APPLICATION OF TIME SERIES ANALYSIS TO SOME INDICES OF INTERNATIONAL TRADE DURING THE PERIOD 1962 T0 2016 IN NIGERIA

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Abstract

Countries trade with each other because it is believed that trading typically makes a country better off. This study aims at investigating the long-run relationship between trade openness, economic growth, and exchange rate in Nigeria and the direction of causality between them. Data spanning from 1962 through 2016, were obtained from the Central Bank of Nigeria Statistical Bulletin. Statistical analysis were achieved by employing the ADF test for stationarity, the Johansen test for cointegration, the Granger causality test for the direction of relationship and Vector Error Correction technique to reconcile the long-run and the short-run relationship of the variables. A long-run relationship was found to exist among the macro economic variables; Trade Openness, Exchange Rate and Gross Domestic Product. Trade Openness has a cause effect on Exchange Rate and Gross Domestic Product in Nigeria. A bi-directional relationship was found to exist between Gross Domestic Product and Exchange Rate. Short-run changes in Gross Domestic Product positively affects Trade Openness with about 33.78% per unit change in Gross Domestic Product in Nigeria. Trade Openness in Nigeria is above its equilibrium value but will adjust back to equilibrium with a speed of about 62.07%.

Keywords: Cointegration, Trade Openness, Exchange Rate, Gross Domestic Product

1.0 Introduction

Most economies of the world today are open to trade. Trade is said to be an engine of economic growth (Osabuhien, 2007). Trade, also called goods exchange economy, is to transfer the ownership of goods from one person or entity to another by getting a product or service in exchange from the buyer. Trade exists between regions because different regions have a comparative advantage in the production of some tradable commodities or because different regions size allows for the benefits of mass production. As such, trade at market prices between locations benefits both locations. Countries trade with each other because trading typically makes a country better off, citizens enjoy a greater variety of goods and services, and generally at a lower cost. Every country will benefit from trade since every nation can produce some products relatively more efficiently than they produce other products, and this is especially true for developing countries.

Nigeria is one of the developing countries in the world today. Nigeria is basically being considered as an open economy with international transactions constituting a significant proportion of her aggregate output. Nigeria's relatively large domestic market can support growth, but alone, cannot deliver sustained growth at the rates needed to make a visible impact on poverty reduction. Hence Nigeria has continued to rely on international trade as well (World Bank; 2016).

International trade is the exchange of capitals, goods and services across international borders or territories. In most countries, such trade represents a significant share of Gross Domestic Product (GDP) (Wikipedia; 2016). While international trade has been present throughout much of history, its economic, social and political importance has been on the rise in recent centuries (Ronald; 1961). International trade leads to specialization in the production of those goods which a country can produce at lower cost. In the presence of international trade, flow of capital goods and technical know-how take place which increases the rate of economic growth and development of a country.

A form of international trade that has gained much attention in recent years is the trade of foreign currencies. The rate at which one country's currency will be traded for another country's currency is known as exchange rate (Wikipedia, 2016). It is also regarded as the value of one country's currency in terms of another currency. Several developing countries that have implicitly or explicitly fixed their exchange rates to the currency of another country and whose inflation rates are higher than that of the foreign country often experience persistent current account deficits and eventual devaluations of their currencies. A high economic growth rate is most likely accompanied by a high investment rate and a high import-export growth as well (Trade openness). Successful exports produce current account surpluses, resulting in nominal appreciation pressure on the currency, unless the Central bank intervenes in the exchange market and accumulates foreign reserve (Fukao, et al; 1999).

Trade openness is believed to stimulate economic growth due to its influence in integrating world economies and generating better markets (Osabuohien, 2007). Countries that were open had experienced economic growth at a rate of 4.5 percent annually in the 1970s and 1980s while countries that were closed, barely managed to grow at a rate of 0.7 percent (Sachs and Warner, 1995). Openness to trade, volume of trade and increased information technology have significant influence on the level of manufacturing output (Ogun, et al, 2005).

Most of the studies have discovered a positive relationship between trade openness and economic growth. Some of have also concluded that trade openness had significant influence on industrialization and information technology. Little or no study have focused on the long-term relationship between trade openness and exchange rate which is not just a form of international trade but a possible indicator of a country's economic strength. This study aims at investigating the long-run relationship between trade openness, economic growth, and exchange rate in Nigeria, the form of long-run relationship between trade openness, economic growth and exchange rate in Nigeria context and the direction of causality between them. This will serve as an important insight into the background of openness to trade in Nigeria. It will also serve as an enlightenment tool to stakeholders and the public as well as a useful tool to the government for planning and policy formulation, particularly in the area of poverty alleviation. The study is presented four sections. Section one is the introduction, followed by section two which is the methodology. Section three covers the results and discussion and section four covers the conclusion of the study.

