EFFECT OF EXCHANGE RATE ON CASSAVA PRICES IN NIGERIA

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ABSTRACT

This study examined the influence of exchange rate on cassava prices using the Johansen co-integration approach and the Vector Error Correction technique on time series data collated from 1991 to 2015. The unit root tests using Augmented Dickey-Fuller (ADF) found that all the variables were non-stationary at level form but stationary after first difference. The study established that exchange rate has insignificant effect on cassava prices in the short run but leads to decline in cassava prices in the long run. Also, it indicated that the prices of rice and yam strongly influence cassava prices both in the short run and in the long run. In view of these findings, the study recommended the adoption of a special exchange rate that is below the official benchmark to favour the import of farm inputs, the restriction of foreign exchange access for importation of cassava-related food products and a lowering of the inflation rate to boost cassava farmers' confidence in the economy. These measures will enhance cassava production and invariably lower the prices of cassava in Nigeria.

JEL classification: E3, E31, O24, P42, Q11

1. Introduction

In Nigeria, cassava production has attracted substantial attention following the pivotal role agriculture played in the economy before the 1970s. It is critical in income generation, employment creation, the provision of domestic food supply and boosting of foreign exchange earnings (Oriavwote & Omojimite, 2012). The crop was initially introduced to Nigeria by early Portuguese explorers from Brazil during the pre-colonial era (Okigbo, 1980). Today, Nigeria is the world's leading cassava producer, producing 34 million metric tonnes out of the 228 million metric tonnes produced globally (CBN, 2015). The country's cassava output was tipped one-third higher than Brazil and was almost twofold of Thailand and Indonesia in 2010 (Grow Africa, 2015). In spite of this, the country has not fared well in the global cassava market as 90% of the country's production is domestically consumed as a major staple food by over seventy per cent of the population at least once a day. The remaining 10% is used as animal feed, raw material for agro-allied industries and export (Ekere-Okoro & Njoku, 2012).

However, the sector has suffered serious neglect since the oil boom of the early 1970s, as the economy witnessed an unprecedented upsurge in revenue from the oil sector, which today accounts for 85% of the country's foreign exchange earnings (Odularu, 2008). With huge revenue, the country hastily embarked on interventionist agricultural programmes with much emphasis on the import of agricultural inputs, spare parts and machines which created structural imbalance in the economy as demand for the dollar became much higher than its supply, resulting in the deterioration of the naira. Thereafter, the rate of the naira depreciation assumed very wide dimensions in response to the failure of government to sustain the path of restrictive monetary growth, coupled with high level of fiscal deficits (Olusola, 2001). The precarious economic condition further worsened as the domestic capital base became highly compromised such that the level of domestic savings became grossly inadequate for procuring capital agricultural inputs, which were largely foreign-based. This further deteriorated the exchange rate.

The deterioration of the exchange rate has placed Nigeria at less competitive advantage in the global cassava market as her cassava export has become more expensive. This has placed other compositing economies in competitive advantage to close the supply gap left by Nigeria. Today, Thailand is a dominant cassava supplier in the world market, accounting for 80% of global supply while Vietnam and Indonesia account for 8%, and the rest of the countries in Latin America, Africa and Asia account for 12% (Grow Africa, 2015).

Exchange rate dynamics is the movement in the number of baskets of a currency that could be exchanged over a period of time for a given basket of another country's currency. Exchange rate dynamics place much emphasis on market forces in determining cassava prices and the allocation of other resources within an economy (Idowu, Osuntogun & Oluwasola*.,* 2007). The policy allows for either the depreciation or appreciation of currency which significantly results in changes in the structure and volume of a country's economic activities, including agricultural output (Oyejide, 1986 and Ihimodu, 1993).

Exchange rate depreciation affects relative domestic and foreign prices, causing expenditures to shift from foreign goods to domestic goods, and this tends to have an impact on domestic cassava price levels (Obstfeld, 2002). This increases the international competitiveness of domestic cassava production as expenditure is shifted from imported cassava products with high prices to domestically produced cassava products with relatively cheap prices (Aliyu & Ammani, 2012). However, according to Naseer (2013), exchange rate appreciation increases imports and reduces exports. It may lead to inflation which increases the price of food crops that feed into the general price levels (Afzal, 2012). Depreciation harms agricultural investment as most developing countries import farm inputs for their agro-based industries and this, in most cases, translates to an increase in production costs. Also, it increases nominal interest rate since price increases resulting from depreciation will raise demands for nominal money, leading to a rise in the cost of borrowing. A rise in the cost of borrowing tends to reduce agricultural investment which may lead to a decline in the supply of foods and consequently a rise in general price levels.

