Does Nominal Devaluation Precede Real Devaluation in Floating Exchange Rate Regime? An Empirical Investigation for Ghana

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Abstract

This paper attempts to examine the link between nominal devaluation and real devaluation with special reference to Ghana. To find this relationship, we have employed some sophisticated tests such as ADF, P-P & Ng-Perron unit root tests; ARDL Bounds Testing, and DOLS test for the long run correlation. The findings of the study suggest that nominal devaluation leads to real devaluation both in the long run and in the short run in the case of Ghana.

Keywords: Nominal devaluation, real devaluation, Inflation, exchange rate regime, Ghana.

1. Introduction

Ghana is an economy where average inflation was more than 24 per cent per annum while trade deficit was US $ 13964.19 millions during 1990-2006. In 2006, inflation was 11 percent while trade deficit was US $ 913.81 millions[1]. Ghana's exports grew at an average rate of 31.7 per cent annually during 1990-2006 but imports also continued to be pushed to an unprecedented level like 47.1 per cent. This shows that import items are rising due to increase in domestic demand. That simply leads to widen the trade deficit. As a consequence, the country's balance of payments deteriorated.

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 narrowing trade deficit. The benefits of devaluation are restricted where inflation severely hits the economy. Moreover, nominal devaluation improves trade balance when it leads to real devaluation.

In early 1990s, most of the developing countries shifted their economies from fixed exchange rate regime to flexible exchange rate regime. In case of Ghana, Government adopted the policy of flexible exchange rate to improve the allocation of resources and balance of payments situation in international market. Exchange rate theory describes some major advantages of adopting flexible exchange rate policy: (i) adoption of flexible exchange rate policy enhances the capacity of an economy to adjust external and real shocks. (ii) In flexible exchange rate regime, country can exercise to an independent monetary policy and (iii) flexible exchange rate policy allows an economy to make use of foreign reserves to fulfill its demands (Bahmani-Oskooee and Knadi, 2007, pp: 2490).

2. Literature Review

According to standard theory, nominal devaluation of local currency stimulates competitive environment in international market by making its products cheaper resulting in improvements in trade balance. On other side, nominal devaluation leads to reduced imports in term of domestic currency due to expensive imports. It is argued that moderate inflation eats up favorable impacts of nominal devaluation. Bahmani-Oskooee, (1998); Bahmani-Oskooee and Gelan, (2007) seem to suggest 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".

[1] See IFS (2007) and WDI (2007) for data information.

Seminal work of Vaubel, (1976) that opens a new direction in international trade & finance by arguing that real devaluations resulted from nominal devaluations effectively during 1959-1975. In the same way; Connolly and Taylor, (1976, 1979); Bruno, (1978) & Edwards, (1988, 1994) concluded that nominal devaluation is effective to promote real devaluation only in the short run to medium span of time. De Grauwe and Holvoet (1978) estimate input-output tables for the European Community and claim that under zero wage indexation, every 0.70 percent real devaluation leads to a 1 percent increase in nominal devaluation. While with the complete wage indexation, every 1 percent increase in nominal devaluation results in a 0.5 percent change in real exchange rate. In contrast, Donovan (1981); Bautista (1981) and Morgan & Davis (1982) seem to suggest that impact of nominal devaluation on real devaluation is no more beneficial in long span of time[2]. However, Kent and Naja (1998) find that nominal devaluation leads to more real devaluation, as the country moves to more flexible exchange rate regime.

Bahmani-Oskooee and Mirzai (2000) apply KPSS test to see changes in real effective exchange rate and verify the existence of Purchasing Power Parity (PPP) in most developing economies. Bahmani-Oskooee (2001) assesses the long run response of trade balance to nominal devaluations in the case of some Middle Eastern countries. Bahmani-Oskooee and Miteza (2002) use error-correction model to investigate the association between nominal effective exchange rate and real effective exchange rate not only in short run but also in the long run in a group of less developed countries including the Philippines. They come to conclusion that there is no long run relationship between nominal effective exchange rate and real effective exchange rate. However, Holmes, (2004) finds a long run alliance between said variables and concludes that nominal devaluation seem to improve real devaluation in most African economies.

