Growth Effects of Real Exchange Rate Misalignment: Evidence from Pakistan

Arshad Ali Bhatti[a], Tauqir Ahmed[b], Babar Hussain[c]

Abstract

This paper assesses the growth effects of real exchange rate (RER) misalignment in Pakistan using annual data over the period 1980-2013. Its objectives are threefold: First, to examine the long run relationship between the real effective exchange rate (REER) and its economic fundamentals. Second, to estimate the equilibrium real effective exchange rate (EREER) and real exchange rate misalignment. Third, to test the hypothesis that undervaluation is associated with economic growth as claimed by Rodrik (2008). This study employs Autoregressive Distributed-lag (ARDL) bounds testing approach of Pesaran et al. (2001) to appraise the long-run equilibrium relationship between REER and macroeconomic variables. Further, the "Hodrick-Prescott (HP) filter" is used to compute the misalignment of REER. The empirical findings suggest that there is long- run relationship among REER, Real GDP per capita, trade openness, terms of trade, government expenditures, discount rate, FDI, and financial development. Further, Pakistani Rupee was found to be undervalued in 1980 by 17 %. It remained overvalued from 1981-85 with a highest misalignment of 24% in 1984. In the period thereafter (1986-1994), Pakistani Rupee remained undervalued. We observe different episodes of appreciation and depreciation of the local currency since 1995. However, the appreciation and depreciation was relatively smaller than the periods of 1980s and early 1990s. It is noted that Pakistani currency remained overvalued since 2010 that might adversely affect economic growth, while moderate undervaluation would increase the economic activity. Finally, it is found that REER misalignment Granger causes real GDP growth, whereas no feedback effect is observed.

Introduction

The failure of Bretton-Woods system in 1971-1973 compelled the developed economies of the world to replace their fixed exchange rate systems with the floating. The changeover witnessed a greater fluctuation and volatility in both the nominal and the real effective exchange rate (REER) and led to an increase in the uncertainty for investors and other economic agents (Mussa, 1986). The role and importance of REER in international trade is undisputed. Rodrik (2008) emphasizes that the management of the RER is essential for development. In contrast to volatility of REER the misalignment of REER is defined as "the deviation of the REER, undervaluation or overvaluation, from its equilibrium level[d] for a relatively long time (Razin and Collins, 1997)".

The REER misalignment affects the economic development of a country. Ample of literature is accessible on the association between the REER misalignment and economic growth. For example, Rodrik (2008) asserts that overvaluation affects economic performance of a country by reducing the economic growth, while undervaluation lead towards export diversifications and economic growth. In contrast, Williamson (1990) is of the view that undervaluation may also affect economic growth severely because it moves the economy towards internal imbalance and high inflation. Moreover, it might curtail the resources available for domestic gross capital formation and hence limits the capacity of growth. The findings of Dubas (2009) and Elbadawi et al. (2012) are in line

[a] Assistant Professor, School of Economics, IIIE, International Islamic University Islamabad. Email: arshad_bhatti@iiu.edu.pk
[b] PhD Scholar, School of Economics, IIIE, International Islamic University Islamabad. Email: tauqir.ahmed@iiu.edu.pk
[c] Assistant Professor, School of Economics, IIIE, International Islamic University Islamabad. Email: babar.hussain@iiu.edu.pk

[d] When an economy achieves both its internal (full employment and low inflation) and external (balance of payment position is at sustainable level) equilibriums.

with the findings of Rodrik (2008); while the results of Zhang and Chen (2014) fully support the views of Williamson (1990). Couharde and Sallenave (2013) conclude that extreme undervaluation beyond the threshold level severely affects economic growth

Like other developing economies, Pakistan has experienced different exchange rate regimes starting from the fixed exchange rate system to managed float on January 08, 1982. Later on, we had different episodes of managed float, multiple exchange rates and dirty float from 1982 to date. Although floating exchange rate system has some advantages over the fixed or managed float, but exchange rate volatility and uncertainty may hamper and dissuade the international trade.

The issue of RER misalignment has received a great deal of attention during the past three decades (Edwards, 1989; Razin and Collins, 1997; Elbadawi et al., 2012). In the context of Pakistan, several studies attempt the issue of exchange rate misalignment of Pakistan rupee. The findings of these studies are mixed in the context of REER overvaluation and undervaluation. The dominant view is that the Pakistani rupee has been significantly overvalued since the inception of managed float (Qayyum et al, 2004; Hyder and Mahboob, 2006; Debowicz and Saeed, 2014). In contrast, Hyder and Mahboob (2006) and Zakaria (2010) find either different episodes of undervaluation and overvaluation or undervaluation of Pakistani currency throughout the sample period.

The focus of these studies is mainly on the measurement of REER misalignment of Pakistani currency, ignoring the association between REER misalignment and economic growth. Moreover, these studies neglect some important determinants of the RER, such as financial development and capital inflows. The present study fills in this gap by incorporating the neglected fundamentals of REER. We use annual time series data for the period 1980-2013 to measure REER misalignment of Pakistani rupee and its impact on economic growth. The behavioral equilibrium exchange rate (BEER) methodology along with Hodrick-Prescott (HP) filter are used to estimate EREER and its misalignment.

From both the descriptive and policy formulation perspective the association between a country's RER and economic growth is a decisive issue. Edwards (1994: 61) said *"…it is not an overstatement to say that RER behavior now occupies a central role in policy evaluation and design…"* The 'right' RER is one that does not go far away (misaligned) from its "equilibrium value". The misalignment of the RER could lead to a distortion in prices and consequently the resources allocation in the economy. All economic agents are concerned with the behavior of the exchange rate, as it affects them directly or indirectly. Therefore, the RER misalignment needs to be understood for better policy prescription.

