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ECONOMETRIC ANALYSIS OF AGRICULTURAL RAW MATERIAL EXPORTS, EXCHANGE RATE AND EXTERNAL RESERVES IN NIGERIA

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Abstract

This study examined the interrelationships among agricultural raw material exports, exchange rates and external reserves in Nigeria spanning 50 years from 1967 to 2017 using data from World Bank, International Monetary Fund and World Trade Organization. Due to the validation of a long-run relationship among the variables by the Johansen cointegration test which showed 2 cointegrating relations significant at 1%, the vector error correction model was adopted. The results showed that agricultural raw materials export has positive effect on external reserves while external reserves have adverse effect on agricultural raw materials export. Exchange rate simultaneously affects agricultural raw material export and external reserves negatively. The Wald test revealed a bi-directional causality between agricultural raw materials export and external reserve as well as a unidirectional causality running from agricultural raw materials export to exchange rate and exchange rate to external reserve. The findings, therefore, provide suggestion that exports should be encouraged.
Keywords: *Agriculture, exchange rate, export promotion, international reserves, time series analysis.*
JEL Codes: *C32, F14, F31, Q17*

1. Introduction

Given that countries of the world are characterized by varying resources endowment as well as varying cost of production of various goods and services, the need for these countries to exchange their produce arises. The chief rationale for such exchange is to explore the comparative advantages of production through division of labour and specialization. Each country specializes in the production of goods in which they are most efficient relative to other countries. The rate at which these goods and services are exchanged is called exchange rate.

Exchange rate is the ratio of a unit of a currency and the amount of another currency for which that unit can be exchanged at a particular time (Ngerebo & Ibe, 2013). The issues of exchange rate and its management are of serious concern to economic agents, especially in developing countries. Amongst others, this concern stems from the fact that exchange rate policies determine the ability of countries to take full advantage of international trade (Essien, Uyaebo & Omotosho, 2017). One of the major ways by which such advantage can be explored is through the earnings of foreign exchange. While parts of these foreign exchange earnings are reinvested in the domestic economy, some are left in the treasury as external reserves.

Generally, countries maintain external reserves in order to manage exchange rate by minimizing the effects of excess fluctuations (Elhiraika & Ndikumana, 2007). Reserves are also used to manage the exchange rate through intervention in the foreign exchange market (Tella, 2007). International trade settlements can be financed by reserves especially when there is deficit between exports and imports. However, foreign exchange can only be earned when exports are initiated.

The demand for Nigeria's exportable products in the international market in particular is an injection into the economy as financial resources are received into the domestic economy; hence it is responsible for increasing the level of external reserve of the country. In the 1960s and 1970s, large proportions of Nigeria's exports were dominated by the agricultural sector and it was a major source of foreign revenue. Nigeria was recognized as the major exporter of groundnut, cocoa, rubber and other agricultural products. The revenues from exports are strongly affected by the incessant nature of the changes in the exchange rate (Owuru & Adesoji, 2016). As a result of the immense role export plays in stimulating growth, most developing countries like Nigeria have opened their economies by adopting export-led development, which is underpinned by a low cost of production and an undervalued exchange rate. Fluctuations in exchange rate, literally perceived as exchange rate volatility, may make or mar the potentials of the export sector of the country which in turn determines her ability to accumulate external reserves necessary for foreign direct investments. Nigerian government, over the years, implemented various exchange rate policies spanning two major regimes, namely, the fixed and flexible exchange rate regimes (Adewuyi, 2005; Sanni, 2006). The fixed exchange policy was in practice from 1960 to 1985 while the flexible or market-driven exchange policy has been in use from 1986 till date but with series of modifications (Obi, Oniore & Nnadi, 2016). The extent to which these policies are effective in boosting or undermining foreign reserves and promoting export remains indiscernible. One noticeable repercussion of such "trials and errors" in exchange rate policy implementation is the alarming fluctuations in exchange rate. While some (Imoughele & Ismaila, 2015; Omojimite & Akpokodje, 2010) argued that the exchange rate uncertainties has a negative and significant impact on agricultural exports, others (Ajinaja, Popoola & Ogunlade, 2017; Dickson & Ukavwe, 2013; Gatawa & Mahmud, 2017) concluded otherwise. Additionally, the revenue Nigeria generates from her agricultural raw material exports is really not commensurate with the quantum of the exported produce. This stems from the fact that exchange rate of the Naira to the currencies of the rest of world is highly volatile. Through a feedback effect, the external reserve which comes about when foreign receipts exceed foreign disbursements according to Nzotta (2004) is also undermined. While some authors (Ekesiobi, Maduka & Onwuteaka, 2016; Olokoyo, Osabuohien & Adeleke, 2009) have carried out an empirical research on the implications of external reserves for agricultural exports on one hand, others (Gokhale & Ramana, 2013; Olayungbo & Akinbobbola, 2011; Umeora, 2013; Usman & Waheed, 2010) have also conducted empirical research on the impact of exchange rate policies on external reserve on the other hand, no scientific research work specifically takes cognizant of agricultural raw material exports. Moreso, no work has been done on the effect of external reserves on Agricultural raw materials export. This study filled the aforementioned gaps by testing the following hypotheses:

H_{01}: There is no long run relationship among agricultural raw material exports, exchange rates and external reserves.

H_{02}: Agricultural raw material export has no significant effect on external reserves.

H_{03}: External reserve has no significant effect on agricultural raw material exports.

H_{04}: Exchange rate has no significant effect on both agricultural raw material exports and external reserves.

