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# MODELLING OF THE LONG RUN IMPACT OF EXPORTS AND IMPORTS ON FOREIGN EXCHANGE RESERVE INFLOW IN NIGERIA

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**ABSTRACT**

This study examined the long run relationship and causality among exports and imports data as explanatory variables to foreign reserves inflow into the Nigeria's economy from January 2008 to December 2018 using Autoregressive Distributed Lag (ARDL) Bounds test approach to cointegration. The secondary data was obtained from the Central Bank of Nigeria. A unit root test of stationarity of the series returned all three series to be I(1) stationary. Bounds test result shows that there is cointegration among the variables specified in the model. The optimal lags specification returned ARDL (3, 0, 0) as overall best fitting model for monthly inflow of Foreign reserves. The speed of adjustment to long run equilibrium of 22.15% is significant to minimized distortions in the long run. The causality result highlights the crucial role exports trade plays in the accumulation of foreign reserves. Diagnostics checks on the model provided no significant evidence of serial correlation or presence of instability in the estimated coefficients at 5% significance level. The study recommends that Policy Makers should ensure definite steps are taken to diversify the country's export trade so as to spur external reserves inflow, this will give the Country worthiness in the international market and leverage in times of economic crises thereby stabilising the economy, a stable economy will attract foreign direct investments which will further boost infrastructural development and in a long run a better living standard of the citizenry.

**Keywords**: ARDL, Cointegration, Causality, Stationarity, Bounds test.

## INTRODUCTION

Foreign Exchange Reserve is any foreign currency held by a country's central monetary authority or other monetary authorities. Foreign exchange reserves are variously called foreign reserves, international reserve or external reserve. The international monetary fund balance of payments manual (2013) defines external reserve as consisting of official public sector foreign assets that are readily available to, and controlled by the monetary authorities for direct financing of payment imbalances, and directly regulating the magnitude of such imbalances, through intervention in the exchange markets to affect the currency exchange rate and/or for other purposes.

Critical functions of the External Reserves include maintenance of liquidity in case of economic crisis, providing confidence and assurance to foreign investors, and helping a country to timely meet its external or international Payments obligations such as sovereign or commercial debts, financing imports and absorbing any unexpected capital movement (Amadeo, 2017).

Nigeria's weak foreign reserve base makes the Country helpless in times of harsh economic realities or shocks: The global economic crises of 2008 and the recent recession of 2015 are good examples of such times. A strong foreign reserve base is one available option that can boosts the Country's credit worthiness and give the economy the needed strength to bounce back quickly during such times

Nigeria's Foreign Exchange reserves oscillated around 11billion dollars from 1981 to 2002, rose sharply from 7.5 billion dollars in 2013 to 51.3 billion dollars by the end of 2007 and reached an all time peak of 58 billion dollars in 2008. The sharp rise could be explained by the increase in the spot price of crude oil from 31 dollars per barrel in 2003 to over 95 dollars per barrel by the end of 2007. With this fortune, the Country's financial situation was expected to become increasingly stable with accompanying improved standard of living. However, the rapid depletion in the Country's enormous reserve from the peak of 58 billion dollars in 2008 to 32 billion dollars in 2010 and a further 23 billion dollars by October 2016 (Senibi *et al.*, 2016), without much to show for in terms of infrastructure and economic development left the country open to an economic recession in 2015 and this made it pertinent to question as to what the reserves are been spent on, how much should be spent and saved at a given time and how do we ensure accountability and transparency in managing our foreign reserves.

According to Abubakar (2011) a nation with mismanaged external reserve will witness crises such as retrogressive growth and development, increasing external debt, weakness in foreign exchange, upsurge in poverty, rising mass unemployment, low level of living standard among other problems. One cannot help but agree that these problems are very much peculiar in our country today with total debt stock standing at N20.37 trillion naira as at September 30$^{th}$ 2017 (ICIR, 2017), while the United Nations Common Country Analysis reported that over 60.9% of Nigerians are living in

absolute poverty, implying that almost 100 million people are living on less that 1 dollar per day. This has placed Nigeria 3rd on the World poverty Index by World Bank estimates.