Literature Review

The exiting literature on exchange rate misalignment can be classified into theoretical or empirical; where the former consists of theoretical debate, while the later provides an insight into actual issues and solutions related concerning the world.

Theoretical Literature

The real exchange rate (RER) is one of the key concepts of open economy. Theoretically, real exchange rate can either be undervalued, overvalued, or be at equilibrium. The deviation of RER from its equilibrium level is the REER misalignment (Razin and Collins, 1997). One of the earliest theoretical study by Edwards (1989) recommends the proper alignment of the REER for economic growth and development. Hence, it is inevitable to consider the role and importance of exchange rate misalignment in economic performance and development of an economy.

In literature, there are different approaches to measure equilibrium level or equilibrium rate. The commonly used are: "The Purchasing Power Parity (PPP) theory of equilibrium exchange rate determination, Interest Parity (IP), Portfolio-Balance Approach (PBA), Fundamental Equilibrium Exchange Rate (FEER), Behavioral Equilibrium Exchange Rate (BEER), Permanent Equilibrium Exchange Rates (PEER), Equilibrium Real Exchange Rate (ERER), Reduced-form ERER, Fundamental Variables in ERER, Macroeconomic Balance (MB), The IMF RER and Natural Real Exchange Rate (NATREX) approach".

MacDonald, R (2000) and Hoontrakul (1999) present a comprehensive overview of equilibrium ER determination theories. However, a brief overview is as under:

One of the simplest and traditional measures of REER misalignment is PPP base. it links the ER to the price levels. In this method, the deviations of the REER with respect to parity in some determined equilibrium year is being used.

The name of Cassel (1918) is considered as a pioneer of this approach. The PPP theory can be classified into absolute and relative PPP. "*The Absolute purchasing power parity holds when the purchasing power of a unit of currency is exactly equal in the domestic economy and in a foreign economy, once it is converted into foreign currency at the market exchange rate*". The absolute PPP may not hold due to different reasons such as the existence of non-tradable goods, government interventions including tariffs, quotas, taxes and other trade restrictions (Taylor, 2004; Qayyum et al., 2004).

The theory of interest parity originated by Keynes (1923) build up connections among exchange rate, interest rate and inflation. The interest parity can also be classified in to two versions (a) covered interest parity (CIP) and (b) uncovered interest parity (UIP). Similarly, the UIP may not hold due to different factors such as policy behavior, time-domain vector auto-regression procedure, and simple market efficiency hypothesis (Debowicz and Saeed, 2014).

Later on, at the end of 1960s Robert Mundell and Harry Johnson give the idea of monetary approach to the balance of payment. This approach emphases on the relationship between ER systems and movements in the domestic currency values (appreciation or depreciation).

According to this approach the demand of money does not depend on the currency itself but on the demand for financial assets. In 1980s Williamson (1985) introduces the FEER (macro-balance approach) and describes it as "equilibrium rate" that is well-matched with internal as well as external equilibrium. In this approach the main role of researchers is to specify the current account balance (CAB) "norm" and the exchange rate (ER) that is consistent with the specified norm (Debowicz and Saeed, 2014). The Equilibrium Real Exchange Rate (ERER) model is firstly suggested by the Edwards (1989) mainly for developing countries. In this approach the ERER of a country is based on reduced-form single equation models. This model is widely used in the literature for developing countries. For the estimation of these single equation models the Johansen (1988) and Johansen-Juselius (1990) techniques are applied commonly.

The BEER model is introduced by the Clark and MacDonald (1998) through which an equation for the RER is econometrically estimated[a] as a function of fundamental macroeconomic determinants[b]. MacDonald (2000) is on the view that a time series estimates can be decomposed into: (a) permanent and (b) transitory components to measure equilibrium exchange rate.

The NATREX approach is developed by the Stein (1994), an extended version of PPP and FEER; focuses on the time span when the fundamentals are non-stationary. However, in empirical

[a]The cointegration technique (VECM by Johansen, 1995) is commonly used estimation technique.

[b] Most frequently used economic fundamental determinants are; terms of trade, openness, government consumption and productivity differential.

literature, generally a reduced form is estimated with cointegration techniques for the RER which makes the NATREX almost identical to the earlier methodologies (Debowicz and Saeed, 2014).

Empirical Literature

The empirical literature on the issue of growth effects of RER misalignment can be categorized into two major categories. The first strand which is in bulk says that there is an inverse correlation between ER misalignment and economic growth. The second strand is on the view that exchange rate misalignment may affect economic growth positively. We already know that the deviation of RER (undervaluation or overvaluation) from equilibrium level is the REER misalignment.

Although the issue of RER misalignment has received great deal of attention in last three decades (Edwards, 1989; Razin and Collins, 1997; Hyder and Mahboob , 2006; Rodrik, 2008; Hussain and Riazuddin, 2008 ; Dubas, 2009; Elbadawi et al., 2012; Wong, 2013; Holtemöller and Mallick, 2013; Chen and MacDonald, 2015; and Grekou, 2015). Surprisingly, growth effects of ER misalignment in context of Pakistan economy has not been examined considerably. To fill the literature gaps, we gauge the growth effects of RER misalignment in Pakistan by estimating the equilibrium REER. We test the long run equilibrium relationship between REER and macroeconomic variables. Moreover, this study tests the hypothesis that undervaluation is associated with economic growth as claimed by Rodrik (2008).

