Abstract

Economy can be affected by the process of devaluation or depreciation of local currency either positively or negatively. The improvement in trade balance is considered as one of the significant and beneficial impacts occurring on account of devaluation by means of an increase in the volume of exports while reduction in the volume of imports. However, higher inflation would lead to expensive imports that offset the growth of economy resulting from increase in the exports. This reduces the effectiveness of devaluation in bringing down trade deficit. The benefits of devaluation are restricted where inflation severely hits the economy. Moreover, nominal devaluation improves the trade balance when it leads to real devaluation.

The relationship between nominal and real effective exchange rates is explored in the present hypothesis. The study is a unique attempt in the case of Pakistan as devaluation has always been a politically sensitive issue. In this paper investigation, regarding “whether nominal devaluation leads the real devaluation or not” both in long run and in short span of time is done. The order of integration has been found through Ng-Perron (2001), whereas ARDL and DOLS are employed for long run correlations. The findings of the paper clearly indicate the fact that nominal devaluation not only leads to real devaluation in long run but also in short span of time. This scenario provides directions for policy-makers to take into consideration both positive and negative implications of devaluation in Pakistan.

JEL Classification: Devaluation, Unit Root, Co-integration
Key Words: F10, C20, C22

* Research Officer at Social Policy and Development Center at Karachi, Pakistan
1.- Introduction

Pakistan is an economy where average inflation was more than 9 percent per annum while trade deficit was US $ 6104 millions during 1971-2005. In 2007, inflation was 10.3 percent inflation prevailed in the economy and trade deficit was US $ 9495 millions. Pakistan’s exports grew at an average rate of 16.4 per cent annually over 2002-2006 but imports also continue to be pushed at an unprecedented level due to rise in oil prices. As well as, imports of food items are rising due to increase domestic demand along with supply shocks. Furthermore, in 2007, growth rates of exports and imports were 11.4 % and 29.7 % respectively that shows heavy reliance on import goods. To improve the trade balance, Pakistan adopted the managed floating exchange rate policy in 1980s while 1990s was the era of flexible exchange rate, which linked the local currency with international market. It may be presumed that an economy devalues or depreciates its currency either in fixed exchange rate or flexible exchange rate regimes to improve the trade balance.

Literature Review

Relevant economic literature reveals that nominal devaluation should improve the trade balance of an economy by making exports cheaper in international markets in terms of international market prices which increases the volume of exports. On the other side of the coin, nominal devaluation makes imports more expensive that leads to less import in terms of domestic currency. While inflationary pressures in the economy always eaten up beneficial impacts of nominal devaluation. *Macro-analysis suggests that nominal exchange rate needs to be adjusted for variations in local and international prices. After adjustment, nominal devaluation policy would be effective and improve the trade balance, if nominal devaluation leads to real devaluation* [Bahmani-Oskooee, (1998); Bahmani-Oskooee and Gelan, 2007].

Recent relevant literature reveals an unconvincing scenario and has empirical evidence for the linkage between nominal and real

---

1 See IFS (2007) and WDI (2007) for data information.
Shahbaz, M. On Nominal and Real Devaluation Relation: Evidence for Pakistan
devaluations. Vaubel, (1976) opens new direction in international trade & finance through an argument that nominal devaluations were effective to escort real devaluations during 1959-1975. Similarly; Connolly and Taylor, (1976, 1979); Bruno, (1978) & Edwards, (1988, 1994) conclude that nominal devaluation leads to real devaluation only in the short span of time to medium term. Grauwe and Holvoet (1978) collect input-output tables for European Community and conclude that under zero wage indexation, 0.70 per cent real devaluation has led by 1 per cent increase in nominal devaluation. While with the complete wage indexation, 1 per cent increase in nominal devaluation occurs to 0.5 per cent real changes in exchange rate. On the contrary, Donovan (1981); Bautista (1981) and Morgan & Davis (1982) claim that lead impact of nominal devaluation on real devaluation begins to erode in long span of time². Kent and Naja (1998) commented that nominal devaluation leads more real devaluation as country moves to more flexible exchange rate regime but their findings about Pakistan are inconclusive for such relationship.

Bahmani-Oskooee and Mirzai (2000) apply KPSS test to see changes in real effective exchange rate and confirm the existence of PPP in most developing economies. Bahmani-Oskooee (2001) assesses long run response of trade balance to nominal devaluations in case of Middle Eastern Countries. Bahmani-Oskooee and Miteza (2002) use error-correction modeling to explore the gossip between nominal effective exchange rate and real effective exchange rate not only in short run but also for long run in less developed economies including Pakistan. They argue that nominal devaluation leads to real devaluation with insignificant values of variables in the case for Pakistan over 1971-1997 periods. Holmes, (2004) finds long run association between running actors but in most African economies nominal devaluation does improve real devaluation.

