Effects of Exchange Rate on Food Inflation in Nigeria: A Non-Linear ARDL Approach

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Abstract

Over the years, exchange rate has been an unstable in the Nigerian economy, despite the stabilization policies introduced by successive governments in the country. This has consequently affected the prices of food products in the country. This study employed the Non-Linear ARDL model to examine the asymmetric effects of exchange rate on food inflation in Nigeria, using quarterly data from 2008Q1 to 2020Q4. The results of bounds testing to Cointegration indicate that there is a long-run relationship between exchange rate and food inflation along with GDP. In addition, both in the long-run and short-run, there is a significant and asymmetric positive relationship between exchange rate and food inflation. GDP is found to be negative and significant relationship on food inflation. Based on these findings, this study recommends that the Central Bank of Nigeria (CBN) should continue to improve the operations of the foreign exchange market to enhance its liquidity. Moreover, the CBN should apply tight monetary policies of price stability to help sustain low food inflation rate. In addition, government through the CBN should create policy to ensure easy and direct access to foreign exchange (FOREX) by individual and businesses. Lastly, Firms should continue to produce goods which help to reduce the rate of importation despite unstable exchange rate in Nigeria.

Keywords: Exchange Rate, Food Inflation, NARDL

1.0 Introduction

Rising food prices have become a cause of global concern that usually affects economic growth and development. An increase in food prices adversely affects purchasing power of households, reduces real income per capita especially in developing countries (Abdulaziz, Rahim & Adamu, 2016). Majority of the households in most of the developing countries are poor, who tend to spend a larger amount of their income on basic foods, and therefore suffer due to rising food inflation (Abdulaziz, *et al*., 2016).

Food and Agriculture Organization (FAO) revealed that 815 million people in the world experience hunger. This confirmed that about 705 million people were estimated to be living in extreme poverty as a result of rising food prices from 6 percent in 2013 to 14 percent in 2017 (FAO, 2017). In Nigeria, the rise in food inflation causes economic uncertainty and may discourage investment especially in small businesses lacking access to credit facilities. This creates domestic economic distortions leading to high poverty and cost of living in the country (Bada *et al.*, 2018). It is not surprising that Nigeria was among the countries with higher rate of food price among the African countries including Ghana and South-Africa, and listed 41 low income food deficits nation in the world. This might be due to the overdependence on imported products which led to high food inflation in country (World Bank [WB], 2018).

Although, putting food inflation/price under control is the desire of every government, fluctuation in exchange rate can influence food prices in Nigeria. In the present competitive world, exchange rate has been an important indicator that can determine the level of food prices and economic growth (Obi et al., 2016). For example, Nigeria Bureau of Statistic (NBS) reported that exchange rate tends to have a strong impact on other macroeconomic variables such as food inflation due to their relative inelastic demand as well as influence on the flow of products and capital in a country (NBS, 2018; Abdulaziz et al., 2016). In addition, unstable exchange rate may have a strong pressure on a country's balance of payment and food prices. This plays a crucial role in affecting the allocation of production and spending between foreign and domestic goods in the economy (WB, 2018; Obi et al., 2016). This instability in exchange rate also increases the level of speculation given the fact that the country relies on imported products, where imported goods rivaled the locally produced goods (Adetiloye & Kehinde, 2010).

Moreover, persistent instabilities of exchange rate stimulated discussions on its effect on food prices in Nigeria. Some scholars argued that it may have an effect on the economy as it induces poverty, food insecurity, including inefficiencies in the market of food products (Ibrahim, 2015). Also, unstable exchange rate can have an adverse effect on the productivity of agricultural sector in urban and rural areas. Hence, it makes farmers difficult to settle back loans, leading to a high decline of investment in the agricultural sectors, and high unemployment rate in the agricultural industry (FAO, 2017). Thus, exchange rate has been listed to be among the factors affecting food prices in Nigeria (Shehu et al., 2019; Ibrahim, 2015).

Nigeria is one of the countries that have experience instability and/or uncertainty in its exchange rate which affects the prices of food products. In addition, the country relied more on food imports for consumption. Despite lower GDP growth rate, food import bills have been increasing over the periods (CBN, 2017). The NBS (2018) stated that given the uncertainty in exchange rate which continues to fluctuate has resulted in to higher food prices, poverty and decline in GDP, which in turn translate to food insecurity in the country. As Nigeria's food insecurity situation is worsening, the country has been listed among the 41 low income food deficits nation in the world (Suleiman & Idris, 2018; WB, 2018).

