Time Series Analysis of the Behaviour of Import and Export of Agricultural and Non-Agricultural Goods in West Africa: A Case Study of Nigeria

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Abstract

This study examines the time series properties of co-integration and causal relationship between oil (non-agricultural) and non-oil (agricultural) import and export in Africa's largest economy. We employed Granger causality and Johansen and Juselius's co-integration methods to investigate causal relationships among the variables Naira-US dollars exchange rate (USD), Naira-Pounds exchange rates (GBP), Oil Import (OI), Non-Oil import (NO), Oil Export (OE) and Non-Oil export (NE). We found empirical evidence for co-integration between oil and non-oil import. Our result reveals the existence of long run equilibrium between exchange rates, oil import and export, and non-oil import (agriculture) and export. Non-oil import and export involves those of agricultural products like Cocoa, Timber, Cassava and Groundnut. We show that there is bidirectional Granger causality from import and export of both agricultural (non-oil) and non-agricultural (oil) goods and vice-versa. This empirical relationship followed closely to what economic theory have suggested. The study recommends amongst others, that government should adopt appropriate monetary and fiscal policies that will ensure realistic and stable exchange rates and foster economic growth through import and export of agricultural products.

Keywords

Causality, import, export, Nigeria, exchange rate.

Introduction

The importance of import and export to a nation's economic growth and development cannot be over-emphasized because they are necessary catalysts to the overall development of an economy. Over the years, the African continent, specifically, West African countries have been predominantly involved in the import and export of primary goods which are highly susceptible to the vagaries of unstable price movements in the world market. Some of the products that constitute the continent's export volume include crude oil, petroleum products, and agricultural products like Cocoa, Timber, Cashew, Cotton, among others. The implication of this is that, African continents' macroeconomic performance is highly correlated with the success of these products in the world market.

However, using Nigeria as a case study for the continent, Africa has experienced periods of instability in the barrel price of oil in the world market which, given the inelastic state of the products, resulted in low income for the economy with its indirect effect on employment, inflation rate, interest rate, and balance of payments. A prominent feature of Nigeria's export has remained basically the same since 1960. In the 1960s, and 1970s the Nigerian economy was dominated by agricultural commodity exports such as cocoa, groundnut, cotton and palm products. From the mid-1970s, crude oil became the main export product of the Nigerian economy. The export of crude oil now constitutes about 96% of total exports. According to Ayinde et.al.,2015, the performance of agriculture in Nigeria since 1970 clearly showed that it contributes more than

40% of its annual Gross Domestic Product

(GDP) and accounts for over 70% of the non-oil exports. The agricultural sector was the second largest export earner after crude oil and the largest employer of rural labor in Nigeria; therefore, it ranks as a key contributor to wealth creation, poverty reduction and food security in Nigeria.

Unfortunately, this position has fallen consistently to date due to, the appalling fluctuation in the non-oil export promotion, the world prices of agriculture and manufacturing products and the emergence of oil have helped in no small measure in diverging the role of agriculture in the nation's development. This situation is worsened by the almost total neglect of the agricultural sector; hence the performance of the non-oil exports in the past two decades leaves little or nothing to be desired. The major policy concern of the Nigerian government over the years has been to expand non-oil (which involves mainly agricultural products) export in a bid to diversify the nation's export base. Moreover, since the 2005 economic reform, the Nigerian government has continued to diversify its international trade market to include agricultural import and export.