In Nigeria, several efforts have been made by successive governments since the adoption of SAP in 1986, to further liberalize the exchange rate system in a bid to stimulate the domestic production of agricultural produce and subsequently a fall in cassava import. These policies include the introduction of the Dutch Auction System in 1987, the Interbank Foreign Exchange Market in 1989 and the Autonomous Foreign Exchange Market in 1995. Also, in 1999, the Interbank Foreign Exchange Market was re-introduced, followed by the Retail Dutch Auction System in 2002 and the Wholesale Dutch Auction System of 2013. However, it is surprising that in spite of the lofty exchange rate policy reforms and the fact that Nigeria is the world dominant producer of cassava; the country has not fared well in the global cassava market. This may be attributed to the deterioration in exchange rate which appears to have translated to a rise in domestic cassava prices. For instance, in 1991, exchange rate depreciated rapidly from ₦9.9 per dollar to ₦21.9 in 1995 and skyrocketed to ₦102.1 in 2000, ₦132.1 in 2005, ₦150.2 in 2010 and ₦197 in 2015 (CBN, 2015). In the same vein, the depreciation of the naira appears to have resulted in the rise of cassava prices as price per tonne of cassava maintained a steady rise from ₦2,066 per tonne in 1991 to ₦4,450 in 1995, ₦14,317 in 2000, ₦21,920 in 2005 and ₦22,154 in 2015 (FAOSTAT, 2015). These trends seemingly suggest a possible connection between exchange rate and cassava prices in Nigeria. It is based on this that this study examines the effect of exchange rate on cassava prices in Nigeria. Also, it assesses the influence of the prices of other food crops such as rice and yam on cassava prices in Nigeria.

2. Literature Review

Exchange rate is the number of baskets of a country's currency traded for a given currency of another country. It is the price of one currency in terms of another. It is the required amount of units of currency that can buy another amount of units of currency. The exchange rate is a key macro-economic variable in the context of general economic policy making, and of economic and agricultural reform programmes in particular. Exchange rate policy has been identified as one of the endogenous factors that can affect the economic performance of a nation (Jameela, 2010). Exchange rate may be fixed by the government or may be determined by market forces, which lead to exchange rate variation. Exchange rate variations affect cassava prices. The appreciation of exchange rate reduces domestic cassava prices and raises its foreign prices while depreciation increases the domestic cassava prices and lowers foreign prices (Södersten & Reed, 1994).

The elasticity approach which is also referred to as the Marshall-Lerner condition examines the price effect of a country's exports and imports in response to her exchange rate. The theory believes that the trade balance of a country tends to improve, provided that the depreciation of her currency raises her domestic import prices and lowers foreign export prices. Therefore, currency depreciation will only be beneficial to the economy if it lowers exports prices in the foreign countries and at the same time raises domestic import prices. The success of currency depreciation depends on the degree of a country's price elasticity of demand for exports and imports. The theory indicates that price elasticity of demand for imports and exports must be elastic before currency depreciation will stimulate economic activities in a country. If it is elastic, a small depreciation of currency will bring about more than a proportionate rise in the price of imports and decline in the foreign prices of exports. Mathematically, the summation of the price elasticity of export and import demand of a country must be greater than unity for the depreciation of currency to exert positive influence on a country's trade surplus. However, if the price elasticity of imports and exports is less than unity, it is an indication that the depreciation of currency has little or no effect on import and export prices. In this case, exchange rate appreciation cannot improve export trade.

Exchange rate pass-through is the transmission effect of exchange rate on the prices of food crops in a home country. According to Bimeier and Bonato (2002), the variation of exchange rate may directly alter both the relative prices of domestic and foreign agricultural produce and indirectly result in changes in economic activities. A change in exchange rate first reflects on the domestic prices of imported farm inputs which is subsequently transferred in the form of higher prices to consumers of food crops (Chew, Ouliaris & Tan, 2011). Exchange rate variation has two transmission effect channels in an economy. First, it alters the general price levels in the home country through a rise in the prices of imports. In general, an appreciation of exchange rate lowers import prices and makes exports expensive while depreciation raises the import prices and lowers export prices. The rise in the price of imported farm inputs due to exchange rate depreciation raises the unit cost of production which invariably translates to a rise in the prices of agricultural produce in a home country. Secondly, depreciation of exchange rate leads to increase in aggregate demand as the export prices decline in foreign countries. The surge in aggregate demand for export of agricultural produce will directly put pressure on the prices of food crops (Ghosh & Rajan, 2006).

Empirically, it appears there is a paucity of empirical studies on the influence of exchange rate on cassava prices. Available studies either focus on the effect of exchange rate on farm machinery, farmers' income or on agricultural exports. For instance, Osei, Saleem and Albert (2009) investigated the influence of the United States dollar exchange rate with the Mexican peso on four non-farm-produced inputs viz. fertilizer, chemicals, farm machinery, and feed in the United States. The finding is akin with a fixed price/flex price conceptual framework, with industrial prices more likely to be unresponsive to the exchange rate than farm commodity prices.

