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Relationship between Real Exchange Rate and Consumption in Nigeria: A Nonlinear Approach*

Jamilu S. Babangida[1] **Aliyu R. Sanusi**[2] **Isah M. Yusuf**[3]

This study analyses the relationship between real exchange rate and domestic consumption in Nigeria using the Smooth Transition Autoregressive (STAR) model from 1981Q1 to 2019Q4. Findings show that domestic consumption determines the regime shift in real exchange rate, suggesting a nonlinear linkage with clearly distinct regimes. The lagged exchange rate is shown to have a significant linear effect on the current exchange rate. On the other hand, current foreign consumption is positive but has no significant impact on the exchange rate in the linear part of the model. In the nonlinear part of the model, evidence of a significant negative relationship between real exchange rate and domestic consumption is found, thus, supporting the proposition of the standard international business cycle model. In addition, the study finds evidence of bi-directional nonlinear granger causality between real exchange rate and domestic consumption. The study concludes that the relationship between real exchange rate and domestic consumption is nonlinear and that fiscal and monetary authorities should aim at policies that would stimulate domestic consumption below the threshold level necessary to keep the exchange rate stable

Keywords: International real business cycle, nonlinear, real consumption, real exchange rate, smooth transition autoregressive model

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1. Introduction

Trade among economies is facilitated by exchange rate as a measuring tool for the value of goods and services. Globally, exchange rate instability is seen as a common phenomenon, which has implications for domestic consumption through the prices of consumer goods and services. Changes in exchange rate could impede or distort

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[1]Ahmadu Bello University, Zaria; Istanbul Ticaret University. jsbabangida@gmail.com

[2]Ahmadu Bello University, Zaria. aliyurafindadiz@yahoo.com

[3]Ahmadu Bello University, Zaria. iyusuf94@gmail.com

the flow of goods and services globally. Besides, one of the central issues in international macroeconomics is the effect of high volatility of the real exchange rate on macroeconomic fundamentals. Hence, the growth of the literature on the determinants of exchange rate instability in international business cycle models (Tretvoll, 2018).

Nigeria depends substantially on import with oil revenue serving as the pool of wealth for settling the trade balance in international market. For instance, many industries and households in the economy import their raw materials and finished goods for production and consumption respectively. This has made the economy vulnerable to the volatility of exchange rate through its impact on aggregate consumption stemming from its implications on consumer prices of imports. The exchange rate of Naira to the Dollar and other major reserve currencies has deteriorated as a result of dwindling crude oil receipts due to both demand and supply factors[4] . Concerns have been raised on the implications of these developments on consumer prices[5] which is a major determinant of domestic consumption, and how it affects the exchange rate (Mamman, 2017).

Pavlidis et al. (2017) argued that exchange rate, characterized by high volatility regimes such as the floating exchange rate regime is linked to (on average) large deviations from equilibrium which (in expectation) are quickly absorbed compared to small deviations as a result of nonlinear nature of the process. In the same view, economic agents react to the abrupt fluctuations in the real exchange rate differently, leading the economy to react differently to unexpected deviations. Despite this form of behaviour, a large body of literature that exist on the relationship between exchange rate and consumption depend on linear models (see Backus & Smith, 1993; Kollmann, 1995; Stockman & Tesar, 1995; Ravn, 2001; Chari et al., 2002; Selaive & Tuesta, 2003; Head et al., 2004; Choi, 2005; Benigno & Thoenissen, 2008;Tuesta, 2013). Empirical evidence on some economies have shown that the relationship could be nonlinear (Pavlidis et al., 2015 and 2017). These evidence suggest that the

[4]Speculation, hedging, investment, exchange rates, inflation, spare production capacity, geopolitical risks, inventories, weather, global economic growth and non-OPEC supply growth.

[5] With a pass-through effect from foreign prices to domestic and import prices as a result of exchange rate fluctuations.

relationship between consumption and exchange rate for countries with excessive intervention in the foreign exchange market yet experiencing exchange rate deviations is best explained by nonlinear models. In support of this, the studies of Pavlidis et al. (2015 and 2017) on nonlinear relationship and granger causality of real exchange rates and consumption basically tested the theoretical preposition of international real business cycle model on OECD (Organisation for Economic Cooperation and Development) countries. However, the few studies that exist for Nigeria do not consider the nonlinear pattern of the relationship, and may have therefore missed out on fundamental aspects of the relationship between exchange rate and consumption (Aliyu, 2016).

This study focuses on the nonlinear linkage between real exchange rate and consumption in Nigeria, and test for the linear or nonlinear direction of causality. Considering the hypothesis that the relationship between the variables is nonlinear, there may be a potential challenge of the choice of linear or nonlinear model to be utilized. The practice of capturing misalignment with the level of deviations from linear trends could result in misleading inferences (Mordi, 2014). In trying to resolve this issue, this study adopts the smooth transmission autoregressive (STAR) model used by Pavlidis et al. (2017). Nested within the STAR model is a linear specification capable to testing whether a relationship is linear or nonlinear. It also identifies the variable that triggers a regime shift and at what speed.

The remainder of the study is organised thus: literature review is in Section 2 while data and methodology are explained in Section 3. Results and discussion are in Section 4 and Section 5 concludes and makes policy recommendations.