Bahmani-Oskooee and Gelan, (2007), have come to the conclusion that nominal devaluation is associated with real devaluation in medium to long run. But in short run, nominal effective exchange

² See for more details (Morgan & Davis, 1982)
rate changes do not lead the real effective exchange rate changes except in few African countries. The relationship between nominal and real devaluation has also been investigated in MENA countries by Bahmani-Oskooee and Kandi (2007) through the validity of Purchasing Power Parity. They conclude that nominal changes in exchange rate would have lead impact to the real effective exchange rate. Bahmani-Oskooee and Harvey (2007), construct quarterly data of concerned variables over the 1971-2004 period for less developed countries. They show significant impact of nominal depreciation on real depreciation for countries in the sample.

Rising trends in trade deficit is a burning issue in Pakistan with respect to international economics and finance. It is necessary to investigate the relationship between nominal and real effective exchange rate changes empirically. This study is a unique exercise that explores long and short run association between differences in nominal and real effective exchange rates. Most advanced unit root test Ng-Perron is employed to find out the order of integration. For long run association, ARDL (Autoregressive Distributive Lag Model) & DOLS (Dynamic Ordinary Least Squares), ECM (Error Correction Method) for short run and Variance Decomposition are also utilized to examine the percentages of innovative shocks. Section-II describes the methodological framework of the study; Section-III explains results of conjunction of variables. Finally, conclusion is summarized in section IV.

2. Modeling and Methodological Framework

Bowers and Pierce (1975) suggested that Ehrlich’s (1975) findings with a log-linear specification are sensitive to functional form. However, Ehrlich (1977) and Layson (1983) argue on theoretical and empirical grounds and, conclude that the log-linear form is superior to the linear form. Both Cameron (1994) and Ehrlich (1996) suggest that a log-linear form is more likely to find evidence of a deterrent effect than a linear form. This makes our results more favorable to the deterrence hypothesis. Log-linear modeling specification utilized in present unique endeavor in context of small developing economy like Pakistan as portrays below. In the light of above discussion,
algebraic equation for empirical investigation is being modeled as following;

\[ LREER = \alpha_0 + \alpha_1 LNEER + \varepsilon_i \]  
(1)

Where;
\[ REER = Real \ Effective \ Exchange \ Rate, \]
\[ NEER = Nominal \ Effective \ Exchange \ Rate \]

### Table-1. Correlation Matrix and Descriptive Statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>LREER</th>
<th>LNEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>LREER</td>
<td>1.0000</td>
<td>0.9453</td>
</tr>
<tr>
<td>LNEER</td>
<td>0.9453</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Median</th>
<th>Maxima</th>
<th>Minima</th>
<th>Std. Dev.</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>LREER</td>
<td>4.7799</td>
<td>4.7042</td>
<td>5.4319</td>
<td>4.1597</td>
<td>0.2927</td>
<td>2.7865</td>
</tr>
<tr>
<td>LNEER</td>
<td>4.9910</td>
<td>5.0431</td>
<td>5.8464</td>
<td>3.4502</td>
<td>0.5403</td>
<td>3.1382</td>
</tr>
</tbody>
</table>

Table-1 represents the correlation matrix and descriptive statistics indicating that there is positive and strong association between nominal and real effective exchange rates. The high correlation between said actors confirms the existence of hypothesis that prices of goods and services adjust sluggishly relative to asset prices such as nominal exchange rate in Pakistan under floating exchange rate regime. Data of both variables have been collected from International Financial Statistics (IFS, 2006) and study period of this particular pioneering idea is 1981Q1-2006Q4.

### 2.1: Ng-Perron Test

Recently developed Ng-Perron (2001) unit root test has been utilized to investigate the order of integration for running actors in the model (Theoretical formation of Ng-Perron is based on Joseph and Sinha, 2006). The Ng-Perron test has good size and explaining power. This test is particularly suitable for small samples. To
describe the Ng-Perron test, augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1979, 1981) is started:

\[ \Delta y_t = \alpha y_{t-1} + x_t' \delta + \beta_1 y_{t-1} + \beta_2 \Delta y_{t-2} + \cdots + \beta_p \Delta y_{t-p} + v_t \]  

(2)

This particular test has null hypothesis assuming \( \alpha = 0 \) while the alternative hypothesis \( \alpha < 1 \) utilizing the predictable t-test. Since the statistics does not follow the traditional student’s t-distribution, Dickey and Fuller (1979) and Mackinnon (1996), among others, critical values are reproduced. In the estimation of ADF test, we can include a constant or a linear time trend and both constant and linear trend. Elliot, Rothenberg and Stock (1996) make amendments to modify the ADF tests for a constant and, constant and a trend. First, a quasi-difference of \( y_t \) in defined. The quasi-difference of \( y_t \) depends on the value of \( \alpha \) representing the specific point against which the null hypothesis below is tested.