In the same vein, using panel data analysis, Bbaale and Mutenyo (2011) asserted that agricultural export led to a rise in per capita income in sub-Saharan African countries, while Shombe (2008) affirmed that agricultural export enhanced Tanzania's economic growth. Corroborating earlier findings, Onogwu (2014) opined that intra-industry trade in cereal crops directly promotes the income per capita of ECOWAS member countries. Using the panel data approach to examine if the export-led growth hypothesis holds in major rice exporting countries such as Thailand, Vietnam and Pakistan, Kang (2015) discovered that the hypothesis is applicable to those countries under study. This assertion was earlier corroborated by Dawson (2005), who in his study of agricultural export and economic performances of developing countries, revealed that agricultural export was the precondition for the rise in economic growth of the countries in review.

Similarly, some empirical studies on Nigeria have indicated that the agricultural export-led hypothesis holds for Nigeria (Bbaale & Mutenyo, 2011; Gbaiye, Ogundipe & Osabuohien, 2013; Ojo, Awe & Ogunjobi, 2014; Onogwu, 2014; Ojide, Ojide & Ogbodo, 2014 and Ijirshar, 2015). Similarly, Abiodun & Sheu (2010) who employed the vector error correction model in determining the response of agricultural output to price dynamics and exchange rate movement, found that agricultural output responded directly to exchange rate movement while exchange rate was inversely related to the price of food crops. However, Faridi (2012) disagreed with the assertion that agricultural export enhances the economic growth of developing countries. He asserted that agricultural export does not have any robust connection in fostering economic growth.

Aliyu and Ammani (2012) investigated the effect of the deregulation of the exchange rate on domestic rice farming and imports between 1986 and 2010 using two simple linear models. The study found that improved rice production cannot be associated with exchange rate deregulation alone since it failed to discourage the country's rice import within the period. Failure to discourage rice import contradicts the theoretical expectation which suggests that the deregulation of exchange rate discourages import and encourages export. The study concluded that market economy does not necessarily stimulate domestic agricultural production, most especially in countries where farmers with lowtechnology face stiff competition with advanced-technology in developed countries.

Oyinbo, Abraham and Rekwot (2014) analysed the nexus between the deregulation of the exchange rate and economic performance of Nigeria from 1986-2011 using pairwise Granger causality and the vector error correction approaches. They revealed that exchange rate Granger-caused economic growth while its deregulation inversely led to a decline in national output. The study concluded that the market-determined exchange rate system was responsible for the poor performance of agricultural share of national output of Nigeria.

Verter and Bečvářová (2016), in their own study examined the influence of agricultural export on Nigeria's economic performance using multiple approaches. Both the OLS and Granger approaches inferred that the agricultural exports-led growth hypothesis holds for Nigeria while variance decomposition revealed that shocks from agricultural exports were responsible for the long-run fluctuation in economic growth in Nigeria. In the analysis of the effect of exchange rate under SAP on cotton production in Nigeria from 1973 to 2007, Aliyu and Ammani (2012) relied on t-test from the OLS-based multiple regression technique and revealed that cotton production does not in any way respond to the deregulation of exchange rate in Nigeria.

Akpan, Vincent, Emmanuel and Etim (2012) studied the influence of macro-economic variables on agricultural share of GDP in Nigeria using co-integration approaches. The results indicate that foreign debt, foreign reserve, domestic price level and total export inversely relate with agricultural share of national output while exchange rate and industrial capacity utilization positively influence agricultural output in Nigeria. Similarly, Oriavwote and Omojimite (2012) asserted that exchange rate has an inverse significant effect on agricultural production.

Also, Oriavwote and Omojimite (2012) investigated the pass-through effect of exchange rate on Nigeria's inflation rate and affirmed that exchange rate volatility significantly transmitted inflation more than inflation itself. They concluded that priority should be given to exchange rate volatility in any effort to stabilize domestic inflation. However, in a similar study of the relationship between exchange rate depreciation and inflation in Nigeria, Enoma (2011) noted that though exchange rate influences inflation rate, it may not directly translate to inflation. It played a critical role in the price dynamics of both imports and exports in Nigeria, which indirectly influence the value of the naira.

Also, Okhiria and Saliu (2008), in their study of the influence of exchange rate on price effect in Nigeria, asserted that exchange rate appreciation resulted in the Dutch disease orchestrated by huge oil revenues. The appreciation of the naira reduces the competitiveness of the non-oil sector. This is because, the appreciation of the naira will make imports cheaper and exports expensive. In their study of exchange rate deregulation and the supply response of Nigeria's cocoa farmers, Olubanjo, Akinleye and Ayanda (2009) observed that exchange rate depreciation was inversely related to cocoa output while exchange rate appreciation discouraged cocoa production. However, Amassoma, Nwosa and Ofere (2011) noted that exchange rate appreciation denotes a decline in the cost of imported agricultural inputs which will invariably translate to improved agricultural production.