Despite efforts taken to promote food security in the country (improve domestic food production and curtail the rise in food prices), through policies and programs such as Operation Feed the Nation (OFN) and Structural Adjustment Program (SAP), food inflation in Nigeria remains high compared to African countries including Ghana and South Africa. This might be due to the exchange rate fluctuation in the country which affects economic growth and productivity which in turn reduce agricultural products (FAO, 2018). Since exchange rate fluctuation influences food prices in the country. Therefore, it is possible that food inflation in Nigeria is caused by exchange rate fluctuation. It is against this background that, the study examined the effect of exchange rate on food inflation in Nigeria with a view to proffering possible suggestions on how to improve food security in the Nigeria.

Numbers of studies have investigated exchange rate and food inflation nexus. However, little attention has been given to the asymmetry effects of exchange rate on food inflation in Nigeria. The scarcely available studies on the effects of exchange rate are (Aye, 2012; Bala, 2018; Bawa et al., 2016; Ismail, Egwuma et al., 2017; Fasanya & Adekoya, 2017; Isiwu & Aminu, 2018; Odusanya & Atanda, 2010; Olarinde & Abdullahi, 2014; Omolora, 2013, Shehu et al., 2019). However, this study indicates that most of the studies have given more emphasis on the symmetric effect of exchange rate. Furthermore, to our knowledge, studies of asymmetry effects of exchange rate on food inflation in Nigeria are scares. Therefore, this study uses quarterly data to capture the asymmetric effect of exchange rate on food inflation in Nigeria, using Non-Linear ARDL model. After the introduction, the paper contains the following sections; second section presents the empirical literature review, followed by theoretical framework and specification of the model in the third section. Empirical results and findings are discussed in the

fourth section. Lastly, is the final section which consists of conclusion and policy recommendations.

2.1 Literature Review on Exchange Rate and Food Inflation

Several empirical studies have been conducted to examine the effect of exchange rate fluctuations on food inflation. For instance, Jongrim *et al.* (2019) examined the impact of global and domestic inflation shocks on exchange rate in 105 countries from 1970 to 2016, using a heterogeneous panel Vector-Autoregressive model. The empirical results indicate that food price influenced by exchange rate in low-income countries. Also, Anh et al. (2017) in their study, quantitatively analyzed inflation dynamics using a Global VAR model in Sub-Sahara Africa. The study demonstrates that food inflation is influenced by exchange rate in the region.

Adu, Karimu and Tei Mensah (2015) in Ghana evaluated the exchange rate and domestic price relationship during the period 1980-2010. The authors applied Structural Vector Autoregressive (SVAR) model, and illustrated that there is a positive relationship exist between the variables in Ghana. Furthermore, Bishir et al. (2011) employed Johansen Co-integration and Vector Error Correction (VEC) approaches to investigate the effect of exchange rate on food inflation in Pakistan from 1972 to 2010. The authors discovered that exchange rate had a positive effect on food inflation in Pakistan. In addition, Mosayed and Mohammad (2009) assessed the determinants of food inflation in Iran between 1971 and 2006. The authors applied an ARDL bounds testing approach, and discovered that there is long run relationship between food inflation and exchange rate in Iran.

Moreover, Ezeanyeji, Priscilla and Frank (2019) examined the relationship between exchange rate and inflation in Nigeria for the period 1981-2017. The results of the analyses revealed that exchange rate and money supply have positive and significant impact on food inflation in Nigeria. Bala (2018) investigated the interconnection between exchange rate and the disaggregate consumer prices from 1976 to 2015 in Nigeria. Autoregressive Distributed Lag (ARDL) technique was used, the results indicate that exchange rate is the significant factor influencing consumer prices in all the disaggregate models In their study, Abdulqadir, Adam and Maimunatu (2018) employed vector autoregressive (VAR) models to examine the effect of exchange rate changes on consumer prices in Nigeria from 2000 to 2017 using quarterly data. The findings reveal that there is positive and significant effect of exchange rate changes on food prices in Nigeria.

Ogundipe and Samuel (2013) developed a Structural Vector Autoregressive to estimate exchange rate and consumer prices relationship in Nigeria. With the use of variance decomposition analyses, the findings revealed that exchange rate affects food inflation in the country. This shows that exchange rate has been a driver in influencing Nigeria's rising inflation. Oyinlola and Babatunde (2009) examined the exchange rate and import prices for Nigeria during 1980-2006 period, using the developed UECM-Bounds approach. The result shows that exchange rate affects imported food prices in Nigeria.