With these prevailing problems, the future of Nigeria and Nigeria's economy is in jeopardy if definite intervening measures are not taken to stabilise the economy, timely meet international payment obligations to reduce the ever increasing external debt burden, provide assurance to foreign investors and still have sufficient reserves as backup in times of economic shocks.

To effectively enhance inflow and manage foreign exchange reserves, policy makers need to understand the factors that influence reserves inflow, and these include policies to enhance domestic demand and foreign trade as well as improved exchange rate management. (Elhiraika and Ndikumana, 2007). According to the Central bank of Nigeria (2019) which is the body vested with the custody and management of the country's reserves, the evolution of foreign reserves in the country is influenced strongly by the changing pattern of international trade.

This study employs Autoregressive Distributed Lag (ARDL) model, a time series model useful for describing the dynamic behaviour of economic series and capturing linear interdependencies to investigate how trade activities of exports and imports have impacted the inflow of foreign reserve into Nigeria's economy suggesting a prior knowledge for policy initiatives and measures that can support efficient reserves inflow.

## MATERIALS AND METHODS

The study discusses methods and procedures concerned with fitting an Autoregressive Distributed Lag (ARDL) model. Secondary data used for the study was obtained from the Central Bank of Nigeria and analysed using Eviews 10 software.

### Preliminary Analysis

Before fitting an ARDL model, it is important to test the stationarity status of all the variables involved so as to determine their order of integration. This procedure is necessary to ensure that none of the variables to be included are integrated of order two, that is I(2) or beyond because the ARDL bound test is based on the assumption that variables are I(0) or I(1) (Pesaran *et al.,* 2001). A stationary time series has its mean and variance constant over time, otherwise the series is non-stationary. Stationarity is tested by graphical check – a thorough visual inspection of the time plot, and then a unit root test for further confirmation of the stationary property. A non-stationary time series $y_t$ can be differenced $d$ times by removing the stochastic trend of the series before it becomes stationary, in which case it is said to be integrated of order $d$, written $y_t \sim I(d)$. Thus, a series that is stationary at level is said to be I(0) stationary while a series that becomes stationary after taking the first difference is said to be I(1) stationary and so on. However, ARDL is not applicable when variables are of higher orders of integration, for instance I(2), this is to ensure that the variables do not become explosive. The Dickey-Fuller Generalised Least Squares (DF-GLS) test developed by Elliott, Rothenberg and Stock (1996) is employed in this study to ascertain the statonarity or non-stationarity of the variables. The null hypothesis of the unit root is rejected in favour of the alternative (no unit root) if the DF-GLS test statistic is less than the corresponding critical value at α level of significance (where α can be 1%, 5% or 10%), in which case the series is said to be stationary. However, if the null hypothesis cannot be rejected, it means the series is non-stationary. The optimal lag order is selected based on the minimum values of Schwarz's Bayesian Information Criterion (SC), proposed by Schwarz (1978) and the Hannan-Quinn criterion (HQ) developed by Hannan and Quinn (1979).

### Model Identification

Pesaran and Shin (1999) introduced ARDL models as least squares regressions of time series data procedure that contains lagged values of the dependent variable and the current and lagged values of the explanatory or regressors. The generalised ARDL(p,q) model is specified as:

$$y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, y_{t-i} + \sum_{i=0}^{q} \beta_i \, x_{t-i} + \varepsilon_{it} \qquad (1)$$

where

$y_t$ is the dependent variable,

$x_t$ are the independent lagged variables

i=1, 2,…, k: p and q are the optimal lag orders

$\beta_0$ is a constant

$\beta_i$ are estimable coefficients of lagged variables

$\varepsilon_i$ = white noise process

The dependent variable is a function of its lagged values, the current and lagged values of other explanatory variables in an ADRL model. It is worthy of note that optimal lag order (p,q) may not necessarily be same for all variables in the model.