2. Literature Review

2.1 Theoretical Framework

To capture the theoretical interdependencies among these aforementioned macro-economic variables, the mercantilist theory and elasticity theory are the underpinnings of the study. The elasticity theory states that if there is downward adjustment of exchange rates, a nation experiencing balance of payment disequilibrium has to raise exports and reduce imports thereby, accumulate more foreign reserves while the mercantilist theory focuses on hoarding international reserves in order to maintain a competitive real exchange rate with the ultimate goal of increasing export growth. By this motive, countries accumulate reserves as a tool for maintaining low exchange rates so as to promote international trade and competitiveness (Aizenman & Lee, 2007; Wijnhold & Kapteyn, 2001).

2.2 Conceptual Framework

It is the maxim of every prudent master of a family to buy from others what it would cost him more to make at home. In the same vein, it is an attempt by others to satisfy their own needs that the surpluses produced by them are offered for sale. Relatively, Smith (1776) in his book titled *Wealth of Nations* stressed the role of self-interest in an exchange economy. He posited that:

"it is not from the benevolence of the butcher, the brewer or the baker that we expect our dinner but from their regards to their own interest."

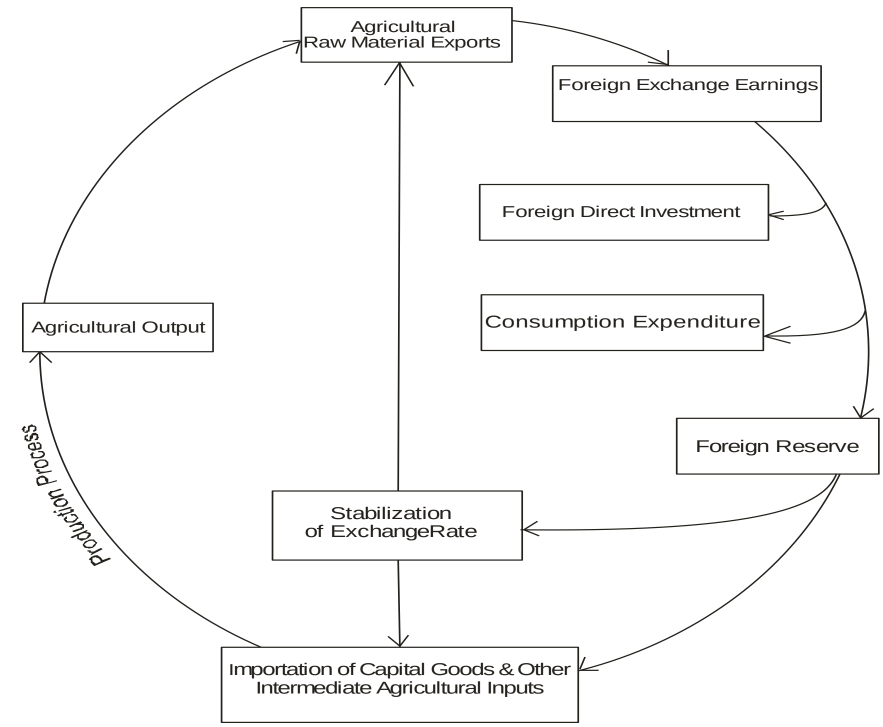
In other words, no one is self-sufficient and various individuals satisfy their own interests by indirectly or unconsciously satisfying the interests of others. These dictums, when applied to country-country relationships, form the basis for international trade - the exchange of capital, goods, and services across borders or territories.

International trade can be likened to a coin which comprises two sides, namely - export and import, which can never be separated from each other. This relationship is such that when a country exports, she has more purchasing power in form of foreign income. Keynes (1936) posited his *absolute income hypothesis* on the fundamental psychological law which forms the basis of his consumption function. He emphasized that:

"the fundamental psychological law upon which we are entitled to depend with great confidence both a priori from our knowledge of human nature and from the detailed acts of experience, is that men are disposed as a rule and on the average to increase their consumption as their income increases but not by as much as the increase in their income"

When countries earn income from exporting their surplus produce abroad, parts of these incomes are disbursed on consumables; some are invested while the leftover is saved as foreign reserves. The foreign reserves could, in turn, be reinvested in the domestic economy or could be used to import capital goods and other intermediate inputs such as synthetic fertilizers, pesticides and other agro-chemical inputs needed for domestic production. Foreign reserves could be used to buy the local currency in foreign exchange markets to maintain a stable exchange rate (International Monetary Fund, 2000). Such other purposes may include stimulating exports, financing external debt in order to be creditworthy. Countries decide to accumulate reserves as a response to terms of trade shocks or trade embargoes, or an attempt to pursuing export-led growth (Anyaogu, 2012). When goods are sold abroad, payment is made in the currency of the importing country; hence, the need for exchange of currency at a given rate (Stephen, 2017).

Exchange rate can either appreciate or depreciate. *Appreciation* in the exchange rate occurs if less unit of domestic currency exchanges for a unit of foreign currency while *depreciation* in exchange rate occurs if more unit of domestic currency exchanges for a unit of foreign currency. Exchange rate depreciation increases exportation which, in turn, increases the foreign exchange earnings and the reverse is the case when exchange rate appreciation occurs (Ekesiobi et al., 2016). Hence, exchange rate serves as one of the core determinants of the external reserves a country could have at a particular period of time (Akinwunmi & Adekoya, 2016). Parts of these foreign reserves are used to import some capital goods and other intermediate inputs that are needed for agricultural production. While parts of these produce are used and consumed locally, some are, in turn, exported abroad as shown in Fig. 1.