2. Literature Review

2.1 Theoretical Literature

Most approaches used to examine the relationship between real exchange rate pay tribute to the Classical interest rate and Keynesian disposable income as the determinants of consumption with some modifications of exchange rate inclusion as well as the standard international real business cycle (IRBC) and the purchasing power parity (PPP).

The IRBC model is an extended version of the closed economy real business cycle models into an international setting where transactions take place both in goods and financial markets. This model predicts a relationship between the real exchange rate and real consumption. The IRBC model, however, did not state the functional form of the adjustment process of exchange rate. Indeed, a common characteristic of the empirical IRBC studies is the assumption of a linear functional form. With regards to specific type of nonlinear dynamics, recent econometric literature presents evidence of nonlinearity of real exchange rate with time varying equilibrium (Lothian & Taylor, 2012). Benigno and Thoenissen (2008) state that a relationship between the real exchange rate and consumption exists even if the assumptions of standard IRBC models are relaxed, and other features introduced into the model, such as incomplete capital markets, sticky prices in local currency pricing, nontraded goods sectors, and habit persistence.

2.2. Empirical Literature

In spite of strong theoretical foundations of IRBC models, the empirical evidence in favor of a relationship between real exchange rate movements and changes in real consumption is only limited (Head et al., 2004). This section summarises the study that contributed to the real exchange rate-consumption relationship.

Pavlidis et al. (2017) re-examined the relationship between real exchange rate and consumption for 14 OECD countries with varying time periods and focuses on the nonlinear relationship and causality between real exchange rate and consumption. This study was based on Pavlidis *et al.* (2015) findings of the nonlinear causality running from real consumption to exchange rate and vice versa. Pavlidis et al. (2017) allows for smooth transition, extended sample period to overcome linear model limitations and accounts for changes in volatility. Finding from the study was in line with Backus and Smith puzzle that correlation among the variables vary widely with the presence of consumption-real exchange rate anomaly. They also found a strong evidence in favour of nonlinear dynamics and the presence of long run relationship between real consumption and real exchange rate which is in line with the predictions of the IRBC models with a volatility shift that increases due to Bretton Wood system collapse. The study suggests that volatility shifts, and economic fundamentals are

significant factors in explaining the behaviour of real exchange rates. In light of this relationship, an earlier study by Pavlidis et al. (2015) extended the IRBC empirical literature to test for nonlinear causality between real exchange rate and real consumption with time varying real exchange rate equilibrium for OECD countries using USA as a reference country and found that causal relationship exists between the variables. There is evidence of bidirectional Granger Causality for Canada, Denmark, Sweden, Switzerland, and United Kingdom. They also detected nonlinear causality for some countries which substantially consolidated for the existence of causality and nonlinearities in the relationship.

Other stacks of literature also examine the correlation puzzle between real exchange rate and consumption with varying restrictions. For instance, Backus and Smith (1993) under the complete market assumption, document the failure of international macroeconomic models to show the lack of correlation between growth rate of real consumption and real exchange rate. Similarly, Corsetti et al. (2008) showed that there is evidence of small and negative cross correlations between real exchange rate for a selection of OECD countries from 1971 to 1990. Using SVAR, they found that positive shock from productivity led to improvement in terms of trade, stimulated real exchange rate appreciation and led to an increase in domestic consumption relative to the rest of the world. Moreover, Benigno and Thoenissen (2008) investigated the relationship between exchange rate and consumption with incomplete financial market and non-traded goods assumption using annual data from 1970 to 2000. Their results suggested that the combination of incomplete financial market and nontraded goods feature is a promising path for explaining the behaviour of real exchange rate and consumption across countries.

In the spirit of testing the empirical evidence between exchange rate and consumption with a wide range of versions on Backus and Smith model, Head et al. (2004) used data for some selected OECD countries between 1961 and 2001 by introducing "money, habit persistence, asset market frictions and alternative specification for aggregate consumption". Head et al. (2004) found a negative relationship between the variables which showed that the model did not perform well empirically. Introducing the asset market frictions and preference shocks improved the performance

of the model but the model remained empirically weak. The results conformed to the literature showing taste shocks or asset market frictions as a way of explaining the real exchange rate-consumption puzzle. On the other hand, Chari et al. (2002) on the other hand calibrated a two-country general equilibrium model with production, nominal rigidities and monetary shocks under two environments for the period 1973 to 2000. They found that real exchange rate is perfectly correlated with relative consumption under both complete and incomplete markets for US and European countries. Their calibrated models lead to the conclusion that theory and empirical evidence on the correlation between consumption and real exchange rate could be reconciled by demand shocks or asset market frictions. This model performed well empirically. Moreover, Nuntramas (2011) revisited the consumption-real exchange rate anomaly with the inclusion of non-traded goods in the model for some selected OECD countries and found evidence of no strong relationship between relative consumption and the real exchange rate.