Leaning on the above theoretical model, this study work includes Foreign Reserve Inflow (FERI) as dependent variable, Total Export (TEXP), Total Imports (TIMP) as explanatory variables of FERI. We hypothesize that; Foreign Reserve Inflow into the Nigeria's economy is a function of the exports and imports which are the explanatory variables, that is;

FERI = (TEXP, TIMP) (2)

An ARDL estimable version of equation (2) can be written as

$$FERI_t = \beta_{01} + \sum_{i=1}^{p} \beta_{1i} FERI_{t-i} + \sum_{i=0}^{d} \beta_{2i} TEXP_{t-i} + \sum_{i=0}^{q} \beta_{3i} TIMP_{t-i} + \varepsilon_{it} \quad (3)$$

where

FERI = Foreign Reserve Inflow

TEXP = Total Exports

TIMP = Total Imports

$u_t$ = Error Term

$\beta_i$ = coefficient matrices

$p, d, and\ q$ = are the optimal lags of FERI, TEXP and TIMP respectively.

**Test of Cointegration Using ARDL Bounds Testing Approach**

Cointegration analysis helps to identify long-run economic relationships between two or more variables. Bound testing is an extension of ARDL modelling that verifies the existence of a long run relationship by conducting an F–test for the joint significance of the coefficient of the lagged levels of the variables in defined ARDL model.

This approach to establishing cointegration relations amongst variables is preferred to other methods due to its relative better performance and its applicability to a mixture of stationary and non-stationary time series. The null hypotheses of no cointegration, $H_0$: $\beta_i = 0$ is tested against the alternate $H_1$: $\beta_i \neq 0$ and the resultant F-test Statistics compared to reject or accepts the null hypothesis. If the calculated F-statistic value exceeds the upper critical bounds value, then $H_0$ is rejected, (there is cointegration), if it falls within the bound, the test is inconclusive. If the F statistic falls below the lower critical bounds value, it implies that there is no cointegration.

**Model Estimation**

The outcome of the ARDL Bounds test indicates the kind of model to be estimated. If the Bounds test establishes no cointegration in a long run, the ARDL (p, d, q) is estimated with short run model as:

$$\Delta FERI = \beta_{01} + \sum_{i=1}^{p} \beta_{1i} \Delta FERI_{t-1} + \sum_{i-0}^{d} \beta_{2i} \Delta TEXP_{t-i} + \sum_{i=0}^{q} \beta_{3i} \Delta TIMP_{t-i} + \varepsilon_t \quad (4)$$

Where $p$, $d$ and $q$ are the optimal lags of FERI, TEXP and TIMP respectively. However, if long run relationship is established an ARDL Error correction Model (ECM) is estimated as follows:

$$\Delta FERI = \beta_{01} + \sum_{i=1}^{p} \beta_{1i} \Delta FERI_{t-1} + \sum_{i-0}^{d} \beta_{2i} \Delta TEXP_{t-i} + \sum_{i=0}^{q} \beta_{3i} \Delta TIMP_{t-i} + \theta ECT_{t-1} + \varepsilon_t \quad (5)$$

The difference is the inclusion of the Error correction term (ECT) and θ is called the speed of adjustment.

**Pairwise Granger Causality Test**

Granger (1969) systematic test and determination of the causal direction of variables useful in ascertaining the direction of causality between time series variables based on the axioms that the past and present can cause the future but the future cannot cause the past. In Granger causality approach, causality is tested by measuring the ability to predict the future values of a time series using prior values of another time series, such that if a variable $y_i$ can be predicted better from the past values of $x_k$ and $y_i$ than from the past values of $y_i$ alone, then $x_k$ is said to granger cause $y_i$.

The null hypothesis of Granger causality test $H_o$; $y_i$ does not Granger-cause $x_k$ is accepted or rejected against the alternative. If $y_i$ Granger causes $x_k$ it implies that $y_i$ provides statistically significant information about the future values of $x_k$.