Source: Authors

Figure 1. Schematic Representation of the Interrelationships among Agricultural Raw Materials Export, Exchange Rate and External Reserves in Nigeria

2.3 Analytical Framework

Testing for the absence or presence of a unit root in a time series data has become a common starting point of applied work in macroeconomics (Serena & Pierre, 1995). The Augmented Dickey Fuller test of stationarity is usually adopted to test for the presence of unit root in the series under the null hypothesis (H_0: $\delta = 0$) meaning that the series is not stationary and the alternative hypothesis (H_1: $\delta < 0$) meaning that the series is stationary implying that such a time series has a constant mean, a constant variance and a constant autocovariance as shown in equations (1), (2) and (3)

$$E(y_t) = \mu \quad (1)$$
$$E[(y_t - \mu)^2] = \sigma^2 < \infty \quad (2)$$
$$E(y_{t1} - \mu)(y_{t2} - \mu) = \gamma_{t2-t1}, \text{for all } t_2 - t_1 \quad (3)$$

A time series, consequently, is non-stationary if any of the conditions is violated, i.e. its mean, variance and covariance are time-dependent (Ssekuma, 2011). If series become stationary by taking their first differences, such series are said to be integrated of order one i.e. *I*(1). Similarly, series that become stationary by differencing their first differences are integrated of order two i.e. *I*(2) (Gujarati & Porter, 2009). The order of integration of each of the variables as determined by the augmented Dickey Fuller (ADF) test serves as a guide to modeling and analyzing relationships among such variables. The vector autoregressive (VAR) in its unrestricted form is used if the set of variables are *I*(0), while a vector error correction (VEC) which is a restricted VAR is used if the set of variables are *I*(1) and an autoregressive distributed lag (ARDL) is used in a situation where the set of variables in question are a mix of different orders of integration, say, combination of *I*(0) and *I*(1) or *I*(1) and *I*(2) (Granger, 1986; Woolridge, 2012; Yusupov & Duan, 2010).

There are three possible ways of modeling a trivariate relationship but in each case there must be at most 2 cointegrating equations given that there must be at most *n*-1 cointegrated equations where *n* is the number of variables if truly there are significant long run relationships among the variables of interest (Johansen, 1995; Lutkepohl, 2005). To determine the number of cointegrating vectors, two different hypotheses tests can be conducted using the Johansen cointegration test.

In the first case, the null hypothesis that there exist at most *r* cointegrating vectors in the system, stating that eigenvalues beyond the restriction values of *r* are equal to zero is tested:

$H_0: \lambda_i = 0$, where $i = r + 1, \ldots, n$

The log of maximized likelihood function for the restricted model is then compared to that of the unrestricted model using a standard likelihood ratio test, the so-called *trace* statistic as shown in equation (4):

$$\lambda_{trace} = -2\log(Q) = -T\sum_{i=r+1}^{n}\log(1-\hat{\lambda}_i) \quad (4)$$

Where $r = 0, 1, 2, \ldots, n-2, n-1$ and $Q = \frac{\text{Restricted Maximized Likelihood}}{\text{Unrestricted Maximized Likelihod}}$.

In the second case, the null hypothesis that there are *r* cointegration vectors is tested. The alternative is that there are $r + 1$ cointegration vectors. The null is tested using the maximal eigenvalue statistic as shown in equation (5):

$$\lambda_{max} = -Tlog(1-\hat{\lambda}_{r+1}) \quad (5)$$

where $r = 0, 1, 2, \ldots, n-2, n-1$

The *trace* statistic is mostly adopted because it results in a consistent test procedure, whereas using maximal eigenvalue statistic does not (Harris & Sollis, 2003). Granger (1986) found that if a set of variables are cointegrated then there must be a causal relationship among them running at least in one direction and as such, a vector error correction *Granger*-causality test for zero restrictions on the coefficients of the model in question is employed. Thus, the Wald test for *granger* causality is used to test for the causal relations among the variables by imposing a zero-restriction on the coefficient matrices of the restricted vector autoregressive model under the null hypothesis that:

H_0: All lags of the independent (impulse) variable of interest do not *granger-cause* the dependent (response) variable of the error correction equation.

Using the Chi-square statistic:

$$(T - 3p - 1)(log|\sum re| - log|\sum un|) \sim \chi^2(2\rho);$$

where T is the number of observations; $\sum un$ is variance/covariance matrices of the unrestricted VAR system; $\sum re$ is variance/covariance matrices of the restricted system; and ρ is the number of lags (Nguyen, 2011). For each set of variables in each equation, if the probability value of the χ^2 is less than 0.05, the null hypothesis of *granger* non-causality will be rejected and such a variable is said to *granger-cause* the dependent variable of the VAR equation in question. Otherwise, the null hypothesis will be accepted implying non-causality.

The Vector Autoregressive (VAR) assumption is that, with inclusion of sufficient lags, the disturbances are independent and identically distributed (i.i.d) innovations that are statistically independent of the explanatory variables in an auto-regressive equation of interest. The lag length chosen by the majority of the criterion is mostly used since there is no consensus, in literature, on the best statistic to be used to determine the appropriate lag length. This is because while some of these criteria are objective-specific, some are sample size-variant (Lutkepohl, 2005). Including too many lagged terms will consume degrees of freedom, not to mention introducing the possibility of multicollinearity. Including too few lags will lead to specification errors.

One way of deciding the lag length is to use the criterion like the Akaike Information Criterion (AIC) or Schwarz Criterion (SC) (Gujarati & Porter, 2009). Thus, the lag length in the VAR model is usually truncated to order ρ so that the residuals are uncorrelated and alternatively, produce corrected (heteroskedasticity and autocorrelation consistent) standard errors. The procedure of transforming the variables in such a way that the transformed variables satisfy the assumptions of the classical model and then applying ordinary least square (OLS) to them is known as the method of generalized least squares (GLS).