In summary, there have been a few number of authors that have provided theoretical explanation for the anomaly behaviour between consumption and real exchange rate by relaxing the assumptions of the IRBC and introducing "incomplete asset markets, limited enforcement of international financial contracts, sticky prices in local currency pricing, nontraded goods production sectors and distribution services, hand-to-mouth agents, and habit persistence" (see, Pavlidis et al., 2017; Benigno & Thoenissen, 2008; Head et al., 2004; and Chari et al., 2002). The empirical findings demonstrated some series of ambiguity in the nature of the underlying relationship with the magnitude of the theoretical contemporaneous correlation taking a wide range of values (from large positive to negative) depending on model assumptions. However, the crux of this study is to analyse nonlinear linkage between real exchange rate and consumption in Nigeria, and test for the linear or nonlinear direction of causality. It is evident that there are studies on the relationship between consumption and real exchange rate but only few examined the relationship in a nonlinear form (e.g., Pavlidis et al., 2017).

It is clear from the literature reviewed, that previous studies rely heavily on linear models. However, studies from Pavlidis et al. (2015, 2017) show that the relationship

could be nonlinear. There is much to be gained by allowing nonlinear specification because economic variables are frequently subject to switching regimes especially if they are policy variables like the exchange rate. Therefore, not accounting for the nonlinearity can be misleading. The notion of the regime switch implies a change depicting how economic variables change regimes in a smooth manner, with transition from one regime to another within a particular period. It is evident from other countries that nonlinear deviation from the equilibrium exchange rate best explains the behaviour of exchange rate due to the excessive interventions in foreign exchange market, over reliance on imports for consumption and production among other factors. Moreover, most of the studies utilised correlation, VAR, SVAR, GMM, Three-stage Least Square, ARDL to analyse the relationship between real exchange rate and relative consumption as predicted by the standard IRBC. However, this study will utilise the STAR model to analyse the nonlinear relationship between real exchange rate and domestic consumption using Nigeria data. From recent studies of various forms of models, we learn that there is much to be gained by allowing for nonlinear specification. For instance, STAR model handles economic variables that are subject to frequent switching regimes and allows for incorporating regime switching behaviour both when the exact time of the regime change is not known with certainty and when there is a short transition period to a new regime (Kavkler et al., 2008). In contrast to discrete switching models like Markov switching model, STAR models switch as a continuous process dependent on the transition variable.

3. Data and Methodology

3.1. Data Description

The study considers quarterly data for the period 1981Q1-2019Q4 to analyse the nonlinear relationship between real exchange rate and consumption in Nigeria. This yields a sample of 156 observations. The data for real exchange rate and domestic consumption were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin 2019 edition. Private final consumption was used to proxy for domestic consumption measured in Naira. The US consumption measured in dollar, serving as a proxy for foreign consumption was obtained from the US Bureau of Economic Analysis (https://www.bea.gov/data/consumer-spending/main). All the series were

log-transformed as prescribed by the theoretical framework in the methodology.

3.2. Theoretical Framework

There are numerous theoretical models linking real exchange rate and consumption. The specific aim of this study is to analyse the generic relationship between these two variables in a nonlinear form and test the causal linkage between them. Under this subsection, the study briefly synthesizes and outlines the standard IRBC and purchasing power parity models to provide a premise for results interpretation. The purchasing power parity links the exchange rate and consumer prices while the standard IRBC models connects relative prices to the ratio of consumption in home and foreign country (Backus & Smith, 1993). The literature is extended in two directions. Firstly, by employing the macroeconomic fundamentals suggested by the standard IRBC model in a nonlinear context which may help in explaining the misleading results found by related studies. Standard IRBC predicts a long run linkage between real exchange rates and consumption without making predictions regarding the functional form of its adjustment process (Pavlidis et al., 2017). The IRBC applied to a two-country exchange economy (home and foreign) is expressed as:

$$U_k = E[\sum_{t=0}^{8} \beta_k^t u_{k,t}(C_{k,t})] \quad k = 2 \tag{1}$$

where E[.] and $\beta_k \in (0,1)$ are the expectations operator and country k's subjective discount factor respectively. K is country i and j, $u_{k,t}(.)$ and $C_{k,t}$ are "country k's instantaneous utility function in period t, and consumption in country k respectively. This benchmark model highlights the key characteristics of individuals that lead to the relationship between real exchange rate and consumption. According to Backus and Smith (1993), each country as an agent with iso-elastic preferences maximises utility over consumption of multiple goods. The iso-elastic utility function exhibits constant relative risk aversion. The risk sharing equilibrium condition for home and foreign countries for all periods and for all states can be derived by equating the real exchange rate to a factor of the ratio of the marginal utilities of the two countries. Following Pavlidis et al. (2017), the risk sharing condition for the country pair (i, j) for all periods and states is given as:

$$RER_t = e_t \frac{p_{i,t}}{p_{j,t}} = \Lambda_{i,j} \frac{\beta_i^t m_{i,t}}{\beta_j^t m_{j,t}} \tag{2}$$

where RER_t is the real exchange rate, e is the nominal exchange rate (expressed in units of home country *i*'s currency per unit of country j's currency, say Nigeria Naira/US dollar) and $p_{k,t}$ is consumer price level for country k (*i, j*). The price level is denoted with p_j for country j (i.e., foreign country) and p_i for country i (i.e., domestic). Common measure of the price level is the consumer price index or the consumption price deflator (Volberg, 2005). $m_{k,t}$ is the marginal utility for country k=i, j. The marginal utilities are equal across countries in equilibrium leading to a direct theoretical link between the cross-country ratio of consumption to their bilateral real exchange rate. Real exchange rates typically feature large and persistent deviations from the PPP. Indeed, under standard theory, where PPP holds, relative price movements are offset directly by nominal exchange rate, resulting in unitary real exchange rates. In developing economies like Nigeria, which is the focus of this study, where two-digit inflation abounds, nominal exchange rate would make up only a modest part of real exchange rate fluctuations suggesting that deviations from PPP could be large and persistent (Seyrek, 2002). Therefore, following the work of Kollmann (1995) and Pavlidis et al., (2017), we adopted the derived and tested model given the assumption of iso-elasticity with an exponent $1-\eta$[6] .