**RESULTS AND DISCUSSION**

**Graphical Examination of the Series**

The time plots in figures 1, 2 and 3 suggest that all series total exports, total imports and foreign exchange reserve inflow in Nigeria fluctuate over time. This indicates that, the means and variances of the study variables change continuously over time - a popular characteristics of non-stationary series. To stabilise the variances and reduce the means of the series, we transform the series to natural logarithm and take the first difference. Figures 4, 5 , 6 reports time plots of the first differenced log transformed series of the study variables, the graphs clearly shows some level of smoothness in the data points of the series indicating that the means and variances are constant over time. This also indicate that, the first differenced series are weakly or covariance stationary. We further investigate the stationary nature of the series using unit root test.

**Unit Root test Result**

This paper investigates the unit root and stationarity properties of the study variable using Dickey-Fuller Generalised Least Square Squares Unit Root test. The result is reported in Table 1 and it shows that when the data series is differenced once, all series become I(1) stationary because the null hypothesis is rejected at 5% level of significance.

**Table 1: Result of DF-GLS Unit Root Test of variables at Level and First Difference**

| Variable | Equations Includes | DF-GLS Test at 5% Significance level | | | | Stationarity |
|---|---|---|---|---|---|---|
| | | Level | | First Difference | | |
| | | t-statistic | Critical-value | t-statistic | Critical-value | |
| LNTEXP | Trend and Intercept | -1.9136 | -3.0000 | -11.0127 | -3.0000 | I(1) |
| LNTIMP | Trend and Intercept | -2.8035 | -3.0000 | -15.1188 | -3.0000 | I(1) |
| LNFERI | Trend and Intercept | -1.7914 | -3.0010 | -16.0087 | -3.0000 | I(1) |
| | Decision | Accept Ho | | Reject Ho | | |

**Result of Bounds Test for Cointegration**

**Table 2: Result of Bounds Test of Cointegration.**

| Variables | F-Statistic | Lower Bound | Upper Bound |
|---|---|---|---|
| F(FERI/TEXP,TIMP) | 5.0666 | I(0) | I(1) |
| 5% | | 3.79 | 4.85 |
| 10% | | 3.17 | 4.14 |

$H_o$: No Levels Relationship

To examine the long-run stable equilibrium relationship among the study variables, this study employs bounds test of cointegration. The null hypotheses of no cointegration, $H_0: \beta_i = 0$ is tested against the alternate $H_1: \beta_i \neq 0$. The F-test Statistics is compared to reject or accepts the null hypothesis. In the result tabulated in Table 2, the F-statistic value of 5.0666 is above the lower critical bound, I(0) value and the upper critical bound I(1) at 5% (3.79, 4.85) and 10% (3.17, 4.14) levels of significance. Therefore the null hypothesis of no cointegration is rejected. This implies that there is a long run relationship between exports, imports and foreign exchange reserve inflow.

**Conditional Error Correction Model**

Table 3 is the Result of the ARDL Conditional Error Correction Regression (long run) coefficients when D(FERI) is the dependent variable. The SIC and HQIC give the same specification for the optimal lags for the ARDL (p, d, q) model as ARDL (3, 0, 0). The results show that all coefficients are statistically significant at 5% level except the coefficient of lnTIMP. The Error Correction Term of -0.2215, which is the speed of adjustment to a stable long run relationship or equilibrium is negative and statistically significant ($p<0.05$) at 5% level and estimates the speed at which a dependent variable returns to equilibrium after a change in other variables. This means that the system corrects its previous period disequilibrium at a speed of 22.15% periodically to reach the steady or equilibrium state. The reliability of the model is checked through diagnostic tests.