Despite the enormity of exchange rate studies, there is still a paucity of studies on the relationship between exchange rate and cassava prices. Most of the studies centered on the effect of exchange rate on the export of agricultural output (Bbaale & Mutenyo; 2011, Gbaiye, Ogundipe & Osabuohien, 2013; Ijirshar, 2015; Ojo, Awe & Ogunjobi, 2014; Onogwu, 2014; Ojide, Ojide & Ogbodo, 2014, and Faridi, 2012). Also, some other studies focused on the relationship between exchange rate and inflation (Okhiria & Saliu, 2008; Enoma, 2011; Oriavwote & Omojimite, 2012). While some of the studies related agricultural exports to economic growth (Onogwu, 2014 and Kang, 2015). This study seeks to close this literature gap by examining the influence of exchange rate on cassava prices. Also, this study employs the Johansen co-integration approach to accommodate the interdependence among the variables.

3. Methodology

3.1 Model specification

The model specification of the study is anchored on Parsley and Popper's (1998) model developed in their study of monetary policy influence on pass-through effect of exchange rate. They specified the model as:

$$p_{it} = E\{f[\, e_{t}, M(g_{\mathrm{t}}), \mathrm{Z}_{\mathrm{it}}]\, \mathrm{I}_{\mathrm{t}}\, \} \tag{1}$$

where:

P_{it} is the price of the *i-th* good in question,

e_t is the nominal exchange rate;

$M(g_t)$ is the monetary policy implemented using some instruments,

g_i; *Zit* summarizes all other factors that affect the individual price;

I_t represents the information available when the price is determined.

However, the model for this study is modified to incorporate variables such as prices of other food crops such as rice and yam, inflation and seasonal effect (dummy). These variables exert some influence on the price of agricultural produce. Therefore, the model for the study is specified in its functional form as:

$$pcs = f(exr, prs, pym, ifr, DUM) \tag{2}$$

Equation 2 shows that the price of cassava (*pcs*) is dependent on exchange rate (*exr*), prices of rice (*prs*) and yam (*pym*), inflation (*ifr*) and *DUM*, which is the dummy variable representing seasonal effect such as harvest period and non-harvest period. The equation is expressed in econometric form as:

$$pcs_t = \alpha_0 + \alpha_1 exr_t + \alpha_2 prs_t + \alpha_3 pym_t + \alpha_4 ifr_t + \alpha_5 DUM_t + \varepsilon_t \tag{3}$$

a priori sign: α_1, α_2 and α_3, $\alpha_4 < 0$

where:

pcs is price of cassava,

exr is exchange rate,

prs is the price of rice,

pym is the price of yam,

ifr is inflation rate,

DUM is dummy,

ε_t, is error term,

α_0 is constant or intercept while α_1, α_2 and α_3 represent the coefficients.

The exchange rate (*exr*) is the real exchange rate of the naira to the United States of America's dollar. The positive sign of exchange rate estimate indicates that the exchange rate of the naira to the dollar leads to an increase in cassava price, while an estimated negative sign shows that it decreases cassava price. *pcs* is the price of cassava which is the dependent variable. Inflation (*ifr*) is expected to lead to a rise in cassava price while a decline in inflation reduces its price. *DUM* is the dummy variable which stands for seasonal effect (harvest and off-peak periods). Harvest period is represented by one (1) and zero (0) for off-peak period. Cassava prices are expected to fall during harvest period and rise during off-peak period.

The monthly data for the analysis were obtained from FAOSTAT and Central Bank of Nigeria. Specifically, data on cassava, rice and yam prices were sourced from FAOSTAT (2015) and FAO (2015) while data on exchange rate and inflation rate were obtained from the *Central Bank of Nigeria Statistical Bulletin, 2015*.

3.2 Estimation procedures

Econometric modelling was applied to express the effect of exchange rate on cassava prices in Nigeria. The purpose of such information is however defeated if appropriate steps are not taken to examine the stationary status and magnitude of the time series. Since most econometric variables are always non-stationary, the application of the ordinary least squares technique on equation (3) may lead to a violation of some of the assumptions of classical regression. Therefore, to avoid this problem, the time series data were subjected to the unit root test. If the test found the series to be non-stationary, the study would proceed to the test for co-integration, and if co-integrated it would be followed by the application of the vector error correction model (VECM).

3.2.1 *Unit Root Test*

Each time series variable is subjected to the unit root test to establish its stationary status in order to avoid the issues of spurious regression. Specifically, the Augmented Dickey-Fuller (ADF) test is deployed for the analysis since it considers the possibility of the auto-correlation of the first differences of the series in a parametric way by guessing the value of additional nuisance parameters. A test statistic is said to be stationary if it is negative and much less than the critical value at 5% significance level but non-stationary if otherwise. The tests are conducted with and without a deterministic trend (t) for each of the series. The Augmented Dickey-Fuller (ADF) is specified in its general form as:

$$\Delta Y_t = \alpha_0 + Y_{t-1} + \sum_{i=1}^{n} \alpha_1 \Delta Y_{t-1} + \delta_t + \varepsilon_t \tag{4}$$

where:

Y is a time series,

t is a linear time trend

Y_{t-1} is the lag of each series

Δ is the first difference operator

ε_t is a pure white noise error term with zero value of mean and constant variance

α_0 is a constant

n is the optimum number of lags in the dependent variable.

