Vol. 3 | No. 4 June | 2016 ISSN 2349-5375

Application Of Autoregressive Distributed Lag Model To Effect Of Savings On Economic Growth In Nigeria

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ABSTRACT

It is a belief that countries that save more also tend to grow faster provided the financial system is deep. The study was conducted to determine the effect of savings on Economic Growth in Nigeria. Data on Gross Domestic Product (GDP) and Total Savings (TSA) were collected from the Central Bank of Nigeria Statistical Bulletin spanning from 1960 through 2013. Analysis of data was achieved using the Augmented Dickey-Fuller test for stationarity, the ARDL Bounds test for Cointegration, the Error Correction Mechanism for reconciling the short-run and long-run relationships and the Wald test to determine the short-run causality .The results indicate that TSA at various lags significantly influence GDP; a long-run relationship exists between both variables and a short-run causality runs from TSA to GDP in Nigeria. Based on these findings, this study recommends that efforts should be channeled to more savings as this will encourage more financial stability and economic growth in Nigeria.

Keywords: Total Savings, Economic Growth, ARDL Bounds Testing, Cointegration, Nigeria

1. INTRODUCTION

Economic growth can be defined as the process by which the productive capacity of an economy increases over a given period, leading to a rise in the level of the national income. The possible measures of the economic growth of a country are; the Gross domestic Product (GDP), the Gross National Product (GNP), total factor productivity, factors of production such as technological change, human capital termed the Schumpeterian approach e.t.c (Odedokun 1998; King, 1993; Allen, 1998).

The economic growth of a country can be affected by several factors such as the volume of trade, total credits, external reserve, total debit, Government expenditure, total savings, and inflation e.t.c. Among the few mentioned factors, total savings play an important role in determining the productive capacity of an economy. Savings can be referred to as that part of income not spent or consumed but reserved for future consumption, investment or unforeseen contingencies. Its role is reflected in capital formation by way of increasing capital stock and the impact it makes on the capital to generate higher incomes. In this light, it is widely agreed that higher savings and the related increase in capital accumulation can result in a permanent increase in growth rates for an economy (Romer, 1986; Lucas, 1988).

Though it is agreed that countries that save more also tend to grow faster provided the financial system is deep, on the other hand, another school of thought expresses the fear that a rising savings rate could hamper economic recovery if consumer expenditures form a large component of aggregate demand. However, studies have concluded that on the average, third world countries with higher growth rates incidentally are those with higher saving rates (World Bank, 2013).

The relationship between savings and economic growth of a country can be affected by the investment potentials of that country. Thus savings and investment can have significant implications on the state of the economy. Higher savings lead to higher investment which in turn leads to higher economic growth (Lewis, 1955; Solow, 1956). Attracting foreign capital, in terms of Foreign Direct Investment, remains a necessity that cannot be avoided especially for a developing economy like Nigeria. Long term and heavy dependence on foreign capital can have adverse effect on economic stability. This will leave countries vulnerable to external shocks and in terms of Foreign Direct Investment there may be a continual outflow of profits lasting much longer than outflow of debt service payment on loan of equivalent amount in terms of repatriation of profits. While a loan involves an obligation for a definite number of years, Foreign Direct Investment may be a long term commitment.

Against this back drop, this research seeks to investigate the effect of total savings, at various lags, on economic growth in Nigeria. Given that investment and savings are highly related, this study will reveal the effect of savings, both in the short-run and long-run, on economic growth in Nigeria. The study is presented in four sections; section one is the introduction, followed by section two which covers the methodology. Section three presents the results and discussion, while section four covers the conclusion.

2. METHODOLOGY

2.1 THE DATA

Data was collected on GDP at Current Basic Prices (otherwise known as the Nominal GDP) which equals GDP at current market prices less indirect taxes net of subsidies, and TSA, which is Total Savings in Nigeria. Data spanning from 1981 through 2013 were obtained from the Central Bank of Nigeria Statistical Bulletin, volume 24, 2013.

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;

$H_0 : \delta = 0 \quad \text{vs} \quad H_1 : \delta < 0$

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 $(= \tau)$ value of the Y_{t-1} coefficient $(= \delta)$.

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

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 STATIC MODELS AND DYNAMIC MODELS

A Static model is a time series model where only contemporaneous explanatory variables affect the dependent variable. A time series variable is related to other time series variables where the effect is assumed to operate within a same period. Whereas, a Dynamic model is a time series model where the lagged value of explanatory variables and/or dependent variable affect the present value of dependent variable (Gujarati, 2004).