\[ d(y_t/a) = y_t \text{ if } t = 1 \text{ and } d(y_t/a) = y_t - ay_t \text{ if } t > 1 \]  

(3)

Second, quasi-differenced data \( d(y_t/a) \) is regressed on quasi-difference as follows:

\[ d(y_t/a) = d(x_t/a)' \hat{\delta}(a) + \eta_t \]  

(4)

Where \( x_t \) involves with a constant or a constant and a trend. Let \( \hat{\delta}(a) \) be the OLS estimate of \( \delta(a) \). For a, ERS recommend using \( \alpha = \bar{\alpha} \) where \( \bar{\alpha} = 1 - 7/T \) if \( x_t = \{1\} \) and \( \bar{\alpha} = 1 - 13.5/T \) if \( x_t = \{1, t\} \). GLS detrended data, \( y_t^d \) are defined as follows \( y_t^d \equiv y_t - x_t' \).

In the ERS, GLS de-trended \( y_t^d \) is substituted for \( y_t \).

\[ \Delta y_t^d = \alpha \Delta y_{t-1}^d + \beta_1 \Delta y_{t-2}^d \Delta y_{t-1} + \cdots + \beta_p \Delta y_{t-p}^d + v_t \]  

(5)

Like ADF test, the GLS unit root test also relies the coefficient value of \( \alpha \). The ERS point optimal test is as follows let the residuals from equation (3) be \( \hat{\eta}_t(a) = d(y_t/a) = d(x_t/a)' \hat{\delta} (\bar{\alpha}) \) and let the sum
of squared residuals, \(SSR(\alpha) = \hat{\eta}_i^2(\alpha)\). \(\alpha = 1\) is the null hypothesis of optimal point test while possibility of alternative hypothesis contains \(\alpha = \bar{\alpha}\). \(P_i = (SSR(\alpha) - SSR(1))/f_0\) which is test statistic, where \(f_0\) an approaches to zero. The test of Ng-Perron contains of the following four unit root tests based on modifications: Phillips-Perron \(Z_a\) and \(Z_t\), Bhargava \(R_1\) and ERS optimal point tests.

The tests are based on GLS de-trend data, \(\Delta y_t\). First, let us define

\[
k = \sum_{i=2}^{T} (y_{i-1}^d)^2 / T^2
\]

The four statistics are listed below.

\[
MZ^d_{\alpha} = (T^1 y_t^d)^2 - f_0 ) / 2k
\]

\[
MZ^d_t = MZ_{\alpha} \times MSB
\]

\[
MSB^d = (k / f_0)^{1/2}
\]

\[
MP^d_T = (\bar{c}^2 k - \bar{c}T^1)(y_T^d T)^2 / f_0 \text{ if } x_i = \{1\}
\]

and \(MP^d_T = (\bar{c}^2 k + (1-\bar{c})T^1)(y_T^d T)^2 / f_0 \text{ if } x_i = \{1,t\}\)

where \(\bar{c} = -7\) if \(x_i = \{1\}\) and \(\bar{c} = -13.5\) if \(x_i = \{1,t\}\)

### 2.2: ARDL Approach for Co-integration

In economic literature, many methods are available for conducting the Co-integration test; the most widely used methods include the residual based Engle-Granger (1987) test, and Maximum Likelihood based Johansen (1991; 1992) and Johansen-Juselius (1990) tests. All these require that the variables in the system be of equal order of integration. The residual-based co-integration tests are inefficient and can lead to contradictory results, especially when there are more than two \(I(1)\) variables under consideration. In addition these methods do not include the information on structural break in time series data and suffer from low predicting power. It goes without saying that

---

3 This theoretical formation of ARDL is based on Chandan, (2001)
structural changes is of considerable importance in the analysis of macroeconomic time series. Structural changes occur in many time series for any number of reasons including economic crises changes in institutional arrangements, policy changes regime shift war. An associated problem with this is the testing of the null hypothesis of structural stability against the alternative of a one-time structural break. If such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, results may be biased towards the erroneous non-rejection stationary hypothesis (Leybourne and Newbold, 2003; Perron, 1989, 1997).