$$rer_t = \lambda + ln\left(\beta_j/\beta_i\right)t - \eta_j c_{j,t} + \eta_i c_{i,t} \tag{3}$$

where rer_t,λ, c_t and c_t^* are all logs of their respective identities in equation 2 and η is the coefficient of risk aversion. Equation 3 implies that a fall in domestic consumption should lead to a rise in the exchange rate (domestic currency depreciation). The more the domestic consumption, the more the exchange rate gains value. It also implies that a rise in foreign consumption will result in increase in the exchange rate. Further implications of the theory are that the growth rates of consumption ratios and of real exchange rate should have identical dynamics and should perfectly correlate

[6]See Kollman (1995) for derivation

(Backus & Smith, 1993).

3.3. Model Specification

In order to ascertain the form of relationship that exists between real exchange rate and domestic consumption, the study utilizes a STAR model in line with Pavlidis et al. (2017) in a multivariate context. As argued in Pavlidis et al. (2017), STAR is the widely used nonlinear model in analysing exchange rate behaviour due to its capability to parsimoniously fit a number of real exchange rates series.

The generic form of the STAR model is specified as:

$$y_t = \beta_1^{'} w_t + \left(\varphi_0 + \varphi_1^{'} w_t\right) G\left(s_{t-p},\ \gamma, \mu_{t-\overline{p}}\right) + \varepsilon_t \tag{4}$$

where: $w_t = \left(z_t^{'}, x_t^{'}\right)^{'}$ is an $(m+1)\times 1$ vector of explanatory variables, with $z^{'} = \left(1, y_{t-1}, \ldots, y_{t-p}\right)^{'}$ and $x_t^{'} = \left(x_t, \ldots, x_{kt}\right)^{'}$, m is the number of explanatory variables, β *and* φ are the parameter vectors of the linear and nonlinear parts, respectively. ε_t is *iid* $(0, \delta^2)$; and $G\left(s_{t-p},\ \gamma, \mu_{t-\overline{p}}\right)$ is a transition function, μ_t is the threshold value and p is the delay parameter. The transition function $G\left(s_{t-p},\ \gamma, \mu_{t-\overline{p}}\right)$ is bounded between 0 and 1 where extreme values represent two different regimes with gradual transition, and a value close to zero represent linearity. Note that equilibrium real exchange rate depends on consumption. Then the representation of the process is as given in Pavlidis *et al.* (2017) as:

$$rer_t - \bar{\mu}_t = \sum_{p=1}^{\overline{p}} \psi_p \left(rer_{t-p} - \mu_{t-p}\right) G\left(rer_{t-\overline{p}},\ \gamma, \mu_{t-\overline{p}}\right) + u_t \tag{5}$$

$$\vartheta_t = \sum_{p=1}^{\overline{p}} \psi_p \left(rer_{t-p} - \mu_{t-p}\right) G\left(rer_{t-\overline{p}},\ \gamma, \mu_{t-\overline{p}}\right) + u_t \tag{6}$$

where: $\vartheta_t = rer_t - \bar{\mu}_t$; $u_t \sim NIID\left(0, \delta^2\right)$ and $\bar{\mu}_t = \lambda + ln\left(\beta_j/\beta_i\right) t - \eta_j \bar{c}_{j,t} + \eta_i \bar{c}_{i,t}$ being the long run IRBC equilibrium or the equilibrium exchange rate which depends on consumption as the threshold variable, p is the delay parameter and G is the transition function. If deviations from the equilibrium follows an exponential smooth

transition autoregressive (ESTAR) process, the transition function, G is expressed as:

$$G(rer_{t-\overline{p}},\ \gamma,\mu_{t-\overline{p}}) = [1+exp\{-\gamma(rer_{t-\overline{p}}-\mu_{t-\overline{p}})\}]^2 \text{ for ESTAR with } \gamma>0 \quad (7)$$

If it does not follow the ESTAR process, the transition variable will either take a Logistic Smooth Transition Autoregressive (LSTAR) process or linear process.

$$G(rer_{t-\overline{p}},\ \gamma,\mu_{t-\overline{p}}) = [1+exp\{-\gamma(rer_{t-\overline{p}}-\mu_{t-\overline{p}})\}]^{-1} \text{ for LSTAR with } \gamma>0 \quad (8)$$

where the transition function G is a continuous function that is bounded between 0 and 1[7] and $\gamma \in (0,\infty)$ is the slope parameter. It determines the smoothness of the transition speed towards equilibrium (i.e., speed of transition from one regime to the other) and p is the delay parameter. Following Teräsvirta (1994), a series of tests is conducted to choose between ESTAR and LSTAR within equation 6. The sequence of hypotheses to be tested is as follows: The F-statistics of the null hypothesis H_{04}, H_{03}, and H_{02} are denoted by F_4, F_3, and F_2 respectively, with the chosen model explicitly stated (Teräsvirta, 1994). The justification behind the sequence is based on interpreting the coefficients β_{ij} which determine the parameters of the STAR model in equation 6, with either equation 7 or 8. The implication of not rejecting the null hypotheses suggest that the relationship is linear in nature.