Growth Effects of Real Exchange Rate(RER) Misalignment

There are many studies that attempt to examine the relationship between undervalued or overvalued RER and economic growth. One of the earliest studies by Collins and Razin (1997) revealed inverse relationship between overvaluation and economic growth. It implies that an overvalued REER negatively affects growth, while an undervalued exchange rate stimulates growth. In contrast, Williamson (1990) is on the view that undervaluation leads to high inflation. Moreover, it might curtail the funds available for domestic gross capital formation and hence limits the capacity of growth. The findings of Edwards, 1989; Rodrik, 2008; Elbadawi et al., 2012; Wong, 2013; and Grekou, 2015 are consistent to Collins and Razin (1997). The well-known study by Rodrik (2008) uses the sample of 184 countries and annual data for 1950–2004 to examine the impacts REER misalignment on economic growth. By employing dynamic panel estimation using GMM he finds that countries with more undervalued REERs achieved higher growth rates, implying that an overvalued REER negatively affects growth, while an undervalued exchange rate stimulates growth.

Following Rodrik (2008), Elbadawi et al. (2012) develop REER misalignment series for a large panel of countries to analyze the empirical links between REER misalignment and economic growth over the period 1980–2004. The study also explores the possible interaction effects between REER misalignment with foreign aid and financial development. The empirical findings suggest that overvaluation is bad for economic growth, while undervaluation is good for growth and export diversifications. Overvaluation reduces growth but that effect is recovered by financial development. The empirical estimations, based on the dynamic system GMM estimator, provide support for several channels of transmissions from aid to growth.

In case of time series analysis, Wong (2013) examines the effects of RER misalignment for the Malaysian economy by employing the ARDL approach. The study suggests that huge RER misalignment adversely affect the growth process in Malaysia. More specifically, REER devaluation promotes economic growth and overvaluation or appreciation hurts economic growth.

Currency Misalignment in Pakistan

In the existing empirical literature, there are several time series attempts regarding the measurement of misalignment of Pak. rupee (Qayyum et al, 2004; Hyder and Mahboob, 2006; Hussain and Riazuddin, 2008; Ahmed, 2009; Zakaria, 2010; Jaffri and Ahmed, 2010; Debowicz and Saeed, 2014). The findings of these studies are mixed in context of REER overvaluation and undervaluation. The dominant view is that the Pak. rupee has been significantly overvalued and adoption of managed floating exchange rate system is one of the main factors behind overvaluation. In contrast, the two studies (Hyder and Mahboob, 2006; and Zakaria, 2010) find either different episodes of undervaluation and overvaluation or undervaluation of Pakistani currency throughout the sample period. Zakaria (2010) evaluates growth effects of RER misalignment in Pakistan for the flexible exchange rate period by using the GMM estimation technique, the study finds that the RER in Pakistan remains undervalue over the sample period (1983Q1 to 2005Q4) which resulted in output growth in Pakistan. Jaffri and Ahmed (2010) examine the impact of FDI inflow on equilibrium real exchange rate (ERER) of Pakistan by utilizing the monthly data for the period of 1993M7 to 2009M3. They use behavioral equilibrium real exchange rate (BEER) approach accompanied by cointegration technique to estimate currency misalignment and determine the long run relationship between REER and its macroeconomic fundamentals. They conclude that the huge FDI inflows as well as workers ‘remittances have appreciated the domestic currency significantly.

Exchange Rate and Currency Misalignment

In debate of regimes effects on REER misalignment Dubas (2009) concludes that ER misalignment is noticeable in developing countries and free-floating exchange rate regime leads to much more RER misalignment. In contrast, Holtemöller and Mallick (2012) find that the fixed regime induces more misalignment than the floating when they take sample of 69 countries and employ panel cointegration model on panel data set from 1970 to 2006. Their results are not consistent to the previous findings of Holtemöller and Mallick (2012); and Dubas (2009). The inconsistency between the results of these empirical studies might be due to differences in the econometric techniques, data sets, samples coverage and variables being used.

The review of existing literature on exchange rate misalignment reveals that the RER misalignment has an inverse impact on economic performance. The empirical evidence shows that the macroeconomic policy variables such as term of trade, trade openness, Govt. expenditures, productivity/technological progress and capital inflows are important drivers of REER misalignment. Similarly, country’s exchange rate regime may also affect the exchange rate misalignment.

Data, Variables and Methodology

This study utilizes annual data over the period of 1980-2013 to measure the REER misalignment of Pakistani rupee and its impacts on economic growth. The dependent variable is real effective exchange rate. We use the consumer price index (CPI)-based trade-weighted real effective exchange rate with a base year of 2005. The independent variable is real per capita GDP growth (RPCGDPG), while the other control variables are trade openness, terms of trade, government consumption, discount rate, money supply and FDI inflows. Openness is calculated as total trade in millions of Pakistani rupee percent of GDP. Terms of trade is the ratio of export unit value index to import unit value index. We use M2 percent of GDP as a proxy of financial development. Similarly, government consumption and foreign direct investment are used as percent of GDP.

Before going to the time series econometric analysis, a detailed statistical analysis is carried out. Our complete data set consists of thirty-four years of annual observations from 1980 to 2013. The descriptive statistics are shown in Table 1.

Table 1: Descriptive Statistics

	REER	RGDPPC	OPEN	TOT	GOV	DR	M2	FDI
Mean	**4.839**	**6.359**	**3.527**	**-0.240**	**2.401**	**2.400**	**3.755**	**-0.376**
Median	**4.747**	**6.361**	**3.517**	**-0.211**	**2.373**	**2.302**	**3.761**	**-0.466**
Maximum	**5.468**	**6.671**	**3.657**	**0.096**	**2.820**	**2.995**	**3.895**	**1.299**
Minimum	**4.575**	**5.982**	**3.336**	**-0.642**	**2.051**	**2.014**	**3.624**	**-2.276**
Std. Dev.	**0.277**	**0.196**	**0.074**	**0.221**	**0.191**	**0.243**	**0.075**	**0.802**
Skewness	**1.115**	**-0.107**	**-0.285**	**-0.169**	**0.130**	**0.757**	**0.164**	**0.083**
Kurtosis	**2.840**	**2.081**	**2.927**	**1.918**	**2.564**	**2.990**	**1.848**	**3.081**
Jarque-Bera (P-Value)	**7.081** (0.028)	**1.260** (0.532)	**0.469** (0.790)	**1.818** (0.402)	**0.364** (0.833)	**3.249** (0.196)	**2.030** (0.362)	**0.048** (0.975)

The above table shows that REER is little bit more volatile as compared to RGDPPC. While, FDI exhibits negative average value and relatively higher volatility as compared to all variables. Further, most of the variables in our data are normally distributed, REER being an exception.

