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ARTICLES

Misalignment of Real Exchange Rate with its Equilibrium Path: Case of Pakistan

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Abstract: *This study estimates the effects of fundamental factors on real exchange rate, determines the path of equilibrium real exchange rate on the basis of sustainable levels of fundamentals and identifies the sources of misalignment. It is found that the real exchange rate has remained historically overvalued in Pakistan. The major factors behind it have been capital inflows and public expenditures.*

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1. Introduction

The fluctuations in real exchange rate may not necessarily indicate the changes in the competitiveness of the economy. If the co-movements in actual and equilibrium real exchange rate is observed due to changes in fundamentals, the policy intervention may not needed. While purchasing power parity (PPP) theory assumes a single value for equilibrium real exchange rate, the theory of fundamentals takes the equilibrium exchange rate as a time path. It is important to understand the causes and consequences of the misalignment of the real exchange rate from its equilibrium path for policy making.

While consensus over the determinants of real exchange rate (RER) is limited, the seminal works of Khan and Montiel (1987), Edwards (1985, 1988, 1988a), Rodriguez (1989), and Elbadawi and Soto (1994, 1997) do offer insightful guidelines in the theory of fundamentals of real exchange rate.[1] In particular, the theory predicts that the determinants of RER can be divided into two broad categories: a) structural variables such as terms of trade (TOT), tariffs,

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[1] Also, see collection of studies in Williamson (1994).

government and private expenditure;[2] and b) nominal variables such as interest rate and devaluation, usually proxied by nominal exchange rate. Despite the lack of consensus over the determinants of RER, the literature nonetheless confirms the theory as the best option because it makes us able to identify position of RER with respect to fundamentals. We apply this theory in case of Pakistan.

This study estimates the effects of real variables and their sustainable levels on the Pakistan's equilibrium exchange rate and their role in real exchange rate misalignment. The earlier studies with reference to Pakistan are confined to determinants of RER except Hyder and Adil (2006) who examine the misalignment.[3] The current study is different from Hyder and Adil (2006) on the three grounds: first, the sample period in their study is too small for cointegration analysis (1978 to 2005) while this paper uses data of 48 years from 1960 to 2007; second, the authors use Engle-Granger technique which is known for its demerits whereas this paper uses Johansen and Joselius method; and last, they use absolute change in the actual values of fundamentals for calculating its contribution in misalignment while this study takes deviations of actual from sustainable levels.

The study is organized as follows: section 2 is devoted to model building and the concepts of sustainability and misalignment; section 3 presents data description and methodology; and sections 4 and 5 present empirical results and analysis of the sources of RER misalignment. Concluding remarks follow in section 6.

2. The Model, Sustainability and Misalignment

RER is generally defined in two principal ways: a) in external terms, as the nominal exchange rate adjusted for price-level-differences between the concerned countries; b) in internal terms, as the ratio of the domestic price of tradable goods to nontradable goods. Therefore, based on the latter definition, equilibrium real exchange rate (ERER) is the relative price of tradables to nontradables that results in the simultaneous attainment of external and internal equilibrium.[4]

Consider an economy with three sectors (exportables, importables, and nontradables). The international price of tradables is given while the price of

[2] Fundamentals, structural and real variables are synonymously used.
[3] Contrary to the results in seminal literature, for Pakistan Chishti and Hasan (1993) conclude significant effects of nominal variables on real exchange rate in the long-run. Afridi (1995) estimates the impact of structural variables on RER of Pakistan. His results confirm the theory but do not contain information about the stationarity of variables thus rendering the findings doubtful.
[4] As defined by Khan (1986), Leventakis (1987), Edwards (1988), and Faruquee (1995).

nontradables is endogenously determined by the market. The ratio of these prices times nominal exchange rate (S) can be defined as RER, i.e.:

$$e = \frac{S\left[\left\{P_x^*\left(1-t_x\right)\right\}^{\alpha}\left\{P_m^*\left(1+t_m\right)\right\}^{(1-\alpha)}\right]}{P_n} \quad (1)$$