Recently, an emerging body of literaure led by Pesaran and Pesaran (1997), Pesaran, Shin and Smith (2000), Pesaran and Shin (1999), and Pesaran et. al., (2001) has introduced an alternative Co-integration technique known as the “Autoregressive Distributive Lag” or ARDL bounds testing. It is argued that ARDL has a numerous advantages over conventional techniques like Engle-Granger and Johansen Co-integration approaches. The first advantage of ARDL is that it can be applied irrespective of whether underlying regressors are purely $I(0)$, purely $I(1)$ or mutually co-integrated (Pesaran and Pesaran, 1999). The second advantage of using the bounds testing approach to Co-integration is that Monte Carlo studies that it performs better than Engle and Granger (1987), Johansen (1990) and Philips and Hansen (1990) Co-integration test in small samples (see for more details Haug, 2002). The third advantage of this approach is that, the model takes sufficient number of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chai, 2003). Finally, ARDL is also having the information about the structural break in time series data. However, Pesaran and Shin (1999) contented that, “appropriate modification of the orders of the ARDL model is sufficient to simultaneously correct for residual serial correlation and the problem of endogenous variables”.

Under certain environment, Pesaran and Shin (1995) latter on by PSS (Pesaran, Shin and Smith, 2001) established that long run association among macroeconomic variables may be investigated by employing
the Autoregressive Distributive Lag Model. After the lag order for ARDLL procedure, OLS may be utilized for estimation and identification. Valid estimation and inference can be drawn through presence of unique long run alliance that is crucial. Such inferences not only on long run but also on short run coefficients may be made which concluded that the ARDL model is correctly augmented to account for contemporaneous correlations between the stochastic terms of the data generating process (DGP) included in the ARDL estimation. It is concluded that ARDL estimation is possible even where explanatory variables are endogenous. Moreover, ARDL remains valid irrespective of the order of integration of the explanatory variables. But ARDL procedure will collapse if any variable is integrated at I(2).

The PSS (2001) procedure is implemented to estimate error correction model given such an equation:

\[ REER = \alpha + \sum_{i=1}^{s} \beta_i \Delta REER_{t-i} + \sum_{j=1}^{m} \sum_{i=1}^{n} \phi_{j,i} \Delta NEER_{t-i} + \left( \delta_i \Delta REER_{t-i} + \sum_{j=1}^{k} \gamma_j NEER_{j} \right) + \eta_t \]  

(6)

PSS F-test is estimated by imposing zero-joint restriction on \( \delta^{'s} \) in error correction model. Distribution of PSS F-test is non-standard (Chandan, 2001). The reason is that lower and upper critical bounds are generated by PSS (1996). Lag order of ARDL model is selected on lower value of AIC or SBC. After empirical estimation, if PSS (2001) confirms the presence of unique cointegration vector among variables. This shows that one is outcome variable while other is forcing actor in model. On basis of selected ARDL, long run and short estimates can investigated in two steps (Pesaran and Shin, 1995).

Assuming that an ARDL \((p,q)\) just for which presence of association between \( x_i \) & \( y_i \) for \( long \ span \ of \ time \) has been recognized. Long run relationship for said actors can be established by estimating ARDL model as given by means of Ordinary Least Squares (OLS):
\[ \text{REER} = \omega + \sum_{i=1}^{p} \beta_i \text{REER}_{t-1} + \sum_{i=0}^{q} \vartheta_i \text{NEER}_{t-i} + \nu_t \quad (7) \]

Where \( \nu \) is normally distributed error term. Long run (cointegration) coefficients can be obtained:

\[ \text{REER} = \alpha + \rho \text{NEER} + \mu_t \quad (8) \]

from:

\[ \hat{\alpha} = \frac{\hat{\omega}}{1 - \sum_{i=1}^{p} \hat{\beta}_i}, \quad \rho = \frac{\sum_{i=0}^{p} \hat{\rho}_i}{1 - \sum_{i=1}^{p} \hat{\beta}_i} \quad (9) \]

Firstly, we try to find out the direction of relationship between nominal effective exchange rate and real effective exchange rate in the case of Pakistan by analyzing the PSS F-test statistics. The calculated \( F \)-statistic is compared with the critical value tabulated by Pesaran and Pesaran (1997) or Pesaran et al. (2001). If the \( F \)-test statistic exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected regardless of whether the underlying orders of integration of the variables are \( I(0) \) or \( I(1) \). Similarly, if the \( F \)-test statistic falls below the lower critical value, the null hypothesis is not rejected. However, if the sample \( F \)-test statistic falls between these two bounds, the result is inconclusive. When the order of integration of the variables is known and all the variables are \( I(1) \), the decision is made based on the upper bounds. Similarly, if all the variables are \( I(0) \), then the decision is made based on the lower bounds.