2.4 AUTOREGRESSIVE DISTRIBUTED-LAG MODEL (ARDL)

An ARDL is a least squares regression containing lags of the dependent and explanatory variables. ARDLs are usually denoted with the notation ARDL $(p, q_1, \cdots q_k)$, where p is the number of lags of the dependent variable, q_1 is the number of lags of the first explanatory variable, and q_k is the number of lags of the k-th explanatory variable.

An ARDL model may be written as:

$$y_t = \alpha + \sum_{i=1}^{p} \gamma_i y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} X_{j,t-i}{}'\beta_{j,i} + \varepsilon_t \qquad \text{..........} \qquad (2.3)$$

Some of the explanatory variables, X_j, may have no lagged terms in the model ($q_j = 0$). These variables are called static or fixed regressors. Explanatory variables with at least one lagged term are called dynamic regressors.

Specification of an ARDL model involves the selection of the number of lags of each variable to be included in the model (ie specify p and $q_1, \cdots q_k$). Since an ARDL model can be estimated using the least squares regression, the selection of lag length can be achieved via the Final Protection Error (FPE), Likelihood-Ratio (LR) test, Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) information criteria.

2.5 LONG-RUN RELATIONSHIPS

Since an ARDL model estimates the dynamic relationship between a dependent variable and explanatory variables, it is possible to transform the model into a long-run representation, showing the long-run response of the dependent variable to a change in the explanatory variables. The estimated long-run coefficients is given by;

$$\theta_j = \frac{\sum_{i=1}^{q_j} \beta_{j,i}}{1-\sum_{i=1}^{p} \gamma_i} \quad \text{........} \quad (2.4)$$

The cointegrating regression form of an ARDL model can be obtained by transforming equation (2.3) into differences and substituting the long-run coefficients from equation (2.4). Thus, we have;

$$\Delta y_t = -\sum_{i=1}^{p-1} \gamma_i^* \Delta y_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_j-1} \Delta X_{j,t-i}{}' \beta_{j,i^*} - \hat{\phi}\, EC_{t-1} + \varepsilon_t \quad \text{....} \quad (2.5)$$

where

$$\left.\begin{aligned} EC_t &= y_t - \alpha - \sum_{j=1}^{k} X_{j,t}{}'\hat{\theta}_j \\ \hat{\phi} &= 1 - \sum_{i=1}^{p} \hat{\gamma}_i \\ \gamma_i^* &= \sum_{m=i+1}^{p} \hat{\gamma}_m \\ \beta_{j,i^*} &= \sum_{m=i+1}^{q_j} \beta_{j,m} \end{aligned}\right\} \quad \text{... .....} \quad (2.6)$$

2.6 BOUNDS TESTING

From the cointegrating relationship form in equation (2.5), a methodology described by Pesaran, Shin and Smith (2001) for testing whether the ARDL model contains a level (or long-run) relationship between the dependent variable and the regressors is known as the Bounds test. The Bounds test procedure transforms equation (2.5) into the following representation;

$$\Delta y_t = -\sum_{i=1}^{p-1} \gamma_i^* \Delta y_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_j-1} \Delta X_{j,t-i}{}' \beta_{j,i^*} - \rho y_{t-1} - \alpha - \sum_{j=1}^{k} X_{j,t-1}{}'\delta_j + \varepsilon_t \quad \text{...........} \quad (2.7)$$

The test for the existence of level relationships is then simply to test of

$$\left.\begin{aligned} &\rho = 0 \\ &\delta_1 = \delta_2 = \ldots = \delta_k = 0 \end{aligned}\right\} \quad \text{...........} \quad (2.8)$$

The coefficient estimates used in the test may be obtained from a regression using equation (2.3) or can be estimated directly from a regression using equation (2.7). Pesaran, Shin and Smith provide critical values for the cases where all regressors and I(0) and the cases where all regressors are I(1), and suggest using these critical values as bounds for the more typical cases where the regressors are a mixture of I(0) and I(1).

2.7 THE MODEL

Consider the following cointegrating regression model;

$$GDP_t = \beta_0 + \beta_1\, TSA_t + u_t \quad \text{.........} \quad (2.9)$$

where β_0 is the constant

β_1 is the slope

u_t is the error term

3. RESULTS AND DISCUSSION

3.1 UNIT ROOT TEST RESULTS

The stationarity test was conducted on the variables, using the Augmented Dickey Fuller (ADF) test, to determine the order of integration (stationary levels) of the variables. The table below shows the result of the analysis.