Where e, P_x^*, P_m^*, P_n, t_x, and t_m stand for RER, foreign price of exports, foreign price of imports, domestic price of nontradables, tax on exports and tax on imports. α and $(1-\alpha)$ are the shares of exports and imports in tradables. Converting equation (1) from foreign currency denomination to domestic currency, we get:

$$e = \frac{\left\{P_x\left(1-t_x\right)\right\}^{\alpha}\left\{P_m\left(1+t_m\right)\right\}^{(1-\alpha)}}{P_n} \quad (2)$$

Where P_x and P_m are domestic prices of exports and imports converted from foreign currency denomination to domestic currency at the market exchange rate. The long-run equilibrium real exchange rate (ERER) is defined as the rate that prevails when the economy is in internal and external balance for sustainable values of exogenous variables. Internal balance holds when the markets for labour and nontraded goods are in equilibrium:

$$Y_n(e,TFP) = (1-\kappa)eC + G_n \quad (3)$$

Where Y_n, *TFP*, κ, *C*, G_n stand for supply of nontradable goods, total factor productivity, share of tradable in total private consumption, total private consumption and government consumption of nontradables. External balance can be expressed in the following equation:

$$\dot{A} = TB + F + rA = Y_t(e,TFP) - G_t - \kappa C + F + rA \quad (4)$$

Where *A* is total foreign assets, and *TB*, *F*, *r*, Y_t, G_t stand for trade balance, net foreign grants received by the government, real yield on foreign assets, supply of tradable goods, and government consumption of tradable goods. External balance can be defined as steady-state equilibrium at which $\dot{A} = 0$, i.e.:

$$Y_t(e,TFP) - G_t - \kappa C + F + rA = 0 \quad (5)$$

Following Elbadawi and Soto (1994 and 1997), equations (3) and (5) can be solved for obtaining RER as under:

$$e = e\left(CF, TOT, t_x, t_m, G_n, G_T, TFP\right) \quad (6)$$

Where *CF* is capital inflow and *TOT* is terms of trade. The equation (6) is assumed as log-log linear form and export and import taxes and government consumption on nontradables and tradables are replaced by trade liberalization (LIB) and total government consumption (GC) due to data limitations.

$$\ln e_t = \delta_1 \ln TOT_t + \delta_2 \ln LIB_t + \delta_3 \ln GC_t + \delta_4 \ln CF_t + \delta_5 \ln TFP_t + \varepsilon_t \quad (7)$$

To establish the model for ERER (e^*), we estimate the sustainable level of every regressor in equation (7) and plug those sustainable levels back into the same equation (7):

$$\ln e_t^* = \delta_1 \ln TOT_t^s + \delta_2 \ln LIB_t^s + \delta_3 \ln GC_t^s + \delta_4 \ln CF_t^s + \delta_5 \ln TFP_t^s \quad (8)$$

Every regressor with superscript "s" represents sustainable level and is estimated by using the methodology given in the next section.

The sustainable level of a series represents its non-transitory component. For the estimation of a sustainable level of a variable, a stochastic nonstationary process is a useful property. The permanent component of the variable can be obtained by using a suitable time-series decomposition technique. This study uses the Newbold (1990) approach of Beveridge and Nelson (BN)'s (1981) version that estimates the permanent component as follows.

Let a non-stationary series Z_t has stationary first difference $W_t = Z_t - Z_{t-1}$ such that:

$$W_t = \mu + \varepsilon_t + \lambda_1 \varepsilon_{t-1} + \ldots \quad (9)$$

Where, ε_t are uncorrelated random innovations. From this, the expression for the change in permanent component is derived as:

$$\overline{Z}_t - \overline{Z}_{t-1} = \mu + \left(\sum_0^\infty \lambda_t \right) \varepsilon_t \text{ and } \lambda_0 = 1 \quad (10)$$

Where $\overline{Z}_t$ stand for permanent component. For implementing this technique, we confine it to linear process of rational form as:

$$W_t = \mu + \frac{\left(1 - L\theta_1 - L^2\theta_2 \ldots L^q\theta_q\right)}{\left(1 - L\phi_1 - L^2\phi_2 \ldots L^p\phi_p\right)}\varepsilon_t \tag{11}$$