Time series methodologies have been applied to analyze agricultural data in recent times (see for instance, Emokaro and Ayantoyinbo, 2014; Aloui, 2015; Hloušková et al., 2018; Kharin, 2018 and Ayinde et al., 2015). For instance, Syed et al. (2015) analysed the impact of agricultural exports on macroeconomic performance of Pakistan. Their Johansen co-integration technique result revealed that agricultural exports have a negative relationship with economic growth of Pakistan while non-agricultural exports have positive relation with economic growth. In a similar paper, Eke et al. (2015) applied co-integration test to examine exchange rate behaviour and trade balance in Nigeria. Their results also confirmed the presence of long-run relationship between trade balance and exchange rates; showing that the latter has a negative influence on trade balance in Nigeria. Uduakobong and Williams (2017) recently analyzed the relationship between exchange rate volatility and agricultural imports in Nigeria using annual data covering the period of 1970 to 2015. Their co-integration and Granger Causality test revealed the presence of a long run relationship between exchange rate volatility and agricultural import and that exchange rate does not Granger cause the movements in agricultural imports. However, time series studies on the behavior of exchange rates and agricultural

(and non-agricultural) imports and exports in West African countries are non-extant.

The main objective of this study, therefore, is to examine the nature of causal relationship between the Nigerian exchange rate and agricultural and non-agricultural trade using time series methodologies. Studying the nature of the relationship between the Nigerian naira exchange rates and agricultural and non-agricultural trade is imperative in finding stability measure for the Nigerian currency which depicts economic growth, therefore, it is imperative to investigate the behaviour of the correlation and time series relationship between foreign trade (agricultural and non-agricultural) and foreign exchanges rates (USD and GBP) in Nigeria. The scope of this study examines the behavior of import and export of agricultural and non-agricultural goods using pre-recession (1960-2010) data on the Nigerian economy. The findings from this study would contribute to the existing evidences of co-integration and causality in the Nigerian foreign trade and exchange rates. Also, the results from this study would be useful for the policy makers and decision makers in the agriculture and economic sector.

Materials and methods

Annual time-series figures from 1960 to 2010 (pre-recession period) of naira-dollar exchange rate, naira-pounds exchange rate, imports (oil and non-oil), and exports (oil and non-oil) were used in this study. The data were obtained from the Central Bank of Nigeria Bulletin, 2010 edition, covering periods of 1960-2010. The unit of measurement for the import and export data is in USD Billions. The analytical techniques employed in this study for time series analysis include unit root test, Pearson correlation and Granger causality models.

Unit root test was conducted to test for the stationarity of the series while the Pearson's correlation coefficient and Granger causality test were used to examine the relationship between the six variables: Naira-US dollars exchange rate (USD), Naira-Pounds exchange rate (GBP), Oil Import (OI), Non-Oil import (NO), Oil Export (OE) and Non-Oil Export (NE). The methods and models used in this work were adapted from the works of Emakoro and Ayantoyinbo (2014), and Ayinde et al. (2015).

It is an established fact that most macroeconomic series appear to be non-stationary at their levels

(Nelson and Plosser, 1982) and the use of such series in regression analyses lead to spurious regression estimates (Granger and Newbold, 1974). Thus, before examining integration relationships between or among financial variables, it is essential to test for unit root, and identify the order of stationarity. Test of the stationarity of financial series is paramount in other to avoid spurious results. There are several methods for testing the presence of unit roots; however, the most widely used method is the Augmented Dickey Fuller (ADF) test.

The ADF test corrects any serial correlation that might exist in the series by including lagged changes of the residual in the regression. It is defined as the regression of the first difference of the time series against the series lagged once of a constant and a time trend. It is expressed as;

$$\Delta y_t = a_0 + a_1 y_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

where y_t represent each time series considered in this work; USD, GBP, OI, NO, OE and NE. Δ is the first difference operator, ε_t is the error term with zero mean and constant variance, $a_0, a_1, \varphi(i = 1, \ldots, p)$ are the parameters to be estimated and i is the included number of lag of each series. The non-rejection of the null hypothesis: H_0: $a_1 = 0$ implies that, the series is nonstationary. Thus, differencing of the series is necessary to reach stationarity.