The ARDL method estimates \((p+1)^k\) number of regressions in order to obtain optimal lag length for each variable, where \( p \) is the maximum number of lags to be used and \( k \) is the number of variables in the equation. The model can be selected using the model selection criteria like Schwartz-Bayesian Criteria (SBC)\(^4\) and Akaike’s

\(^4\) The mean prediction error of AIC based model is 0.0005 while that of SBC based model is 0.0063 (Min B. Shrestha, 2003).
Information Criteria (AIC). SBC is known as the parsimonious model: selecting the smallest possible lag length, whereas AIC is known for selecting the maximum relevant lag length. In the second step, the long run relationship is estimated using the selected ARDL model. When there is a long run relationship between variables, there should exist an error correction representation.

Therefore, finally, the error correction model is estimated. The error correction model result indicates the speed of adjustment back to the long run equilibrium after a short run shock. To ascertain the goodness of fit of the ARDL model, the diagnostic tests are conducted. The diagnostic or sensitivity tests examine the serial correlation, autoregressive conditional heteroscedasticity, normality and heteroscedasticity associated with the model.

2. 3: Dynamic Ordinary Least Squares Model (DOLS)
To observe the robustness of long run rapport, DOLS (Ordinary Least Squares) Model employed developed by Stock and Watson (1993) for the investigation of long run relationships among dependent variable and explanatory variable. This procedure involves regressing the dependent variable on constant and explanatory variable on levels, leads and lags of the first difference of all $I(1)$ explanatory variables (Masih and Masih, 2000). This method is superior to a number of other estimators as it can be applied to systems of variables with different orders of lags (Stock-Watson, 1993). The inclusion of leads and lags of the differenced explanatory variable corrects for simultaneity, endogeneity, serial correlation and small sample bias among the regressors (Stock and Watson, 1993). DOLS estimates and t-statistics have better small sample properties and provide superior approximation to normal distribution (Stock and Watson, 1993). The specification of DOLS model is follows given below:

$$ REER_t = \varphi_0 + \varphi_1 NEER_t + \sum_{j=-p}^{p} \phi_j \Delta NEER_{t-j} + \eta_t............... (10) $$
Where $REER_t$ is real effective exchange rate, $NEER_t$ is a nominal effective exchange rate and $\Delta$ is lag operator.

3. Empirical Interpretation Design

ARDL has the advantage of avoiding the classification of variable into $I(0)$ or $I(1)$ since there is no need for unit root pre-testing. As argued by Sezgin and Yildirim, (2002) that ARDL can be applied regardless of stationary properties of variables in the sample and allows for inferences on long run estimates, which is not possible under alternative Co-integration techniques. In contrast, according to Ouattara (2004) in the presence of $I(2)$ variables the computed F-statistics provided by PSS (2001) become invalid because bounds test is based on the assumption that the variables should be $I(0)$ or $I(1)$. Therefore, the implementation of unit root tests in the ARDL procedure might still be necessary in order to ensure that none of the variable is integrated of order $I(2)$ or beyond.

For this purpose, Ng-Perron (2001) test employed which is more powerful and reliable for small data set. Mostly in literature to find out the order of integration ADF (Dicky & Fuller, 1979), P-P (Philip & Perron, 1988) and DF-GLS (Elliot, et, all, 1996) tests are often used respectively\(^5\). Due to the poor size and power properties, both tests are not reliable for small sample data set (Dejong et al, 1992 and Harris, 2003). They concluded that these tests seem to over-reject the null hypotheses when it is true and accept it when it is false. Therefore, Ng-Perron test utilized to overcome these above-mentioned problems about order of integration of running actors in the model alongwith ADF & P-P tests. The results described in Table-A2 in the Annex, showing that nominal effective exchange rate and real effective exchange rate are having 1\(^{st}\) order of integration.

\(^5\) We also utilized these three tests but decision is based on Ng-Perron test.
Shahbaz, M.  On Nominal and Real Devaluation Relation: Evidence for Pakistan

**Table-3. Lag Length Criteria**

<table>
<thead>
<tr>
<th>Lag order</th>
<th>Log likelihood</th>
<th>AIC</th>
<th>SBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>409.3483</td>
<td>-7.8303</td>
<td>-7.5730</td>
</tr>
<tr>
<td>3</td>
<td>410.7663</td>
<td>-7.8567*</td>
<td>-7.4942</td>
</tr>
<tr>
<td>4</td>
<td>406.4624</td>
<td>-7.7692</td>
<td>-7.3003</td>
</tr>
</tbody>
</table>

Sensitivity Tests
Serial Correlation LM Test = 2.1098(0.1268)
ARCH Test = 0.152042(0.6974)
White Heteroscedasticity Test = 13.4401(0.000)
Normality J-B Value = 0.8186(0.6641)

Note: Lag 3 is selected by AIC.