3.1 Theoretical Framework

This study employed the Purchasing Power Parity (PPP) theory developed by Gustav and Cassel to examine asymmetry effect of exchange rate and prices of goods. The underlying assumptions of the PPP doctrine is that trade barriers or transport cost which can increase the price of good and service might influence a country's exchange rate (Bada et al., 2016). Furthermore, previous studies employed the model to examine the asymmetric effect of exchange rate and food inflation in the country (see Olarinde & Abdullahi, 2014; Bada et al., 2016). For example, Bada et al. (2016) assumed that when there is trade barrier and or transport cost the price of the product might be influenced, thereby causing general increase of price of products in the country. Thus, theory is presented in Equation 1

$$INF = f(EXCR) \quad (1)$$

Where, INF= Inflation and EXCR= Exchange Rate. The PPP theory postulates that changes in bureau de change exchange rate (appreciation and depreciation) affect food prices in a country. Studies have shown that when a country's importation is greater than its exportation, then, it is possible that prices of domestic food and non-food products increases over time and vice versa (see Adetiloye & Kehinde, 2010). Therefore, apart from exchange rate, other variable such as GDP influences food inflation in Nigeria (see Olarinde & Abdullahi, 2014). Thus, equation 1 has been modified to include variable that affect food inflation.

$$FI_t = f(EXCR_t, GDPGR_t\ u_t) \quad (2)$$

FI is the food inflation refers to the rise in average price level for food in particular countries or region or on a global scale, EXCR is an official exchange rate, which implies the price of one currency in terms of another, GDP is the Gross Domestic Product which is the total production of goods and services in a country. All the data on the variables such as INF, EXCR and GDP were collected from CBN (2020).

3.2 Model Specification

Following the works of Shin and Greenwood (2014) and Ibrahim (2015), the model in which food inflation is depended on exchange rate is specified in stochastic model as;

$$\Delta FI_t = a_0 + a_1 EXCR^{+}_{t-1} + a_2 EXCR^{-}_{t-1} + a_3 RGDP^{+} + a_4 RGDP^{-} + \varepsilon_t \quad (3)$$

Where, FI=Food inflation. $EXCR^{+}$ = Partial sum of positive change (Δ) in official exchange rate, $EXCR^{-}$ =Partial sum of negative change (Δ) in official exchange rate. Also, GDP^{+} =Partial sum of positive change (Δ) in Real gross domestic product and GDP^{-} =Partial sum of positive change (Δ) in Real gross domestic product.

4.1 Method and Data Analysis

This study employed Non-Linear ARDL to examine the asymmetric effects of exchange rate on food inflation. The NARDL model developed by Shin and Greenwood-Nimmo (2014) indicates positive and negative partial sum decompositions allowing detection of the asymmetric effects in the long-run and the short-run. Unlike classical co-integration models, NARDL models present some other advantages. First, they perform better for determining cointegration relations in small samples (Romilly, Song, & Liu, 200; Zakari & Umar, 2020). Second, they can be applied irrespective of whether the variables are stationary at I(0), or I(1) or combined (Umar & Zakari, 2020). Thus, NARDL model is specified as;

$$\begin{aligned}\Delta FI_t = {} & a_0 + a_1 FI_{t-1} + a_2 EXCR^{+}_{t-1} + a_3 EXCR^{-}_{t-1} + a_4 RGDP^{+}{}_{t-1} + a_5 RGDP^{-} \\ & + \sum_{i=1}^{p} \phi_1 \Delta FI_{t-i} + \sum_{i=0}^{r} \phi_2 \Delta EXCR^{+}_{t-i} + \sum_{i=0}^{k} \phi_3 \Delta EXCR^{-}_{t-i} \\ & + \sum_{i=0}^{f} \phi_4 \Delta RGDP^{+}{}_{t-i} \\ & + \sum_{i=0}^{j} \phi_5 \Delta RGDP^{-}{}_{t-i} + \varepsilon_t \end{aligned} \quad (4)$$

