International Journal of Education and Social Science Research

ISSN 2581-5148

Vol. 1, No. 02; 2018

DOES INFLATION LEAD TO CURRENCY DEPRECIATION IN NIGERIA? AN AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) BOUND TESTING

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ABSTRACT

This study applied monthly time series data ranging from January 2008 to April 2017 to examine whether inflation leads to currency devaluation in Nigeria. An autoregressive distributed lags (ARDL) procedure was used in the assessing the short and the long-run results while ordinary least square (OLS) fully modified OLS (FMOLS) and dynamic OLS (DOLS) are used for robustness checking. The result reveals that inflation is positively affecting exchange rate in Nigeria. Once inflation rises, the Nigerian currency (Naira) depreciated. Therefore, the central bank of Nigeria (CBN) should determine the specific threshold level of inflation target (inflation adverse) with a minimum influence on exchange rate.

Keywords: exchange rate, inflation, currency devaluation, ARDL

INTRODUCTION

Inflation is the most important indicator in an economy, which can hold the responsibility to influence the exchange rate movement. High level of inflation may reduce the value of the domestic currency especially when the economy highly depends on foreign products. However, a moderate inflation may help an economy to maintain the value of domestic currency since inflation reduces the purchasing power in the domestic economy. During inflation what happened to the domestic currency in the international market? The exchange rate is the intermediary to measure the value of a nation's currency against other nation's currency through the monetary policy. The changes in exchange rate might induce changes in the economic external sector, capital flow, and financial stability, which may affect the relative prices of goods and services and the level of spending by individuals and firms. Has inflation is one of the major macro economic indicator in every economy that policy makers are targeted to maintain a specific digit in order to have favorable and smooth economic activities. In Nigeria, Inflation has a serious issue the policy makers especially Central Bank of Nigeria (CBN) has encountered unstable and nonstop fluctuated of inflation in the past decades. Looking at the huge discrepancy between the real and the nominal exchange rate this study tried to explore whether the exchange rate depends on the level of inflation. There is substantial theoretical base together with the empirical literatures that have attempted to examine the link between inflation and exchange rate in the previous studies (McCarthy, 1999; Takhtamanova, 2010;

Iwayemi and Fowowe, 2011 Adeyeye et al., 2012; Jiang and Kim, 2013; Aleem and Lahiani, 2014; Oppong et al., 2015). There are many researchers that have done on the exchange rate pass-through to import price (Goldberg and Knetter, 1997; Ghoshand Rajan, 2009; Doğan, 2013; Jimborean, 2013; Beckmann et al., 2014). Some researchers focus on the degree of exchange rate pass-through to consumer and producer price (Woo, 1984; Feinberg, 1986; Feinberg, 1989; Mirdala, 2014; Aron et al., 2014). The research investigates the exchange rate pass through to aggregate prices (Bacchetta and Wincoop, 2003; Gagnon and Ihrig, 2004; Campa and Goldberg, 2005; Bala et al., 2017). McCarthy (1999) did research in nine developed countries on exchange rate pass-through, he concludes that in recent years, exchange rates do not expect a greater impact on their domestic inflation, and might be a minor impact. Guillermo et al. (2014) applied Mexico monthly data of annual growth rates used structural vector autoregressive model. Reveal that consumer prices that are affected by exchange rate pass-through are relatively insignificant. Cunningham and Haldane (2000) reveal that there is an indication of a decreasing in pass through in Brazil, Sweden, and United Kingdom. (Garcia, 2001) the highlight there is little pass-through in Chile. Takhtamanova (2008) found that the extended level of how producers are passing the fluctuations of exchange rate into the general price level depends on the elasticity of demand and cost functions. Among the exchange rate and inflation studies that have done in Nigeria are: Imimole and Enoma (2011) investigated how inflation is affected by the exchange rate depreciation found that exchange rate depreciation leads to an increase in inflation. Oriavwote and Oyovwi (2012) used annual data range from 1970 to 2010, the results indicate that real effective exchange rate is influencing by the level of price, while Adeyeye et al. (2012) in their paper revealed that all the independent variables were significantly affected inflation. (Olofin et al., 2014) Their main findings indicate that the Central Bank of Nigeria (CBN) under the financial policy to create an optimal level of exchange rate, which that the main target of sustaining a favorable transaction will be achieved.