Econometric Model

Following Wong (2013), we estimate the following empirical model which includes two additional variables: financial development and net inflow as a percent of GDP. We estimate our model using log–linear specification that may produce better results compared to the linear functional form of the model. Another advantage is that the regression coefficients can be interpreted as direct elasticities. Therefore, our econometric model is fiven as follows:

$$REER_t = \beta_1 + \beta_2 RPCGDP_t + \beta_3 OPEN_t + \beta_4 TOT_t + \beta_5 GOV_t + \beta_6 DR_t + \beta_7 M2_t + \beta_8 FDI_t + u_t \quad \ldots\ldots \quad \ldots.. \quad (1)$$

where, REER is real effective exchange rate, RPCGDPG is the real per capita GDP growth, OPEN is trade openness, TOT is terms of trade, GOV is government expenditures percent of GDP, DR is the discount rate, M2 percent of GDP is proxy for financial development, FDI is the FDI inflows percent of GDP, ***u*** is the error term and ***t*** is time subscript that ranges from 1980 to 2013. All variables are transformed in logarithmic form. We employ ARDL bounds testing approach of Pesaran et al. (2001) to appraise the long run equilibrium relationship between REER and macroeconomic variables. The Hodrick-Prescott (HP) filter is used to compute the misalignment of REER. For sensitivity analysis and robustness, Johansen cointegration test is applied.

Results and Discussion

Yule (1926) pointed out that using the time series data often include the possibility of obtaining spurious or nonsense regression. Granger & Newbold (1974) reveal that if we regress two independent nonstationary series on each other, the chance of occurrence of spurious regression become high. Nelson and Plosser (1982) claim that most of macroeconomic time series are unit root. Engle and Granger (1987) assert that two or more variables are cointegrated if they are integrated of same order and their linear combination is stationary. Therefore, stationarity analysis is needed.

Stationarity Analysis

For unit root testing, we have used Augmented Dickey Fuller (ADF) test at level and at first difference. To implement the ADF test, we estimate the following regression:

$$\Delta X_t = \alpha + \Phi X_{t-1} + \sum_{j=1}^{8} \delta_j \Delta X_{t-j} + \mu_t \quad \ldots\ldots \quad \ldots\ldots \quad (2)$$

Where "Δ" is the "difference operator", "X" is the series being tested, "j" stands for the "number of lagged difference" and "μ" refers to "white noise error term". To reject the null hypothesis of non- stationary time series (unit root) "the calculated value of the ADF Statistics" must be greater than the "critical value".

The results in Table 2 indicate that the variables are non-stationery at level, however when ADF is performed at first difference they are found to be stationary, that is, they are integrated of order 1, I (1).

Table 2: Augmented Dicky-Fuller Unit Root Test (At Level)

Variable	Specification	t-ADF	P-Value	Optimal lag*	Result
REER	Constant	-2.018	0.278	0	Non-stationary
RPCGDP	Constant	-0.744	0.821	1	Non-stationary
OPEN	None	-0.339	0.555	0	Non-stationary
TOT	None	-1.459	0.132	0	Non-stationary
GOV	None	0.061	0.695	0	Non-stationary
DR	None	-0.178	0.614	0	Non-stationary
M2	None	-0.218	0.600	0	Non-stationary
FDI	Constant	-1.838	0.356	0	Non-stationary

Notes: * Optimal lag length, max lag = 8, is selected using Schwarz Information Criterion (SIC).

First Difference

Variable	Specification	t-ADF	P-Value	Optimal Lag*	Result
REER	Constant	-4.961	0.000	0	Stationary
RPCGDP	Constant	-3.747	0.007	0	Stationary
OPEN	None	-6.764	0.000	0	Stationary
TOT	None	-7.257	0.000	0	Stationary
GOV	None	-4.955	0.000	0	Stationary
DR	None	-4.839	0.000	0	Stationary
M2	None	-5.405	0.000	0	Stationary
FDI	Constant	-4.970	0.000	0	Stationary
Notes: * Optimal lag length, max lag = 8, is selected using Schwarz Information Criterion (SIC).					

Cointegration Analysis

To examine the long run relationship, ARDL bounds testing approach to cointegration developed by Pesaran et al. (2001) is implemented. The main advantages of this approach are: first, the order of integration for independent variables may be different, I(0) or I(1); second, it can be applied in case of small samples; and third, we can derive a dynamic error-correction-model (DECM) from the ARDL model through linear transformation. An ARDL representation of equation (1) is expressed as follows:

$$\Delta REER_t = \alpha_1 + \sum_{i=1}^{p}\alpha_i\Delta REER_{t-i} + \sum_{j=0}^{q}\alpha_j\Delta RGDPPC_{t-j} + \sum_{k=0}^{r}\alpha_k\Delta OPEN_{t-k} + \sum_{l=0}^{s}\alpha_l\Delta ToT_{t-l} +$$
$$\sum_{m=0}^{t}\alpha_m\Delta GOV_{t-m} + \sum_{n=0}^{u}\alpha_n\Delta DR_{t-n} + \sum_{o=0}^{v}\alpha o\Delta M2_{t-o} + \sum_{p=0}^{w}\alpha_p\Delta FDI_{t-p} + \delta_1 REER_{t-1} +$$
$$\delta_2 RGDPPC_{t-1} + \delta_3 OPEN_{t-1} + \delta_4 TOT_{t-1} + \delta_5 GOV_{t-1} + \delta_6 DR_{t-1} + \delta_7 M2_{t-1} + \delta_8 FDI_{t-1} + \varepsilon_t \quad \ldots\ldots \quad \ldots\ldots \quad (3)$$

where, Δ is the first difference operator and μ is error term, $\alpha i \ldots \alpha p$ refer are short run and $\delta 1 \ldots\ldots\ldots \delta 8$ are long run parameters. The null hypothesis H0: ($\delta 1, \delta 2 \ldots \delta 8 = 0$) of no long-run relationship between the variables is tested against the alternative hypothesis H1: ($\delta 1, \delta 2 \ldots \delta 8 \neq 0$).