Upon estimation of the model using GLS, an impulse-response functions (IRFs) analyses are conducted to capture the cross-effects among the variables in the system. Illustratively, an *n*-variable VAR(*ρ*) with the variables $y^1, y^2, \ldots, y^n$, can be written in *n* equations of the VAR as:

$$y_t^i = \beta_{i0} + \sum_{j=1}^{n}\left(\sum_{s=1}^{p} \beta_{ijs} y_{t-s}^j\right) + v_t^i \qquad (6)$$

where i =1, 2,…, n

The impulse-response functions are the *n* x *n* set of dynamic marginal effects of a one-time shock to variable *j* on itself or another variable *i*:

$$\frac{\partial y_{t+s}^i}{\partial \mu_t^j}$$

where s = 0, 1, 2, …

In principle, there is no limit on how far into the future these dynamic impulse responses can extend. If the VAR is stable, then the IRFs should converge to zero as the time from the shock *S* gets large:

$$\lim_{S\to\infty} \frac{\partial y_{t+s}^i}{\partial \mu_t^i} = 0$$

There are two common conventions for determining the size of the shock to the impulse variable. One is to use a shock of magnitude one. Since we can think of the impulse shock as the $\partial\mu$ in the denominator setting the shock to one means that the values reported are the dynamic marginal effects (Sims, 1980). Second is to use a shock of one standard deviation of the variable rather than one unit. Under this convention, the values plotted are

$$\frac{\partial y_{t+s}^i}{\partial \mu_t^j}\hat{\sigma}_j$$

where $s = 0, 1, 2, \ldots$

and are interpreted as the change in each response variable resulting from a one-standard-deviation increase in the impulse variable. If the variables have different scales, it is sometimes useful to consider innovations of one standard deviation rather than unit shocks (Lutkepohl, 2005). Hence, the use of a magnitude of 1-standard deviation shock to measure the impulse-response relationships among the variables.

2.4 Review of Related Empirical Literature

While Olayungbo and Akinbobola (2011); Usman and waheed (2010) and Osabuohien and Egwakhe (2008) found out that external reserves holdings is a major factor that stabilizes exchange rate, Umeora (2013) and Nteegah and Okpoi (2016) found out that exchange rate has a significant positive relationship with foreign reserve accumulation. On the contrary, Gatawa and Mahmud (2017) and Hasanov (2010) found out that exchange rate has negative impact on export volume. Stephen (2017) found out that exchange rate *granger-causes* export, Nteegah and Okpoi (2016) discovered that exchange rate and non-oil export *granger-cause* foreign reserves. Non-oil exports contribute positively to foreign reserves according to Osabuohien and Egwakhe (2008), Olokoyo et al. (2009), Gantt (2010), Nteegah and Okpoi (2016) and Ekesiobi et al. (2016).

3. Methodology

3.1 Method of Data Collection

Secondary data consisting of annual time series were used for the study. Data were collected from International Monetary Fund (IMF), World Bank and World Trade Organization (WTO) online databases.

3.2 Measurement of Variables

The variables used were agricultural raw materials export, official exchange rate and total external reserve. Agricultural raw materials comprise standard international trade Classification (SITC) section 2 (crude materials except fuels) excluding divisions 22 (Oil seeds and oleaginous fruits), 27 (crude fertilizers and minerals excluding coal, petroleum, and precious stones), and 28 (metalliferous ores and scrap). The vector of exported agricultural raw materials is denoted by *AREX*.

Official exchange rate, denoted by *EXR*, is the units of local currency (Nigeria Naira) relative to the U.S. Dollar. It was calculated as an annual average based on monthly averages.

Total External Reserves, measured in U.S. Dollars, is the sum of Nigeria's external reserves held by the IMF, special drawing rights plus holdings of foreign exchange under the control of the Central Bank of Nigeria. The vector of total foreign reserve is denoted by *TER*.

3.3 Model Specification

Vector autoregressive (VAR) is a stochastic process model used to capture the linear interdependencies among multiple time series. If there is true simultaneity among a set of variables, they should all be treated on an equal footing; there should not be any *a priori* distinction between endogenous and exogenous variables (Sims, 1980). Thus, the below $VAR(\rho)$ model algebraically represents the interdependencies among agricultural raw materials export (AREX), total external reserve (TER) and exchange rate (EXR):

$$TER_t = \beta_{11} + \sum_{i=1}^{\rho} \beta_{12i}\, TER_{t-i} + \sum_{j=1}^{\rho} \beta_{13j}\, AREX_{t-j} + \sum_{k=1}^{\rho} \beta_{14k}\, EXR_{t-k} + \mu_{1t} \quad (7)$$
$$AREX_t = \beta_{21} + \sum_{i=1}^{\rho} \beta_{22i}\, AREX_{t-i} + \sum_{j=1}^{\rho} \beta_{23j}\, TER_{t-j} + \sum_{k=1}^{\rho} \beta_{24k}\, EXR_{t-k} + \mu_{2t} \quad (8)$$
$$EXR_t = \beta_{31} + \sum_{j=1}^{\rho} \beta_{33j}\, TER_{t-j} + \sum_{k=1}^{\rho} \beta_{34k}\, AREX_{t-k} + \sum_{i=1}^{\rho} \beta_{32i}\, EXR_{t-i} + \mu_{3t} \quad (9)$$