From 1996 till 2015 inflation rate was recorded averagely 12.13 percent, in January of 1996 inflation rate reaches the threshold level of 47.56 percent while in January of 2000 was the lowest recorded inflation rate of -2.49 percent. Since from February of 2013 Nigerian inflation was below 9.3 this may be because of the increase in oil price. Some evidence that is driven the inflation rate is due to the devaluation of the currency, causes the prices of both imported and domestic made increased, especially during a seasonal festival period like Eid-Fitri/Kabir and Xmas period (NBS, 2015). Since 2011 the central bank of Nigeria under the monetary section agenda has concentrated on a strong aim to maintain inflation in a single digit, this really helps the fluctuation in inflation rate prospects. The consequence and the impacts of the fiscal consolidation and contraction monetary policy, the inflation rate benefited and remain monitored. Once currency is affected by inflation it will tend to lose its values, which is not reflecting the real value. In another way, in the foreign exchange market, the domestic currency will pay more in order to exchange with other international currencies. Indirectly all the imported goods and services will become more expensive in the domestic country. While to the rest of the world will benefit has exported goods and services from depreciated currency are less expensive. Inflation is when the prices of good and services are increasing over time compared to their actual market value. Figure 1 shows the exchange rate of Nigerian currency (Naira) was strong as the value of U.S dollar since the independence in 1960. Even in 1985, the exchange was at the rate of N0.935 to $1.00. The implementation of structural adjustment program (SAP) in 1986 contributed significantly in promoting the depreciation of the currency. Consequently, a devaluation of Nigerian currency usually occurred during the high level of inflation.

In 1990, the Nigerian currency Naira exchanged N7.901 to $1.00 but the demand pressure pushed the value down. In 1994, the central bank of Nigeria decided to peg the currency at the rate of N21.886 to $1.00. But it was not stable in 1999 which was depreciated to N86 to $1.00 also in 2007 it was exchanged at N117.97 to $1.00. In 2014, Naira was devalued by the Central Bank of Nigeria from N168 to 176 to $1.00.