If the variables are non-stationary it is necessary to perform a co-integration test.

3.2.2 *Co-integration Test*

If the results of the Augmented Dickey-Fuller test found all the variables to be non-stationary and integrated of the same order, then a linear combination of them are tested to know whether they are stationary. In the first place, residuals from OLS estimates of the supposed long-run relationship can be used to detect the presence of co-integration. Meanwhile, if the residuals are stationary or integrated of order zero [I(0)], the model can be considered to be co-integrated and a valid long-run relationship exists between the variables. In the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) co-integration tests, the appropriate null hypothesis is that the residuals possess a unit root against the alternative hypothesis that the residuals are stationary. Where a co-integrating relationship cannot be found, no long-run relationship among the variables can be demonstrated.

This study adopted the Johansen co-integration test to analyse the long-run effect of naira-dollar exchange rate on the prices of agricultural food crops in Nigeria. Unlike the OLS techniques, the Johansen co-integration test considers the interdependence among the variables and, mostly, is used when the variables are non-stationary. The Johansen co-integration model is specified in its general form as:

$$\lambda_{trace} = \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \tag{5}$$

$$\lambda_{max} = -T \ In\ (1-\lambda_{r+1}) \tag{6}$$

where: λ_{trace} and λ_{max} are trace statistic and eigen-max statistic respectively, λ_i represents eigen-values while T stands for sample size.

The r = 0 of no co-integration is accepted if the trace or maximum eigen value statistic is less than the critical value at 5 per cent level of significance. The lag length is determined using Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC).

3.2.3 *Error Correction Model*

The vector error correction (VECM) technique is used to analyse the short-run relationship between exchange rates on cassava prices in Nigeria. The method is mostly used when the variables are co-integrated. The error correction mechanism provides a means to reconcile the short-run (dynamic) and long-run (static) relationship between the variables. Moreover, this approach provides a method of simultaneously assessing the short-run and long-run effects of one variable on the other. At the same time, the VECM has an appealing long-run coefficient and the ECM along with the short-run parameters becomes necessary. The sign of the error correction (ECT) coefficient must be negative and significant to ensure the convergence of the dynamics to the long-term equilibrium. To analyse the short-run influence of exchange rate dynamics on cassava prices in Nigeria, the VECM model is specified as:

$$\Delta logpcs_t + \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta logpcs_{t-i} + \sum_{i=1}^{m} \delta_i \Delta logexr_{t-i} + \sum_{i=1}^{m} \gamma_i \Delta logprs_{t-i} +$$

$$\sum_{i=1}^{m} \Phi_i \Delta logpym_{t-i} + \sum_{i=1}^{m} \vartheta_i \Delta ifr_{t-i} + \sum_{i=1}^{m} \vartheta_i \Delta DUM_{t-i} + \theta_1 ECT_{t-1} + \varepsilon_t \tag{7}$$

Equation 7 examines the short-run effect of exchange rate, prices of rice and yam, inflation, and a dummy on cassava prices in Nigeria. Where Δ represents first order difference, *m* is the lag length, *ECT* represents the error correction term which measures the speed of adjustment to long-run equilibrium and μ_t is the series of independent and identically distributed random variables with mean zero and variance. The error correction model result indicates the speed of adjustment back to long-run equilibrium after a short-run shock. The test is very sensitive to the lag length employed in the VECM. Including too few lags will not remove all of the auto-correlation, thus biasing the results; and including too many lags will increase the coefficient standard errors since the additional parameters will simply use up available degrees of freedom (Brooks, 2008). So, it is useful to try and select the optimal lag length. Most econometric software have the facility for a multivariate information criterion which allows for comparison across information criteria for use in this regard. In order to determine the appropriate lag lengths, we employed the multivariate generalization of Akaike's information criterion (AIC) and Schwarz information criterion (SIC).

Equation 7 is subjected to causality test using the vector error correction model and Granger causality test. The choice of this test is based on the fact that the variables are co-integrated and integrated of the same order. The model is subjected to the following diagnostic tests: normality test, auto-correlation, heteroskedasticity, and specification. The null hypotheses of these tests are accepted if the probability value is greater than 0.05. The acceptance of the null hypotheses is an indication that the variables have normal distribution, no autocorrelation and that the residuals are homoskedastic. Also, the CUSUM tests were performed to determine the structural stability within the model. The CUSUM test shows the graphical cumulative sum of errors together with critical lines of 5 per cent. The CUSUM test measures the variation in the parameters and is considered unstable if the recursive errors crossed the 5 per cent critical lines while the lines of CUSUMQ investigate the consistency of the parameters.