After finding integrating order of all variables, the two-step ARDL Co-integration (See Pesaran et al., 2001) procedure is employed in the estimation of equation (6) for Pakistan by utilizing quarterly data over the period 1981Q1-2006Q4. In the first stage, the order of lag length on the first difference estimating the conditional error correction version of the ARDL model for equation-6 is usually obtained from unrestricted vector auto-regression (VAR) by means of Akaike Information Criteria (AIC) which is 3 based on the minimum value as shown in Table-3. In such small sample of observations we cannot take lag length more than 3 lag.

**Table 4. ARDL Estimation for Long-run Relationship**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Lag Order</th>
<th>F-statistics</th>
<th>Wald-Test (Prob-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LREER</td>
<td>2</td>
<td>7.089</td>
<td>6.791(0.002)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4.939</td>
<td>4.673(0.012)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3.0168</td>
<td>2.817(0.065)</td>
</tr>
</tbody>
</table>

Critical Values at 1 % (5 %) 10 % respectively

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Bounds</td>
<td>Upper Bounds</td>
</tr>
<tr>
<td>Lower Bounds</td>
<td>Upper Bounds</td>
</tr>
<tr>
<td>2.840</td>
<td>4.100</td>
</tr>
<tr>
<td>2.330</td>
<td>3.460</td>
</tr>
<tr>
<td>2.070</td>
<td>3.160</td>
</tr>
</tbody>
</table>
The total number of regressions estimated following the ARDL method in the equation No.2 is \((2+1)^3 = 27\). The results of the bounds testing approach for Co-integration show that the calculated \(F\)-statistics is 4.939\(^6\) which is higher than the upper level of bounds critical value of 4.350 and 4.515 (Pesaran, et, al (2001) and Narayan, P (2005) at the 5 percent level of significance respectively as given in Table-4. This implies that the null hypothesis of no Co-integration cannot be accepted and that there is indeed a co-integrating relationship among the variables in this model.

Both \(\text{NEER}\) and \(\text{NEER}\) are integrated at \(I(1)\) that led to support for implementation of DOLS approach. The results of DOLS (Dynamic Ordinary Least Square) are reported in lower part of Table-4; only significant regressors are shown, Adjusted-\(R^2\) value of 0.8932 is an indication of good-fit for the dataset, the \(F\)-statistics-203.87 (\(Prob\)-value = 0.00) is statistically significant at 1 percent level of significance. It is concluded that the explanatory variable (nominal devaluation) is having significant influence on real devaluation for a small developing economy like Pakistan. The results of DOLS regression show that in long run, nominal effective exchange rate stimulates real effective exchange rate more 51 percent (approximately results of DOLS are same as compare to OLS ).

\(^6\)As can be seen from Table-4, although the results of the \(F\)-test changes significantly at lag order 2, support for Co-integration is more. F-test statistics is highly sensitive with the lag order; there is strong evidence for Co-integration because our calculated \(F\)-value is grater than its critical value when third lag is imposed.
However, first lead impact of nominal effective exchange rate declines real devaluation. In long span of time, OLS has revealed that nominal currency devaluation leads real devaluation of local currency more than 51 percent while less than 49 percent share of real devaluation explains through the hidden factors. Stability values (Prob-values) are given in parentheses with coefficient of constant and NEER as given below. After the comparison of OLS and DOLS results, it is concluded that long run association of NEER with REER is robust.

\[ LREER = 2.233(0.00) + 0.512(0.00)LNEER \]

R-squared = 0.8936  F-statistic = 856.54  AIC = -1.8303  SBC = -1.7795

Figure-1 graphical Behavior of REER and NEER

![Graphical Behavior of REER and NEER](image)

After establishing the long run relationship between nominal and real effective exchange rates in the case of Pakistan as mentioned in Table-4. Short run dynamics are investigated through an empirical equation being modeled as given below:

\[ \Delta LREER = \lambda_o + \sum_{i=1}^{n} \Delta LREER_{t-i} + \sum_{i=0}^{n} \Delta LNEER_{t-i} + \eta ECT_{t-1} + \mu_t \]

... (11)

Table-5 shows the short-run coefficient estimates obtained from the ECM version of ARDL model. The ECM coefficient shows how quickly/slowly variables return to equilibrium and it should have a statistically significant coefficient with negative sign. The error correction term ECT\(_{t-1}\), which measures the speed of adjustment to restore equilibrium in the dynamic model, appear with negative sign.
and is statistically significant at 5 percent level, ensuring that long run equilibrium can be attained. Kremers et al. (1992); Bannerjee et al., (1993) & Bannerjee et al., (1998) hold that a highly significant error correction term is further proof of the existence of stable long run relationship. Indeed, he has argued that testing the significance of ECT$_{t-1}$, which is supposed to carry a negative coefficient, is relatively more efficient way of establishing co-integration.

