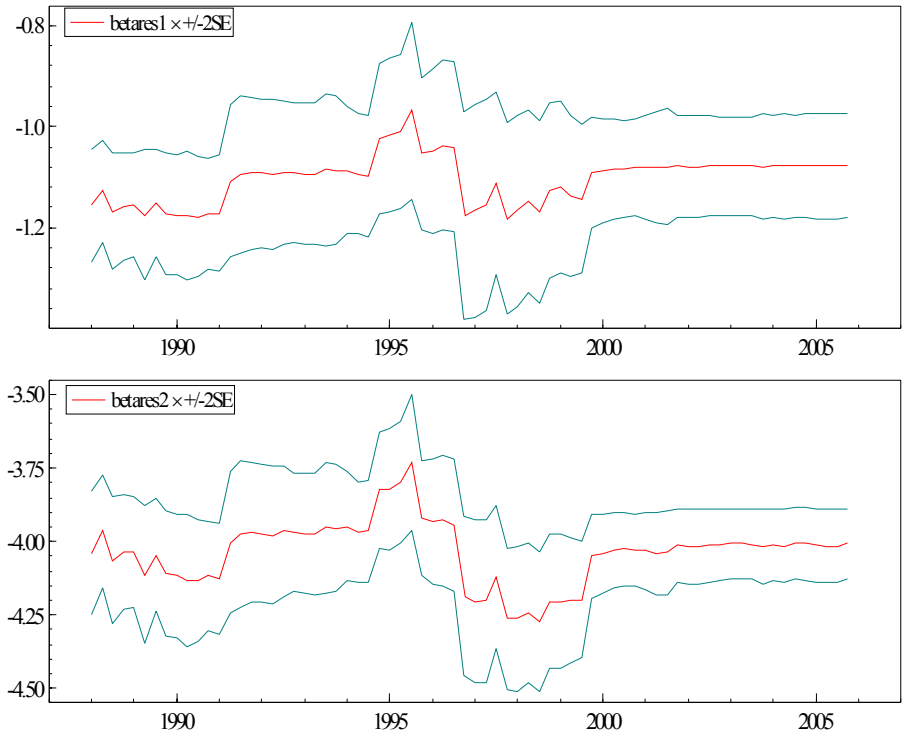
*indicate 95% level of significance. Figures in parenthesis represent p-values. The critical values are taken from Pesaran *et al.* (2000). # represents max and trace statistics adjusted for degrees of freedom.

It may be noted that the exchange rate and price series reveals strong evidence of cointegration using either of the two statistics with the existence of one significant cointegrating vector. The presence of one cointegrating vector confirms the long-run relationship between the nominal exchange rate and relative prices over the sample period 1982Q2-2005Q4. Thus, we get a considerable support for

the weak-form of PPP, which purport that exchange rate and relative prices are cointegrated to produce stationary residual. Interesting findings are the adjustment coefficients (panel C, Table 2) indicating the speed with which the deviations from PPP are corrected in each period to bring back the nominal exchange rate on the path dictated by the long-run equilibrium. The results suggest that around 12% of the deviations from PPP are corrected within a quarter.[20] Recursive estimation of the parameters associated to first cointegrating vector is depicted in Figure 1.

FIGURE 1

Recursive Estimation of Parameters




The recursive estimates of the coefficients show that the slope and intercept coefficients exhibits large movements in the parameters between 1995 and 2000 but remained within the band. However, these parameters remain stable since 2000 and onward. This implies that the free floating exchange rate enhance the exchange rate stability since 2000.

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[20]First element of the first column of the adjustment matrix is the error-correction term for PPP.

To examine the evidence of strong-form PPP, we normalized the first cointegrating vector on nominal exchange rate by imposing exactly-identifying restrictions and tested for the proportionality restriction.[21] The results are reported in Table 3.