Where μ, θ and ϕ are parameters of ARIMA (p,1,q) process and ε_t is the innovations of original series. Using (11) we get the steady-state gain function as:

$$\overline{Z}_t - \overline{Z}_{t-1} = \mu + \frac{\left(1 - \theta_1 - \theta_2 \ldots \theta_q\right)}{\left(1 - \phi_1 - \phi_2 \ldots \phi_p\right)}\varepsilon_t \tag{12}$$

This difference in equation describes the evolution of the permanent component of the time-series as the innovations ε_t occur (Cuddington and Winters 1987). Once the initial value, Z_0, which may be the mean or starting value, is determined, the remaining permanent values of the relevant variables can be computed.

Misalignment

Finally, to determine the level of misalignment, defined as the degree of deviation from ERER at the sustainable level, following equation can be used:

$$m_t = \ln e_t - \ln e_t^* = (\ln e_t - \hat{\delta}' F_t) + \hat{\delta}'(F_t - F_t^s) \tag{13}$$

Where m_t, $\hat{\delta}'$, F_t, F_t^s stand for misalignment, estimators of fundamentals, fundamentals, and fundamentals at sustainable level. m_t is also decomposed into an error-correction term that captures the deviation of exchange rate from the fitted RER using long-run parameters and a term that captures the deviation of current fundamentals from sustainable level.

3. Data Description and Estimation Methodology

The data used in the estimation is based on equation (7) for Pakistan. Starting with the assumption of three goods economy (exportables, importables, and nontradables), RER is defined as $e = (P_x^{\alpha} P_m^{(1-\alpha)}) / P_n$. This definition is also given in Edwards (1988) and it closely corresponds to real effective exchange rate as

available in International Financial Statistics, a publication be International Monetary Fund.

The regressors's description is as follows. External capital inflows (CF) include short and long term inflow such as foreign direct investment, portfolio investment, remittances and long-term external loans. Terms of Trade (TOT) is defined as the ratio of domestic price of unit value of export to the price of unit value of import. Trade liberalization (LIB) is defined as the ratio of exports plus imports to GDP {Elbadawi and Soto, 1994; Baffes et al., 1999; and Tan, 1998). Separate data on government consumption on tradables and nontradables is not available, therefore following Edwards (1985, 1988a) and Chishti and Hasan (1993) the study uses total government consumption (GC) as a proxy. The next regressor for knowing Blassa effect is the total factor productivity (TFP). For this variable we use the series estimated by Khan (2006).

The data consists of 48 years from 1960 to 2007 and its primary source is *Handbook* of *Statistics on Pakistan Economy* published by the State Bank of Pakistan in 2005. Other sources include *International Financial Statistics and Direction of Trade* of the International Monetary Fund, and *Statistical Bulletin* of the State Bank of Pakistan.

Estimation Methodology

Given ample evidence regarding unit-root properties of time-series, the approach is to look for evidence of cointegration between RER and its fundamentals. Therefore, all variables are tested to verify whether they can be represented as difference or trend stationary processes. For testing unit-root hypothesis we apply the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests. The results show that all variables present evidence of non-stationarity at level. Rejection of unit-root hypothesis for the first difference ensures integrated processes of first order. Consequently all these series can enter into the cointegration equations. We use the maximum likelihood cointegration procedure suggested by Johansen and Juselius (1990). The results, as shown in Table 1, suggest that there is only one cointegrating vector.

After confirming the existence of a significant cointegrating vector between the variables, we estimate the long-run parameters of the VAR model. Although a long-run model for RER can easily be estimated, however, main task is the determination of ERER which involves finding a practical approximation to the concept of "sustainability" on the part of fundamentals. Using the combination of autoregressive and moving average (ARMA) process we remove the transitory

Table 1. The λ_{max} and λ_{trace} Tests

Null Hypothesis	Alternative Hypothesis	Computed Value	95% critical value
λ_{trace}	λ_{trace}	λ_{trace}	
$r = 0$	$r > 0$	59.02*	58.90
$r \leq 1$	$r > 1$	29.66	47.18
$r \leq 2$	$r > 2$	9.55	29.50
λ_{max}	λ_{max}	λ_{max}	
$r = 0$	$r = 1$	29.36*	27.60
$r = 1$	$r = 2$	20.11	20.77
$r = 2$	$r = 3$	9.55	14.04

* is 95% level of significance

shocks and obtain permanent evolution of the fundamentals which are multiplied by their respective estimated coefficients of the cointegrating model which results in the determination of ERER. Finally, Granger causality test as shown in Table 2 concludes that these variables significantly Granger-cause RER.