In the prescence of cointegration, (7), (8) and (9) are generalized to (10), (11) and (12):

$$\Delta TER_t = \alpha_{11} + \sum_{i=1}^{\rho} \beta_{12i}\, \Delta TER_{t-i} + \sum_{j=1}^{\rho} \beta_{13j}\, \Delta AREX_{t-j} + \sum_{k=1}^{\rho} \beta_{14k}\, \Delta EXR_{t-k} + \lambda_{11}\mathcal{E}_{1t-1} + \lambda_{12}\mathcal{E}_{2t-1} + \mu_{1t} \quad (10)$$
$$\Delta AREX_t = \alpha_{21} + \sum_{i=1}^{\rho} \beta_{22i}\, \Delta AREX_{t-i} + \sum_{j=1}^{\rho} \beta_{23j}\, \Delta TER_{t-j} + \sum_{k=1}^{\rho} \beta_{24k}\, \Delta EXR_{t-k} + \lambda_{21}\mathcal{E}_{1t-1} + \lambda_{22}\mathcal{E}_{2t-1} + \mu_{2t} \quad (11)$$
$$\Delta EXR_t = \alpha_{31} + \sum_{j=1}^{\rho} \beta_{32j}\, \Delta TER_{t-j} + \sum_{k=1}^{\rho} \beta_{33k}\, \Delta AREX_{t-k} + \sum_{i=1}^{\rho} \beta_{34i}\, \Delta EXR_{t-i} + \lambda_{31}\mathcal{E}_{1t-1} + \lambda_{32}\mathcal{E}_{2t-1} + \mu_{3t} \quad (12)$$

where $\mathcal{E}_{1t-1}$ and $\mathcal{E}_{2t-1}$ are the lags of the following respective cointegrating equations when made the subject:

$$AREX_t = \alpha_{41} + \beta_{42}EXR_t + \mathcal{E}_{1t} \quad (13)$$
$$TER_t = \alpha_{51} + \beta_{52}EXR_t + \mathcal{E}_{2t} \quad (14)$$

The ρ represents the lag order, μ are the error terms, epsilons $\mathcal{E}$ are the various error correction terms (ECT), the lambdas λ are the various long run coefficients also known as speed of adjustments, alphas α are the intercepts and Betas β are the short-run coefficients also known as parameters of the adjustment processes.

4. Results

4.1 Unit Root and Cointegration

The test for stationarity of each variable was conducted using the Augmented Dickey Fuller (ADF) test. The test shows that all the variables are not stationary in levels but became stationary in first differences (see Table 1).

Table 1. Results of Augmented Dickey-Fuller Test

Variables	Tests	τ-statistic (p-values)	Critical Values		
			0.01	0.05	0.10
AREX	Level	-2.6047 (0.2801)	-4.1525	-3.5024	-3.1807
	First Difference	-6.1515*** (2.19e-05)	-2.6102	-1.9472	-1.6128
TER	Level	-1.7859 (0.6978)	-4.1373	-3.4953	-3.1766
	First Difference	-6.1856 *** (1.78e-05)	-2.6085	-1.9470	-1.6129
EXR	Level	0.1575 (0.9971)	-4.1305	-3.4921	-3.1748
	First Difference	-5.0214*** (0.0007)	-4.1338	-3.4937	-3.1757

Note: *** denotes significant at 1% level.

Hence, all the variables are $I(1)$. If variables are integrated of the same order, the likelihood of the existence of long run relationships among such variables is very high. The Johansen Cointegration test was conducted using a lag interval of 1 to 5. The lag length (ρ) was determined on the grounds of the lag order selection criteria, each criterion indicates lag length of 5 except the Schwarz Criterion (see Table 2). The cointegration test indicates two cointegrating equations with p-value of .8155 (see Table 3). This implies that there is a long run relationship among agricultural raw materials exports (AREX), exchange rate (EXR) and external reserves (TER) at 1 %. This is similar to the findings of Chowdhury et al. (2014) which revealed the presence of strong long run relationship among foreign exchange reserves, exchange rate, remittances, domestic interest rate, broad money, united payment interface (UPI) of export and import, and GDP per capita. Hence, the rejection of H_{01} which states that there is no long run relationship among agricultural raw materials exports, exchange rate and external reserves.

Table 2. Results of Lag Order Selection Test

ρ	Final Prediction Error	Akaike Information Criterion	Schwarz Information Criterion	Hannan-Quinn Information Criterion
0	7.66e+41	104.9554	105.0680	104.9985
1	4.29e+39	99.7708	100.2211	99.9435
2	8.94e+38	98.1971	98.9851	98.4992
3	7.43e+38	98.0027	99.1284	98.4343
4	3.99e+38	97.3638	98.8272*	97.9248
5	3.50e+38*	97.2021*	99.0032	97.8926*

Note: * indicates lag order selected by each criterion, ρ denotes the hypothesized lag length.

Table 3. Results of Johansen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	critical values	*p*-values
None ***	0.5060	59.6806	29.7971***	3.37e-06
At most 1 ***	0.3712	23.7144	15.4947***	0.0023
At most 2	0.0011	0.0544	3.8415	0.8155

Note: *** denotes significant at 1% level.

4.2 Cross-Variable Effects and Interrelationships

4.2.1 Effect of Agricultural Raw Material Exports on External Reserves

The estimation of the VEC Model showed that Agricultural raw materials export (AREX) has positive effect on external reserves (TER) as shown in Table 4. This is in consistency with the findings of Ekesiobi et al. (2016); Osabuohien and Egwakhe (2008); and Nteegah and Okpoi (2016). This effect is significant at 1% as indicated by a p-value of 0.0004 (see Table 5). Hence, the rejection of H_{02} which states that agricultural raw materials export has no significant effect on external reserves.

Quantitatively, the cumulative impulse-response function analysis using a 10-year horizon revealed that external reserves (TER) increased by US$3.98b resulting from a one-standard-deviation increase in agricultural raw materials export (AREX) as shown in Table 6. By implication, agricultural raw materials export propels external reserve. This is attributable to the fact that more foreign income is earned from exportation, and parts of these earnings are saved for the rainy days in form of external reserves.