The rejection of H0 (no cointegration among variables) is based on the F-statistic. “The critical bounds (CB) have been tabulated by Pesaran et al. (2001)”. The upper critical bound (UCB) is based on the postulation that all series are I (1), while lower critical bounds (LCB) apply if the series are I(0). If F-statistic is greater than the UCB then there exist long run relationship and vice versa. The decision become inconclusive if the value of F lies within the bounds. In such situation, we must check the order of integration of the series. If the order of integration is I (0) then decide on the basis of LCB which imply that there exist cointegration and long run relationship. If the order of integration is I (1) then decide on the basis of UCB which imply that there is no cointegration[a]. A summary of bound testing results is given in Table 2 below.

TABLE 3: ARDL BOUND TEST RESULTS

			Bonds Critical Values*	
F-Statistics	**Lag**	**Significance Level**	**Lower bounds I(0)**	**Upper bounds I(1)**
6.9934	1	5%	2.32	3.50
Notes: * Critical values of upper and lower bounds are from Pesaran (2001) with unrestricted intercept and no trend.				

Table 3 illustrates that the calculated value of F-statistics is 6.9934 which is greater than the upper bound, which implies that that there exists long run equilibrium among real effective exchange rate, Real GDP per capita, openness, term of trade, government expenditure, discount rate, FDI and financial development over the period of 1982-2013 in Pakistan. The existence of long-run (LR) equilibrium relationship among variables show that an error-correction-model (ECM) also exists, which combines the both effects and shows that how preceding disequilibrium is removed in current period. Therefore, we estimate the error correction model (ECM) as given in the equation 4.

$$\Delta REER_t = \sum_{i=1}^{p} \alpha_i \Delta REER_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta RGDPPC_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta OPEN_{t-k} + \sum_{l=0}^{s} \alpha_l \Delta ToT_{t-l} +$$
$$\sum_{m=0}^{t} \alpha_m \Delta GOV_{t-m} + \sum_{n=0}^{u} \alpha_n \Delta DR_{t-n} + \sum_{o=0}^{v} \alpha o \Delta M2_{t-o} + \sum_{p=0}^{w} \alpha_p \Delta FDI_{t-p} + \eta_1 ECT_{t-1} + + \varepsilon_t \quad \ldots\ldots \quad \ldots\ldots \quad (4)$$

The long-run and short run estimated coefficients along with different tests are shown in Table 3[b]. The coefficient of the error correction term carries a negative sign but it is insignificant. The results of both the ARDL bounds testing and Johansen cointegration approaches show that there is LR relationship among real effective exchange rate, Real GDP per capita (RGDPPC), trade openness (TOT), term of trade (TOT), government expenditure (GOV), discount rate (DR), FDI and financial development (M2) over the period 1982-2013 in Pakistan. In short run Real GDP per capita, trade openness, term of trade, and FDI and financial development are significant.

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[a] The detail of estimation results/ output is available from authors.
[b] See Appendix for complete estimation results and software outputs.

Table 4: Estimated Long and Short Run Coefficients

LONG RUN COEFFICIENTS		
Variable	**Coefficient**	**P-value**
Constant	12.496*	0.000
$REER_{t-1}$	-1.363*	0.000
$RGDPPC_{t-1}$	-1.272*	0.000
$OPEN_{t-1}$	0.738**	0.015
TOT_{t-1}	-0.705*	0.000
GOV_{t-1}	-0.181**	0.028
DR_{t-1}	0.157*	0.002
$M2_{t-1}$	-0.165	0.409
FDI_{t-1}	-0.115*	0.003
SHORT RUN COEFFICIENTS		
Variable	**Coefficient**	**P-value**
$\Delta REER_{t-1}$	0.154	0.601
$\Delta RGDPPC$	0.207	0.665
$\Delta RGDPPC_{t-1}$	-1.098**	0.038
$\Delta OPEN$	0.171	0.334
$\Delta OPEN_{t-1}$	0.304***	0.092
ΔTOT	-0.248**	0.025
ΔTOT_{t-1}	-0.126	0.218
ΔGOV	0.033	0.758
ΔGOV_{t-1}	0.033	0.758
ΔDR	0.050	0.443
ΔDR_{t-1}	-0.020	0.694
$\Delta M2$	0.023	0.879
$\Delta M2_{t-1}$	0.016	0.91
ΔFDI	-0.037	0.120
ΔFDI_{t-1}	-0.043**	0.046
ECT_{t-1}	-0.334	0.394
Asymptotic test: Chi Sq. (2)	0.80120 [0.6699]	
Normality test: Chi Sq. (2)	0.36034 [0.8351]	
RESET test	F(1,5) = 1.0629 [0.3498]	
Note: *, ** and *** show significance at 1%, 5% and 10% levels respectively.		