Table 2. Results of Granger Causality Test

H_0 = Real exchange rate is not Granger caused by:	F-Statistics
CF	(3.28)*
TFP	(3.68)*
GC	(2.28)*
LIB	(2.90)*
TOT	(2.22)*

* 5% level of significance.

4. Empirical Results

The results presented in Table 3 accord to the theoretical model outlined in equation (4) as a long-run relationship. Note that an increase in the dependant variable (RER) implies depreciation. In this static model CF, as suggested by the theory and almost all empirical studies, has appreciating effects on RER. Theoretically, CF leads to increased domestic income and consequently to demand for nontradables that causes rise in the price level of domestic products thereby causing RER to appreciate.

Unlike the Balassa view that productivity takes place mostly in tradables that appreciates RER, the results in this study indicate that in the long-run productivity bears depreciating effects on RER, as shown by TFP. This result also supports the

conclusion derived in Mongardini (1998) and Tan (1998) that productivity growth significantly depreciates RER.

Table 3. Long Run Estimates (dependent variable: LRER)

	CF	TFP	GC	LIB	TOT
coefficient	-0.42*	0.08*	-0.04*	0.30*	0.73*
std. error	0.13	0.02	0.017	0.18	0.33
t-stat	-3.10	3.75	-2.35	1.66	2.18
Log likelihood = 79.83					

* 5% level of significance

The results for GC show that it has appreciating impact on RER. The negative coefficient implies that the public sector concentrates more on nontradables that causes rise in their price and appreciating RER. Khan and Lizondo (1987) and Lizondo (1989) conclude the same results for the impact of GC on RER.

The interesting result in Table 3 is that of the LIB in determining the level of RER. The positive and significant sign supports the notion that reforms aimed at reducing tariffs and eliminating other trade restrictions are consistent with more depreciating RER.

While the effects of shocks to TOT are theoretically ambiguous, positive sign in Table 3 confirms the dominance of substitution over income effect. It implies that in the long-run TOT depreciates RER. This finding conforms to Elbadawi and Soto (1997), Tan (1998), and Edwards (1988a).

For computation of ERER and misalignment of RER, we use the estimated values of the model reported in Table 3. As mentioned earlier, ERER is determined by the sustainable level of fundamentals; therefore, we interpret the estimated results of sustainability as reported in Table 4.

Table 4. ARIMA Models for Fundamentals (variables in first difference)

	CF	TFP	GC	LIB	TOT
AR(1)	0.94*	0.27*	0.99*	1.00*	0.96*
MA(1)	-	-1.28*	-	-	-
R^2	0.97	0.59	0.99	0.98	0.87
DW	2.00	2.35	1.91	2.07	2.25
Gain Function	0.48*	0.06*	0.13*	0.09*	0.51*