Furthermore, the study, following Pavlidis *et al.* (2015) examines the existence of a linear and nonlinear Granger causal relationship between real exchange rate and domestic consumption in Nigeria. The model is mathematically expressed thus;

$$Y_t = f\left(Y_{t-1},\ldots,Y_{t-p1},X_{t-1},\ldots,X_{t-q1};\theta\right)+e_t \quad (9)$$

where θ is a vector of parameters, e is a vector of serially uncorrelated and homoscedastic normal errors and $f(.)$ is a continuously differentiable function. By taking K^{th}-order Taylor series expansion of equation 9, the equation yields:

$$Y_t = \alpha_0+\sum_{j=1}^{p_1}\alpha_j y_{t-j}+\sum_{j=1}^{q_1}\phi_j x_{t-j}+\sum_{j_1=1}^{p_1}\sum_{j_2=j_1}^{p_1}\alpha_{j_1 j_2}y_{t-j_1}y_{t-j_2}+\sum_{j_1=1}^{p_1}\sum_{j_2=j_1}^{q_1}\varphi_{j_1 j_2}y_{t-j_1}x_{t-j_2}$$

[7]This realizes the smooth transition between regimes dynamically.

$$+\sum_{j_1=1}^{q_1}\sum_{j_2=j_1}^{q_1}\phi_{j_1 j_2}x_{t-j_1}x_{t-j_2}+\ldots+\sum_{j_1=1}^{p_1}\sum_{j_2=j_1}^{p_1}\ldots..\sum_{j_k=j_{k-1}}^{p_1}\varphi_{j_1\ldots..j_k}y_{t-j_1}\ldots..y_{t-j_k}$$

$$+\sum_{j_1=1}^{q_1}\sum_{j_2=j_1}^{q_1}\ldots..\sum_{j_k=j_{k-1}}^{q_1}\phi_{j_1\ldots..j_k}x_{t-j_1}\ldots..x_{t-j_k}+u_t \tag{10}$$

where $u_t = e_t + R_k(y_t, x_t)$ with $R_k(.)$ denoting the remainder term of the Taylor series expansion. The specified function is appealing as "it is an approximation of quite a number of nonlinear models, such as smooth transition and bilinear models as well as nests the equation for its linear counterpart" (Pavlidis et al., 2015:14). The equation includes all combinations between lagged *y's* and *x's.* The *x's* and *y's* represent real exchange rate and consumption, respectively. Under the null hypothesis that *x* fails to Granger cause *y*, the coefficients including lagged x's are equated to zero. This means:

$$H_0 = \begin{cases} \phi_j = 0, & j = 1,....q_1 \\ \phi_{j_1 j_2} = 0, & j_1 = 1,.....p_1; j_2 = 1,.....q_1 \\ \phi_{j_1 j_2} = 0, & j_1 = 1,.....q_1; j_2 = j_1,....., q_1 \\ \\ \phi_{j_1\ldots..j_2} = 0, & j_1 = 1,....., q_1; j_2 = j_1,....., q_1,....., j_k = j_{k-1},.....q_1 \end{cases}$$

The study estimates both linear and nonlinear granger causality models on the time series in order to confirm the existence of causality between the variables under study. The traditional Granger causality test neglects the nonlinearity observed in time series dynamics. Neglecting the nonlinear dynamics may reduce the estimation power of the test. Thus, the study employs the nonparametric statistical method to detect nonlinear granger causality between the real exchange rate and consumption. The nonlinear Granger causality test uses nonparametric estimators of temporal relations within and across time series (Baek & Brock, 1992).

4. Results and Discussions

4.1. Descriptive Statistics

Table 1 presents the summary statistics of the series. From the table, we observe that the average real exchange rate during the sample period is 2.15.

Table 1: Descriptive Statistics

	Rer	c_i	c_j
Mean	2.1471	9.0774	8.4878
Median	2.1570	9.0648	8.2209
Std. Dev.	0.8754	0.5330	0.5802
Skewness	1.0640	1.4573	0.1279
Kurtosis	4.7008	5.3522	1.4302
Jarque-Bera	48.2359	91.1799	16.4429
Probability	0.0000	0.0000	0.0003
Sum Sq. Dev.	118.7854	44.0302	52.1746
Observations	156	156	156

Source: Authors' computation using Eviews 9.

Domestic consumption is shown to be 9.08 while foreign consumption is shown to be 8.49. The skewness coefficients indicates that all the variables are positively or rightly skewed. The kurtosis coefficient for domestic consumption is shown to be 1.43. It reflects a platykurtic distribution while that of real exchange rate and foreign consumption are greater than 3. This reflects a leptokurtic distribution. That is, the datasets have heavier tails than normal distribution. From the Jarque-Bera, it is shown that the null of normality is rejected. This means that the variables exhibit non-normality features.