For sensitivity analysis and robustness, we perform the Johansen cointegration test and assess the cointegrating relationship between real effective exchange rate (REER) and other variables being used. (See appendix A-1). According to the results, Trace test indicates 4 cointegrating equations, while Max-eigenvalue test indicates 2 cointegrating equations at 5% level of significance. So we reject the null hypothesis of no cointegrating vector in favor of at least one cointegrating vector under both the tests. It implies that the long-run relationship between or among the variables is valid and robust. The stability of parameters is tested through CUSUM test (see Appendix A-2).

Measurement of Equilibrium Real Effective Exchange Rate(EREER) and its Misalignment

The Hodrick-Prescott (HP) filter introduced by Hodrick and Prescott (1997) is frequently used in empirical macroeconomic research to extract a trend component from a time series. We use HP filter to decompose the estimated long run relationship between the real effective exchange rate and its determinants into two parts:

(a) Permanent part of a time series,
(b) Transitory or cyclical components of a time series,

Suppose $y_t = \tau_t + c_t$ …… …… (5)

The HP filter decomposes y_t into a smooth trend (long-run component), τ_t, and a transitory or cyclical component (residual), c_t.

where, $\tau_t = (\lambda F+I_T)^{-1} y$ is built to minimize:

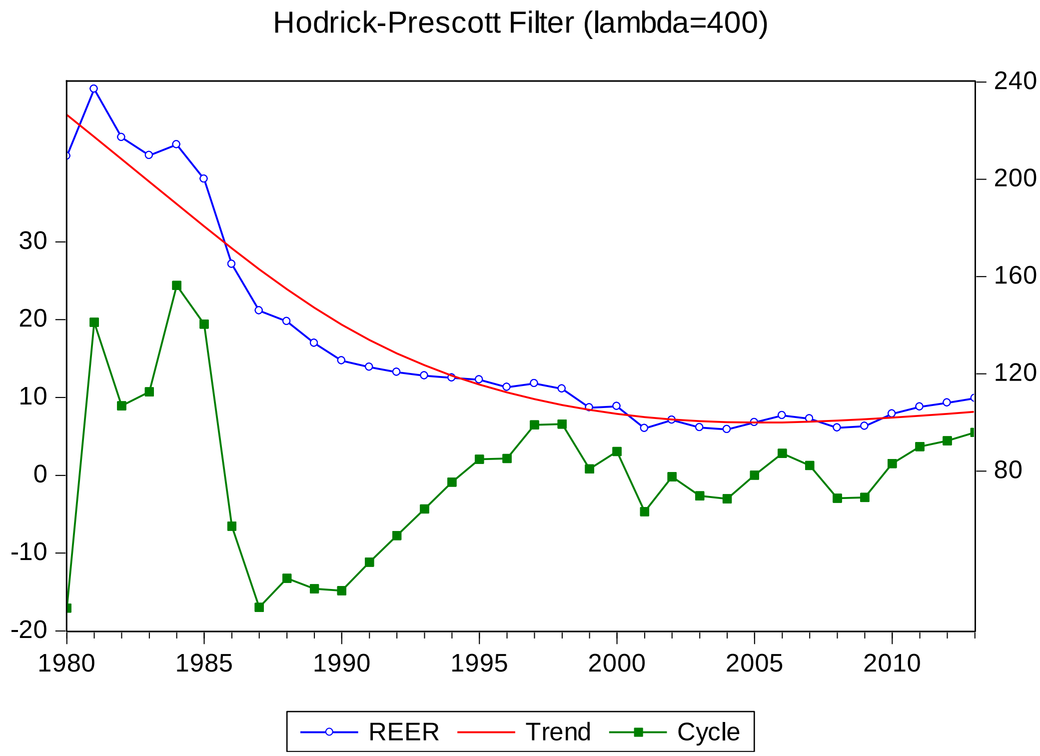
$$\sum_{1}^{T}(y_t-\tau_t)^2+\lambda\sum_{2}^{T-1}[(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1})]^2 \qquad \ldots\ldots \qquad (6)$$

$$\sum_{1}^{T}(y_t-\tau_t)^2+\lambda\sum_{2}^{T-1}[(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1})]^2 \qquad \ldots\ldots \qquad (7)$$

The larger value of parameter **λ**, indicate greater penalty and the smoother trend resultantly. In applied research, Hodrick and Prescott suggest that $\lambda = 1600$ is a sensible choice for quarterly data. As we have used the annual data in our empirical analysis, therefore we take $\lambda = 400$. Figure 1 shows the misalignment of the real effective exchange rate. We can measure the misalignment of a currency at any point in time as the gap between the actual REER (AREER) and the equilibrium REER (EREER). The misalignment is calculated as follows:

$$[(AREER - EREER) / EREER] * 100 \qquad \ldots\ldots \qquad (8)$$

FIGURE 1: MISALIGNMENT OF THE REAL EFFECTIVE EXCHANGE RATE



The results indicate that the Pakistani rupee was undervalued in 1980 by 17 %. It remains overvalued from 1981-85 with a highest misalignment of 24% in 1884. The substantial appreciation of Pakistani rupee during the early 1980s may be due to the appreciation of US Dollar against the major currencies. One of the other reasons may be to shift from the fixed exchange rate system to the managed float. Pakistan moved on to managed float on January 8, 1982 from fixed exchange rate regime (FY73-FY81).

The period thereafter (1986-1994), Pakistani rupee remained undervalued. In the years since 1995, we see the different episodes of appreciation and depreciation of the local currency. However, the appreciation and depreciation was relatively smaller than the period of 1980s and beginning of the 1990s. Pakistani rupee remains overvalued from 1995 to 2000, undervalued from 2001 to 2004, slightly overvalued from 2005 to 2007 and again becomes slightly undervalued during 2008-09. During the time since 2010, we see an upward trend of overvaluation in Pakistani currency (see Figure 2). Table 4 and Figure 2 clearly depict the RER misalignment in a historical perspective.