Bahmani-Oskooee and Gelan, (2007) document that nominal devaluation does improve real devaluation in the long run. Nevertheless, in short run, nominal effective exchange rate changes do not lead to real effective exchange rate changes except in a few African countries while Ghana was excluded from this study due to non-staionarity of nominal and real effective exchange rates at I(0) or I(1). Bahmani-Oskooee and Gelan, (2007) have also investigated the existence of PPP theory in some African counters excepting Ghana[3]. The relationship between nominal and real devaluation has also been investigated in MENA countries by Bahmani-Oskooee and Kandi (2007) through the validity of PPP. They conclude that nominal changes in exchange rate do have impact on the real effective exchange rate. Bahmani-Oskooee and Harvey (2007), use quarterly data of concerned variables over the period 1971-2004 for less developed countries. They show significant impact of nominal depreciation on real depreciation for countries in the sample. In country case studies, Shahbaz (2009) also confirms that nominal devaluation leads to real devaluation during 1975Q1-2006Q4 in case of developing economies like Pakistan. Similarly, Wahid and Shahbaz, (2009, 2008) suggest that not only in the long run, but also in the short run, nominal devaluation does lead to real devaluation in the case of Philippines and Bangladesh respectively while Rena, Shahbaz and Adnan (2008) for Papua New Guinea. Therefore the above discussion reveals that most of the empirical literature supports the long run positive effect of nominal effective exchange rate on real effective exchange rate although some studies show somewhat different results.

3. Modeling and Methodological Framework

Literature reveals that the log-linear form is superior to the linear form on theoretical as well as on empirical grounds [Bowers and Pierce (1975); Ehrlich's (1975); Ehrlich (1977) and Layson (1983)]. Log-linear modeling is being utilized in present pioneer endeavor in context of Ghana. Above discussion permits us for algebraic equation for empirical investigation is being modeled as following;

$$LREER = \alpha_o + \alpha_1 LNEER + \varepsilon_t \quad \textbf{(1)}$$

Where;

REER = Log of Real Effective Exchange Rate,

NEER = Log of Nominal Effective Exchange Rate

[2] See for more details (Morgan & Davis, 1982)

[3] These issues have inspired us to make study on said relationship of financial variables.

Table -1 Correlation Matrix and Descriptive Statistics

Variables	Mean	Median	Maxima	Minima	Std. Dev.	Kurtosis	REER	NEER
REER	4.8337	4.7991	5.2056	4.4599	0.2042	0.1252	1.0000	0.7698
NEER	5.2141	5.3176	6.8807	3.8212	1.0454	1.5927	0.7698	1.0000

Correlation matrix and descriptive statistics described in Table-1 represents that NEER & REER are correlated positively. This high correlation proves the hypothesis that 'prices of goods and services adjust sluggishly relative to asset prices such as nominal exchange rate in Ghana under floating exchange rate regime' (Kent and Naja, 1998). The main appeal of this study is that we are using monthly time series data which has never been used in any study in literature regarding the said issue for Ghana. Data has obtained from International Financial Statistics (IFS-CD ROM, 2007) and study period of this particular pioneering idea is 1990M1-2006M12.

3.1 ADF Unit Root Test

In the time series realization is used to draw inference about the underlying stochastic process. So to draw inference from the time series analysis, stationarity tests become essential. A stationary test which has been widely popular over the past several years is unit root test. In this study Augmented Dickey Fuller (ADF) test applied to estimate the unit root. ADF test to check the stationarity series is based on the equation of the below given form:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \alpha_i \sum_{t=1}^{m} \Delta y_{t-1} + \varepsilon_t \tag{2}$$

Where ε_t is a pure white noise error term and

$$\Delta y_{t-1} = (y_{t-1} - y_{t-2}),\ \Delta y_{t-2} = (y_{t-2} - y_{t-3}) \quad \text{etc}$$

These test determine whether the estimates of δ are equal to zero. Dicky and Fuller (1979) provided cumulative distribution of the ADF statistics, if the calculate-ratio (value) of the coefficient δ is less than τ critical value from Fuller table, then y is said to be stationary[4].