TABLE 3

Testing for coefficient Restrictions

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

| Panel A: Coefficients and Coefficient Restrictions | | | |
|---|---|---|---|
| $\beta_0$ | | | 4.0073 (0.0603)** |
| $\beta_1$ | | | 1.0775 (0.0511)** |
| $\chi^2$ ($\beta_0 = 0$) | | | 8.2172 [0.0041]* |
| $\chi^2$ ($\beta_1 = 1$) | | | 2.1919 [0.1387] |
| Panel B: Adjustment Coefficient ($\alpha$) | | | |
| $\Delta s_t$ | | | –0.121 (0.028)** |
| $\Delta (p_t - p^*)_t$ | | | 0.015 (0.022) |
| Panel C: Exclusion Restrictions | | | |
| $s_t$ | | | $\chi^2$ (1) = 7.5672 [0.0059]* |
| $(p_t - p^*)_t$ | | | $\chi^2$ (1) = 7.7429 [0.0054]* |
| Panel D: Coefficient Restrictions and Weak Exogeneity (Standardized eigenvector ($\beta$) and Adjustment Coefficient ($\alpha = A\theta$) | | | |
| $\beta'$ (normalized on $s_t$) | $s_t$<br>1.0000 | $(p_t - p^*)_t$<br>1.0791<br>(0.0556)* | Constant<br>4.0333<br>(0.0658)* |
| $\alpha$ | $s_t$<br>–0.1134<br>(0.0256)** | $(p_t - p^*)_t$<br>0.000 | |
| LR test of restrictions: $\chi^2$ (1) = 0.4309 [0.5116] | | | |

* and ** indicate significant at the 99% and 95% level. Figures in ( ) indicate standard errors while figures in [ ] indicate p-values.

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

The results indicate that all the coefficients are correctly signed and statistically significant. The coefficient restrictions test reveals that the hypothesis of $\beta_0 = 0$ is rejected. This result could be due to: (*i*) barrier to free trade such as tariffs and transport costs, (*ii*) different consumption patterns across partner countries, (*iii*) preference of non-traded goods in consumer bundles, (*iv*) under developed and segmented domestic markets, and (*v*) price stickiness. The proportionality hypothesis (*i.e.* $\beta_1 = 1$) cannot be rejected. This result confirms the proportionality proposition which means that exchange rate move one-by-one with the relative price levels of both countries. Therefore, PPP holds true in Pakistan in the long run. These results are consistent with the previous results obtained by Tang and Butiong (1994), Bhatti (1996, 2000), Qayyum *et al.* (2004) and Junjua and Ahmed (2006) for Pakistan.

Given the number of cointegrating vectors, the statistical property of the data was also verified by imposing long-run exclusion test. This test provides useful information about which variables can or cannot be omitted from cointegration analysis. The test rejects the exclusion of exchange rate and relative prices from the analysis (Table 3 panel C).

Now the question is whether nominal exchange rate or relative prices adjust to clear the deviations from long-run PPP. For this purpose weak exogeneity test is implemented. Panel D of table 3 presents the result of long-run weak exogeneity of $s_t$ and $(p_t - p^*)_t$. Along with the normalized first cointegrating vector, we impose zero restriction on the adjustment coefficient associated to relative price variable. The restriction does not rejected at the 5% level of significant. This suggests that exchange rate alone clear the short-run deviations by about 11% per quarter and the relative price variable is weakly exogenous. This finding is consistent with the fact that in Pakistan inflation is associated to the budget deficit and determine outside the system.

To check the robustness of the empirical results obtained from the Johansen cointegration method and to ensure that the conclusions are fully coherent with the data, bound testing approach to cointegration advanced by Pesaran *et al.* (2001) is used. To implement the bound testing approach, 2 lags were selected on the basis of Akaike Information Criterion (AIC). We estimated unrestricted error-correction model (UECM) and tested for the presence of cointegration among exchange rate and relative prices by setting the coefficients of lag-level variables equal to zero by means of F-statistic. The calculated F-statistic is 4.73 which are higher than the upper bound of the F-statistic (*i.e.* 3.87) at the 5% level,[22] rejects the hypothesis of no cointegration. Thus we get considerable support for the existence of cointegration among nominal exchange rate and relative prices. In the next step, we have estimated the long-run relationship between $s_t$ and $(p_t - p^*)_t$ and tested for coefficient restrictions. The results are reported in Table 4.

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[22]See Pesaran *et al.* (2001), p. T.1 Table C1 case II.

TABLE 4

Long-run Coefficients and Coefficient Restrictions ((ARDL) Approach)

| $s_t = \beta_0 + \beta_1 (p - p^*)_t + u_t$ | |
|---|---|
| $\beta_0$ | 4.0270 (82.0414)* |
| $\beta_1$ | 1.00939 (21.3522)* |
| $\chi^2$ ($\beta_0 = 0$) | 6730.8 [0.000]* |
| $\chi^2$ ($\beta_1 = 1$) | 3.3580 [0.067] |

* and ** indicate significant at the 99% and 95% level. Figures in ( ) indicate t-values, while figures in [ ] indicate p-values. ARDL (2, 2) selected based on AIC