**Table 3: Conditional Error Correction Regression ARDL(3, 0, 0) model**

| | Coefficient | Standard Error | t-ratio | p-value |
|---|---|---|---|---|
| C | 0.4026 | 0.5370 | 0.7496 | 0.4549 |
| ΔlnFERI(-1) | -0.2215 | 0.0650 | -3.4091 | 0.0009 |
| ΔlnFERI(-2) | -0.3835 | 0.0915 | -4.1923 | 0.0001 |
| ΔlnFERI(-3) | -0.2126 | 0.0875 | -2.4302 | 0.0165 |
| ΔlnTEXP | 0.1549 | 0.0564 | 2.7480 | 0.0069 |
| ΔlnTIMP | 0.0397 | 0.0756 | 0.4230 | 0.6730 |
| ECM | -0.2215 | 0.0564 | -3.9303 | 0.0001 |

A diagnostic check result of the Breusch-Godfrey test of Serial Correlation of the model reveals no serial correlation because the F-statistic of 0.523766 is greater than 0.05, A Ramsey-Reset test that helps to determine the stability of a model also has F-Ststistic value of 0.7496 with a probability of 0.3883 which is insignificant implying that there is no specification error and stability in the model.

**Granger Causality Result**

Analysis so far points towards causality, the result of Granger causality test in Table 4, further confirms the causality relationship among the variables. The result shows that at 5% level of significance shows a strong directional causality from TEXP to FERI, FERI to TIMP and TEXP to TIMP with (F-test Statistic, p-value) of (13.0105, 0.0004), (3.4889, 0.0461) and (21.4221, 0.0000) respectively. On the other hand, there is no causality running from FERI to TEXP, from TIMP to FERI, and from TIMP to TEXP. The result implies that, only Exports can influence the inflow of Foreign Reserve in the Nigerian economy. Foreign reserve can influence total import and total export can influence total import in Nigeria.

**Table 7: Result of Granger Causality pairwise Test**

| Null Hypothesis: | Observations | F-Statistic | Prob. |
|---|---|---|---|
| LNTEXP does not Granger Cause LNFERI | 131 | 13.0105 | 0.0004 |
| LNFERI does not Granger Cause LNTEXP | | 0.18348 | 0.6691 |
| LNTIMP does not Granger Cause LNFERI | 131 | 2.3529 | 0.1275 |
| LNFERI does not Granger Cause LNTIMP | | 3.48888 | 0.0461 |
| LNTIMP does not Granger Cause LNTEXP | 131 | 0.01592 | 0.8998 |
| LNTEXP does not Granger Cause LNTIMP | | 21.4221 | 0.0000 |

**CONCLUSION**

Foreign reserves are important and its accumulation is crucial to Nigeria's development. Since it is found that higher exports imply higher foreign reserves inflow, the study recommends that Policy Makers should ensure definite steps are taken to diversify the country's export trade so as to spur external reserves inflow, this will give the Country worthiness in the international market and leverage in times of economic crises thereby stabilising the economy, a stable economy will attract foreign direct investments which will further boost infrastructural development and in a long run a better living standard of the citizenry.