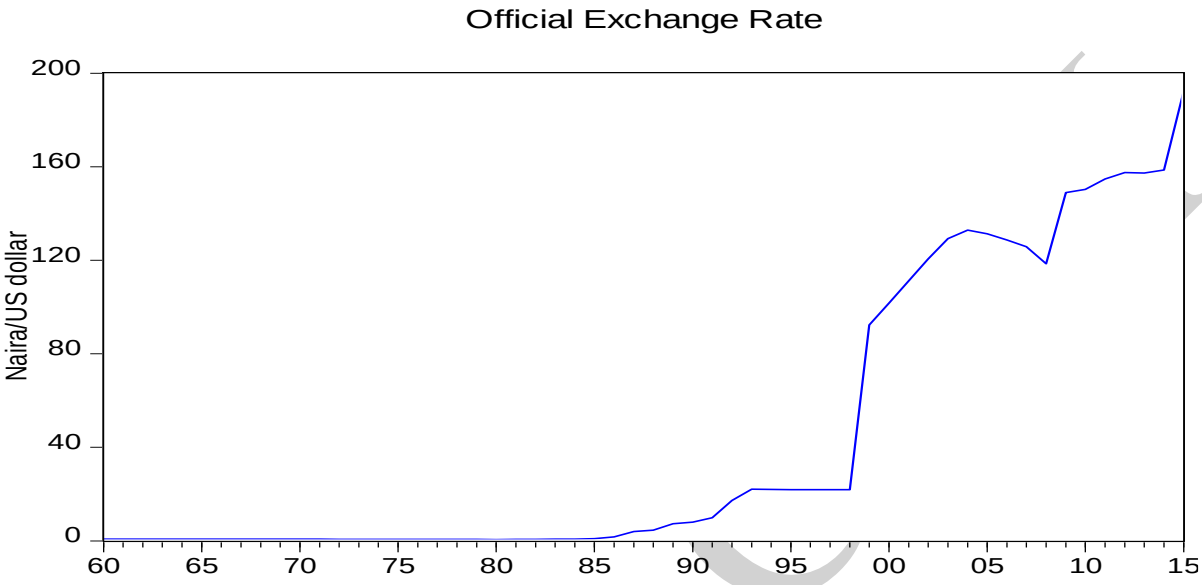


Figure 1 Exchange Rate Movement
Source: World Bank online Database

Nevertheless, Nigerian currency Naira still depreciates more than expected in the day to day foreign exchange market. Even though the policy makers adopt all the necessary majors, the target is not achieved, in which it is attributed by the fluctuation of oil price and high demand of foreign products and services by Nigerian. The real effective exchange rate marginal appreciation is influencing by the relatively high inflation rate in Nigeria compare to its trading partners inflations (CBN, 2014). Figure 2 shows that in the fourth quarter of 2014, the analysis of the traded-weight average Nigerian currency exchange rate via their major trading partner's currency has indicated that in the nominal effective exchange rate (NEER) Nigerian currency slightly loss value to 96.3 from 94.3 recorded in the preceding quarter. Indicate a nominal appreciation of the Nigerian currency during the review period relative to the currencies of its trading partners. Also, the real effective exchange rate (REER) indicated that Nigerian currency loss value to 58.6 from 62.1 recorded in the corresponding quarter of 2014. In the real term, the Nigerian currency is indicating an appreciation to its trading partners and the level of competitiveness is a loss. Figure 3 shows the positive correlation between inflation and the two proxies of exchange rate (real and nominal). This means that the more inflationary pressure, the exchange rate depreciation/devaluation in Nigeria. Earlier than 2014 even inflation increases, the exchange rate is not much depreciated.

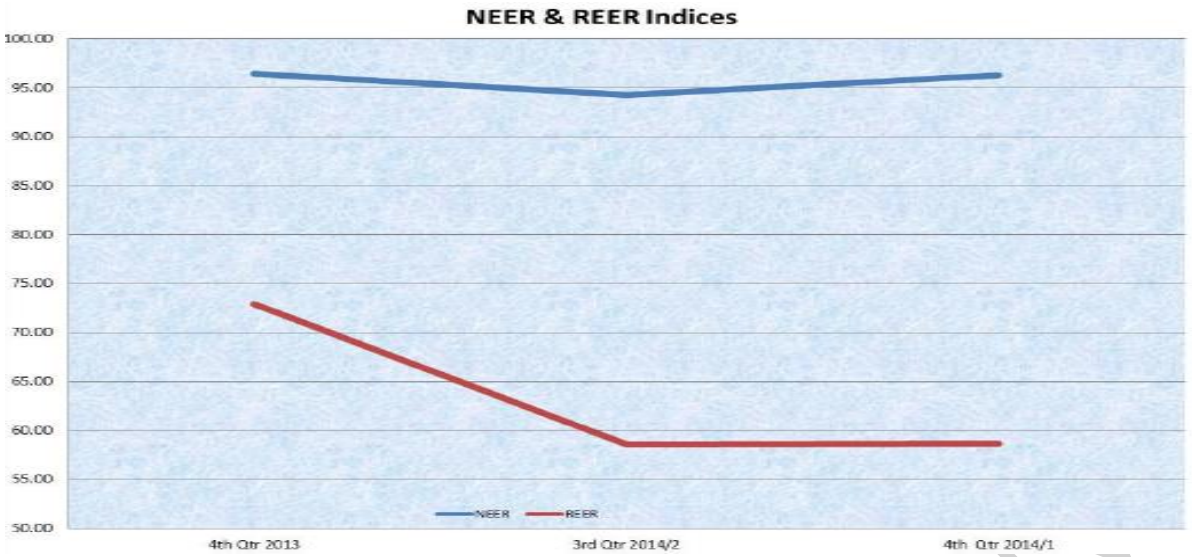


Figure 2 Nominal and Real Indices in Nigeria
Source: Central Bank of Nigeria (2014)