Table 3.1: ADF Unit Root Test Results

Variable	Level		First Difference	
	ADF Test Stat.	Critical Value (5%)	ADF Test Stat.	Critical Value (5%)
GDP	6.0790	-1.9471	-4.2468	-1.9472
TSA	8.2007	-1.9471	-2.5782	-1.9472

The results of the unit root tests from table 3.1 shows that the Gross Domestic Product (GDP) and Total Savings are both integrated of order one , I(1) respectively. That is, each of the variables is expected to be stationary after first differencing. This implies that both variables, GDP and TSA are possibly related in the long-run.

3.2 SELECTION OF OPTIMAL LAG LENGTH AND THE ARDL MODEL

The optimal lag length to be included in the ARDL model was selected using the Final Protection Error (FPE), Likelihood-Ratio (LR) test, Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) information criteria. The table below shows the result of the analysis.

Table 3.2: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1602.295	NA	9.40e+25	65.48141	65.55863	65.51070
1	-1465.103	257.5841	4.10e+23	60.04502	60.27667	60.13291
2	-1454.614	18.83658	3.15e+23	59.78018	60.16627	59.92666
3	-1405.667	83.90971	5.04e+22	57.94560	58.48612	58.15067
4	-1376.641	47.38996	1.82e+22	56.92411	57.61907	57.18778
5	-1335.639	63.59465*	4.05e+21*	55.41383*	56.26322*	55.73609*

From table 3.2, the Final Protection Error (FPE), Likelihood-Ratio (LR) test, Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) information criteria indicate that the optimal lag length to be included in the ARDL model is 5. This can be identified by the asterisked (*) figures corresponding to lag 5. Hence the ARDL model result is given in the table below.

Table 3.3: The ARDL Model Result

Dependent Variable: D(GDP)
Method: Least Squares
Date: 01/05/16 Time: 18:53
Sample (adjusted): 1966 2013
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	72141.63	76893.67	0.938200	0.3546
D(GDP(-1))	-1.014155	0.266662	-3.803142	0.0005
D(GDP(-2))	-2.040988	0.252241	-8.091414	0.0000
D(GDP(-3))	-1.517761	0.272863	-5.562357	0.0000
D(GDP(-4))	-0.080384	0.332443	-0.241796	0.8103
D(GDP(-5))	-0.853436	0.319039	-2.675025	0.0113
D(TSA(-1))	21.20487	5.369157	3.949386	0.0004
D(TSA(-2))	14.25811	5.155673	2.765519	0.0090
D(TSA(-3))	26.62781	5.930522	4.489961	0.0001
D(TSA(-4))	-7.719666	5.466341	-1.412218	0.1667
D(TSA(-5))	76.47048	7.247449	10.55137	0.0000
GDP(-1)	1.215222	0.226929	5.355070	0.0000
TSA(-1)	-18.01557	5.246109	-3.434082	0.0015

R-squared	0.993326	Mean dependent var	1671230.
Adjusted R-squared	0.991037	S.D. dependent var	4660816.
S.E. of regression	441247.4	Akaike info criterion	29.05841
Sum squared resid	6.81E+12	Schwarz criterion	29.56520
Log likelihood	-684.4019	Hannan-Quinn criter.	29.24993
F-statistic	434.0782	Durbin-Watson stat	2.150937
Prob(F-statistic)	0.000000		

$$D(\widehat{GDP_t}) = 72141.63 - 1.0142\,D(GDP_{t-1}) - 2.0410\,D(GDP_{t-2}) - 1.5178\,D(GDP_{t-3}) - 0.0804\,D(GDP_{t-4}) - 0.8534\,D(GDP_{t-5}) + 21.2049\,D(TSA_{t-1}) + 14.2581\,D(TSA_{t-2}) + 26.6278\,D(TSA_{t-3}) - 7.7197\,D(TSA_{t-4}) + 76.4705\,D(TSA_{t-5}) + 1.2152\,GDP_{t-1} - 18.0156\,TSA_{t-1} \quad \ldots\ldots\ldots \quad (3.1)$$

Equation (3.1), extracted from the ARDL output (table 3.3), presents the ARDL (5, 5). This tells us that 5 lags of both the dependent variable, GDP, and the regressor, TSA, have been included in model (3.1). The regressors, GDP_{t-1} and TSA_{t-1} , included in the model (3.1) are the long-run variables. The significance of these log-run variables, using the Wald test, will imply that both variables are cointegrated. However, some basic diagnostic test has to be carried out on the output of table 3.3.