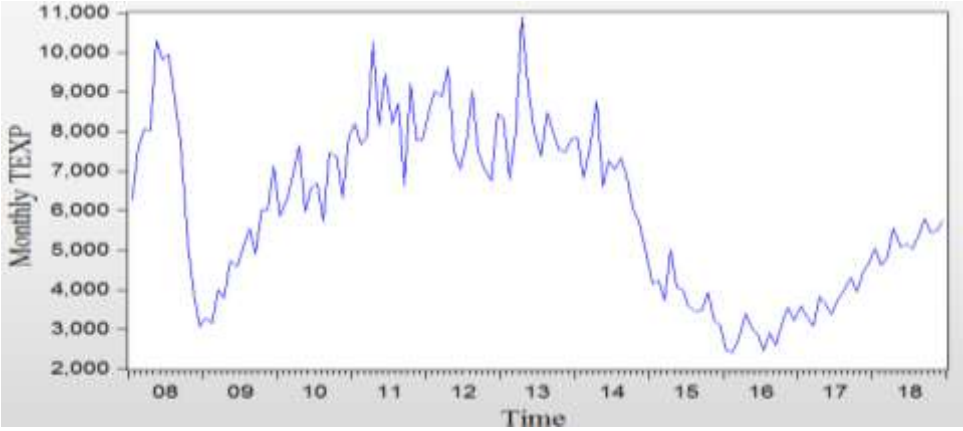


Fig. 1: Time Plot of Total Exports of Nigeria from January 2008 – December 2018

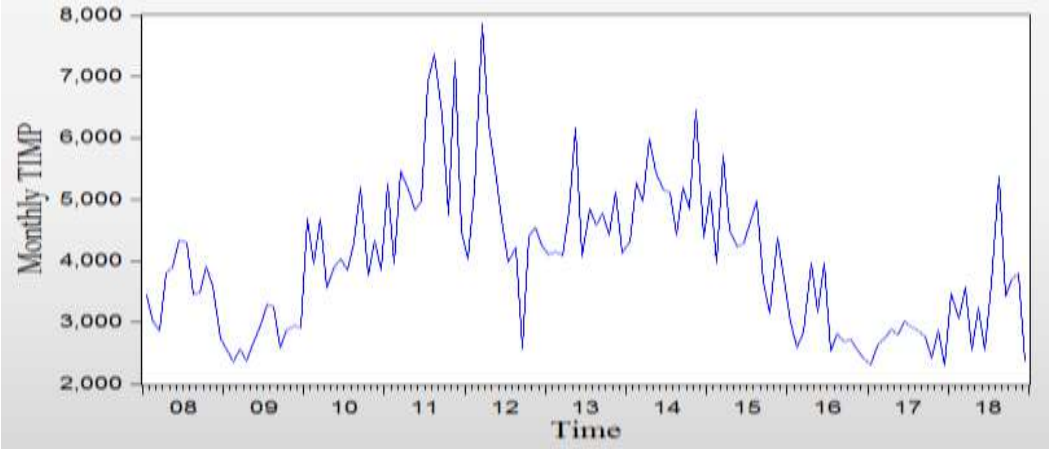


Fig. 2: Time Plot of Total Imports of Nigeria from January 2008 – December 2018

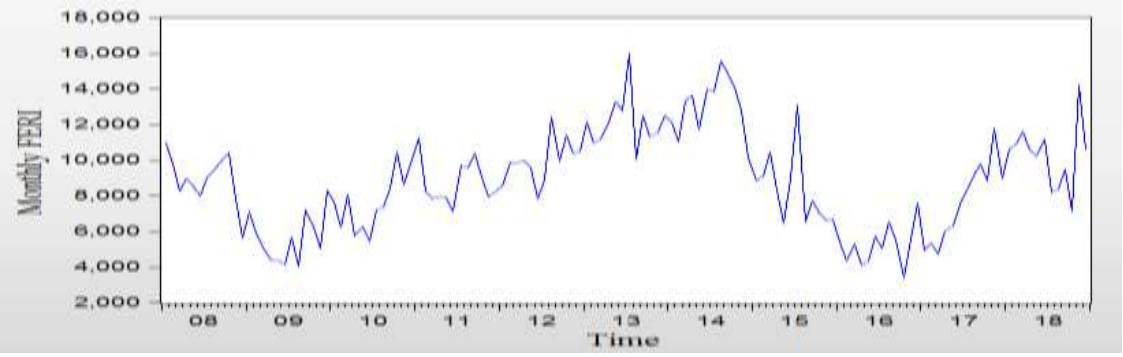


Fig. 3: Time Plot of Foreign Exchange Reserve Inflow into Nigeria's economy from January 2008 – December 2018