2.0 Methodology

2.1 The Data

Data was collected on Export EX_t, Import IM_t (in terms of Naira), Gross Domestic Product GDP_t and Exchange rate EXR_t. Trade openness TOP_t was obtained by a sum of Export Ex_t and Import IM_t at time t, divided by Gross Domestic Product GDP_t at time t. Data for this study spanning from 1962 through 2012 was obtained from the Central Bank of Nigeria Statistical Bulletin.

2.2 The Unit root test

According to augmented Dickey-Fuller (1979), a random walk model without drift and trend is given by

$$Y_t = \rho Y_{t-1} + u_t \; ; \quad -1 \leq \rho \leq 1 \qquad \ldots\ldots\ldots \qquad (2.1)$$

where u_t is a white noise error term.

By a little transformation,

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t$$

$$\Delta Y_t = \delta Y_{t-1} + u_t \qquad \ldots\ldots\ldots\ldots \qquad (2.2)$$

where $\delta = (\rho - 1)$

Δ is the first difference operator.

Thus we test the hypotheses;

$H_0 : \delta = 0$ vs $H_1 : \delta < 0$

If the null hypothesis is accepted, $\delta = 0$, then $\rho = 1$, that is we have a unit root, meaning the time series under consideration is non-stationary.

The augmented Dickey-Fuller, ADF (1979) test values can be used to compare for the test statistic given by the t (= τ) value of the Y_{t-1} coefficient (= δ).

$$\text{where } \tau = \frac{\hat{\delta} - 0}{\hat{\sigma}_{\hat{\delta}}}, \qquad \hat{\sigma}_{\hat{\delta}} = \hat{\sigma}\left[\frac{1}{\sqrt{(\sum Y_{t-1}^2 - nY_{t-1}^2)}}\right]$$

If the computed absolute value of the tau statistic ($|\tau|$) exceeds the DF critical tau value, we reject the hypothesis that $\delta = 0$.

2.3 Testing for cointegration

A number of methods for testing cointegration have been proposed in existing literature. Here we shall consider only the Johasen method;

The Johansen's methodology takes its starting point in the VAR of order p given by;

$$Y_t = \varphi D_t + \pi_1 Y_{t-1} + \ldots + \pi_p Y_{t-p} + \varepsilon_t \qquad \ldots\ldots\ldots \qquad (2.3)$$

where Y_t is an (n x 1) vector of variables that are integrated of order one, commonly denoted as I(1) and ε_t is an

(n x1) vector of innovations.

This VAR can be rewritten as;

$$\Delta Y_t = \varphi D_t + \pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \varepsilon_t \quad \ldots\ldots \quad (2.4)$$

where; $\pi = \pi_1 + \ldots + \pi_p - I_n$

$$\Gamma_k = -\sum_{j=k+1}^{p} \pi_j \ , \quad k = 1, \ldots, p-1$$

If the coefficient matrix π has reduced rank, $0 < \text{rank}(\pi) = r < n$, then there exist n x r matrices α and β each with rank r such that $\pi = \alpha\beta'$ and $\beta' Y_t$ is stationary. r is the number of cointegrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a cointegrating vector.

2.4 Error Correction Model

The Error Correction Model (Sargan, *et al*, 1983) links the long-run equilibrium relationship implied by cointegration with the short-run dynamic adjustment mechanism that describes how the variables react when they move out of long-run equilibrium.

Consider a bivariate I(1) vector $Y_t = (y_{1t}, y_{2t})'$ and assume that Y_t is cointegrated with cointegrating vector;

$\beta = (1, -\beta_2)'$

so that;

$\beta' Y_t = y_{1t} - \beta_2 y_{2t}$ is I(0).

Then the existence of an error correction model (ECM) implied by the above cointegrated, Y_t is of the form;

$$\Delta y_{1t} = C_1 + \alpha_1(y_{1t-1} - \beta_2 y_{2t-1}) + \sum_j \varphi^{j}_{11} \Delta y_{1t-j} + \sum_j \varphi^{j}_{12} \Delta y_{2t-j} + \varepsilon_{1t} \ldots\ldots (2.5)$$

$$\Delta y_{2t} = C_2 + \alpha_2(y_{1t-1} - \beta_2 y_{2t-1}) + \sum_j \varphi^{j}_{21} \Delta y_{1t-j} + \sum_j \varphi^{j}_{22} \Delta y_{2t-j} + \varepsilon_{2t} \ldots\ldots (2.6)$$

Equation (2.5) relates the change in y_{1t} to the lagged disequilibrium error $y_{1t-1} - \beta_2 y_{2t-1}$, and equation (2.6) relates the change in y_{2t} to the lagged disequilibrium error as well. The reactions of y_{1t} and y_{2t} to the disequilibrium error are captured by the adjustment coefficients α_1 and α_2.