3.2 Philip-Perron Test

Theory of Dickey-Fuller tests assumes that the errors are statistically independent and have constant variance. Philip and Perron (1988) developed the generality of the Dickey-Fuller formula that allows for fairly mid assumptions concerning the distribution of the errors. Thus the Philip-Perron test permits the disturbance to be dimly dependent and heterogeneously dispersed. In this case the regression equations are as follows:

$$x_t = \delta_1^* + \delta_2^* x_{t-1} + \nu_t \tag{3}$$

$$x_t = \varphi_1 + \varphi_2 x_{t-1} + \varphi_3 (t - n/2) + \eta_t \tag{4}$$

n = number of observations

$\nu = \eta$ = E(μt) = 0……but there is no requirement that the disturbance term is serially uncorrelated or homogenous. The hypothesis in this case δ_1 =1, φ_1 = 1 and φ_3 = 0

3.3. Ng-Perron Test

Recently developed Ng-Perron (2001) unit root test is conducted 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:

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + \beta_1 y_{t-1} + \beta_2 \Delta y_{t-2} + \cdots\cdots + \beta_p \Delta y_{t-p} + \nu_t \tag{5}$$

[4] 't' ratio of coefficient δ is always with negative sings.

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, From 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, Rothemberg 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 α representing the specific point against which the null hypothesis below is tested.

$$d(y_t/a) = y_t \; if t = 1 \; and \; d(y_t/a) = y_t - ay_t \; if \; t > 1 \quad (6)$$

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

$$d(y_t/a) = d(x_t/a)'\delta(a) + \eta_t \quad (7)$$

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 $\alpha = \overline{\alpha}$ where $\overline{\alpha} = 1 - 7/T$ if $x_t =$ {1} and $\overline{\alpha} = 1 - 13.5/T$ 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.

$$\Delta y_t^d = \alpha \Delta y_{t-1}^d + \beta_1 \Delta y_{t-2}^d \Delta y_{t-1} + \cdots\cdots + \beta_P \Delta y_{t-P}^d + \nu_t \quad (8)$$

Like ADF test, the GLS unit root test also relies on the coefficient of α. The ERS point optimal test is as follows let the residuals from equation (5) be $\hat{\eta}_t(a) = d(y_t/a) = d(x_t/a)'\hat{\delta}(\overline{\alpha})$ and let the sum of squared residuals, $SSR(\alpha) = \hat{\eta}_t^{\,2}(\alpha).$ $\alpha = 1$ is the null hypothesis of optimal point test while possibility of alternative hypothesis contains $\alpha = \overline{\alpha}$. $P_t = (SSR(\overline{\alpha}) - SSR(1)/f_0$ which is test statistic, where f_0 approaches to zero. The test of Ng-Perron consists of the following four unit root tests based on modifications: Phillips-Perron $Z_a and\ Z_t$, Bhargava (1986) R1 and ERS optimal point tests. The tests are based on GLS de-trend data, Δy_t. First, let us define

$$k = \sum_{t-2}^{T} (y_{t-1}^d)^2 / T^2$$

The four statistics are:

$$MZ_\alpha^d = (T^1 y_T^d)^2 - f_0)/2k$$
$$MZ_t^d = MZ_\alpha \times MSB$$
$$MSB^d = (k/f_0)^{1/2}$$

$MP_T^d = (\overline{c}^2 k - \overline{c}T^1)(y^d T)^2 / f_0 \; if \; x_t =$ {1}

and $MP_T^d = (\overline{c}^2 k + (1-\overline{c})T^1)(y^d T)^2 / f_0 \; if \; x_t =$ {1,t} where $\overline{c} = -7$ if $x_t =$ {1} and $\overline{c} = -13.5$ if x_t ={1,t}

3.4 ARDL Approach for Co-integration

In economic literature, many methods are available for examining cointegration among variables, residual based Engle-Granger (1987) test, and Maximum Likelihood based Johansen (1991; 1992) and Johansen-Juselius

(1990) tests etc. These tests require that integrating order of variables must be same[5]. They do not include the information about structural break in sample period as well as suffer from low predicting power[6]. Structural changes occur in many time series for any number of reasons including economic crises changes in institutional arrangements, policy changes regime shift war (Leybourne and Newbold, 2003)[7]. If such structural changes prevail in the data generating process and results may be biased towards the erroneous non-rejection stationary hypothesis due to misspecification of model (Leybourne and Newbold, 2003; Perron, 1989, 1997).