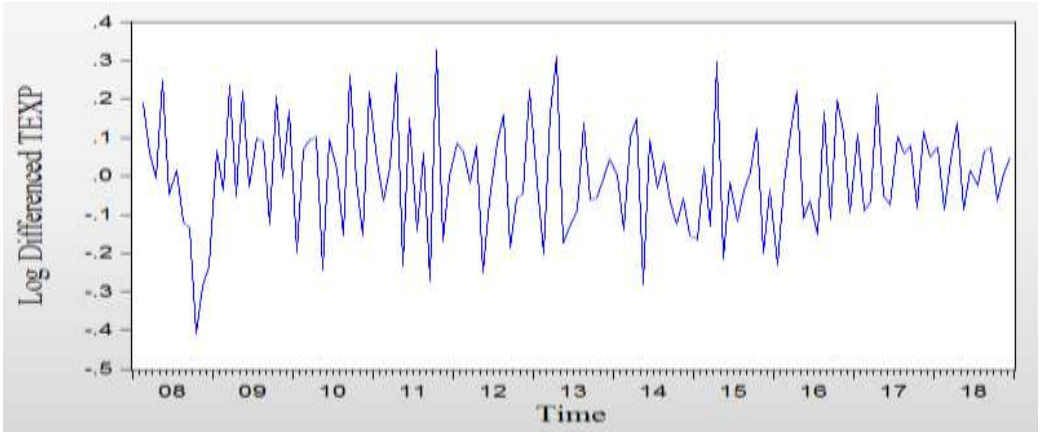


Fig. 4: Time Plot of Differenced Log of Total Exports of Nigeria from January 2008 – December 2018

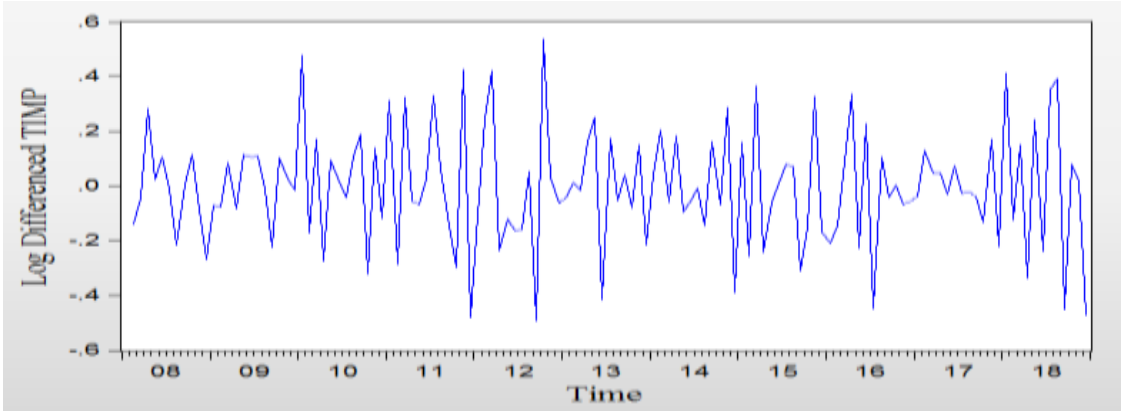


Fig. 5: Time Plot of Differenced Log of Total Imports of Nigeria from January 2008 – December 2018

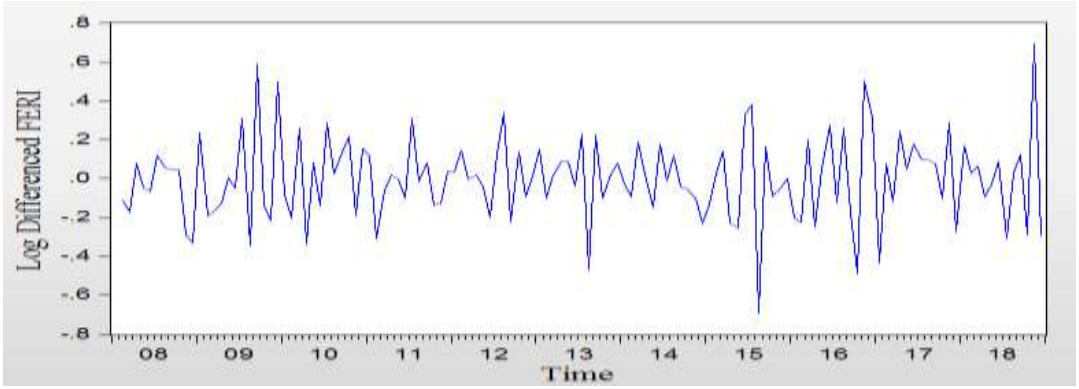


Fig. 6: Time Plot of Differenced Log of Foreign Exchange Reserve Inflow of Nigeria from January 2008 – December 2018

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