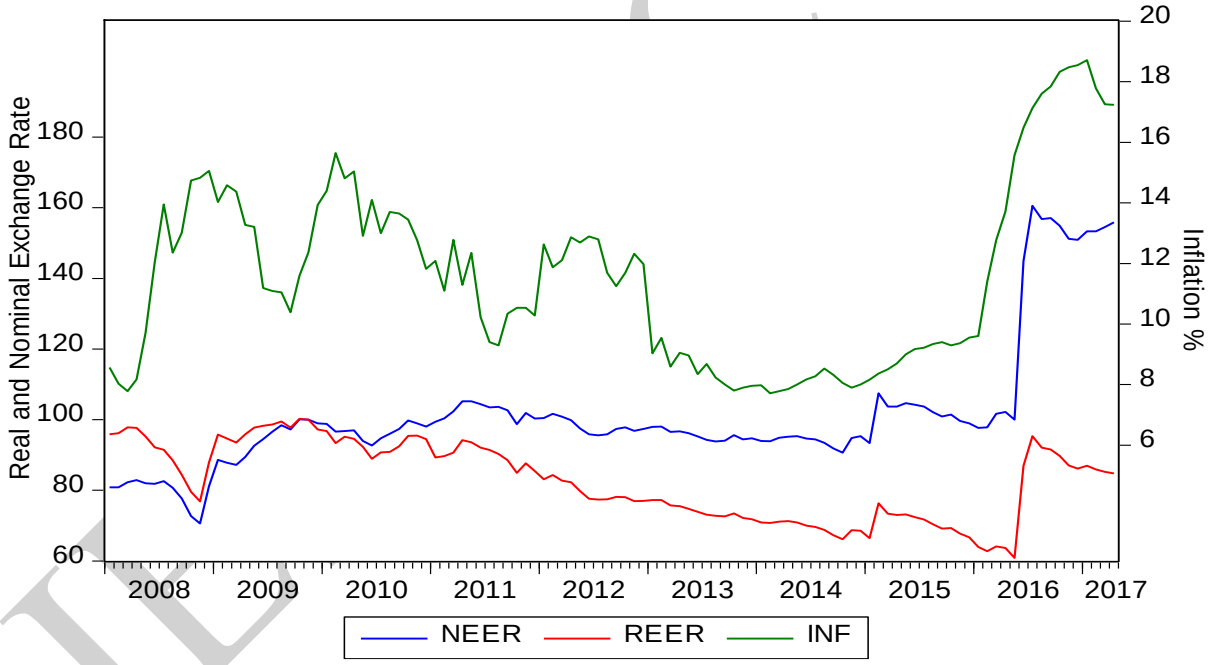


Figure 3 Nominal, Real Exchange Rate and Inflation Rate
Source: Central Bank Statistical Bulletin

The rest of the paper is arranged as follows, a literature review in the following subheading, followed by explaining the methodological process and data. In the next section is discussion and presents the estimated results, lastly, conclusion and recommendations.

Data and Methodology

For purpose of this research, we applied monthly time series data ranging from January 2008 to April 2017. Inflation is an average inflation rate while the exchange rate is the real and nominal

domestic exchange rate (Naira) units relative to the U.S. dollar. All data are sourced from World Bank online database. Autoregressive Distributed Lag (ARDL) framework accomplished the simultaneous and logical modeling in both short and long-run relationships were adopted. The importance of ARDL cointegration equation is based on the assumption of serially uncorrelated residuals, it generates the dynamic error correction illustration connected with the long-run cointegrating regressions. Following Pesaran and Shin (1998) employed practical bounds testing valid irrespective of whether the variables are I(0), I(1). Finally, the methods have a range of Monte Carlo experiment, which largely validates the estimation and inferential framework, revealing little bias in estimation and considerable power of the key test statistics. Moreover, it calculates observed p-values for the cointegration value and confidence intervals for dynamic multipliers by means of a non-parametric bootstrap. These exercises highlight a further desirable power and quality of this method. It is simple estimation by OLS and easy inferential methods provide a straightforward and reliable means of discriminating between the various forms of combinations. This study attempts an empirical procedure to explore the interlink between exchange rate and inflation in Nigerian by applying ARDL bound test properties to test for the long-run and short-run relationship in bivariate models. Augmented Dickey-Fuller and Philips-Perron test was applied to neutralize the data and free them for a unit root. Based on the past research we developed a hypothesis.