Recently, an emerging body of literature 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, 1997). The second advantage of using the bounds testing approach to Co-integration is 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) document 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 ARDL 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:

$$REER = \alpha_o + \left\{ \sum_{i=1}^{n} \beta_i \Delta REER_{t-i} + \sum_{j=1}^{m} \sum_{i=1}^{p} \phi_{ji} \Delta NEER_{t-1} \right\} + \left(\delta_1 REER_{t-1} + \sum_{j=1}^{k} \gamma_1 NEER_j \right) + \eta_t \tag{9}$$

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 (Chandana, 2001)[8]. 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 be investigated in two steps (Pesaran and Shin, 1995).

Assuming that an ARDL (p,q) just for which the existence of association between x_t & y_t for long span of time is recognized, long run relationship for said actors can be established by estimating ARDL model as given by means of Ordinary Least Squares (OLS):

$$REER = \varpi + \left(\sum_{i=1}^{p} \beta_i REER_{t-1} + \sum_{i=0}^{q} \vartheta_i NEER_{t-i} \right) + \nu_t \tag{10}$$

[5] 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.

[6] It goes without saying that structural changes is of considerable importance in the analysis of macroeconomic time series.

[7] An associated problem with this is the testing of the null hypothesis of structural stability against the alternative of a one-time structural break

[8] This theoretical formation ARDL technique is based on Chandana, (2001)

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

$$REER = \alpha + \rho NEER + \mu_t \quad (11)$$

from:

$$\hat{\alpha} = \frac{\hat{\varpi}}{1 - \sum_{i=1}^{p} \hat{\beta}_i}, \quad \& \quad \hat{\rho} = \frac{\sum_{i=0}^{p} \hat{\rho}_i}{1 - \sum_{i=1}^{p} \hat{\beta}_i} \quad (12)$$

Firstly, we try to find out the direction of relationship between nominal effective exchange rate and real effective exchange rate in the case of Ghana 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)[9] and Akaike's 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 establish the integrity of the ARDL model, the diagnostic tests are conducted. The diagnostic or sensitivity tests examine the serial correlation, autoregressive conditional heteroskedasticity, normality and heteroskedasticity associated with the model.

3. 5 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:

$$REER_t = \varphi_o + \varphi_1 NEER_t + \sum_{j=-p}^{p} \phi_j \Delta NEER_{t-1} + \eta_t \quad \ldots\ldots (13)$$

Where REERt is real effective exchange rate, NEERt is a nominal effective exchange rate and Δ is lag operator.

9 The mean prediction error of AIC based model is 0.0005 while that of SBC based model is 0.0063 (Min B. Shrestha, 2003).

4. Empirical Interpretations

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.

In most of the available literature, to find out the order of integration ADF (Dicky & Fuller, 1979), P-P (Philip & Perron, 1988) tests are often used respectively[10]. Due to the poor size and power properties, both tests are unreliable for small sample data (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 is employed to overcome these above-mentioned problems about order of integration of running actors in the model along with ADF & P-P tests. This compelled us to rely on results and decision provided by Ng-Perron (2001). The results described in Table-2 showing that nominal effective exchange rate and real effective exchange rates are having 1st order of integration.

Table-2 Unit Root Estimation

Variable	ADF at Level		ADF at 1st Difference	
	T-value	Inst-value	T-value	Inst-value
NEER	-1.0867	0.9277	-9.3880	0.0000
REER	-1.8186	0.6922	-4.7116	0.0009
Variable	Philip Perron at Level		Philip Perron at 1st Difference	
NEER	-1.2955	0.8861	-9.5398	0.0000
REER	-1.9266	0.6369	-10.2290	0.0000
Variable	Ng-Perron at Level			
	MZa	MZt	MSB	MPT
NEER	-4.5940	-1.3572	0.2954	18.7646
REER	-7.2124	-1.8364	0.2546	12.7506
Variable	Ng-Perron at 1st Difference			
NEER	-27.304	-3.6949	0.13532	3.33735
REER	-30.980	-3.9347	0.1270	2.9474

[10] We also utilized these three tests but decision is based on Ng-Perron test.