Table 4. VEC Model Parameters Estimates Showing the Effects of Agricultural Raw Materials Export (AREX) on External Reserves (TER)

Error Correction Model (equation 10)	Coefficient	Standard Error	*t*-statistic	Probability
$\hat{\alpha}_{11}$	2.68E+09	7.8E+08	3.45608***	0.0015
ΔTER_{t-1}	0.491241	0.15758	3.11750***	0.0038
ΔTER_{t-2}	-0.090120	0.19597	-0.45986	0.6486
ΔTER_{t-3}	0.029452	0.20543	0.14337	0.8869
ΔTER_{t-4}	-0.312257	0.18756	-1.6648	0.1054
ΔTER_{t-5}	-0.137406	0.19943	-0.68899	0.4956
$\Delta AREX_{t-1}$	4.085303	0.78243	5.22131***	9.60e-06
$\Delta AREX_{t-2}$	0.600372	1.03167	0.58194	0.5646
$\Delta AREX_{t-3}$	2.035244	0.83385	2.44077**	0.0202
$\Delta AREX_{t-4}$	0.049820	0.77508	0.06428	0.9491
$\Delta AREX_{t-5}$	0.690915	0.86430	0.79939	0.4298
ΔEXR_{t-1}	-1.24E+08	5.7E+07	-2.16250**	0.0379
ΔEXR_{t-2}	-1.66E+08	4.8E+07	-3.43270***	0.0016
ΔEXR_{t-3}	-2.10E+08	4.9E+07	-4.26931***	0.0002
ΔEXR_{t-4}	-1.67E+08	5.8E+07	-2.88745***	0.0068
ΔEXR_{t-5}	-25579624	5.6E+07	-0.45784	0.6501
ε_{1t-1}	-0.456864	0.17180	-2.65930***	0.0120
ε_{2t-1}	-2.217163	1.07371	-2.06496**	0.0469

Note: *** and ** denote significant at 1% and 5% levels respectively. Response Variable: Total External Reserve; Δ is the first difference operator; R^2= .84; F = 10.39; Prob(F-statistic) = 8.73e-09.

Table 5. Wald Test of significance of the effects of Agricultural Raw Materials Exports (AREX) on External Reserves (TER)

Test Statistic	Value	df	Probability
F-statistic	6.249601***	(5, 33)	0.0004
Null Hypothesis:	H_{02}: $\hat{\beta}_{131} = \hat{\beta}_{132} = \hat{\beta}_{133} = \hat{\beta}_{134} = \hat{\beta}_{135} = 0$		
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value		Std. Err.
$\hat{\beta}_{131}$	4.085303		0.782428
$\hat{\beta}_{132}$	0.600372		1.031668
$\hat{\beta}_{133}$	2.035244		0.833854
$\hat{\beta}_{134}$	0.049820		0.775075
$\hat{\beta}_{135}$	0.690915		0.864303

Note: *** denotes significant at 1% level; $\hat{\beta}_{131},\ldots,\hat{\beta}_{135}$ are the estimated coefficients of Agricultural Raw Materials Exports in equation 10.

Table 6. Impulse-Response Function analysis showing the response of External Reserves (TER) to non-factorized One-Std. Dev. increase in shocks to Agricultural Raw Materials Export (AREX)

Period (Years)	Periodic Effects (US$)	Cumulative Effects (US$)
1	0.000000	0.000000
2	9.30E+08	9.30E+08
3	-17655754	9.12E+08
4	-1.72E+09	-8.11E+08
5	-1.66E+09	-2.47E+09
6	-4.67E+08	-2.93E+09
7	1.01E+09	-1.92E+09
8	2.78E+09	8.59E+08
9	2.75E+09	3.61E+09
10	3.70E+08	3.98E+09

4.2.2 Effect of External Reserves on Agricultural Raw Material Exports

Total external reserves (TER) have negative effect on agricultural raw materials exports (AREX) as indicated in Table 7 significant at 1% with a p-value of 0.0000328 (see Table 8).

Table 7. VEC Model Parameter Estimates Showing the Effects of External Reserves (TER) on Agricultural Raw Materials Export (AREX)

Error Correction Model (Equation 11)	Coefficient	Standard Error	*t*-statistic	Probability
$\hat{\alpha}_{21}$	7.37E+08	1.70E+08	4.332728***	0.0001
ΔTER_{t-1}	-0.148918	0.034547	-4.310533***	0.0001
ΔTER_{t-2}	-0.128653	0.042966	-2.994285***	0.0052
ΔTER_{t-3}	-0.106082	0.045039	-2.355315**	0.0246
ΔTER_{t-4}	-0.095766	0.041122	-2.328858**	0.0261
ΔTER_{t-5}	-0.062341	0.043724	-1.425791	0.1633
$\Delta AREX_{t-1}$	1.014128	0.171542	5.911820***	1.25e-06
$\Delta AREX_{t-2}$	-0.091382	0.226187	-0.404013	0.6888
$\Delta AREX_{t-3}$	0.357352	0.182817	1.954694*	0.0591
$\Delta AREX_{t-4}$	-0.456216	0.169930	-2.684721***	0.0113
$\Delta AREX_{t-5}$	-0.386329	0.189493	-2.038753**	0.0496
ΔEXR_{t-1}	-17697445	12565066	-1.408464	0.1683
ΔEXR_{t-2}	692442.8	10599942	0.065325	0.9483
ΔEXR_{t-3}	-19623216	10758929	-1.823900*	0.0772
ΔEXR_{t-4}	-20565768	12690800	-1.620526	0.1146
ΔEXR_{t-5}	-17166015	12249304	-1.401387	0.1704
ε_{1t-1}	0.087356	0.037666	2.319239**	0.0267
ε_{2t-1}	-1.309084	0.235404	-5.561011***	3.52e-06

Note: *** and ** denote significant at 1% and 5% levels respectively. Response Variable: Agricultural Raw Material Exports (AREX); Δ is the first difference operator; R^2= .88; F = 14.50; Prob(F-statistic) = 1.04e-10.