4.2. Stationarity Test

In analysing time series data, testing for stationarity is an important condition for estimating the parameters of the model of the study. This is so because the use of nonstationary series produces results that are spurious indicating a relationship that is inexistent. To obtain consistent and reliable results, the non-stationary data have to undergo a transformation by differencing into stationary data. Table 2 shows the result of the unit root tests as the first step of the analysis.

Table 2: Result for Unit Root Tests

Variable	ADF			PP		
	Level	1^{st} Difference	Remark	Level	1^{st} Difference	Remark
Rer	-2.1007	-12.6151***	I(1)	-1.4908	-12.6352***	I(1)
	(0.5410)	(0.0000)		(0.5358)	(0.0000)	
c_i	-2.4555	-16.7864***	I(1)	0.1485	-4.0793***	I(1)
	(0.3498)	(0.0000)		(0.9684)	(0.0084)	
c_j	-0.8572	-12.3735***	I(1)	0.4501	-12.5427***	I(1)
	(0.9571)	(0.0000)		(0.9844)	(0.000)	

Note: Values in parenthesis are the probability values.

The unit root tests were carried out using the Augmented Dickey Fuller (ADF) and the Philips Perron (PP) methods. The lag selection criteria were applied to determine the appropriate number of lags to be used in the model. Both the ADF and the PP indicated the presence of unit root for domestic consumption (C) at 5% level of significance. That is, domestic consumption is integrated of order one (I(1)). There is also evidence of unit root at levels for both real exchange rate (rer) and foreign consumption (C*) at 5% level of significance. In other words, domestic consumption, real exchange rate and foreign consumption indicate stationarity at first difference for both ADF and PP, that is I(1).

Table 3 shows the results of the lag order selection process which is critical for the determination of the order of the AR process for equation 11. From the result shown in Table 3, it can be seen that the lag length of one (1) period is the optimal lag as jointly suggested by Akaike information criteria (AIC), Schwarz information criteria (SIC), Hannan-Quinn (HQ), and final predictor error (FPE) criteria with the exception of likelihood ratio (LR) that suggest 5 lags. This study relies on AIC and SIC to proceed with lag one (1).

Table 3: Optimal Lag Order Selection Result

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-270.1822	NA	0.008051	3.691651	3.752406	3.716336
1	354.5317	1215.659	1.96e-06*	-4.628807*	-4.385789*	-4.530069*
2	356.0887	2.966690	2.17e-06	-4.528225	-4.102945	-4.355435
3	359.3112	6.009661	2.35e-06	-4.450152	-3.842609	-4.203309
4	361.1209	3.301412	2.59e-06	-4.352985	-3.563179	-4.032089
5	372.6883	20.63378*	2.50e-06	-4.387680	-3.415611	-3.992731
6	378.9491	10.91411	2.60e-06	-4.350664	-3.196332	-3.881662
7	382.3713	5.826937	2.81e-06	-4.275288	-2.938693	-3.732233
8	384.3757	3.331556	3.10e-06	-4.180752	-2.661895	-3.563644

4.4. Cointegration Tests

The Johansen cointegration test result is presented in Table 4. The Trace and Max-eigen statistics indicates one (1) cointegrating equation implying that there exists a long-run equilibrium relationship. The result confirms that there is an empirical relationship between real exchange rate and consumption and the assumption that equilibrium real exchange rate depends on consumption. This existence of a long run relationship between the variables meets the precondition for adopting the smooth transition model of the adjustment process. This long run relationship is in line with the study of Pavlidis et al. (2017) which supports the predictions of the standard IRBC models. This result is however in contrast with the result found by Kollman (1995) which shows that there is no evidence of long-run relationship between exchange rate, domestic consumption and foreign consumption.

Table 4: Cointegration Result

Hypotheses	Trace Statistic	Critical Values	Max Values	Critical Values
r$\leq$ r = 0	32.2308 (0.0107)**	29.7978	23.1380 (0.0449)**	21.1316
r $\leq$ r >1	8.0212 (0.4632)	15.4947	6.2136 (0.5859)	14.2646
r $\leq$ r > 2	1.8076 (0.1788)	3.8415	1.8076 (0.1788)	3.8415

Note: Values in paranthesis are the probability values.

4.5. Nonlinearity Test Results

Results in the Table 5 shows that domestic consumption is the transition variable because it has the lowest p-value.

Table 5: Linearity vs Nonlinearity Test

Transition variable	F	F4	F3	F2	Remark
rer(t-1)	7.8742e-03	6.8172e-03	2.3470e-01	1.4249e-01	LSTR1
$c_i(t)*$	9.8804e-06	9.0288e-05	9.8376e-01	6.7023e-01	LSTR1
$c_j(t)$	9.3725e-01	9.8966e-01	9.8715e-01	8.2304e-01	Linear

variables in AR part: $CONST\ rer(t-1)\ c_i(t)\ c_j(t)\ c_i(t-1)\ c_j(t-1)$

This indicates that the null hypothesis of linearity is rejected and LSTAR1(that is, Logistic Smooth Transition Autoregressive model) is accepted. In the next step, a grid search is performed since the hypothesis of linearity was rejected against STAR nonlinearity.