Where, L denotes logarithm and p, r, k, and f are the lag lengths orders of the variables in the model. α_1 α_2, α_3 and α_4 denote the long-run impacts of the positive and negative changes in bureau de change exchange rate on food inflation. ϕ_1,ϕ_2, ϕ_3, ϕ_4 and ϕ_5 denote short-run impacts of the positive and negative changes of Real Gross Domestic Product. Lastly, Δ denotes first difference operator, and ε_t is

the error term. In order to get the short-run coefficients, an Error Correction Model (ECM) will be estimated. The NARDL specification of the ECM model specified as:

$$\Delta FI_t = \phi_0 + \sum_{i=1}^{p} \phi_1 \Delta FI_{t-i} + \sum_{i=0}^{r} \phi_2 \Delta EXCR^{+}_{t-i} + \sum_{i=0}^{k} \phi_3 \Delta EXCR^{-}_{t-i} + \sum_{i=0}^{f} \phi_4 \Delta RGDP^{+}{}_{t-i} + \sum_{i=0}^{f} \phi_4 \Delta RGDP^{-}{}_{t-i} + \delta ECT_{t-1} + \varepsilon_t \quad (5)$$

4.1 Results and Discussion

4.1 Unit Root Test

This study began with the unit root tests to confirm that none of the variables are I(2) or above. Using augmented Dickey-Fuller ADF and Philip-Perron PP tests, the results of the unit root tests in Table 1 indicate that all the variables such as exchange rate, Gross Domestic Product (GDP) (appreciation and depreciation) have unit roots, or they are not stationary at level. After taking their first differences, each variable turned out to be stationary, implying that they are I(1), since they became stationary only after the first differencing. Therefore, the only exception is in food inflation which is found to be stationary at level and is integrated in to the order of I(0).

Table1: Results of Unit Root Test

	ADF Test with Trend and Intercept		PP Test with Trend and Intercept		
Variables	Level	First Difference	Level	First Difference	Stationary Status
LFI	-2.6753*	_____	-8.3459***	_____	I(0)
$LEXCR^{+}$	-1.5901	-5.6417***	-1.8175	-5.6051***	I(1)
$LEXCR^{-}$	-2.2917	-6.5346***	-2.2977	-6.6864***	I(1)
$LRGDP^{+}$	-1.8940	--6.977***	-2.0331	-6.9768***	I(1)
$LRGDP^{-}$	- 0.5198	-6.8077***	-2.1815	-6.9588***	I(1)

Source: Author's computation (2021). Note:***, * denotes significance at 1%, and 10%, respectively.

4.2 Results of Non-Linear Bounds Test to Cointegration

The result of bounds test given in Table 2 indicates that the value of F-Statistic (19.58) is greater than the upper critical bound at 1% level. This shows that there is a long-run cointegration between exchange rate (positive and negative), GDP (positive and negative) and food inflation in the model.

Table 2: Result of Bounds Test to Cointegration

Dependent variable	Function	F-Statistic
FI	f(LFI, $LEXCR^{+}$, $LEXCR^{-}$, $LRGDP^{+}$, $LRGDP^{-}$)	19.58***

Critical values bounds							
10%		5%		2.5%		1%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
2.75	3.79	3.12	4.25	3.49	4.67	3.93	5.23

Source: Author's calculation (2021). *** denotes statistical significance at 1% level, and critical bounds (k = 4).

4.3 Results of Selected Long-run and Short-run Models

The existence of cointegration suggests that the estimated relationship is not spurious. In the presence of cointegration, the study further examined the long-run effect of appreciation and depreciation of exchange rate using the non-linear ARDL technique. The long run and short run results of the estimated NARDL model for 2008Q1-2020Q4 periods are reported in Table 3. The optimal lag length is indicated by the AIC is (1, 2, 0, 0, 0). The results of estimated long run NARDL model show that there is a significant and asymmetric relationship between depreciation in exchange rate and food inflation in the long-run and short-run. A 1% depreciation in the exchange rate increases food inflation by 0.6% and 0.79% both in the long-run and the short-run, respectively.