4. Results

The presentation of results begins with the result of the Augmented Dickey-Fuller test, followed by those of the Johansen co-integration test, the vector error correction techniques and the Granger causality test.

4.1 Unit root test results

The results of the Augmented Dickey-Fuller (ADF) tests performed on each variable are presented in table 1. All the variables have unit root at level form but are stationary after first difference. Therefore, the variables are found to be integrated of order one, that is [I(1)], thus the need to proceed to the co-integration test.

Table 1. Results of Augmented Dickey-Fuller Unit Root Test

Variables	Level Form			First Difference			Order of Integration
	t-statistics	5% critical	p-value	t-statistics	5% critical	p-value	
log(pcs)	-2.756798	-3.622033	0.2254	-7.767164*	-3.622033	0.0000	I(1)
log(exr)	-1.944921	-3.612199	0.6004	-4.781336*	-3.622033	0.0046	I(1)
log(prs)	-3.248881	-3.612199	0.0990	-7.152004*	-3.622033	0.0000	I(1)
log(pym)	-3.126757	-3.612199	0.1229	-5.715402*	-3.622033	0.0006	I(1)
ifr	-2.846238	-3.622033	0.1964	-3.730224*	-3.252896	0.0415	I(1)
DUM	-1.952576	-3.612199	0.5964	-4.682677*	-3.622033	0.0057	I(1)

Note: * denotes significance at 5% level .

Source: Researchers' calculations, 2017.

4.2 Co-integration results

The study proceeded to determine the presence of co-integration between exchange rate dynamics and cassava prices in Nigeria having established that the variables were non-stationary at level. The results of the Johansen trace and maximum eigen-statistic co-integration at 5% level of significance are presented in table 2.

From table 2, the trace statistics with the asterisks, which were much higher than their respective critical values at 5% significance level, are an indication of co-integration. This outcome is further affirmed by their respective probability values that were less than 0.05, suggesting that exchange rate has a long-run influence on cassava prices. Similarly, the maximum eigen-value test corroborated the submission of the trace tests, which were equally conducted at 5% significance level. The max-eigen statistics, which are in tandem with their probability values affirm the evidence of co-integration among the variables. The results of the trace statistics and max-eigen statistics indicate five co-integrating equations each.

Table 2. Results of Johansen Co-integration Tests

	Trace Test			Maximum Eigen-Value Test		
Hypothesized no of CE(s)	Trace statistic	0.05 critical value	Prob**	Max-eigen statistic	0.05 critical value	Prob**
None	116.3423*	69.81889	0.0000	45.05455*	33.87687	0.0016
At most 1	71.28778*	47.85613	0.0001	29.86994*	27.58434	0.0250
At most 2	41.41785*	29.79707	0.0015	16.71839	21.13162	0.1857
At most 3	24.69945*	15.49471	0.0016	14.29406*	14.26460	0.0495
At most 4	10.40539*	3.841466	0.0013	10.40539*	3.841466	0.0013

Note: * indicates significant**.** Trace test indicates 5 co-integrating equations while maximum eigen-value test indicated 4 co-integrating equations at the 0.05 level,.

Source: Researchers' calculations, 2017.

The long-run impact of exchange rate, prices of rice and yam, inflation and seasonal effect (dummy) on cassava prices is extracted from the normalized co-integration result and presented in a linear form as follows:

$$\log(pcs\,(-1)) = 1.8565 - 0.3146\log(exr(-1)) - 1.1586\log(prs(-1) + 0.2245\log(pym(-1))$$

Std Error	0.03164	0.13954	0.07110
t-stat.	−9.94683*	−8.30342*	3.15817*

$$+\ 0.0002ifr(\text{-}1)\ \text{-}\ 0.6273DUM(\text{-}1)$$

0.00183	0.06626

Note: * denotes significance at 5% level.

The results reveal that exchange rate is significant and has a negative relationship with cassava prices in the long run. The exchange rate elasticity of -0.3146 signifies that it passes-through the cassava prices in the long run. Therefore, in the long run, a 10 per cent depreciation of the naira will result in a 3.1% decline in domestic cassava prices in Nigeria. This finding is in line with the pass-through effect of exchange rate. The fact that exchange rate elasticity is negative in the long run is an indication that a depreciation of exchange rate raises the import prices of cassava products which will invariably stimulate domestic cassava investments. This will raise domestic production and the supply of cassava. The increase in aggregate supply of cassava will translate to a decline in cassava prices in the long run. The results equally reveal that the prices of rice exhibited inverse relationship with cassava prices while yam prices showed a positive effect with cassava prices. Also, inflation was found to have a positive relationship and an insignificant impact on cassava prices but the dummy (seasonal effect) suggests that it has significant impact on cassava prices.