Next, the Pearson correlation was used to examine the strength of the relationships among the variables considered. That is, to observe the pairwise-relationships between foreign trades including agricultural and non-agricultural products (import and export) and exchange rates (naira-dollars and naira-pounds). Given the price of each series at time t, X_t and Y_t, the degree of linear association between the variables were measured by the sign and magnitude of the correlation coefficient, r. The model is given as:

$$r = \frac{\sum_{i=1}^{n}((X_i - \bar{X})(Y_i - \bar{Y}))}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sum_{i=1}^{n}(Y_i - \bar{Y})^2}} \qquad (2)$$

Where:

r = Pearson correlation coefficient

X_i and Y_i = pairwise variables at time t

$\bar{X}$ and $\bar{Y}$ = mean of the variables.

After observing the inter-relationships between the variables considered in this work, it is needful for us to validate the linear combinations and co-integrations that exist between the variables.

Moreover, according to Granger (1988), causality tests are valid only in the presence of co-integration among the variables involved. Consequently, a necessary precondition to causality testing is to check the co-integration properties of the variables of interest. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a linear combination exists, the non-stationary (with a unit root), time series are said to be co-integrated. The stationary linear combination is called the co-integrating equation and may be interpreted as a long-run equilibrium relationship between the variables. This study further investigated whether or not the variables are co-integrated using Johansen and Juselius (1991) maximum likelihood method.

This test relies on two test statistics; the trace and maximum eigenvalue tests. The trace test statistics; $\lambda_{trace} = T \sum_{i=r+1,n} \ln(1 - \lambda_i)$ tests the null hypothesis that, there are at most r number of co-integration against the alternative of no co-integrating vectors. In the equation above, T represents the sample size and λ represents the largest canonical correlation under trace. The maximum eigenvalue test uses the relationship; $\lambda_{max} = -T \ln(1 - \lambda_{r+1})$ with the null hypothesis same as that of trace value above against the alternative hypothesis of $r + 1$.

Finally, the Granger causality test was employed to further examine the relationships between the variables. That is, to provide additional evidence as to whether and in which direction cost of foreign trade influence exchange rates and vice-versa. The Granger causality analysis was proposed by Granger (1969) to examine the causal relationship between variables. This concept introduced by Granger, has turned out to be extremely important to economist and financial analyst in testing plausible economic relationships between non-stationary economic time series. It uses a one-sided distributive lag whereby the incremental forecasting value of past and present history of one variable on another variable is used as the yard stick. Consequently, it stated that, ''Y_t is causing X_t if the former is better able to predict the latter using all available information''. In Granger (1969)'s bi-variate framework, variable X is said to cause Y if the past and current values of X facilitates the forecasting of Y when employed in conjunction with the past value of Y as compared with when only past values of Y are employed.

Results and discussion

The study uses figures (graphs) and tables to present the results for easy understanding. Figure 1 is the graph of each series (import and export) before any stationarity test was performed on them. It clearly shows the non-stationarity properties of the series. The lowest and highest prices of each variable were observed for the duration of the data. Considering the trend of these data, we observed from Figure 1 that all the series increased sharply in the mid-1990 except non-oil (agricultural) export which started increasing in early 2000, probably during the democratic regime of 2003. We also noticed that there was a sharp drop in the value of non-oil (agricultural) import around the year 2007 during the end of another democratic regime in Nigeria, while the change in cost of non-oil export was negligible from 1960-1995.

Table 1 shows the minimum, maximum, mean and standard deviation of the six variables. The study shows that, oil export has the highest standard deviation, followed by non-oil import. The implication of this is that both variables experienced high level of volatility during the sample period. This means that the price of oil export and non-oil imports change often over the periods under study. Persistence change in the movement of oil export data could be due to constant fluctuations in the depreciation of the naira exchange rates while that of non-oil (agricultural) imports could be due to high rate of importation among the Nigerian citizens.

With respect to the econometric methodology presented previously, it is expedient that all variables in this study are tested for stationarity using Augmented Dickey-Fuller (ADF) test. The ADF test reveals that the exchange rate variables are non-stationary and integrated of order 1, while the remaining variables are integrated of order two 2 (see Table 2). This is an indication of co-integration between the variables considered.