2.5 Granger causality test

The Granger (1969) causality test assumes that the information relevant to the prediction of the variables involved, y_{1t} and y_{2t}, is contained solely in the time series data on these variables. The test involves estimating the following pair of regressions;

$$y_{2t} = \sum_{i=1}^{n} \alpha_i y_{1t-i} + \sum_{j=1}^{n} \beta_j y_{2t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots \quad (2.7)$$

$$y_{1t} = \sum_{i=1}^{n} \lambda_i y_{1t-i} + \sum_{j=1}^{n} \delta_j y_{2t-j} + u_t \quad \ldots\ldots\ldots\ldots \quad (2.8)$$

where it is assumed that the disturbances ε_t and u_t are uncorrelated.

Equation (2.7) postulates that current y_{2t} is related to past values of itself as well as that of y_{1t} and equation (2.8) postulates a similar behavior for y_{1t}. Granger distinguished four cases;

(1) Unidirectional causality from y_1 to y_2 is indicated if the estimated coefficients on the lagged y_1 in (2.7) are statistically different from zero as a group (ie $\sum \alpha_i \neq 0$) and the set of estimated coefficients on the lagged y_2 in (2.8) is not statistically different from zero (ie $\sum \delta_j = 0$).

(2) Unidirectional causality from y_2 to y_1 exists if the set of lagged y_1 coefficients in (2.7) is not statistically different from zero (ie $\sum \alpha_i = 0$) and the set of the lagged y_2 coefficients in (2.8) is statistically different from zero (ie $\sum \delta_j \neq 0$).

(3) Feedback, or bilateral causality, is suggested when the sets of y_1 and y_2 coefficients are statistically significantly different from zero in both regressions.

2.6 The Model

Consider the following model

$$TOP_t = \alpha_0 + \alpha_1 EXR_t + \alpha_2 GDP_t + \mu_t \quad \ldots\ldots\ldots\ldots \quad (2.9)$$

Where;

TOP_t = the Trade Openess at time t

EXR_t = the Exchange Rate at time t

GDP_t = the Gross Domestic Product at time t.

3.0 Results and Discussion

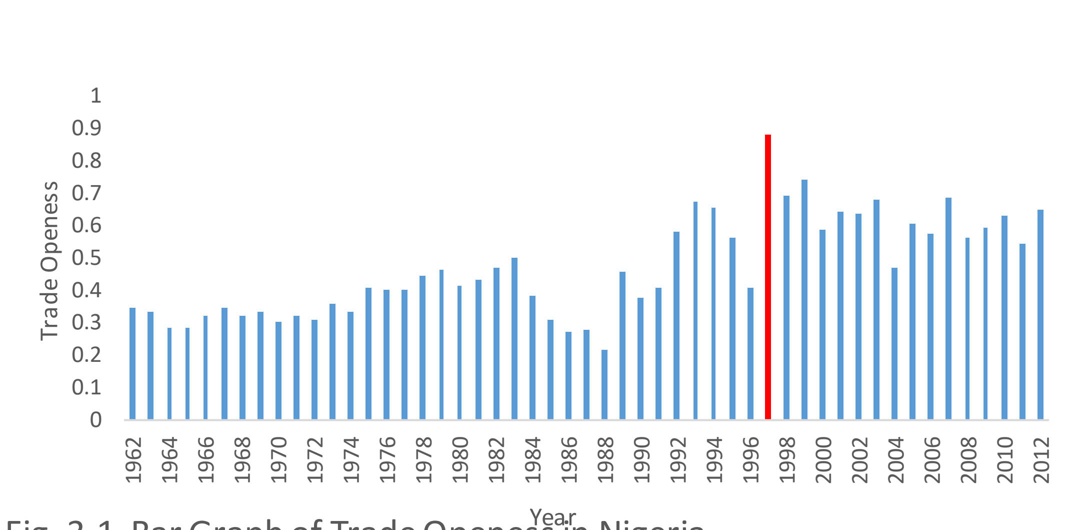

Fig. 3.1 Bar Graph of Trade Openess in Nigeria

From figure 3.1 above, one can observe that the year 1997 experienced the highest level of international trade as indicated by the red bar, which is followed by the year 1999 in Nigeria. However, between 1962 and 2012, the year 1988 experienced the least of international trade.