TABLE 5

Results of Specific Error Correction Model for $\Delta s_t$
(1982Q4-2005Q4)

| Variables | Coefficient | t-value | p-value | Split1 | Split2 | Reliable |
|---|---|---|---|---|---|---|
| $\Delta s_{t-1}$ | 0.327 | 4.516 | 0.000 | 0.0116 | 0.0000 | 1.0000 |
| $\Delta (p - p^*)_{t-1}$ | –0.251 | –2.370 | 0.020 | 0.0316 | 0.0170 | 1.0000 |
| $EC_{t-1}$ | –0.117 | –6.650 | 0.000 | 0.0033 | 0.0000 | 1.0000 |
| I1993:3 | 0.073 | 4.096 | 0.000 | 0.0000 | 0.0000 | 1.0000 |
| I1996:4 | 0.071 | 3.990 | 0.000 | 0.0000 | 0.0001 | 1.0000 |
| I2000:4 | 0.071 | 3.967 | 0.000 | 0.6914 | 0.0000 | 0.4926 |
| RSS = 0.03 | $\sigma = 0.02$ | | $R^2 = 0.49$ | | $\overline{R}^2 = 0.46$ | |
| Diagnostic Tests | | | Value | | Prob | |
| Chow (1994:2) | | | 1.4555 | | 0.1122 | |
| Chow (2003:3) | | | 0.1037 | | 0.9995 | |
| AR 1-4 test | | | 0.8884 | | 0.4747 | |
| ARCH 1-4 test | | | 0.4499 | | 0.7722 | |
| Hetero test | | | 2.3397 | | 0.0217 | |

NOTE: Figure in brackets is the p-values. F (20,152) means that the test has an F-distribution with 20 degrees of freedom in the numerator and 152 degrees of freedom in the denominator. Chi^2(4) refers to the $\chi^2$ test with 4 degrees of freedom. I1993:3, I1996:4 and I2000:4 are the dummy variables created to correct the outliers.

The results based on autoregressive distributed lag (ARDL), reported in Table 4 confirm the Johansen-Juselius cointegration results reported in Tables 2 and 3 in terms of signs and significance. Results based on ARDL are very much similar to those from the Johansen procedure and conclusions are not affected by the used of ARDL method of estimation.

Since relative prices are weakly exogenous, hence we estimate the short-run dynamics only for the nominal exchange rate using general-to-specific methodology. The results of specific model subject to a battery of multivariate diagnostics are presented in Table 5. While the results of error-correction model based on ARDL are reported in Table 6.

TABLE 6

Error-Correction Representation for the Selected ARDL Model
ARDL (2, 2) selected Based on AIC

| Dependent Variable: $\Delta s_t$ (1983Q1- 2005Q4) | | | |
|---|---|---|---|
| Regressor | Coefficient | t-ratio | Prob |
| $\Delta s_{t-1}$ | 0.326 | 3.362 | 0.001 |
| $\Delta (p - p^*)$ | 0.133 | 1.009 | 0.316 |
| $\Delta (p - p^*)_{t-1}$ | –0.294 | –2.143 | 0.035 |
| $\Delta$ Constant | 0.417 | 3.340 | 0.001 |
| $EC(-1)$ | –0.103 | –3.257 | 0.002 |
| $R^2$ | 0.22 | $\overline{R}^2$ | 0.18 |
| S.E. Regression | 0.02 | F-statistic | 6.17 |
| R.S.S | 0.04 | Equation-LL | 224.58 |
| AIC | 218.58 | SBC | 211.02 |
| D.W-statistic | 1.93 | | |