Table 3 Result of NARDL model

Panel A: Long-run Coefficients – dependent variable is FI				
Regressor	Coefficient	Standard Error	t-Ratio	Prob.
C	39.0476	10.8819	3.5882	0.00113
LEXCR+	-0.0064	0.0025	-2.5469	0.0166
LEXCR-	0.0060	0.0044	1.3582	0.0185
LGDP+	-1.0553	0.3553	-2.9698	0.0061
LGDP–	-1.0859	0.3479	-3.1240	0.0041
Panel B: Short-run Coefficients – dependent variable is ΔFI				
$\Delta LEXCR+_{t-1}$	-0.0325	0.0055	5.9009	0.0000
ΔLEXCR-	0.0079	0.0058	1.3564	0.0858
$\Delta LEXCR-_{t-1}$	0.0485	0.0119	4.0630	0.0004
ΔLGDP+	-1.4013	0.4610	-3.0396	0.0051
$\Delta LGDP-_{t-1}$	-1.4419	0.4773	-3.0305	0.0053
ECT_{t-1}	-0.3103	0.0668	-4.6452	0.0000
Adjusted R^2	0.8233			
F-statistic	19.58			0.0000

Note: NARDL (1, 2, 0, 0, 0) is selected based on SIC criterion. Δ is the first difference operator.

This result is in line with the PPP theory which postulates that changes in exchange rate (appreciation and depreciation) affects food prices in a country. The results are consistent with the previous studies that exchange rate influences food inflation (Abdulqadir, 2018; Ezeanyeji et al., 2019; Bala, 2018). The estimations reflect the situation in Nigeria, where depreciation of exchange rate increases the prices of food products. For instance, between December 2014 and January 2019, food inflation rose from 1.16% to 2.21%, while exchange rate increased from N158=1$

to N413.07=1$ in 2014 and 2021, respectively (CBN, 2021). However, the result of the findings are not surprising because in Nigeria, whenever the domestic currency depreciates relative to that of foreign currency an increase in the rate of food inflation is recorded. Furthermore, understanding the high food prices in Nigeria can be emphasized on imported inflation and depreciation in exchange rate. Nigeria is an import dependent nation, where imported products have taken over the domestic produce goods. This has consequently impacted on several sectors of the economy and the welfare of the citizens (Abdulqadir, 2018).

In addition, the results of estimation indicate that appreciation in exchange rate has significant effect on food inflation in the long-run and the short-run. A 1% appreciation in exchange rate leads to a 0.64% decreases in food inflation in the long-run and 3.2% in the short-run at 5% and 1% level, respectively. This finding is in tandem with the Nigerian situation, because when the domestic currency appreciates relative to that of the foreign country, people prefer to export the food produce for domestic consumption. Therefore, high demands of food products both within and outside the country with low supply raise the prices of food products. An appreciation in exchange rate is important if the economy increases its level of productivity. However, this is not the case with the Nigeria, as the country exports primary products with little monetary value attached to it, imports a large number of food and non-food products (Bala, 2018; Ahmed & Sing, 2014). In fact, the CBN (2020) stated that increasing reliance on food imports has been addressing shortages of food demand in the country. Food import bills indicate a significant proportion of the annual national budgets that can however be reasonably invested which can affect the performance of the agricultural sector. However, failure to invest in the agricultural sector has limited the scope of agricultural programmes, and thus the sector performs relatively low compared to some of the developing nations. This indicates that food insecurity will continue to deter growth in the country, since all 51 agricultural projects launched to enhance food production have minimal contribution on the economy (CBN, 2020).

Moreover, the results indicate that appreciation of GDP is found to be negative and significant effect on food inflation both in the short-run and long-run. A 1% increase in GDP reduces food inflation by 1.05% and 1.40% in the long-run and short-run, respectively. This result is consistent with the previous studies that appreciation in GDP reduces food inflation in the country (see Adetiloye, 2010; Audu, Karimu & Mensa, 2015). All economies doing well have good economic performance which reduces the supply of food products, thereby affect the rate of

food inflation in Nigeria. Due to an increase in food inflation rate, there has been decline in purchasing power of money which reduces consumption and decrease in GDP. This implies that the economic performance of Nigeria is affected by balance of payment deficit, expensive exports and high importation. This has made investment less desirable because it creates uncertainty for the future (Adetiloye, 2010; Audu et al., 2015). In addition, a depression in GDP has a negative and significant effect on food inflation in Nigeria. Thus, A 1% decrease in GDP raises food inflation by 1.08% in the long-run and 1.44% in the short-run, respectively. This result is in line with the previous studies that decrease in GDP increase food price in Nigeria (see Bala, 2018).

Furthermore, the F- stat (19.58) reveals that all the coefficients jointly are significant at 1% level. The R^2 shows that 82% of the variation in the dependent variable (food inflation) is explained by the explanatory variables (official exchange rate and real gross domestic product). Also, the coefficient of ECM which measure the speed of adjustment towards equilibrium is negative and statistically significant at 1% level, this means that 31% of deviations from the equilibrium path will be adjusted within first quarter of the year.