Table 3.4: Diagnostic Test Result of ARDL (5, 5)

Test	Test Statistic Value	Probability Value
B-G Serial Correlation	0.6734	0.7141
Breusch-Pagan-Godfrey Heteroskedasticity	18.0896	0.1130

From table 3.4 above, the probability value of the B-G Serial Correlation test statistic: 0.7141 is greater than 0.05 (at 5% level of significance), which implies that the null hypothesis of no serial correlation in the residual of equation (3.1) can be accepted. In the same vein, the probability value of Breusch-Pagan-Godfrey test statistic: 0.1130 is greater than 0.05 (at 5% level of significance), which also implies that the null hypothesis of no heteroskedasticity in the residual of equation (3.1) can be accepted. However, we can go further to test for the stability of the above model using the CUSUM test.

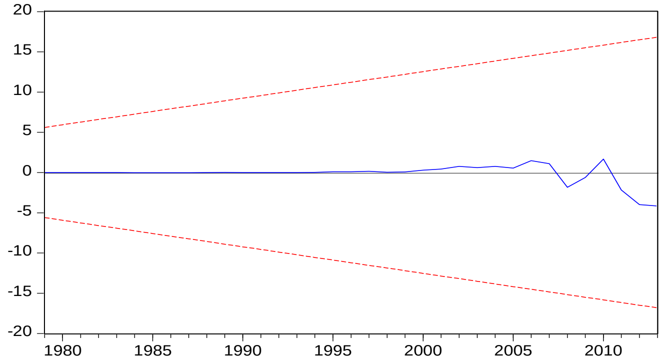

Fig. 3.1 CUSUM Test

From figure (3.1) above, the CUSUM test reveals that model, ARDL (5, 5), presented in equation (3.1) is stable and can be relied on. This is as a result of the plot-line (blue line) falling within the upper and the lower limits (red lines).

Having satisfied the three criteria in the diagnostic test carried out, we can go ahead to test for the significance of the long-run variables using the Wald test.

Table 3.5: The Wald Test Result

Test Statistic	Value	Df	Probability
F-statistic	14.46747	(2, 35)	0.0000
Chi-square	28.93494	2	0.0000

From table 3.5, the Wald test gives the F-Statistic value as 14. 4675 (in 4 d.p). Comparing this value with I(0) = 4.934 and I(1) = 5.764, at 95% under intercept and no trend, as presented by Pesaran and Pesaran (1997), p. 478 Appendices, we notice that the F-Statistic value is greater than both I(0) and I(1) values. This implies that GDP and TSA are cointegrated, meaning that a long-run relationship exist between both variables. This is also indicated by the probability value of the F-Statistic: 0.0000, which is less than 0.05, meaning that the null hypothesis of no cointegration can be rejected.

Having established that a long-run relationship exist between GDP and TSA, for the time period covered, an Error Correction Model (ECM) can be built to reconcile the short-run and the long-run behavior of both variables. Consider the cointegrating regression model of equation (2.9), the estimate, EC_t of the error term u_t can be obtained by regressing GDP on TSA. Hence, we have the Error Correction Model as;

Table 3.6: ECM Regression Result

Dependent Variable: D(GDP)
Method: Least Squares
Date: 01/08/16 Time: 19:16
Sample (adjusted): 1966 2013
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	314464.8	78421.06	4.009953	0.0003
D(GDP(-1))	-0.991399	0.239686	-4.136246	0.0002
D(GDP(-2))	-2.036235	0.226324	-8.997008	0.0000
D(GDP(-3))	-1.759788	0.161445	-10.90022	0.0000
D(GDP(-5))	-0.826326	0.299392	-2.760018	0.0089
D(TSA(-1))	11.19304	1.058481	10.57462	0.0000
D(TSA(-2))	5.307969	2.065502	2.569820	0.0143
D(TSA(-3))	16.05121	1.856479	8.646052	0.0000
D(TSA(-4))	-16.85006	2.494377	-6.755217	0.0000
D(TSA(-5))	63.82919	2.413036	26.45182	0.0000
EC(-1)	1.015764	0.182373	5.569714	0.0000