Error-Correction (EC) = $s_t$ – 1.0939 * $(p - p^*)_t$ – 4.0270 * constant

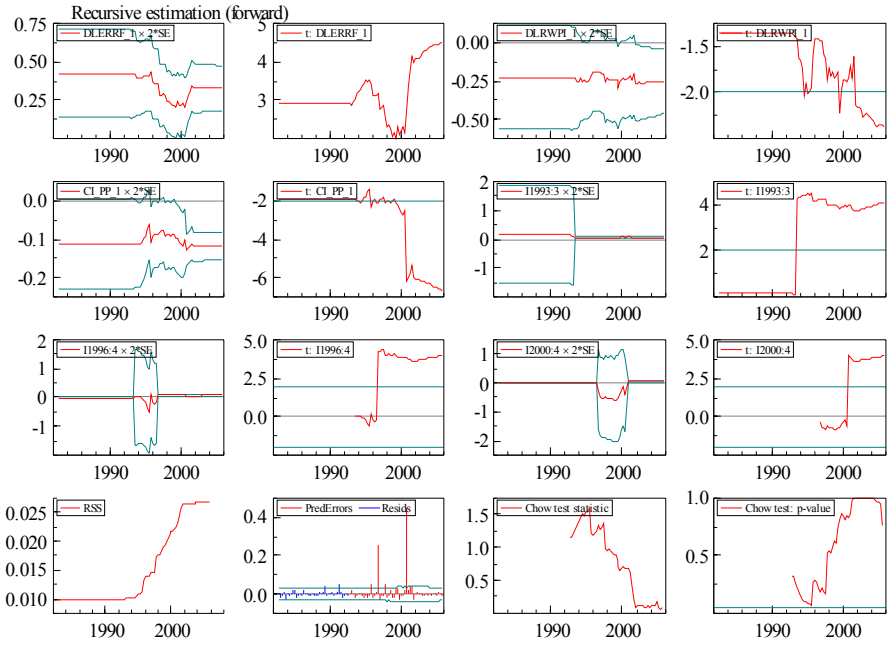
The results of the error-correction model suggest that changes in exchange rate ($\Delta s_t$) lagged by one period is positively correlated to current changes in exchange rate. This result implies that the exchange rate depreciation further weakening the strength of Pak-rupee. The coefficient of inflation differential lagged by one period exerted negative impact on exchange rate in the short-run. This could be due to the fact that during the late 1990s the inflation in Pakistan remained low as compared to partner countries. The error-correction coefficient remains significant and possesses expected negative sign. The magnitude of the error-correction term is –0.12 indicates that the exchange rate would adjust about 12% of the inflation difference between Pakistan and United States per quarter. The ARDL-based error-correction

model also provides similar results to those obtained by using general-to-specific methodology.

Various specification tests suggest that the estimated model is quite reasonable given its parsimony. Particularly, Chow tests indicate that the model is stable over time. The model evaluation statistics show that at the system level, vector autocorrelation, vector heteroscedasticity and vector ARCH have been kept under control. We judge the parameter constancy through forward recursive estimation. The summary of recursive estimates given in Figure 2 indicates that despite the various structural shifts during the sample period, parameter constancy cannot be violated.

FIGURE 2

Diagnostic Graphs for Parameters Constancy
(Based on the Results Reported in table 5)




## V. CONCLUSIONS

The main purpose of this paper is to examine the validity of PPP for Pakistan using quarterly data over the period 1982Q2 to 2005Q4. The mean reversion hypothesis is examined by testing the stationarity of the real exchange rate. Stationarity test of real exchange rate show that PPP does not holds. However, using Johansen-Juselius multivariate cointegration test we find one significant cointegrating vector, which indicates the presence of PPP in Pakistan. The robustness of the Johansen results is

confirmed by implementing ARDL cointegration technique. ARDL verified the Johansen-Juselius results. An important finding of the study includes: *first*, the nominal exchange rate is cointegrated with WPI-based relative price level. The cointegration coefficient between nominal exchange rate and the WPI-based price ratio is close to unity, confirming the proportionality proposition. These results lend strong support for the validity of WPI-based PPP. The reason for the presence of PPP in the traded sector could be: (*i*) the economic development of Pakistan is heavy dependent on the developed countries, and (*ii*) the government is pursuing trade, finance and exchange rate liberalization policies since 1990. To this end, various price controls were lifted and significant efforts were made in liberalizing the trade and payment systems. These liberalization policies allowed the LOP to work more efficiently as shown by the supportive evidence of PPP. The results further implies that high inflation rate due to monetary shocks have been neutralized over the long-run. *Second*, the validity of PPP indicates a higher degree of goods and foreign exchange markets integration. The short-run deviation from PPP has frequently occurred, but the long-run validity of PPP could not be rejected. An error-correction term is negative and significant. The size of the error-correction term is small indicating that the speed of adjustment towards long-run equilibrium is rather slow. *Third*, economic reforms helped to increase the flexibility of prices and nominal exchange rates in adjusting the short-term deviations and shortened the time span required for dampening these deviations.[23]

The major policy implications drawn from this study includes:

- The findings confirm WPI-based PPP as a long-term anchor; namely, nominal exchange rate will tend to adjust to inflation differentials.
- If the monetary authorities wish to stabilize domestic prices and reduce balance of payments deficits, then monetary growth should be contained.
- High degree of integration between foreign exchange and goods markets unable the monetary authority to run monetary policy independently.
- Depreciation of exchange rate further weakening the strength of Pak-rupee.

[23]Empirical findings for developed countries suggest that the time period required for re-establishing PPP is shorter under floating exchange rate regimes; in this case, deviations from PPP could have a half-life as short as three to four years.

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