Next, the Johansen and Juselius (1991) testing procedure was applied on the differenced series
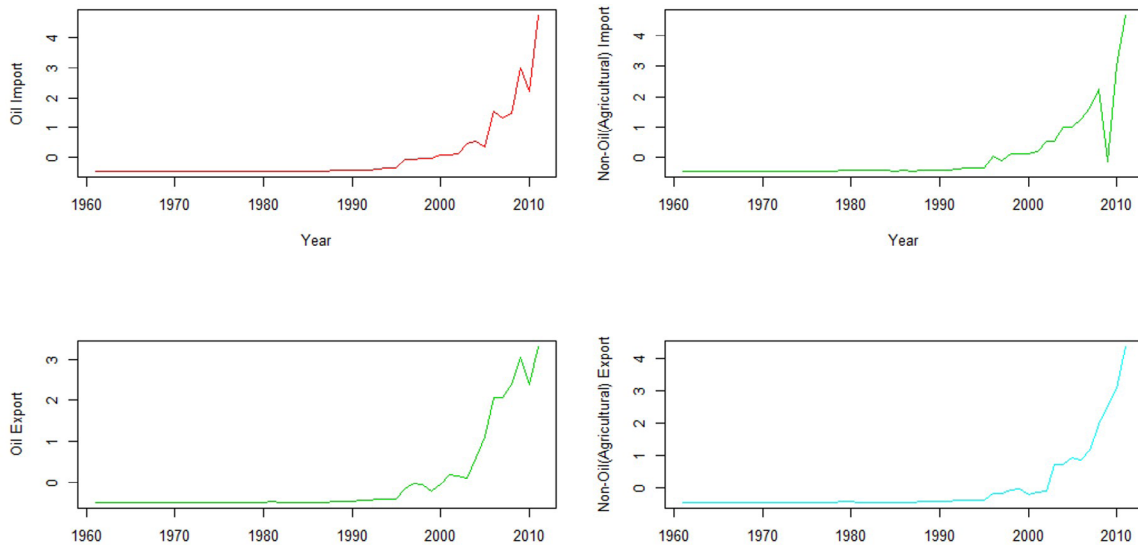
Source: Author´s processing

Figure 1: Time series trend of agricultural and non-agricultural import/export.

Variables	Minimum	Maximum	Mean	Std Deviation
USD	0.5464	148.455	34.3192	52.4815
GBP	1.077	249.993	57.91	89.3748
OI	22	2073579	183155.3	400706.7363
NO	346	5931795	547506	1154799.581
OE	9	10639417	1379064	2803497.872
NE	203.2	396377.2	37216.2	81985.82829

Source: Author's computation

Table 1: Descriptive statistics of the variables.

Variables	Form	P-value	ADF test	Critical-Value		Lag order
				1%	5%	
US Dollar	Level	0.9959	0.9869	-3.5683	-2.9212	10
	First Difference	0.0203	-3.3007	-3.5744	-2.9238	10
	Second Difference	0.0006	-4.6083	-3.6105	-2.9389	10
Pounds	Level	1	2.4356	-3.6056	-2.9369	10
	First Difference	0.0066	-3.7304	-3.5744	-2.9238	10
	Second Difference	0.0001	-5.3015	-3.5847	-2.9281	3
Oil Import (OI)	Level	1	3.6923	-3.5885	-2.9297	6
	First Difference	1	3.6381	-3.5811	-2.9266	3
	Second Difference	0.0482	-2.9442	-3.5847	-2.9281	3
Non-Oil Import	Level	0.9977	1.2019	-3.5885	-2.9297	6
	First Difference	0.6614	-1.2121	-3.5811	-2.9266	3
	Second Difference	0	-5.6242	-3.5847	-2.9281	3
Oil Export (OE)	Level	0.9999	2.3037	-3.6055	-2.9369	10
	First Difference	1	5.8796	-3.6105	-2.9389	10
	Second Difference	0	-6.7108	-3.5847	-2.9281	3
Non-Oil Export	Level	1	5.3183	-3.5885	-2.9297	3
	First Difference	1	6.7055	-3.6056	-2.9369	6
	Second Difference	0.0018	-4.1978	-3.5847	-2.9281	3