Hypothesis 1: Exchange rate depends on inflation or,
Hypothesis 2: Exchange rate does not depend on inflation

The study specified the model's equations in an econometrics relation specification between the dependent and independent variable as below.

$$EX_t = \alpha + \beta INF_t = \mu_t \qquad (1)$$

Where: EX_t= Exchange rate which consist REER and NEER, INF_t= Inflation, μ_t= Error term, both the variables were transform into natural log. The expected sign of inflation is positive, means that any increases in inflation will lead to increase the exchange rate (currency depreciation).

ARDL Bounds Test for Cointegration

$$\Delta EX_t = \alpha_0 + \sum_{i=0}^{p} b_i \, \Delta EX_{t-i} + \sum_{i=0}^{p} c_i \, INFx_{t-i} + \delta_1 EX_{t-1} + \delta_2 INF_{t-1} + \mu_t \qquad (2)$$

The optimum lag is chosen by Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) for small sample compare the F-statistics with the critical bounds by Pesaran et al. (2001) for large sample Narayan (2005).

If the F-statistics is greater than F-critical: Reject null, therefore cointegration exists
If the F-statistics is less than F-critical: Fail to reject null, therefore no cointegration
If the F-statistics is equal to F-critical: Inconclusive

The satisfaction of cointegration leads to both the long run and short run estimation.

Estimation of Long run Coefficients

$$EX_t = \alpha_0 + \sum_{i=1}^{p} b_i \, EX_{t-i} + \sum_{i=0}^{p} c_i \, INF_{t-i} + \mu_t \quad (3)$$

Estimation of Short-run Coefficients

$$\Delta EX_t = \alpha_0 + \sum_{i=0}^{p} b_i \, \Delta EX_{t-i} + \sum_{i=0}^{p} c_i \, \Delta INF_{t-i} + \gamma ECT_{t-1} + \mu_t \quad (4)$$

In estimated by OLS based on re-parameterization of the long-run model, ECT represents the potential retreats from the long run equilibrium (Baharumshah et al, 2009). γ is the adjustment coefficient.

Results and Discussion

In the time series literature, it is recommended that there is the possibility of having a non-meaningful outcome when the model contains variables is that are identified in the non-stationary or level form. Therefore, in order to take care of the spurious results, we used two prominent unit root test to avoid the problem. Moreover, we used the differences variables from the data to subtract the long-run information. This would only provide incomplete evidence or short run evidence. The solution of this kind of issue such, in econometrics, it is recommended that the models will be tested for cointegration first before any further estimation. There are two unit root tests employed in this study Augmented Dickey-Fuller by Dickey and Fuller (1979) and the Phillips-Perron (1988). The null hypothesis under the ADF and PP tests are that the observed variable (tested) unit root. Once the variables are found to be stationary, then the study will continue to examine the long-run relationship. Assume X to be any variable and the Augmented Dickey-Fuller (ADF) model can be defined as follows:

$$\Delta X_t = \beta_1 + \beta_2 t + \delta X_{t-1} + \sum_{i-1}^{m} \alpha_i \Delta X_{t-i} + \varepsilon_t \quad (5)$$

Where ε_t is a pure white noise error term and $\Delta X_{t-1} = (X_{t-1} - X_{t-2})$, $\Delta X_{t-2} = (X_{t-2} - X_{t-3})$, $\Delta X_{t-i} = (X_{t-i} - X_{t-j})$, and i represents the number of recent time and j as the number of previous times or years. The hypothesis of ADF is

$$H_0 : \delta = 0, X_t \text{ is non-stationary, (unit root)}$$
$$H_0 : \delta \neq 0, X_t \text{ is stationary, (no unit root)}$$

The first differencing in unit root test is to be tested if non-stationary time series Y need to be "differenced" at the times to make it stationary. Then the result can be stationary and correct, hence one can proceed to test for the co-integration. Table 1 present the unit root results conducted with ADF and PP procedures. The results indicate that both the three variables are not stationary at level with trend or without trend. In first difference, all the variables become stationary with trend and without trend.