Table 6: Smooth Transition Autoregressive Test Result

Linear Component			Nonlinear Component		
Rer	estimates	P-Value	Rer	estimates	P-Value
Constant	-47.4179	0.0038***	Constant	48.4171	0.9058
Rer(-1)	0.6164	0.0000***	Rer(-1)	0.8291	0.9049
c_i	0.51639	0.002***	C	-0.51648	0.000***
c_j	0.61022	0.9142	γ	0.80123	0.1687
c_i(-1)	-0.3640	0.0000***	μ_t	2.639	0.0029***
c_j(-1)	-0.3640	0.9028			

Notes: This table 6 provides the results following Pavlidis et al. (2017) and applying the test procedures of Terasvirta (1994) to examine the relationship between real exchange rate dynamics and domestic consumption using the inbuilt mechanism on JMULTi software.

Overall, the results of the nonlinearity tests, thus far, suggest that the relationship between exchange rate and consumption in Nigeria follows a non-linear adjustment process with clearly distinct regimes. These regimes are demarcated by the level of domestic consumption relative to foreign consumption.The first regime in this study is captured by an Autoregressive (AR) process. As the results showed, at low exchange rate variation environment that is, the lower regime, the lagged exchange rate has significant influence on the current exchange rate. That is, about 62% of the variation in the exchange rate is accounted for by its previous value. Hence, this indicates that there are situations the economy reacts to exchange rate fluctuations with a time lag. On the other hand, current foreign consumption have positive insignificant influence on the exchange rate with a value of 61% while the lagged foreign consumption

has a negative insignificant effect of 36% on the exchange rate in the linear part of this study.

Since the variable of concern in this study is the domestic consumption, the rest of the analysis would be focused on the relationship between domestic consumption and exchange rate dynamics. The coefficient of domestic consumption in the linear part is positive and statistically significant at the 1% critical level. It specifically indicates that a one percent rise in current domestic consumption causes the real exchange to depreciate by 52%. That is, the real value of the naira falls with real consumption at home. This result is in line to the conventional view that there is a positive relationship between consumption and exchange rate. The results for current domestic consumption in the linear part (i.e. the lower regime) is overall, supportive of the predictions of standard IRBC models that suggest a long-run positive relationship. In other words, since the coefficient has a positive value, it implies that a rise in domestic consumption would lead to higher exchange rate, that is the domestic currency depreciation and vice versa. The result also shows evidence of a negative significant relationship between lagged domestic consumption and exchange rate. The combination of both positive and negative coefficients of current domestic consumption (lagged domestic consumption) indicates the tendency of domestic consumption to trigger adjustment to equilibrium for real exchange rate dynamics.

In switching from low regime to high exchange rate regime, the results indicates that the relationship between exchange rate and domestic consumption switches smoothly following a logistic transition shape. The result presented in Table 5 shows that exchange rate switches to a higher regime at certain threshold value of domestic consumption, that is, μ_t. This threshold value represents a specific level of domestic consumption. The threshold value is found to be about 2.639 and statistically significant. This means that a rise in domestic consumption as much as the threshold value would trigger a regime switch from low to high exchange rate deviation regime.

Recall from the upper part of Table 5, domestic consumption was found to be the transition variable which causes the change in regime. Furthermore, the result in Table 6 indicates that the speed (γ) with which the threshold value can trigger a shift to higher exchange rate regime was found to be about 80%. This means that a

rise in relative value of the consumption would cause exchange rate's transition to a higher deviation level with a speed of 80% quarterly. Hence domestic consumption is critical in explaining exchange rate dynamics in Nigeria. In other words, this result suggests that the shocks that could trigger a regime change at the estimated threshold value stem from domestic consumption relative to foreign consumption. More so, empirical evidence from the results show that domestic consumption is the major determinant of exchange rate dynamics in a high exchange rate regime.

The exchange rate switches to high (low) regime when the domestic consumption marginally increases (reduces). The result reveals that the speed of adjustment (transiting between regimes) is 80% in a quarter. This is relatively a fast transition. This high speed can be attributed to the direct impact of domestic consumption on exchange rate due to the dependence on importation for consumption in the economy, though, the speed is statistically not significant. From Table 5, the coefficient of domestic consumption in the nonlinear part is shown to have a negative value of 0.52 and statistically significant. This evidence suggests that domestic consumption has an inverse relationship with real exchange rate in upper regime. This implies that a fall in domestic consumption leads to appreciation in the value of naira. The empirical finding contradicts the standard IRBC model. This finding can be interpreted as evidence of nontraded goods effect on the economy which causes naira to increase in real value with consumption abroad and fall with domestic consumption.

The results show that domestic consumption which is the most important variable among the explanatory variables has the most significant influence on exchange rate dynamics in Nigeria. Compared to the first regime, the high exchange rate regime is characterized by a negative relationship between the variables of concern unlike the first regime where there was evidence of both positive and negative signs for current and past values of domestic consumption respectively. Furthermore, the coefficient of domestic consumption is relatively high in the upper regime and there is no evidence that an increase in domestic consumption would reduce the value of domestic currency on one hand and a decrease in domestic consumption would as well increase the value of domestic currency on the other hand. This suggests that depreciation in the value of naira is as a result of high consumption of imported goods as well as

non-tradable good in the economy.