Table 8. Wald Test of Significance of the Effects of External Reserves (TER) on Agricultural Raw Materials Exports (AREX)

Test Statistic	Value	df	Probability
F-statistic	8.404872***	(5, 33)	3.28e-05
Null Hypothesis: H_{03}: $\hat{\beta}_{221} = \hat{\beta}_{222} = \hat{\beta}_{223} = \hat{\beta}_{224} = \hat{\beta}_{225} = 0$			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value		Std. Err.
$\hat{\beta}_{221}$	-0.148918		0.034547
$\hat{\beta}_{222}$	-0.128653		0.042966
$\hat{\beta}_{223}$	-0.106082		0.045039
$\hat{\beta}_{224}$	-0.095766		0.041122
$\hat{\beta}_{225}$	-0.062341		0.043724

Note: *** denotes significant at 1% level, $\hat{\beta}_{221}$,…, $\hat{\beta}_{225}$ are the estimated coefficients of Total External Reserves in equation 11.

Thus, H_{03}, which states that external reserve has no significant effect on agricultural raw material export, was rejected. Following the cumulative impulse-response function analysis using a 10-year horizon, it was revealed that agricultural raw materials export (AREX) decreased by US$2.02m resulting from a one-standard-deviation increase in shocks to external reserves (TER) as indicated in Table 9.

By implication, external reserve impedes agricultural raw materials exports. This is due to the opportunity cost of holding reserves. Such money which should have been channelled to procuring inputs and providing an enabling environment for increased agricultural output so that it is sufficient enough to be exported is rather kept in form of reserves.

Table 9. Impulse-Response Function Analysis Showing the Response of Agricultural Raw Materials Export (AREX) to non-factorized One-Std. Dev. Increase in Shocks to External Reserves (TER)

Period (Years)	Periodic Effects (US$)	Cumulative Effects(US$)
1	0.000000	0.000000
2	-1.40E+08	-1.40E+08
3	-1.76E+08	-3.16E+08
4	53689140	-2.62E+08
5	2.89E+08	27300319
6	3.69E+08	3.96E+08
7	3.16E+08	7.12E+08
8	-11475184	7.01E+08
9	-4.90E+08	2.11E+08
10	-4.13E+08	-2.02E+08

4.2.3 Simultaneous effect of Exchange Rate on Agricultural Raw Materials Export and External Reserves

Exchange rate (EXR) has negative effects on agricultural raw materials export (holding TER constant) and external reserves (holding AREX constant) as indicated in Table 10. This is similar to the findings of Gatawa and Mahmud (2017). Quantitatively, agricultural raw materials export (AREX) and external reserves (TER) decreased by approximately US$23,817,564 and US$248,492,298 respectively when exchange rate of Nigeria Naira to U.S. Dollar increased by a unit and *vice versa*.

However, these effects are collectively significant at 1 % with a p-value of 0.0001 (see Table 11). Hence, the rejection of H_{04} which states that exchange rate has no significant effect on both agricultural raw materials export and external reserves. The negative effects are due to the undervaluation of Nigerian Naira compared to United States Dollars. Though, this adverse effect is more on External Reserves due to the fact that the proceeds from Export are not commensurate with the volume. Through a feedback effect, the likelihood of the nation to save part of these proceeds in form of Reserves is lessened.

Table 10. Simultaneous Effects of Exchange Rate (EXR) on Agricultural Raw Material Export (AREX) and External Reserve (TER)

Variables	Cointegrated Equation 13	Cointegrated Equation 14
TER_{t-1}	1.000000	0.000000
$AREX_{t-1}$	0.000000	1.000000
EXR_{t-1}	-2.48E+08	-23817564
Std. Err.	(3.1E+07)	(3875814)
t-statistics	[-8.04329]	[-6.14518]
α	5.98E+08	6.83E+08

Note: α is the constant; TER was regressed on EXR holding AREX constant in equation 13 while AREX was regressed on EXR holding TER constant in equation 14.

Table 11. Wald Test of significance of the simultaneous effect of Exchange Rate (EXR) on Agricultural Raw Materials Export (AREX) and External Reserves (TER)

Test Statistic	Value	df	Probability
Chi-square	36.68766***	10	0.0001
Null Hypothesis: H_{04}: $\hat{\beta}_{141} = \hat{\beta}_{142} = \hat{\beta}_{143} = \hat{\beta}_{144} = \hat{\beta}_{145} = \hat{\beta}_{241} = \hat{\beta}_{242} = \hat{\beta}_{243} = \hat{\beta}_{244} = \hat{\beta}_{245} = 0$			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value		Std. Err.
$\hat{\beta}_{141}$	-1.24E+08		57310958
$\hat{\beta}_{142}$	-1.66E+08		48347761
$\hat{\beta}_{143}$	-2.10E+08		49072924
$\hat{\beta}_{144}$	-1.67E+08		57884443
$\hat{\beta}_{145}$	-25579624		55870722
$\hat{\beta}_{241}$	-17697445		12565066
$\hat{\beta}_{242}$	692442.8		10599942
$\hat{\beta}_{243}$	-19623216		10758929
$\hat{\beta}_{244}$	-20565768		12690800
$\hat{\beta}_{245}$	-17166015		12249304

Note: $\hat{\beta}_{141},\ldots,\hat{\beta}_{145}$ and $\hat{\beta}_{241},\ldots,\hat{\beta}_{245}$ are the coefficients of exchange rate in equations 10 and 11 respectively.