The fact that exchange rate variation leads to decline in domestic cassava prices is akin to the earlier studies of Abiodun and Sheu (2010) who in their examination of the responses of agricultural output to price dynamics and exchange rate movement established that exchange rate is inversely related to food crop prices. However, this finding is in contrast with Aliyu and Ammani (2012) who, in their investigation of the effect of the deregulation of exchange rate on domestic rice farming and import, noted that improved rice production cannot be associated with exchange rate deregulation as it failed to discourage rice import.

4.3 Vector error correction model results

The short-run influence of exchange rate on cassava prices is examined using the vector error correction model, after establishing that the variables are co-integrated. The results of the vector error correction model (VECM) are presented in table 3.

Table 3. Results of Vector Error Correction Model

	Coefficient	Std. Error	t-Statistic	Prob.
Ect(-1)	-0.825330	0.276034	-2.989953	0.0092
D(LOG(PCS(-1)))	-0.933619	0.275244	-3.391968	0.0040
D(LOG(EXR(-1)))	-0.242177	0.156464	-1.547816	0.1425
D(LOG(PRS(-1)))	-0.458104	0.208185	-2.200472	0.0439
D(LOG(PYM(-1)))	0.590076	0.280677	2.102329	0.0528
D(IFR(-1))	-0.014091	0.004170	-3.379388	0.0041
D(DUM(-1))	-0.229442	0.244374	-0.938899	0.3627
C	0.174811	0.048481	3.605731	0.0026
R-squared	0.782974	Durbin-Watson stat	2.233279	
Adjusted R-squared	0.635029	Prob(F-statistic)	0.006233	
F-statistic	4.616391			

Note: * denotes significance at 5 per cent level

Source: Researchers' calculations, 2017

From table 3, the error correction term (ect(−1)) has a high speed of adjustment with the coefficient of −0.825330 and probability of 0.0092, indicating that it needs to adjust by 82.53% per month for short-run disequilibrium to be corrected in the long run. Its negative sign conforms with the theoretical expectation. The previous years' cassava prices (pcs(−1)), with the elasticity of 0.194408 and the probability of 0.0040, reveal that previous year cassava prices significantly influence current cassava prices. Its negative sign is an indication that previous years' cassava prices (pcs(−1)) lead to a decline in current cassava prices by 0.93% per month.

Exchange rate (exr(-1)) is statistically insignificant suggesting that exchange rate does not have a short run pass-through effect on cassava prices in Nigeria. However, its negativity is in line with the theoretical belief. The findings reveal that the prices of other food crops such as rice and yam have significant effect on cassava prices in the short run. This finding is in contrast with an earlier study by Oriavwote and Omojimite (2012), who in their investigation of the pass-through effect of exchange rate on Nigeria's inflation, found that exchange rate volatility has a pass-through effect on prices.

The elasticity of the price of rice exhibited a negative relationship with cassava prices while the price of yam showed direct influence over cassava prices. Also, inflation is statistically significant and its negative coefficient is in line with theoretical expectations. This connotes that falling inflation reduces cassava prices in Nigeria. Finally, the dummy variable is negative and statistically insignificant. The R-squared of 0.782974 is a good fit which indicates that the 78.29% variation in cassava prices is explained by explanatory variables. It is supported by the adjusted R-squared of 0.757215 while the probability value of the F-statistic is significant. Also, the Durbin-Watson d-statistic of 2.278393 reveals the absence of auto-correlation.

4.4 Granger causality results

The study employed the vector error correction-based Granger causality test to determine the presence of a causal relationship between exchange rate and cassava prices. The choice of this technique over the vector auto-regressive (VAR) pairwise method is based on the fact that the variables are co-integrated and also the models are multivariate in nature. The null hypothesis of no causal link between exchange rate and cassava prices tested at 5% level of significance.

The null hypothesis is rejected if the computed p-value is less than 0.05. The results are presented in table 4.

Table 4. Results of Granger Causality Test

	D(log(pcs))	D(log((exr))	D(LOG(PRS))	D(LOG(PYM))	D(ifr)	D(DUM)
D(log(pcs))	-	0.259222	12.12914*	10.70519*	0.057206	0.321649
		(0.6107)	(0.0005)	(0.0011)	(0.8110)	(0.5706)
D(log(exr))	2.395733	-	0.429471	5.424707*	3.072371	0.615340
	(0.1217)		(0.5122)	(0.0199)	(0.0796)	(0.4328)
D(LOG(PRS))	4.842076*	1.522206	-	5.038345*	2.342947	0.054467
	(0.0278)	(0.2173)		(0.0248)	(0.1259)	(0.8155)
D(LOG(PYM))	4.419788*	0.389834	2.407156	-	1.452970	0.497333
	(0.0355)	(0.5324)	(0.1208)		(0.2281)	(0.4807)
D(ifr)	11.42026*	0.296127	10.83999*	18.20657*	-	0.326250
	(0.0007)	(0.5863)	(0.0010)	(0.0000)		(0.5679)
D(DUM)	0.881532	0.000349	1.943489	9.728666*	0.5329	-
	(0.3478)	(0.9851)	(0.1633)	(0.0018)	(0.5329	

Note: * denotes significance at 5% level. Figures outside and inside bracket represent Chi-sq and p-value respectively.