Table-3: Lag Length Criteria

Lag order	Log likelihood	AIC	FPE
2	1050.663	-10.6190	8.38e-08
3	1056.733	-10.6401*	8.21e-08*
4	1060.054	-10.63320	8.26e-08
Sensitivity Tests			
Serial Correlation LM Test = 0.4928(0.6117)			
ARCH Test =1.7636(0.1378)			
White Heteroscedisticity Test = 0.4527 (0.9734)			
Ramsey RESET Test = 0.7151 (0.5825)			

After we obtain the order of integration for both variables concerned, the two-step ARDL co-integration (See Pesaran et al., 2001) procedure is applied to the estimation of equation-9 for Ghana by using monthly data during the period 1990M1-2006M12. 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-9 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 large sample of observations we cannot take lag length more than 3.

Table-4: ARDL Estimation for Long-run Relationship

Dependent Variable	Lag Order	F-statistics	Wald-Test (Prob-value)
REER	2	8.632	4.825(0.009)
	3	4.793	4.668 (0.010)
	4	4.353	4.215(0.016)
NEER	2	3.569	3.495(0.023)
	3	3.758	3.617(0.028)
	4	3.302	3.197(0.043)
Critical Values at 1 % (5 %) 10 % respectively			
Pesaran, at, al., (2001)		Narayan P (2005)	
Lower Bounds	Upper Bounds	Lower Bounds	Upper Bounds
5.17	6.36	5.620	6.908
4.01	5.07	4.203	5.320
3.47	4.45	3.688	4.605

DOLS Estimation for Long Run Association			
Variables	Co-efficient	T-value	Prob-value
Constant	4.0935	95.814	0.0000
NEER	0.1528	18.877	0.0000
ΔNEERt-1	0.8514	2.623	0.0094
ΔNEERt-2	0.6643	1.886	0.0609
ΔNEERt+3	-0.3978	-1.210	0.2276
ΔNEERt-3	0.6679	1.928	0.0554
ΔNEERt+4	-0.0542	-0.154	0.8777
ΔNEERt-4	0.8541	2.488	0.0137
ΔNEERt+5	-0.1599	-0.489	0.6254
ΔNEERt-5	0.6993	2.059	0.0409
ΔNEER t+6	0.8781	2.744	0.0067
R-square = 0.7100 Adjusted R-square = 0.6940 Akaike info criterion = -1.4963 F-statistic = 44.333			

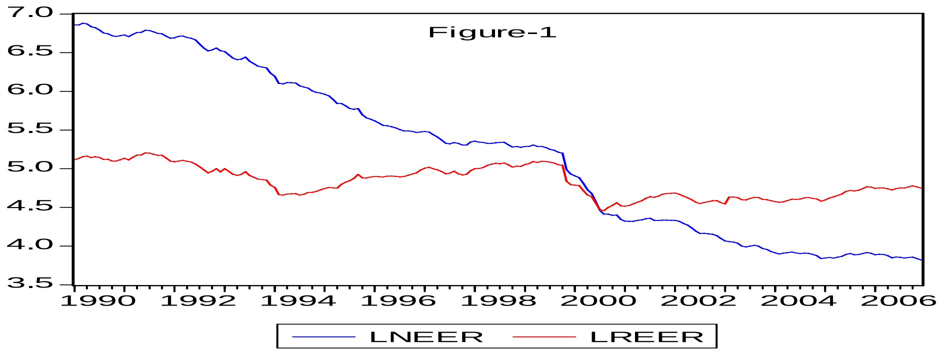
The total number of regressions estimated following the ARDL method in the equation-9 is $(2+1)^3 = 27$. The results of the bounds testing approach for co-integration show that the calculated F-statistics (Wald-Statistics) is 4.793 (4.668)[11] which is higher than the upper level of bounds critical value of 4.450 and 4.605 (Pesaran, et, al (2001) and Narayan, P (2005) at the 10 percent level of significance respectively as given in Table-4. This implies that the null hypothesis of no co-integration cannot be accepted which implies that there is at least one cointegrating vector confirming the presence of cointegration among the variables.