Table-5. Short Run Dynamics (3, 3)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>T-Statistic</th>
<th>Inst-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.0006</td>
<td>-0.2903</td>
<td>0.7722</td>
</tr>
<tr>
<td>ΔLREER(-1)</td>
<td>0.2733</td>
<td>2.7419</td>
<td>0.0073</td>
</tr>
<tr>
<td>ΔLREER(-2)</td>
<td>0.0753</td>
<td>0.7327</td>
<td>0.4655</td>
</tr>
<tr>
<td>ΔLNEER</td>
<td>0.6193</td>
<td>24.0095</td>
<td>0.0000</td>
</tr>
<tr>
<td>ΔLNEER(-1)</td>
<td>-0.2019</td>
<td>-2.9855</td>
<td>0.0036</td>
</tr>
<tr>
<td>ΔLNEER(-2)</td>
<td>-0.0971</td>
<td>-1.3912</td>
<td>0.1674</td>
</tr>
<tr>
<td>ECT$_{t-1}$</td>
<td>-0.0289</td>
<td>-1.5313</td>
<td>0.1291</td>
</tr>
</tbody>
</table>

R-squared = 0.871326 Adjusted R-squared = 0.863112
F-statistic = 106.0878 Durbin-Watson stat = 2.030146
Prob(F-statistic) = 0.000000 Akaike info criterion = -5.248532 Schwarz criterion = -5.067286

The coefficient of ECT$_{t-1}$ is equal to (-0.0289) for short run model and implies that deviation from the long-term nominal devaluation is corrected by (2.89) percent over the each quarter at 12 percent level of significance for real devaluation. The lag length of short run model is selected on basis of both Akaike Information Criteria and Schwartz Bayesian Criteria. Real devaluation improves 27.33 percent through its differenced lag and nominal devaluation leads real devaluation by almost 62 percent with high significance while differenced lag of nominal effective exchange rate impacts negatively to dependent actor but this affect becomes positive in future.
Variance decomposition is an alternative method to impulse response function for investigating the response of dependent variable due to effects of shocks by explanatory actors [Diagram of Impulse Response Function (IRF) and Variance Decomposition of DLREER and DLNEER are is also given in Appendix-2]. This method explains that how much of predicted error variance for any variable is described by innovations generated through each independent variable in a system over the horizons.

The shocks also affect other variables in the system due to innovative shocks explained by error variance. Table-6 shows that fraction of Pakistani real devaluation forecast error variance attributable to variations in nominal devaluation is 0.00 percent respectively.

The descriptive influence of running actor, namely nominal effective exchange rate (nominal devaluation) increases till 20-time horizon. More than 91 percent real effective exchange rate explains by its own innovative shocks and vice versa. While fraction of Pakistani nominal devaluation forecast error variance attributable to variations in real devaluation is 14.13 percent respectively. Table-7 indicates that at 20-time horizons, nominal effective exchange rate changes 59 percent from its innovative and 41 percent approximately by real effective exchange rate.

4. Conclusions
The present unique hypothesis explores the association between nominal and real effective exchange rate changes. The structure established to examine “whether nominal devaluation leads the real devaluation or not” in the case of Pakistan both in long run as well as in short span of time. Results of this study reveal that nominal devaluation not only leads to real devaluation in longer periods but also in short span of time. Real effective exchange changes explained 92 percent approximately through its own innovative shocks while nominal effective exchange rate 59 percent by its shocks and 41 percent in the course of real effective exchange rate’s innovative shocks.
In the context of policy implications, average inflation in Pakistan is more than 9 % that captures improving impact of nominal
devaluation and making the exports more expensive. Low quality of export goods together with low-profitable exports will deteriorate the trade balance. Government should need to formulate some adjustments in inflation\(^7\) for long period of time through a comprehensive policy to obtain the beneficial impacts of nominal devaluation in the form of improvements in real devaluation generally and to improve the trade balance particularly.

Government must adopt demand management policies to curtail the domestic demand. Supply shocks will be low if aggregate demand is low and in resulting inflation will be under controlled. Curtailed demand will improve exports bas in international markets and decrease the import volume. In this scenario, nominal devaluation policies will be effective in improving the trade balance and lead to real devaluation.