Table 1 ADF and PP Unit-root Tests

LEVEL					1st DIFF.			
	ADF		PP		ADF		PP	
	C	C w T	C	C w T	C	C w T	C	C w T
REER	-1.8991	-1.9303	-2.0044	-2.1573	-8.9268***	-8.9242***	-8.8103***	-8.8120***
NEER	-0.7074	-1.6735	-0.3915	-1.1213	-8.6311***	-8.6720***	-8.5579***	-8.5561***
INF	-1.9650	-1.9495	-1.5516	-1.5404	-5.5738***	-5.5458***	-10.472***	-10.438***

The research applied the ARDL bound testing in estimating the relationship between inflation and exchange rate in short and long run. The ARDL comes with numerous benefits and advancement over some cointegration methodologies. Among benefit and advancement in ARDL procedure, it is applicable even the variables in the model are stationary at the level or first difference or are a mixture of the two but not second difference variable (Pesaran, 1997). It therefore devoid of protesting problem, it is also applicable to a small sample scope (Narayan, 2005). Another advantage of this methodology is used general to the specific procedure in order to generate the appropriate number of lags and to detect the data generating process that will fit the model (Laurenceson and Chai, 2003). In addition, the error correction model (ECM) can be derived from ARDL through a simple linear transformation (Banerje et al., 1993). The error correction term has captured the mixes with the short run adjustment with long run symmetry cointegration together with the long run evidence. However, the illustration estimation of this model is more advanced than that of the Johansen and Juselius'scointegration technique (Pesaran and Shin, 1999). To determine the cointegration relationship between inflation and exchange rate unrestricted error correction model was used to generate the value of F-statistic presented in Table 2. The computed F statistics must be greater than the upper bounds critical value of the Narayan (2005) Table. We have computed the F-statistic to be 6.5311, shows is greater than the upper bounds value, 6.070 at 5 percent level of significance. Therefore, they have long run relationship (they are cointegrated). This is the evidence of rejection of the hypothesis of they are not cointegrated and accept the alternative. While in the second model 1.2553 is less than the Narayan upper bound value means no cointegration. Furthermore, we continue with the first model.

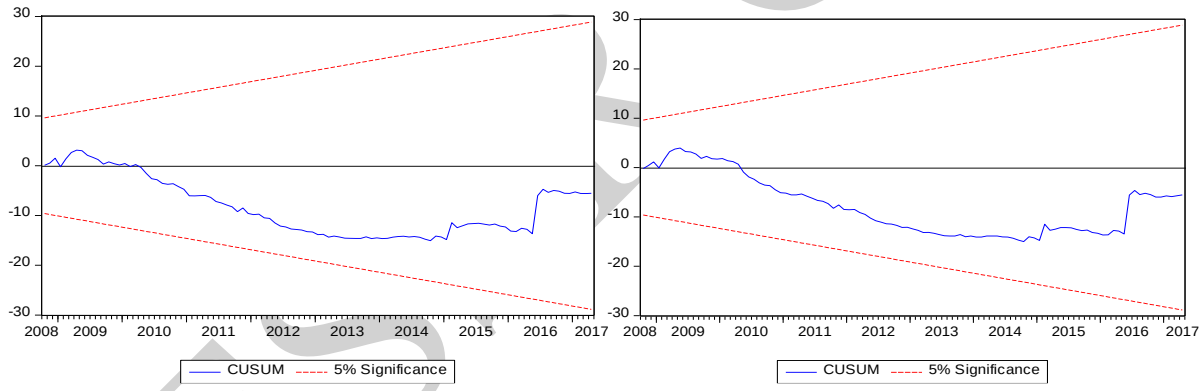
Bounds test result	F-statistics	Lag	Level of significant	Unrestricted intercept and no trend	
$LREER_t = f(LINF_t)$	6.0241	2	1%	6.1	6.73
$LNEER_t = f(LINF_t)$	5.6204	2	5%	4.05	4.49
N=110			10%	4.68	5.15