Table 4: Misalignment of the Real Effective Exchange Rate

Year	AREER	EREER	Degree of Misalignment (MIS) (%)	RGDPPCG (Annual %)	RGDPG (annual %)
1980	209.5	226.566	-17.066	6.602	10.216
1981	237.1	217.432	19.667	4.335	7.921
1982	217.19	208.257	8.933	2.967	6.537
1983	209.78	199.044	10.735	3.191	6.778
1984	214.22	189.825	24.395	1.550	5.065
1985	200.08	180.653	19.427	4.027	7.592
1986	165.12	171.647	-6.527	2.041	5.502
1987	146.01	162.971	-16.961	3.005	6.452
1988	141.53	154.774	-13.244	4.224	7.625
1989	132.59	147.163	-14.572	1.766	4.960
1990	125.38	140.211	-14.830	1.426	4.458
1991	122.79	133.954	-11.164	2.175	5.061
1992	120.66	128.394	-7.734	4.894	7.706
1993	119.19	123.502	-4.312	-0.817	1.758
1994	118.35	119.230	-0.880	1.120	3.737
1995	117.58	115.520	2.0599	2.279	4.963
1996	114.47	112.313	2.157	2.111	4.846
1997	116.04	109.552	6.488	-1.642	1.014
1998	113.77	107.189	6.581	-0.098	2.550
1999	106.01	105.189	0.821	1.123	3.660
2000	106.59	103.535	3.055	1.903	4.260
2001	97.54	102.213	-4.673	-0.118	1.982
2002	101.03	101.215	-0.185	1.268	3.224
2003	97.87	100.5211	-2.651	2.971	4.846
2004	97.09	100.113	-3.023	5.478	7.3686
2005	100	99.964	0.036	5.745	7.667
2006	102.86	100.040	2.820	4.241	6.177
2007	101.57	100.307	1.2627	2.900	4.833
2008	97.81	100.740	-2.930	-0.174	1.701
2009	98.47	101.314	-2.844	0.966	2.832
2010	103.51	101.999	1.511	-0.186	1.607
2011	106.43	102.757	3.673	0.989	2.748
2012	108	103.553	4.447	1.777	3.507
2013	109.89	104.364	5.526	2.699	4.409

Notes: RGDPPCG is real per capita GDP growth. Mainly, the data is taken from WDI, however AREER, EREER, and Degree of Misalignment (MIS) are constructed by the author.

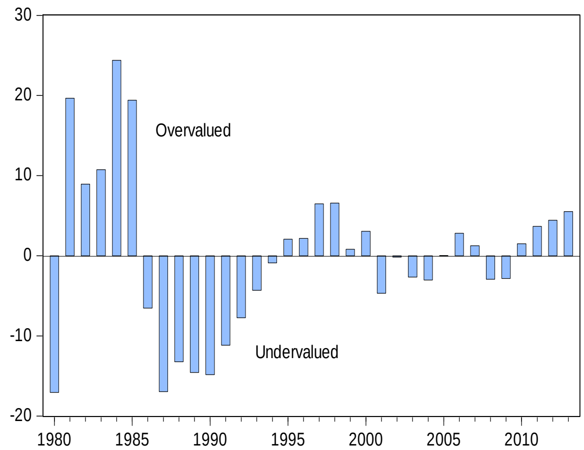


FIGURE 2: REER MISALIGNMENT IN PAKISTAN (1980-2013)

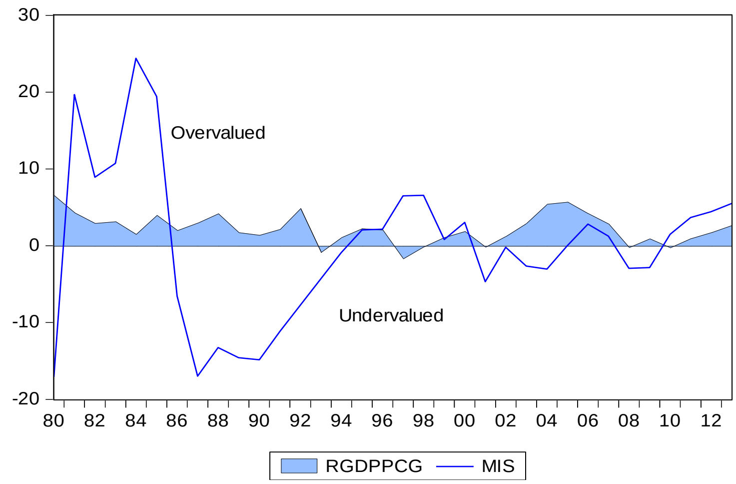


FIGURE 3: REER MISALIGNMENT AND RGDPPC GROWTH (ANNUAL %)

Real Exchange Rate Misalignment and Economic Growth in Pakistan

The Figures 3 and 4 show the impact of REER misalignment on economic growth of the economy. The hypothesis that undervaluation is associated with growth and overvaluation is harmful for economic growth is valid in case of Pakistan.