Both NEER and REER are integrated of I(1) that tends to support for application of DOLS approach. The results of DOLS (Dynamic Ordinary Least Square) are reported in lower part of Table-4; only significant regressors are shown, the value of adjusted-R2 is 0.6940 indicating good-fit for the dataset, the F-statistics is 44.333 (Prob-value = 0.00) which 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 in case of Ghana. The results of DOLS regression show that in long run, nominal effective exchange rate stimulates real effective exchange rate 15 percent more (approximately results of DOLS are same as compared to OLS). However, first and second differenced lag impact of nominal effective exchange rate improves real devaluation. While, with 3rd differenced lead and lag real effective exchange rate is being impacted negatively with insignificance and positively by nominal effective exchange rate.

[11] As can be seen from Table-4, although the results of the *F-test* changes significantly at lag order 4, support for Co-integration is more. F-test statistics is highly sensitive with the lag order; there is strong evidence for having two co-integrating vectors.

Table-5 OLS Regression Empirical Estimations

Dependent Variable: REER			
Variable	Coefficient	T-Statistic	Prob.
NEER	0.150405	17.14263	0.0000
Constant	4.049541	86.80006	0.0000



In long span of time, OLS results have revealed that nominal currency devaluation leads real devaluation of local currency approximately 15 percent while remaining share of real devaluation explained through the hidden factors. Both OLS and DOLS results are similar and consistent implying that the long run association between NEER and REER is robust. After establishing the long run relationship between nominal and real effective exchange rates in the case of Ghana, short run dynamics are investigated through an empirical equation being modeled as given below:

$$\Delta LREER = \lambda_o + \sum_{i=1}^{n} \Delta LREER_{t-i} + \sum_{i=0}^{n} \Delta LNEER_{t=i} + \eta ECT_{t-1} + \mu_t \quad \ldots (15)$$

Table-6 Short run behavior

Dependent Variable: DREER			
Variable	Coefficient	T-Statistic	Prob.
Constant	0.0037	2.925	0.0039
ΔREERt-1	0.3534	4.996	0.0000
ΔREERt-2	0.1741	2.352	0.0197
ΔREERt-3	0.1561	2.243	0.0261
ΔNEER	0.9919	32.634	0.0000
ΔNEERt-1	-0.4142	-5.282	0.0000
ΔNEERt-2	-0.1662	-1.999	0.0470
ΔNEERt-3	-0.1362	-1.731	0.0850

ΔNEERt-4	0.0198	0.630	0.5291
ecmt-1	-0.0199	-2.988	0.0032
R-squared = 0.8702 Adjusted R-squared = 0.8640 Akaike info criterion = -6.1979 Sum squared resid = 0.0214 Schwarz criterion = -6.0324 F-Statistic= 140.851 Prob(F-Statistic) = 0.000 Durbin-Watson = 2.008			

Table-6 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 (Bannerjee et al., 1998). Kremers et al, (1992); Bannerjee et al., (1993) & Bannerjee et al., (1998) hold that a highly significant error correction term is further substantiation of the existence of stable long run rapport. Indeed, Bannerjee et al., (1998) seem to argue that testing the significance of $\mathbf{ecm_{t-1}}$ with negative coefficient is relatively other well-organized way for establishment of co-integration.

The coefficient of $\mathbf{ecm_{t-1}}$ is equal to (-0.0199) for short run model and implies that deviation from the long-term nominal devaluation is corrected by (1.9) per cent each month at 1 percent level of significance for real devaluation. The lag length of short run model is selected on the basis of both Akaike Information Criteria and Schwartz Bayesian Criteria. Real devaluation improves 99.19 per cent through its differenced lags of nominal devaluation impact negatively to real devaluation by almost 41. 42, 16.62 and 13.62 per cent respectively with high significance while differenced lag of real effective exchange rate improves dependent actor as given in Table-6.

5. Conclusions

This study has attempted to verify the long run positive relationship between nominal and real effective exchange rate changes. It examined whether nominal devaluation leads to real devaluation or not, in the case of Ghana. Findings suggest that nominal devaluation leads to real devaluation not only in the long run but also in the short run. The results are consistent with most of the earlier empirical findings. It is also observed that the association is stronger during flexible exchange rate regime.

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