4.3 Causalities among the Variables

The VEC Multivariate granger Causality test was used instead of the conventional pairwise granger causality test due to the presence of cointegration.

4.3.1 Short-run Causality

The results of the short-run causality using wald test shows the existence of a bi-causal short-run relationship between agricultural raw materials export (AREX) and external reserve (TER) conditional on exchange rate (EXR) indicated by a p-value of 8.37e-06 (0.00000837) and 5.82e-08 (0.000000582) respectively (See Table 12), while a unidirectional short run causal relationships running from agricultural raw materials export (AREX) to exchange rate (EXR) revealed by a p-value of 0.0015 and from exchange rate (EXR) to external reserve (TER) revealed by a p-value of 0.000016 (see Table 12). This is in consistency with the findings of Olayungbo and Akinbobbola (2011); Usman and Waheed (2010); and Osigwe and Uzonwanne (2015).

Table 12. Short-run Causal Relationships among Agricultural Raw Materials Export (AREX), External Reserve (TER) and Exchange Rate (EXR)

Null Hypotheses	df	χ^2-statistic	Probability
AREX does not *granger-cause* TER conditional on EXR	5	31.2480***	8.37e-06
TER does not *granger-cause* AREX conditional on EXR	5	42.0244***	5.82e-08
EXR does not *granger-cause* AREX conditional on TER	5	6.8660	0.2307
AREX does not *granger-cause* EXR conditional on TER	5	19.5528***	0.0015
EXR does not *granger-cause* TER conditional on AREX	5	29.8216***	1.60e-05
TER does not *granger-cause* EXR conditional on AREX	5	5.6827	0.3383

Note: *** denotes significant at 1%; df – degree of freedom

4.3.2 Long-run Causality

The significance of the coefficient of the error correction terms λ indicates the long run causality between the response variable and the set of impulse variables in the autoregressive equation of interest. There is a long run causality running from agricultural raw materials exports (AREX) and exchange rate (EXR) to external reserves (TER) indicated by a p-value of 0.0000251 (2.51e-05) on one direction which is similar to the findings of Nteegah and Okpoi (2016); and from external reserves (TER) and exchange rate (EXR) to agricultural raw materials export (AREX) indicated by a p-value of 0.000000182 (1.82e-07) on the other direction which is similar to the findings of Stephen (2017).

Table 13. Long-run Causal relationships among Agricultural Raw Materials Export (AREX), External Reserve (TER) and Exchange Rate (EXR)

Null Hypotheses	Normalized restriction (=0)	df	$\chi^2 -$ statistic	Prob.
AREX and EXR do not *co-cause* TER	λ_{11}=λ_{12}=0	2	21.18538***	2.51e-05
TER and EXR do not *co-cause* AREX	λ_{21}=λ_{22}=0	2	31.03721***	1.82e-07
AREX and TER do not *co-cause* EXR	λ_{31}=λ_{32}= 0	2	2.291508	0.3180

Note: *** denotes significant at 1%; df – degree of freedom

Simply put, external reserves (TER) is *granger-caused* by both agricultural raw materials export (AREX) and exchange rate (EXR) while agricultural raw materials export (AREX) is, in turn, *granger-caused* by both external reserves (TER) and exchange rate (EXR) in the long run but none of these variables significantly *granger-causes* exchange rate (EXR) in the long run due to the insignificance of the coefficients of the Error Correction Terms: λ_{31} and λ_{32} (see Table 13).

5. Conclusion and Policy Implications

The study captured the interdependencies among agricultural raw materials exports, exchange rate and external reserve using data from Nigeria. The research work was informed by the missing link, in literature, particularly the agricultural raw material export which is a component of non-oil export. Generally, a statistically significant long run relationship among agricultural raw material export, exchange rate and external reserves was revealed by a test of cointegration which informed the adoption of a vector error correction model.

On the basis of the signs of coefficients reported in the estimated model and the outcome of the Wald test of significance of the model coefficients, agricultural raw materials export increases external reserves while external reserve serves as an impediment to agricultural raw material exports. While the relationship between agricultural raw materials exports and external reserves is stable, the relationship between exchange rate and agricultural raw materials export is unstable which is possibly due to the fluctuations in exchange rate. External reserve, which is part of the earnings from export, is also adversely affected. The study revealed that there is a feedback among agricultural raw materials export, external reserves and exchange rate and that exchange rate acts as a transmission channel through which agricultural raw materials exports and external reserves affect each other.

From the foregoing, exchange rate plays an immense role in an economy and its instability could have disastrous implications for agricultural raw materials exports and external reserves. However, the instability of exchange rate, irrespective of the policy in practice whether floated or fixed, is inevitable. This is because the practitioners of the fixed exchange rate policy still intervene to inject some money into the foreign exchange market in a situation where the side effect of overriding the market forces in regulating exchange rate boomerangs. The inevitability of the exchange rate fluctuation stems from the variations in exchange rate policies adopted by the countries of the rest of the world and as such, it becomes almost esoteric and relatively unfavourable to arbitrarily regulate exchange rate.

On this note, coupled with the unidirectional causality found running from agricultural raw materials exports to exchange rate, more focus should rather be placed on exports. When exports is encouraged, through a multiplier effect, more reserves can be earned and these reserves can, in turn, be used to cushion the effects of exchange rate instability on reserves, exports and other key macroeconomic variables.

In support of the above position, it is recommended that high tariffs should be imposed on importation of finished agricultural products in order to discourage imports thereby encouraging local production, more domestic agrochemical industries should be established, farmers should be allowed to have easy access to single-digit interest loans and more rural-integrated agricultural projects should be implemented.

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