5.0 Results of Diagnostic Tests

The study computed various diagnostics tests including serial correlation, normality and functional form tests. The results reported in Table 4 shows we cannot reject the null hypothesis, because there is no serial correlation among the residuals, since the $\chi 2$ is 0.23 and the p-value is 0.79. Also, the error terms are homoscedastic because the $\chi 2$ is 0.92 and p-value is 0.52.

Table 4 ARDL-ECM model diagnostic tests

Test statistic	Values	P-values
Functional Form: Ramsey Reset F-stat (1, 38)	0.053	0.25
Serial Correlation: Breuch-Pagan LM test	0.23	0.79
Hetroscedasticity: Breuch-Pagan LM test	0.92	0.52
Normality: Jargue-Bera	11.32	0.83

Source: Author's computation (2021).

Another result from the diagnostic test is that the error terms are normally distributed, since the histogram is bell shaped and the p-value is 0.83. Lastly, the results of the functional reset form reveal that there is no omitted variable bias since the p-value is (0.25) which is statistically insignificant.

Overall, the cumulative sum of recursive residuals (CUSUM) and the cumulative sum square of recursive residuals (CUSUMSQ) tests were executed. The results reveal that there is stability in the model in the long-run (CUSUMQ) in figure 1 and 2.

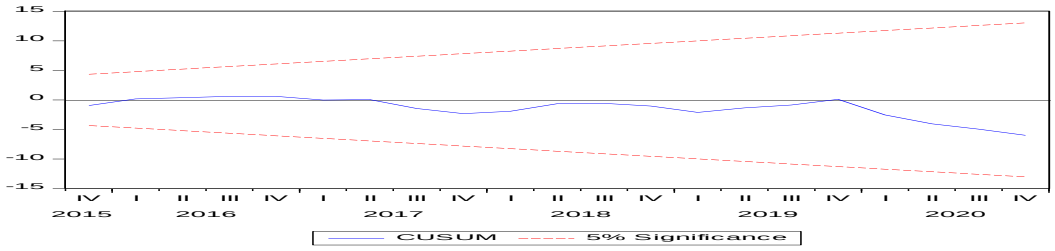

Figure 1: Plot of cumulative sum of recursive residuals

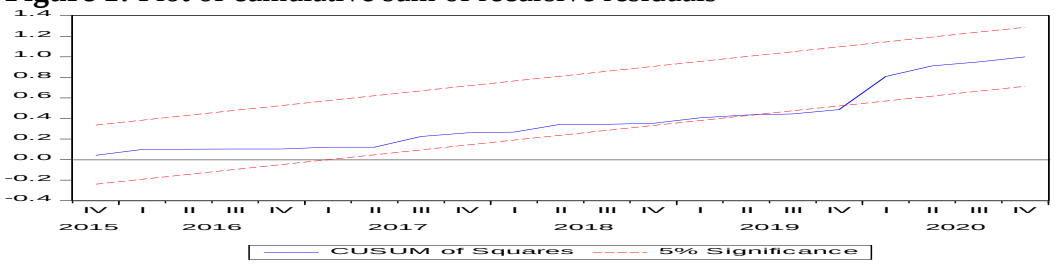

Figure 2: Plot of cumulative sum of square of recursive residuals

5.0 Conclusion

Food inflation in Nigeria is rising, while exchange rate continues to fluctuate over the years. This study examined the asymmetric effect of exchange rate on food inflation in Nigeria. Using the NARDL bounds approach, the results revealed that there is asymmetric relationship between exchange rate and food inflation in Nigeria. This indicates that appreciation and depreciation of exchange rate has significant effect on food inflation in Nigeria. Furthermore, LGDP is found to be significant in affecting food inflation both in the short-run and the long-run. Therefore, this study recommends that several strategies need to be adopted with regards to curtailing food inflation in Nigeria. First, exchange rate stabilization policy should be adjusted by the government that will help businesses and individuals to invest more, which in turn, decrease importation thereby reducing food inflation in the country. Second, The CBN and or government should re-introduce tight monetary policies by implementation of price stability programmes to help sustain low food inflation rate in Nigeria. Third, government through the

CBN should create policy to ensure easy and direct access to forex by individual and businesses. Lastly, local Firms should continue to produce goods or services which help to reduce the rate of importation, despite unstable exchange rate in Nigeria.

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