Source: Author's computation

Table 2: Unit root test on the variables.

to test whether they are co-integrated or not. The co-integration test reported in Table 3 shows the presence of five co-integrating vectors in the model. The implication of this result is that, variables considered share the same stochastic trend. That is, there is a long-run relationship between them (Enders and Lee, 2004).

Furthermore, the correlations between the six variables considered in this work were estimated and reported in Table 4 to determine the level of the linear relationships. The Pearson correlation coefficients among the variables signal positive correlation between the variables. It suggests co-movements between the variables. All the bi-variate correlations computed between oil and non-oil import and export and exchange rates (USD and GBP) reveal that there was no correlation coefficients lower than 0.5. The high correlations of the variables pairs are consistent with the high degree of integration between import, export and naira exchange rate; showing that a shock in each variable may have an influence on any of the variables considered in this study. For instance, a shock in non-oil export will have an impact on oil import.

Lastly, the Granger causality test was carried out in order to assert the statement that, any two co-integrated variables have either unidirectional or bi-directional causality between them (Awe, 2012, Awe et al., 2016). The decision rule for this test states that, if the coefficients of both cases in a pair are not significant, there is no causality between them, otherwise, there is bi-directional causality between them. However, if one of the coefficients is significant and the other is not, then the former Granger-causes the later and it is termed unidirectional. The pairwise comparison tests results on all the pairs of variables are presented in Table 4. These results confirm that, any two co-integrated variables have either unidirectional or bi-directional causality between them.

The results in Table 5 suggest that, in the fifteen linear combination, the direction of causality is unidirectional in 6 cases, bidirectional in 4 cases and absence of causality in the remaining 5 cases. Specifically, there is no causality between the following pairs of variables: OI and USD, NO and USD, NE and USD, NO and GBP and NE and GBP. This finding supports the evidence found in Uduakobong and Williams (2017). More so, the study reveals that; naira-US dollars (USD) Granger-causes naira-pounds and oil export while naira-pounds (GBP) granger-cause oil import and oil export. Moreover, according to international trade policies, when price of an export rises, it produces a demand, thereby

No of CE	λ_{trace}			λ_{max}		
	Test stat.	C.values	p-values	Test stat.	C.values	p-values
$r = 0$	732.0864	95.7537	0.0001	278.4324	40.0776	0.0001
$r \leq 1$	453.654	69.8188	0.0001	199.9524	33.8769	0.0001
$r \leq 2$	253.7016	47.85613	0.0001	141.916	27.5843	0
$r \leq 3$	111.7856	29.79707	0	92.08442	21.1316	0
$r \leq 4$	19.70119	15.49471	0.0109	19.16648	14.2646	0.0077
$r \leq 5$	0.534701	3.841466	0.4646	0.534701	3.8415	0.4646

Source: Author's computation

Table 3: Johansen-Juselius co-integration test results.

Variables	USD	GBP	OI	NO	OE	NE
USD	1	0.9931	0.7909	0.8098	0.8444	0.8004
GBP	0.9931	1	0.7842	0.7997	0.8622	0.8007
OI	0.7909	0.7842	1	0.8782	0.9538	0.9748
NO	0.8098	0.7997	0.8782	1	0.8598	0.913
OE	0.8444	0.8622	0.9538	0.8598	1	0.9442
NE	0.8004	0.8007	0.9748	0.913	0.9442	1

Source: Author's computation

Table 4: Pearson correlation coefficints results.