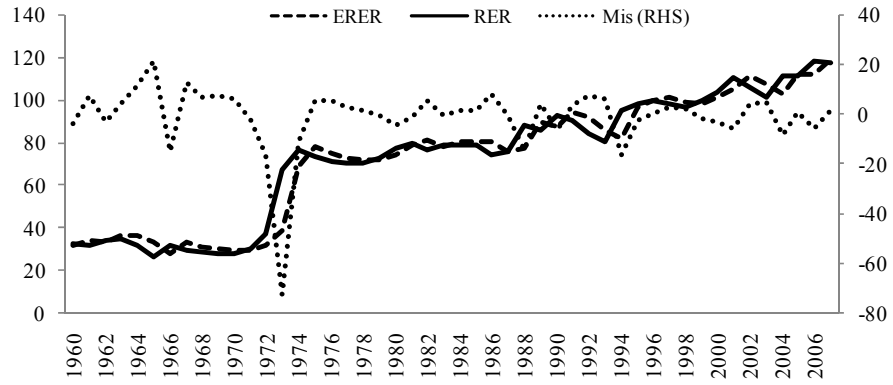
* is 5% level of significance

As described earlier, all variables in the model are nonstationary that proves to be useful property for the concept of sustainability. Because, in case of nonstationary variables their fluctuations correspond to combination of permanent and transitory shocks of which only the former are of interest when computing ERER. Estimating the gain function of every variable by using the BN method, we can conclude that the value of the gain function for each of the variables is less than 1 which implies that these variables converge to their sustainable level in the long-run.

Equilibrium RER is the relative price of tradables to nontradables that for given long-run sustainable values of other real variables results in the simultaneous attainment of internal and external equilibrium. Therefore, the pre-requisite for RER is sustainable values of the concerned variables. These values are estimated and are plugged back into the estimated cointegrating equation. The percentage misalignment is computed as the deviating values from the corresponding ERER values.

These series are shown in Figure 1. It is clear from the figure that ERER is not a single value rather a time path responding to the changes in fundamentals. The apparent noise in the ERER reflects that it should be allowed to change when its fundamentals change.

Figure 1. RER: Actual, Equilibrium, Misalignment



5. Sources of RER Misalignment

Although it is easy to know and interpret the effects of misalignment over the economy, yet the difficult task is to explain the causes (the role of every variable)

behind misalignment of RER and propose policy guide-lines accordingly. For this purpose and for the sake of brevity, we divide actual data into four periods as presented in Table 5. Averages of both the actual and sustainable values for the respective periods are separately computed to analyze the factors responsible for misalignment.

Besides this comparison, we also attempt to point out the causes of misalignment in the light of the inflationary trend both within the country and the rest of the world, particularly the price level in terms of US dollar. Further note that the following analyses are made while simultaneously taking into account both the coefficients in Table 3 and the level of misalignment in RER.

Table 5. Average Level of the Actual and Sustainable Fundamentals

	1970-1978	1979-1988	1989-1999	2000-2007
Mis (percent)	-8.71	0.22	-2.28	-1.20
Pinf (percent)	13.10	7.61	8.40	6.50
Winf (percent)	9.70	4.03	2.40	4.20
ACF (bil. of Rs)	9.06	54.17	257.74	819.47
SCF (bil. of Rs)	8.52	54.35	239.28	806.66
ATFP (percent)	0.98	2.77	1.17	3.28
STFP (percent)	1.95	2.48	1.63	2.80
AGC (bil. of Rs)	10.55	50.30	209.61	456.51
SGC (bil. of Rs)	10.18	47.16	214.14	465.39
ALIB (ratio)	0.02	0.07	0.18	0.42
SLIB (ratio)	0.02	0.07	0.20	0.29
ATOT (percent)	123.73	95.35	78.34	62.52
STOT (percent)	126.11	99.08	83.95	66.23

Note 1: Mis, Pinf, and Winf respectively stand for misalignment, inflation in Pakistan, and world inflation.
Note 2: Variables with prefix A are actual values and with S are sustainable.

First Period (1970-1978)

As reported in Table 5, the RER appreciated about 8.7 percent on average during this period. Perhaps, the crisis in 1971-72 played a significant role in the

overvaluation of RER.[5] Besides impairment in other variables due to this crisis, average inflation of 13.1 percent coupled with oil price shock of 1974-75 were the main causes of RER appreciation. Though this shock was not confined to Pakistan, its negative effects over domestic price (Pinf) level were relatively more severe than the world price (Winf) level. Another important factor behind the appreciation of RER was the deterioration in TOT; it significantly depreciated RER. During this period, the estimated average sustainable level of TOT to maintain RER at equilibrium was about 126.1 percent which is greater than the actual level of 123.7 percent. This deterioration in TOT played a vital role in the appreciation of RER. Another important factor in appreciating RER was CF because its sustainable level was less than its actual level.