Table 3 presents the short and long run coefficient results, inflation is positively affecting exchange rate at 1 per cent level of significance. Select the lag length selection criteria to select the ARDL model. For example, the Akaike information (AIC) criteria select the ARDL (2, 2) and ARDL (2, 2) specifications, respectively. The estimates of the long run and short run coefficients based on these models are summarized in Table below: the models are separated into two sets (REER and NEER). Based on the coefficient results the first model with REER indicates that 1 percent increases in inflation are related to 0.32 percent depreciation of Nigerian currency Naira. In the second model with NEER indicate that 1 percent increases in inflation are related to 0.43 percent depreciation in Nigerian currency Naira. To understand the differences between the real effective exchange rate and nominal effective exchange rate we compare the value of the two coefficients in the estimated models. The results from the two models clearly show that the nominal effective exchange rate is affected more than the real effective exchange rate.

Table 2 Estimating long run and the short run coefficient

	REER – ARDL (2, 2)		NEER – ARDL (2, 2)	
Regressors	**Coefficient**	**T-statistics**	**Coefficient**	**T-statistics**
Long-run results				
$LINF$	0.3291***	4.2526	0.4348***	4.7989
$\mathbf{input_t}$	-0.0023***	-3.9234	0.0040***	5.9056
Short run results				
D(LREER(-1))	0.1772	1.9574	0.1925**	2.1387
D(LINF)	-0.0246	-0.4594	0.0243	0.4574
D(LINF(-1))	0.0017	0.0313	-0.0152	-0.2733
C	0.8347***	4.2850	0.6496***	4.1747
$ect(-1)$	-0.2235***	-4.2922	-0.1937***	-4.1459
LM	0.1145	-	01147	-
ARCH	0.6771	-	0.8464	-
Normality	0.0000	-	0.0000	-

The research is conducted some diagnostic checking to validate the true mode of the model free from spurious results referred to by Pesaran (1974). The study is conducted serial correlation test, functional form, heteroscedasticitytest,Jaque-Bera normality test and lastly CUSUM test. All the diagnostic tests hypothesize that there is no which is good for the model when the p-value reveal insignificant at 5 percent level. The Cumulative Sum of Recursive Residuals (CUSUM) stability tests is piloted to show the relative stability of the model within the study period at 5percent significance level.



To confirm the robustness of the results, the estimation was conducted with three different methods OLS, FMOLS and DOLS estimations. These methods address the bias caused by the endogeneity of the regressors by incorporating the Phillips and Hansen (1990) semi-parametric correction into the OLS estimator. The left-hand side presents the real effective exchange rate (REER) results while the right-hand side presents the nominal effective exchange rate (NEER) results. It can be observed that both the three estimators reveal similar results, the coefficient of NEER is greater than for REER results.

Table 3 Robustness results

	Real Effective Exchange Rate (REER)			Nominal Effective Exchange Rate (NEER)		
	OLS	**FMOLS**	**DOLS**	**OLS**	**FMOLS**	**DOLS**
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
LINF	0.2562***	0.3082***	0.2796***	0.3042***	0.3301***	0.3608***
	(5.81)	(3.57)	(5.09)	(5.77)	(3.02)	(5.96)
C	3.7876***	3.6635***	3.8767***	3.8688***	3.8093***	3.5536***
	(35.35)	(17.48)	(28.06)	(30.20)	(14.33)	(23.22)

CONCLUSION

The objective of this research is to examine whether inflation leads to currency depreciation in in Nigeria using monthly time series data ranging from January 2008 to April 2017. The findings reveal that the two proxies of exchange rate in the model are cointegrated. Furthermore, the findings reveal that there is a positive and significant influence of inflation on exchange rate in Nigeria over the period of the study. The results imply that there is evidence of exchange rate misalignment in Nigerian currency due to the unstable level of inflation. This suggestion shows that there is an indication of a substantial transfer of inflation into weakening the Nigerian currency Naira in the foreign exchange market. Usually, the weakening in the Nigerian currency is caused by inflation has confirmed by the results when the nominal exchange rate is used. This research is more focus on how inflation stimulates and influences the weakening the Nigerian currency to less value is slightly unfavorable. The actual value of Nigerian currency is affected by other externalities, the central bank of Nigeria has to make more effort, policies that will rise and make the currency more stable. This will encourage the participation of both domestic and foreign investors to invest their capital in the economy.

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