The result of the stationary tests for the data on the economic variables TOP, EXR and GDP, during 1962 to 2012 in Nigeria can be seen in table 3. 1 below.

Table 3.1 Unit root tests.

Variable	Level		First Difference	
	ADF Test	Artificial value (5%)	ADF Test	Artificial value (5%)
TOP	-0.3755	-1.9474	-11.1406	-1.9474
EXR	1.7548	-1.9474	-6.0531	-1.9474
GDP	10.8943	-1.9474	-3.9633	-3.5025

Based on the above table, it can be seen that the data in this study are not stationary at their levels but stationary after first differencing. This implies that the three variables TOP, EXR and GDP are integrated of order one I(1). This conclusion was reached due to the fact that, at level, the ADF test statistic(s) were greater than the artificial value at 5% whereas first differencing the ADF test statistic(s) were less than the critical value at 5%. Being that the data used in this study are all integrated of order one, they have the tendency for long-run relationship. To test the long-term relationship between the variables studied, the cointegration test using the Johansen method can be employed. The results are given below.

Table 3.2: Johansen cointegration test.

Series: TOP EXR GDP				
Eigen value	Likelihood Ratio	5% Critical value	1% Critical value	Hypothesized number of CE(S)
0.6799	64.6064	29.68	35.65	None**
0.1631	8.7945	15.41	20.04	At most 1

(**) denotes rejection of the hypothesis at 5% (1%) S.L
L.R test indicates 1 cointegrating equation at 5% S.L.

From the above table, Likelihood Ratio (LR) test indicate that a long-run relationship exist between TOP, EXR and GDP. Thus comparing the likelihood ratio value of 64.6064 to the corresponding critical values at 5% and 1%, we can observe that the likelihood ratio value is greater than the respective critical values. This led to the rejection of the null hypothesis of no cointegrating equation. However, from the second row of table 3.2, we can see that the likelihood ratio value was less than the 5% and 1% critical values. Hence the hypothesis of at most 1 cointegrating equation was accepted. This normalized cointegrating equation is given as

$$\widehat{TOP} = 15.72 - 0.14EXR - 2.76 \times 10^{-7}GDP \quad \ldots\ldots \quad (3.1)$$

The above equation (3.1) tells us that in the long run, a decrease in EXR and GDP causes an increase in TOP and vice versa.

To determine if there are causal relationships between TOP and EXR; TOP and GDP; and EXR and GDP, the method of Granger Causality test can be applied. The result of the Granger Causality test is given below.

Table 3.3 Granger Causality test

Null hypothesis	Observation	F - Statistic	Probability
D(EXR) does not Granger Cause D(TOP)	44	0.38401	0.88357
D(TOP) does not Granger Cause D(EXR)		4.21784	0.00325
D(GDP) does not Granger Cause D(TOP)	44	0.05975	0.99902
D(TOP) does not Granger Cause D(GDP)		3.31696	0.01221
D(GDP) does not Granger Cause D(EXR)	44	37.2709	7.6E – 13
D(EXR) does not Granger Cause D(GDP)		37.5301	6.9E – 13

The results of the granger causality test reveals that EXR does not granger cause TOP being that the associated probability value of 0.88357 is greater than the significant level of 0.05. While the hypothesis that TOP does not granger cause EXR was rejected. This implies that lead-lags of TOP could be used to forecast EXR. In the same vein, the above result shows that GDP does not granger cause TOP, whereas TOP granger causes GDP. This was a result of their corresponding probability values being greater than and less than 0.05 level of significance respectively. It can be deduced from above that GDP and EXR granger cause each other. This was as a result of the associated probability values being less than 0.05 level of significant respectively.

To determine how TOP adjust to long-run equilibrium, the Error Correction Mechanism can be used. The result of the Error Correction Model can be seen below.

Table 3.4 ECM Regression.

Dependent variable: D(LTOP)				
Variables	Coefficient	Standard Error	t- statistics	Probability
C	-0.0763	0.0531	-1.4364	0.1587
D(LTOP(-2))	0.1642	0.1331	1.2334	0.2246
D(LEXR)	-0.0295	0.1061	-0.2776	0.7827
D(LEXR(-2))	-0.0466	0.1040	-0.4474	0.6570
D(LGDP)*	0.3378	0.1478	2.2847	0.0277
D(LGDP(-1))	0.0853	0.1600	0.5329	0.5970
D(LGDP(-2))	0.0865	0.1578	0.5481	0.5866
ECM(-1)*	-0.6207	0.1403	-4.4254	0.0001
Rsquared 0.4087				
Adjusted Rsquared 0.3052				
Prob(F- stat) 0.0023				
SSE 1.3403				
AIC -0.4071				
SBIC -0.0952				
Diagnostic Tests				
Jarque- Bera (Normality)	0.9308			
Bruesch- Godfrey LM	0.1293			
White- Heteroskedasticity	0.1067			