R-squared	0.992613	Mean dependent var	1671230.
Adjusted R-squared	0.990616	S.D. dependent var	4660816.
S.E. of regression	451486.2	Akaike info criterion	29.07653
Sum squared resid	7.54E+12	Schwarz criterion	29.50534
Log likelihood	-686.8367	Hannan-Quinn criter.	29.23858
F-statistic	497.1790	Durbin-Watson stat	1.853726
Prob(F-statistic)	0.000000		

$$D(\widehat{GDP_t}) = 314464.8 - 0.9914\, D(GDP_{t-1}) - 2.0362\, D(GDP_{t-2}) - 1.7598\, D(GDP_{t-3}) - 0.8263\, D(GDP_{t-5}) + 11.1930\, D(TSA_{t-1}) + 5.3080\, D(TSA_{t-2}) + 16.0512\, D(TSA_{t-3}) - 16.8501\, D(TSA_{t-4}) + 63.8292\, D(TSA_{t-5}) + 1.0158\, EC_{t-1} \quad (3.2)$$

Before any interpretation can be made on the Error Correction Model (3.2), we have to check if this model can be relied on. Hence, we have the following diagnostic test;

Table 3.7: Diagnostic Test on Error Correction Model

Test	Test Statistic Value	Probability Value
B-G Serial Correlation	2.0668	0.3558
Breusch-Pagan-Godfrey Heteroskedasticity	13.2919	0.2078

From table 3.7 above, the probability value of the B-G Serial Correlation test statistic: 0.3558 is greater than 0.05 (at 5% level of significance), which implies that the null hypothesis of no serial correlation in the residual of equation (3.2) can be accepted. In the same vein, the probability value of Breusch-Pagan-Godfrey test statistic: 0.2078 is greater than 0.05 (at 5% level of significance), which also implies that the null hypothesis of no heteroskedasticity in the residual of equation (3.2) can be accepted. However, we can go further to test for the stability of the above model using the CUSUM test.

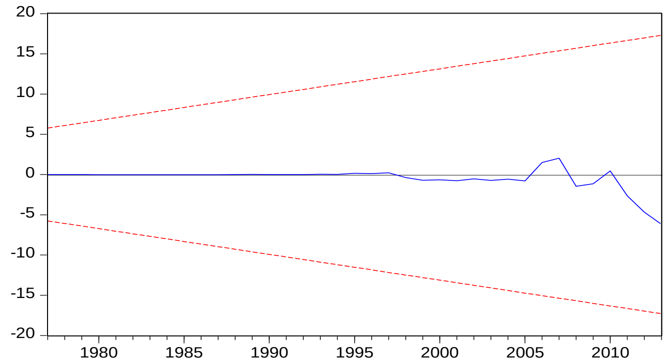

Fig. 3.2 CUSUM Test on ECM Result

From figure (3.2) above, the CUSUM test reveals that the Error Correction Model [equation (3.2)] is stable and can be relied on. This is as a result of the plot-line (blue line) falling within the upper and the lower limits (red lines).

The Error Correction Model [equation (3.2)] reveals that the constant C is significant and has a positive value. While the short-run variables: the first differences of GDP at lag 1, 2, 3 and 5, and that of TSA at lag 1, 2, 3, 4 and 5 are all significantly related the first difference of GDP at current time t. All the lag values of GDP are negatively related to the current GDP, whereas all the lags of TSA, except that of lag 4, are positively related to GDP at current time t. The positive coefficient of the equilibrium error term, EC_{t-1} indicates that the GDP is below its equilibrium value. Given that this coefficient is significant and positive, the GDP is expected to rise in period t with a speed of about 102% in order to restore the equilibrium. However, the significant coefficient of EC_{t-1} indicates that a long-run effect exist between GDP and TSA.

Having reconciled the short-run and the long-run behavior between GDP and TSA, we can go ahead to test for the short-run causality between GDP and TSA using the Wald test.

Table 3.8: Wald Test Result on Causality

Test Statistic	Value	df	Probability
F-statistic	237.7163	(5, 37)	0.0000
Chi-square	1188.581	5	0.0000

From table 3.8, the F-statistic has a probability value of 0.0000 which is less than 5% level of significance, indicating that the null hypothesis that C(6) = C(7) = C(8) = C(9) = C(10) = 0, can be rejected. This implies that a short-run causality run from TSA to GDP, that is TSA at lags 1, 2, 3, 4 and 5 jointly causes GDP.

4. CONCLUSION

Based on the above results of analysis and discussions, the following conclusions were reached.

- Total savings at various lags significantly influence economic growth in Nigeria.
- A long-run relationship exist between total savings and economic growth in Nigeria. Meaning that this two economic variables do not wander away from each other if savings is sustained.
- The economic growth in Nigeria, with respect to total savings, is below it equilibrium and is expected to rise in period t in order to restore its equilibrium.
- A short-run causality runs from total saving to economic growth in Nigeria.

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