As the role of other variables such as TFP and LIB is concerned, the former bears appreciating effects on RER (Table 3). In this period, the average actual level of TFP was less than average sustainable level and its coefficient is significantly positive (Table 3); therefore, it can be concluded that TFP had also appreciated RER. In the case of LIB, positive coefficient and higher volume of actual trade than its sustainable level lead to a depreciated RER. As shown, the negative coefficient in Table 3, GC had appreciating impact and its actual value of Rs 10.6 billion was more than the required sustainable value. It implies that GC appreciated RER. Although LIB had depreciating impacts on RER, its role was outpaced by the appreciating impact of inflation, CF, GC and deterioration in TOT and TFP.

Second Period (1978-1988)

During this period average misalignment of RER was 0.22 percent. It implies that the average value of RER over this period remained close to equilibrium. As compared to the domestic price level, the world price level was lower which appreciated RER. An important factor that played a vital role in maintaining RER at equilibrium is LIB whose actual average level comes to its sustainable level. In this period, average TFP of 2.77 percent also caused depreciation of RER because the actual growth rate was more than the average sustainable level of 2.5 percent. In this period CF also depreciated RER because its average actual level was less than the sustainable value. On the other hand, GC and TOT appreciated RER because average actual level for the former was more, and average actual value for the latter was less than their average sustainable levels. To conclude the whole picture in this period, the overvaluation of RER due to GC, inflation, and

[5] War between India and Pakistan.

deterioration in TOT was neutralized by the depreciating impact of TFP, CF and LIB.

Third Period (1989-1999)

In this period the average misalignment (overvaluation) of RER was at -2.28 percent. This appreciation in RER can be traced to inflation, TFP, CF, LIB and deterioration in TOT. Average Pinf, 8.4 percent, was relatively more than the Winf of 2.4 percent. One of the highly appreciating factors of RER was the increase in CF: as compared to the average sustainable level of Rs 239.3 billion, the average actual level amounts to Rs 257.7 billion per year. The role of TFP in appreciating RER was also important in this period as average TFP was less than its sustainable level. The deterioration in TOT to 78.3 percent from sustainable level of 83.9 percent caused overvaluation of RER. The LIB also had appreciating effect on RER because its actual level was less than the sustainable level. The GC depreciated RER but its strength of depreciation was overtaken by the above mentioned variables.

Fourth Period (2000-2007)

In this period RER remained appreciated by 1.2 percent. The main factors behind this appreciation seemed to be inflation, CF, and deterioration in TOT. TOT as shown in Table 3 had depreciating effects on RER. The actual value again was less than sustainable level so rather than depreciating; it appreciated RER in this period. The most important factor in appreciating RER in this period was CF because its actual average level of Rs 819.5 billion exceeded the sustainable level of Rs 806.7 billion. As compared to Winf, higher level of inflation in Pakistan (Pinf) also appreciated RER.

In this period GC, LIB and TFP caused depreciation of RER. The average actual level of GC was less than its sustainable value which lead to depreciation of RER. TFP and LIB also depreciated RER because their average actual levels exceeded the sustainable levels; however, the depreciating impact of these variables was overtaken by the appreciating effects of other variables, thus causing RER on average to remain overvalued in this period.

6. Concluding Remarks

Real Exchange Rate (RER) is a key macroeconomic variable. The concepts of equilibrium and misalignment of RER are very important for policymakers. Despite its importance, no serious attempt has been made so far to compute

Pakistan's ERER and its misalignment. Therefore, this paper makes an attempt to determine long-run cointegrated equilibrium and misalignment of RER having estimation of sustainability of the fundamentals to be consistent with internal and external balances.

After estimating the sustainable level for every variable, we compute equilibrium RER and percentage level of misalignment. On average RER remains overvalued over the entire period. Like other empirical studies, capital inflows and government consumption appreciate RER in the long-run. Similarly terms of trade plays a vital role in affecting RER. In this case shocks to terms of trade show the dominance of substitution over income effects which depreciate RER. Despite this positive effect, terms of trade plays appreciating role because of its deterioration. To move RER towards equilibrium it is of considerable importance to have more exports of manufactured goods instead of primary goods.

Though this study confirms the theory of RER based on fundamentals, yet it can be improved by including more variables and enlarging the sample size.

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