4.5. Linear and Nonlinear Granger Causality Results

Table 7 shows the result of the linear and nonlinear Granger causality tests. It suggests that there is no causality in linear manner between real exchange rate and consumption in Nigeria.

Table 7: Granger Causality Tests

Hypothesis	Linear Granger causality		Nonlinear Granger causality	
	F-Stat	P-value	F-stat	P-value
$rer \overset{GC}{\Longleftrightarrow} C$	0.3057	0.6923	6.3478	0.0000***
$C \overset{GC}{\Longleftrightarrow} rer$	0.0793	0.5381	7. 9085	0.0000***

In other words, real exchange rate does not linearly Granger cause consumption and consumption does not also linearly Granger cause real exchange rate in Nigeria. As shown in Table 7, the p-value of causality running from real exchange rate to domestic consumption is 0.69, implying that the null hypothesis cannot be rejected. Similarly, the p-value of 0.54 indicates that causality running from consumption to real exchange rate cannot be rejected The traditional linear Granger causality does not take into account the nonlinearity observed in the time series dynamics. The study therefore examine nonlinear causality between the variables.

The nonlinear granger-causality results on Table 7 shows that real exchange rate nonlinearly granger causes domestic consumption at 1% significance level. On the other hand, the F-statistics for the nonlinear causality running from domestic consumption to real exchange is 7.91 with a p-value of 0.0000. The results show that there is a bi-directional nonlinear Granger causality between the series. This is contrary to the results of linear models. These results support the notion that the attitude of depending excessively on import places pressure on the local currency, thereby, leading to persistent exchange rate deviations from the market rate or equilibrium (Obadan, 2016). This is also plausible since exchange rate is one of the economic indicators that affects consumption directly through prices of consumer goods and indirectly through the prices of intermediate goods.

According to the above estimated results, there is nonlinearity in the relationship between real exchange rate and domestic consumption in Nigeria from both smooth

transition and Granger causality tests. For the STAR model results, this is evident by the successive regime switches in the model. There is evidence of one regime switch across the period under review showing the nonlinear behaviour of the real exchange rate and domestic consumption in Nigeria. For the Granger causality, there is no evidence of linear Granger causality between real exchange rate and domestic consumption. But when we tested using the nonlinear Granger causality test, we found evidence of bi-directional causality between the variables following a nonlinear path. This study finds the critical role domestic consumption plays in exchange rate. First, the domestic consumption being the transition variable, determines whether the economy is in high or low exchange rate regime. The monetary policy authority cannot achieve exchange rate stability with all its available measure alone as long as the economy continues to import goods for its consumption. The economy should take measures that could help in domestic production in order to reduce the effect of import demand and relief the pressure on domestic currency.

Table 8: Test of Autocorrelation

lag	F-value	p-value
1	0.0467	0.8562
2	0.4265	0.3472
3	0.5939	0.5291
4	0.1647	0.7346
5	0.3561	0.4268
6	0.2350	0.6902
7	0.9437	0.2948
8	0.6514	0.4775

Table 9: Test of no remaining nonlinearity

variable	F	F4	F3	F2
	9.25E-01	7.26E-01	8.17E-01	8.59E-01

Table 10: Parameter Constancy Test

Transition Function	F-value	p=value
H1	9.606	0.000
H2	5.174	0.000
H3	5.062	0.000

However, while the findings of significant nonlinearity and estimation of the appropriate non-linear form are in themselves important, a further issue concerns checking

the quality of the estimated nonlinear model against misspecification like in the linear case. From the battery of tests in Tables 8, 9 and 10, that is, tests of no autocorrelation, no remaining nonlinearity and parameter constancy, the models are robust and significant. The results reported that there is no existence of autocorrelation in the model. The p-values are above the conventional level for all the number of lags which makes it necessary to accept the null hypothesis of no autocorrelation. The F-statistics and p-values for both parameter constancy test and test of no remaining nonlinearity are also significant in the models.

5. Conclusion and Policy Recommendations

Having indicated the presence of nonlinearity in the findings, the study has shown that the relationship between real exchange rate and domestic consumption is indeed nonlinear. Domestic consumption is found to be one of the most important determinants of exchange rate dynamics in Nigeria with a fast pace in the speed between upper and lower regimes. Foreign consumption is statistically not significant in determining exchange rate dynamics in Nigeria. Allowing for nonlinearity gives a more comprehensive information about the relationship showing distinct real exchange rate regimes and the role of domestic consumption in determining the changes in regimes.

Based on the findings of this study, it is therefore recommended that the monetary authority should also place forex and trade restrictions on food importation as a means to stabilize the currency. In addition, since the relationship is nonlinear, there is a need for the monetary authority to closely monitor the pattern of movement of exchange rate to provide the appropriate monetary policy responses in different regimes. Finally, this study recommends that fiscal and monetary authorities should aim at policies that would stimulate domestic consumption below the threshold level necessary to reduce pressure on the exchange rate.

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