Pairs	Pairs (H_o)	F-stat	P-value	Decision	Types of Causality
1	GBP to USD	2.1699	0.1262	DNR H_o	Unidirectional
	USD to GBP	8.4845	0.0008*	Reject H_o	
2	OI to USD	1.2135	0.3069	DNR H_o	No Causality
	USD to OI	0.7597	0.4738	DNR H_o	
3	NO to USD	1.0091	0.3728	DNR H_o	No Causality
	USD to NO	3.0092	0.0596	DNR H_o	
4	OE to USD	0.0277	0.9727	DNR H_o	Unidirectional
	USD to OE	12.4798	5.E-05*	Reject H_o	
5	NE to USD	0.0436	0.9573	DNR H_o	No Causality
	USD to NE	0.6330	0.5357	DNR H_o	
6	OI to GBP	1.5871	0.216	DNR H_o	Unidirectional
	GBP to OI	4.5554	0.0159*	Reject H_o	
7	NO to GBP	1.2519	0.2959	DNR H_o	No causality
	GBP to NO	2.0901	0.1358	DNR H_o	
8	OE to GBP	1.8949	0.1624	DNR H_o	Unidirectional
	GBP to OE	15.1594	1.E-05*	Reject H_o	
9	NE to GBP	1.0262	0.3668	DNR H_o	No Causality
	GBP to NE	0.7507	0.478	DNR H_o	
10	NO to OI	7.4791	0.0016*	Reject H_o	Bidirectional
	OI to NO	50.7303	4.E-12*	Reject H_o	
11	OE to OI	2.7699	0.0736	DNR H_o	Unidirectional
	OI to OE	34.7268	9.E-10*	Reject H_o	
12	NE to OI	10.9912	0.0001*	Reject H_o	Bidirectional
	OI to NE	19.0855	1.E-06*	Reject H_o	

Source: Author's computation

Table 5: Pair-wise Granger causality test results (to be continued).

Pairs	Pairs (H_o)	F-stat	P-value	Decision	Types of Causality
13	OE to NO	17.2806	3.E-06*	Reject H_o	Bidirectional
	NO to OE	47.4544	1.E-11*	Reject H_o	
14	NE to NO	31.3377	3.E-09*	Reject H_o	Unidirectional
	NO to NE	5.9267	0.0053	DNR H_o	
15	NE to OE	3.4364	0.0410*	Reject H_o	Bidirectional
	OE to NE	23.4456	1.E-07*	Reject H_o	

Source: Author's computation

Table 5: Pair-wise Granger causality test results (continuation).

driving up the value of a nation's currency. From this study, we also note that unidirectional causality runs from oil import to oil export and non-oil export to non-oil import. Furthermore, bi-directional causality was found in oil import and non-oil import, non-oil (agricultural) export and oil import; oil export and non-oil import; and non-oil export and oil export.

Conclusion

This paper has examined the co-integration and causal relationship of import and export of agricultural and non-agricultural goods in Nigeria. The Pearson correlation coefficient result shows that agricultural and non-agricultural trade and the Nigerian exchange rates variables were positively linearly correlated. These results are significant because the co-integration test results reveal the presence of a long-run relationship between the Nigerian exchange rates and agricultural and non-agricultural import.

The time series method of Granger causality test on the six variables revealed that, the naira-dollar and naira-pounds do not influence the movement in non-oil (agricultural) import. More so, the test shows the presence of bi-directional causality between foreign trades in Nigeria. That is, it confirms the inter-relationship that exist between agricultural and non-agricultural import and export in Nigeria. This study has also revealed the critical role that exchange rate plays in a country's economy given its long run relationship with agricultural and non-agricultural imports and exports. Evidence from this study revealed that agricultural trade, just like non-agricultural trade also influenced Nigerian exchange rates movement.

We therefore recommend that, the reform agenda of governments in West African countries should be systematic and sustainable such that government strategies can be channeled to improve the competitiveness of their agricultural products in the international market. Also, policy makers in Nigeria should take bold steps to improve productivity in agriculture on a larger scale so that non-oil (agricultural) export can considerably compete with oil export in the economy in order to forestall recurring recessions.

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