$$\widehat{DLTOP}_t = 0.0763 + 0.1642\ D(LTOP_{t-2}) - 0.0295\ D(LEXR_t) - 0.0466\ D(LEXR_{t-2}) + 0.3378\ D(LGDP_t) + 0.0853\ D(LGDP_{t-1}) + 0.0865\ D(LGDP_{t-2}) - 0.6207\ ECM_{t-1} \quad \ldots\ldots\ldots\ldots \quad (3.2)$$

From table 3.4 of the Error Correction Model, one can observe that the constant is not statistically significant; meaning that its value is not different from zero. In the same vein, the first differences of TOP at lag 2, EXR at current time t, EXR at lag 2, GDP at lag 1 and GDP at lag 2 are not significant, hence they do not contribute, in the short-run, to TOP at current time t. However, short-run changes in GDP at current time t positively influences TOP at current time t. The equilibrium error term ECM at lag 1 can be seen to be negative and statistically significant. This implies that TOP is above its equilibrium value and will start falling in the next period to restore the equilibrium. Hence, in the long-run TOP adjusts to its equilibrium value with a speed of about 62%.

The diagnostic test from table 3.4 also reveals that the Error Correction Model (3.2) satisfies the assumptions of normality, absence of serial correlation and homogeneity of variance in the residuals. These deductions were made as a result of the respective probability values being greater than 0.05 (5% level of significance). Hence, the Error Correction Model (3.2) can be relied on. However, we can still go further to test the stability of the Error Correction Model using the CUSUM test.

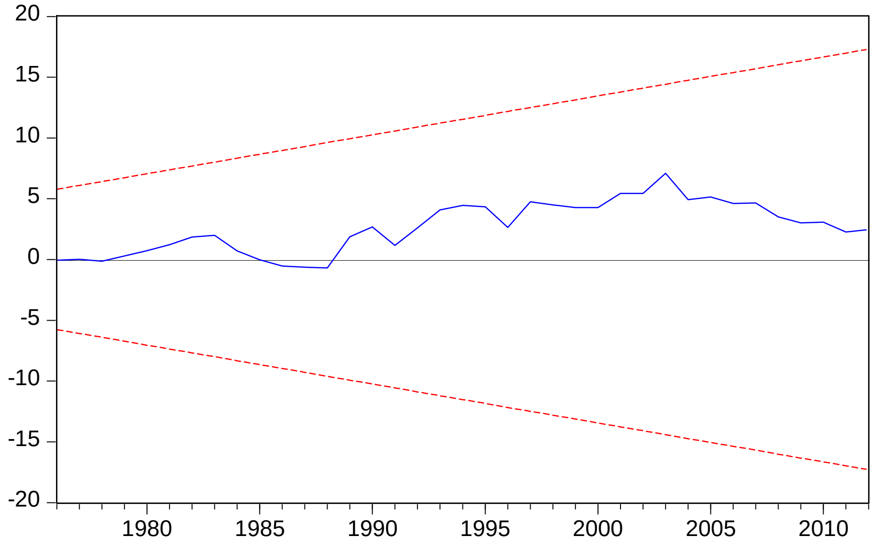

Fig. 3.2 CUSUM Test

Figure 3.2 gives the CUSUM test for stability, it reveals that the Error Correction Model (3.2) is stable and can be used for predictions. This is as a result of the plot lines (blue lines) falling within the upper and the lower limits (red lines) as shown above.

4.0 Conclusion

Based on the above results of analysis and discussion, the following conclusions were made;

1. Between 1962 and 2012 in Nigeria, the year 1997 experienced the highest level of international trade. Whereas the year 1988 experienced the least of international trade.

2. A long-run relationship exist among the macro economic variables; Trade Openness, Exchange Rate and Gross Domestic Product. Meaning that they do not wander far from each other in the long-run.

3. Trade Openness has a cause effect on Exchange Rate and Gross Domestic Product; hence economic growth in Nigeria. A bi-directional relationship was found to exist between Gross Domestic Product and Exchange Rate in Nigeria.

4. Short-run changes in Gross Domestic Product positively affects Trade Openness with about 33.78% per unit change in Gross Domestic Product in Nigeria.

5. Trade Openness in Nigeria is above its equilibrium value but will adjust back to equilibrium with a speed of about 62.07%.

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