Source: Researchers' calculations, 2017.

Table 4 shows that the prices of other food crops such as rice and yam, and inflation Granger-cause cassava prices in Nigeria while exchange rate (EXR) seasonal effect (DUM) do not significant Granger-cause cassava prices. This indicates that rises in cassava prices in Nigeria are not attributable to exchange rate and seasonal effects but to inflation and the prices of other food crops such as rice and yam. The causality results further reveal that variations in yam prices are caused by the price of cassava and the level of inflation while the price of yam is determined by the exchange rate, the prices of cassava and rice, inflation and seasonal effects (DUM).

4.5 Post-estimation tests results

Diagnostic tests such as normality test, autocorrelation, heteroskedasticity, specification and CUSUM tests were conducted to determine if the variables are normally distributed, that there is no presence of auto-correlation, that errors are homoskedastic and there is structural stability among the residuals. The results are presented in table 5.

Table 5. Diagnostic Tests Results

Post Test	F-Statistic	df	p-value
Jarque-Bera Normality Test	1.282551	23	0.526620
Breusch-Godfrey Serial Correlation LM Test	0.456291	2, 13	0.6434
Heteroskedasticity Test (ARCH)	0.495673	1, 20	0.4895

Note: * denotes significant at 0.05 levels.

Source: Researchers' calculations, 2017.

Table 5 shows the post estimation test results on the relationship between exchange rate and cassava prices in Nigeria. The Jarque-Bera result reveals that the variables are normally distributed while the Breusch-Godfrey and heteroskedasticity tests indicate the absence of autocorrelation among the residuals and that the residuals are homoskedastic since their probability values are less than 0.05.

The CUSUM and CUSUMQ in figure 1 lie within critical bounds at 5% level, this indicates that that there is long-run stability of parameter estimates. This reveals a consistency of parameter estimates. The results show that there is long run-stability between exchange rate and cassava prices and other variables.

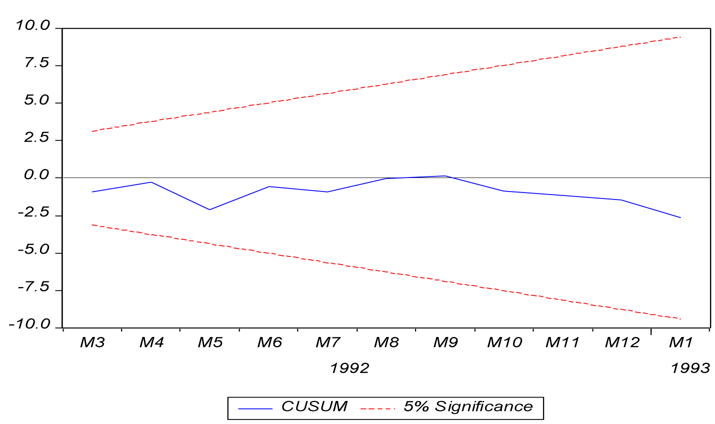

Figure 1a.

Figure 1b.

Figure 1a & b. CUSUM Test Results.
Source: Researchers' calculations, 2017.

5. Conclusion

This study investigated the effect of exchange rate on cassava prices. The results show that exchange rate does not influence cassava prices in the short run but leads to its decline in the long run. This indicates that exchange rate has the tendency to bring about a decrease in cassava prices in the long run. This implies that in the long run, depreciation of the naira will lead to an increase in the global competitiveness of Nigerian cassava prices which will motivate farmers to increase their productivity, and thus being about a decline in prices. Also, the study found that the prices of foods such as rice and yam are influential in determining cassava prices both in the short run and in the long run. The following recommendations are made to aid policy makers in policy formulation:

- Having revealed that exchange rate impact on cassava prices in the long run, it is recommended that government adopt a more liberal exchange rate policy that guarantees exchange rate stability to boost confidence in the domestic currency. This will help to increase food crop farmers' confidence in the economy.
- To encourage stability in domestic cassava prices and its competitions in global trade, monetary authorities are advised to come up with special exchange rate incentives with specific target on the import of cassava farm

inputs and implements. This exchange rate if given below the current official benchmark will not only encourage the import of farm inputs but also reduce agricultural cost of production.

- Monetary authorities are advised to restrict foreign exchange access on the import of cassava-related food products, in order to shift consumption from foreign foods to related domestic ones as import prices become expensive. This will encourage domestic cassava production which will consequently result in fall in prices.
- Declining inflation has been discovered to have contributed to the fall in cassava prices in Nigeria; therefore, monetary authorities should adopt policy measures that will ensure single digit inflation in the country. The continuous fall in inflation will enhance the purchasing power of food crops farmers which will lead to increase in output and fall in cassava prices in Nigeria.

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