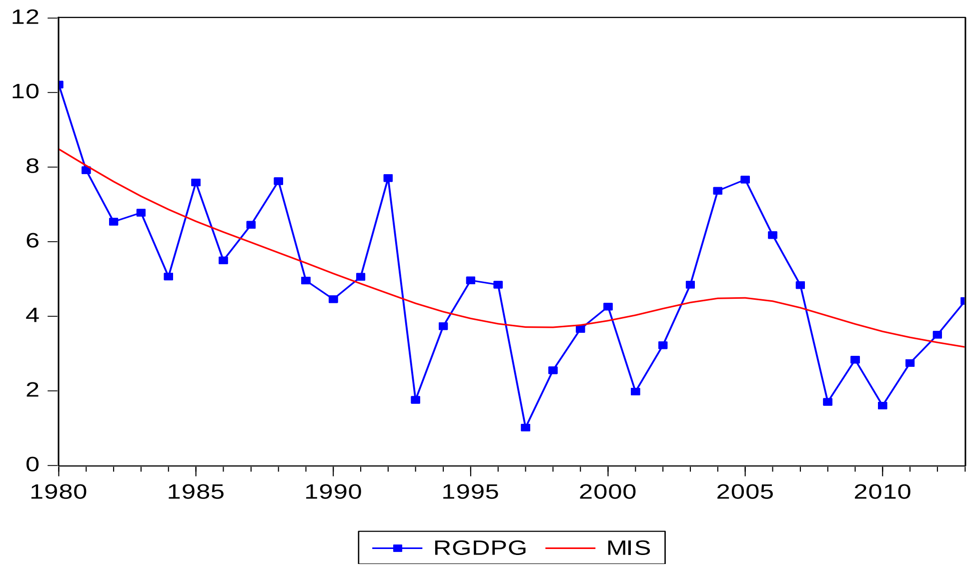


FIGURE 4: REER MISALIGNMENT AND RGDP GROWTH (ANNUAL %)

Both the variables, real GDP growth and degree of misalignment (MIS) in percent are stationary at level. So, there is no long run relationship, we don't have to go for the cointegration analysis but the causality analysis can be done. For casualty analysis we check the granger causality between RPCGDPG and MIS. We use Schwarz information criterion (SIC) for the selection of lags. The lag 1 is selected accordingly. The results of granger causality test are shown in Table 5.

Table 5: Pair-wise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
(MIS) does not Granger Cause (RGDPG)	33	4.998	0.033
(RGDPG) does not Granger Cause (MIS)		0.130	0.720

we can reject the "null of MIS does not Granger Cause RGDPG at 5 % level". The results of granger causality test show that REER misalignment (MIS) granger causes the Real GDP growth (RGDPG) significantly. However, the causation is unidirectional as we do not find feedback effect of Real GDP growth (RGDPG) on REER misalignment (MIS).

Conclusion and Policy Recommendation

We measure the REER misalignment of Pakistani rupee and assess the growth effects of the REER misalignment by using the annual data over the period of (1980-2013). The objectives of the study are threefold. Firstly, we examine the long run relationship among the real effective exchange rate (REER) and its economic fundamentals. Secondly, we calculate the equilibrium real effective exchange rate (EREER) and REER misalignment for Pakistan. Thirdly, we attempt to evaluate that whether the undervaluation of currency is associated with growth as claimed by the Rodrik (2008). The "Autoregressive Distributed Lag (ARDL) bounds testing approach" developed by Pesaran et al. (2001) has been applied to assess the long run equilibrium relationship between the REER and other variables being used. For sensitivity analysis and robustness, Johansen cointegration test is performed.

We use the Hodrick-Prescott (HP) filter to measure the misalignment of the REER. The results of both the ARDL bounds testing and Johansen cointegration approaches show that there is LR relationship among real effective exchange rate, Real GDP per capita, trade openness, term of trade, government expenditure, discount rate, FDI and financial development over the period 1982-2013 in Pakistan. The results of HP filter indicate that the Pakistani rupee was undervalued in 1980 by 17 %. It remains overvalued from 1981 to 1985 with a highest misalignment of 24% in 1884. The period thereafter (1986-1994), Pak rupee remains undervalued. In the years since 1995, we see the different episodes of appreciation and depreciation of the local currency. However, the appreciation and depreciation was relatively smaller than the period of 1980s and beginning of the 1990s. In the years since 2010, we see an upward trend of overvaluation in Pakistani currency. Moreover, in case of Pakistan we reject the hypothesis that undervaluation is associated with economic growth and overvaluation is harmful for economic growth. However, granger causality output show that REER misalignment granger causes the Real GDP growth significantly. The causation is observed to be unidirectional as we do not find any feedback effect of Real GDP growth on REER misalignment.

One of the limitations of the study is non-availability of data for longer time span (before 1980) on REER and some other variables. Similarly, due to non-availability of monthly and quarterly data on some important variables, the annual data has been used for empirical analysis. For better policy prescriptions, it is important to know the deviation of REER from equilibrium exchange rate. We suggest that the EREER needs to be calculated on a regular basis and it could be published in different reports and surveys, such as Pakistan economic survey, statistical year book and related reports of State Bank of Pakistan. We have used the behavioral equilibrium exchange rate (BEER) methodology along with Hodrick-Prescott (HP) filter to calculate the equilibrium real effective exchange rate (EREER) and its misalignment. Future research in this direction may use other methodologies. We need to explore different channels such as capital inflows, foreign aid, remittances, financial development and external debt dynamics through which REER misalignment may affect the economic growth and development.

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Appendix: A-1

Table 1: Results of Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.934	248.196	159.530	0.000
At most 1 *	0.791	161.322	125.615	0.000
At most 2 *	0.707	111.186	95.753	0.002
At most 3 *	0.589	71.938	69.819	0.033
At most 4	0.546	43.450	47.856	0.122
At most 5	0.301	18.141	29.797	0.555
At most 6	0.179	6.692	15.495	0.613
At most 7	0.011	0.365	3.841	0.545
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.934	86.874	52.363	0.000
At most 1 *	0.791	50.136	46.231	0.018
At most 2	0.707	39.248	40.077	0.061
At most 3	0.589	28.488	33.877	0.191
At most 4	0.546	25.309	27.584	0.095
At most 5	0.301	11.448	21.132	0.602
At most 6	0.179	6.328	14.265	0.571
At most 7	0.011	0.365	3.841	0.545
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

Appendix: A-2

Figure 1: The plots of cumulative sum of recursive residuals (CUSUM) – the REER determination