Reference


\(^7\) There is also need to redefine the formula of core inflation.
On Nominal and Real Devaluation Relation: Evidence for Pakistan


Shahbaz, M. On Nominal and Real Devaluation Relation: Evidence for Pakistan


Appendix 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF test at Level</th>
<th>P-P test at Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T. Statistics</td>
<td>Prob-value</td>
</tr>
<tr>
<td>LREER</td>
<td>-2.0026</td>
<td>0.5927</td>
</tr>
<tr>
<td>LNEER</td>
<td>-0.3208</td>
<td>0.9891</td>
</tr>
</tbody>
</table>

Ng-Perron Test at Level

<table>
<thead>
<tr>
<th>Variables</th>
<th>MZa</th>
<th>MZt</th>
<th>MSB</th>
<th>MPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LREER</td>
<td>-8.3136</td>
<td>-1.9787</td>
<td>0.2380</td>
<td>11.1585</td>
</tr>
<tr>
<td>LNEER</td>
<td>-3.5890</td>
<td>-0.7739</td>
<td>0.2156</td>
<td>18.0418</td>
</tr>
</tbody>
</table>

ADF & P-P Tests at 1st Difference
On Nominal and Real Devaluation Relation: Evidence for Pakistan

<table>
<thead>
<tr>
<th>Variables</th>
<th>MZa</th>
<th>MZt</th>
<th>MSB</th>
<th>MPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LREER</td>
<td>-48.3652*</td>
<td>-4.91506</td>
<td>0.1016</td>
<td>1.8968</td>
</tr>
<tr>
<td>LNEER</td>
<td>-49.3262*</td>
<td>-4.96561</td>
<td>0.1007</td>
<td>1.8503</td>
</tr>
</tbody>
</table>

Ng-Perron Test at 1st Difference

Note: * represents significance at 1% level.

Appendix-2

Table-6. Variance Decomposition of DLREER

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>DLREER</th>
<th>DLNEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0462</td>
<td>100.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>3</td>
<td>0.0472</td>
<td>97.9940</td>
<td>2.0059</td>
</tr>
<tr>
<td>5</td>
<td>0.0474</td>
<td>97.3089</td>
<td>2.6910</td>
</tr>
<tr>
<td>7</td>
<td>0.0477</td>
<td>96.3870</td>
<td>3.6129</td>
</tr>
<tr>
<td>9</td>
<td>0.0479</td>
<td>95.6476</td>
<td>4.3523</td>
</tr>
<tr>
<td>11</td>
<td>0.0480</td>
<td>94.9039</td>
<td>5.0960</td>
</tr>
<tr>
<td>13</td>
<td>0.0482</td>
<td>94.1619</td>
<td>5.8380</td>
</tr>
<tr>
<td>15</td>
<td>0.0484</td>
<td>93.4357</td>
<td>6.5642</td>
</tr>
<tr>
<td>17</td>
<td>0.0486</td>
<td>92.7210</td>
<td>7.2789</td>
</tr>
<tr>
<td>18</td>
<td>0.0487</td>
<td>92.3675</td>
<td>7.6324</td>
</tr>
<tr>
<td>19</td>
<td>0.0488</td>
<td>92.0170</td>
<td>7.9829</td>
</tr>
<tr>
<td>20</td>
<td>0.0489</td>
<td>91.6691</td>
<td>8.3308</td>
</tr>
</tbody>
</table>

Table-7. Variance Decomposition of DLNEER

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>DLREER</th>
<th>DLNEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.069174</td>
<td>85.87347</td>
<td>14.12653</td>
</tr>
<tr>
<td>3</td>
<td>0.072706</td>
<td>78.51750</td>
<td>21.48250</td>
</tr>
<tr>
<td>5</td>
<td>0.07698</td>
<td>70.36251</td>
<td>29.63749</td>
</tr>
<tr>
<td>7</td>
<td>0.081021</td>
<td>63.79441</td>
<td>36.20559</td>
</tr>
<tr>
<td>9</td>
<td>0.084606</td>
<td>58.70168</td>
<td>41.29832</td>
</tr>
<tr>
<td>11</td>
<td>0.088105</td>
<td>54.32000</td>
<td>45.68000</td>
</tr>
<tr>
<td>13</td>
<td>0.091478</td>
<td>50.56416</td>
<td>49.43584</td>
</tr>
<tr>
<td>15</td>
<td>0.094724</td>
<td>47.32222</td>
<td>52.67778</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>16</td>
<td>0.096307</td>
<td>45.85894</td>
<td>54.14106</td>
</tr>
<tr>
<td>17</td>
<td>0.097864</td>
<td>44.48850</td>
<td>55.51150</td>
</tr>
<tr>
<td>18</td>
<td>0.099397</td>
<td>43.20146</td>
<td>56.79854</td>
</tr>
<tr>
<td>19</td>
<td>0.100906</td>
<td>41.99100</td>
<td>58.00900</td>
</tr>
<tr>
<td>20</td>
<td>0.102393</td>
<td>40.85039</td>
<td>59.14961</td>
</tr>
</tbody>
</table>

Response to Cholesky One S.D. Innovations ± 2 S.E.

![Graph of Response of DLREER to DLREER](image)

![Graph of Response of DLREER to DLNEER](image)

![Graph of Response of DLNEER to DLREER](image)

![Graph of Response of DLNEER to DLNEER](image)