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REAL GROSS DOMESTIC PRODUCT OF NIGERIA (2017-2030): AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODEL-BASED FORECASTS

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Abstract
Appropriate policy initiatives to sustain the reversal of the downturn recently experienced in Nigeria, and proactive measures capable of forestalling future re-occurrence require hindsight knowledge of time series values of real gross domestic product as a basis for projecting the possible output growth of the country in the years ahead. This paper has presented forecast values of real gross domestic product of Nigeria from 2017 to 2030, using univariate autoregressive moving average (ARMA) model. Based on real gross domestic product series for 1981-2016 period, the forecasts showed the possibility of attaining sustained increases in real gross domestic product in the years ahead, given appropriate policies and commensurate macroeconomic environment.

Keywords: Time series, Correlograms, Stationarity, ARIMA model, Real GDP forecasts.
JEL Classification Codes: C22, C35, C53, F47

1. Introduction

Sustainable economic growth is the bedrock for the success of every economy. Therefore, attention of governments since the seventeenth and eighteenth centuries has been directed towards policies that have the potential real output growth. And neoclassical economists such as Lewis (1978), state theorist like Karl Marx, as well as Adam Smith have all been worried with the mission for finding the forces and processes that cause a change in the material progress of man. This is also applicable to successive governments and states in modern times. In Nigeria for a case in point, the broad objective of the national economic policy has been the aspiration to promote sustainable economic growth for the vast majority of

Nigerians through the adoption of various fiscal and monetary policies. Regrettably, growth performance of the economy is still characterised by fits and starts; and the prospects of speedy economic growth appear unattainable as reflected by the inability to realise sustainable growth potentials in Nigeria so as to significantly decrease the rate of poverty in the economy.

A number of countries that have achieved speedy economic growth since World War II have some conspicuous common features; they invested in human and physical capital, and provide efficient capital market for investments with higher level of economic efficiency driven by technological capabilities, stable polity, appropriate economic policy and economic system.

Economic growth is a key policy objective of any government. In addressing the relevant issues in economic management, experts and economic planners have had to choose between or combine some of the macroeconomic variables. Gross domestic product, as proxy for economic growth aimed at accomplishing the basic needs of man to a substantial majority of the populace, is a quantity determined at regular time intervals. Obviously, economic stagnation can induce destabilising consequences on the citizenry (Lewis, 1978). Though, the trail growth-related issues are many, central to the subject matter is its stochastic nature and unpredictability.

The Nigerian economy is basically an open economy with international transactions constituting significant proportion of aggregate economic activity. Therefore, economic prospects and development of the country, like many developing countries, are anchored mainly international interdependence. Despite the considerable degree of trade openness, the performance in terms of real output as proxy for economic growth, has remained sluggish and discouraging over the years (Odedokun, 1997). Nigeria's trade policy since independence in 1960 has been characterised by policy swings, from high protectionism to liberalism. The main thrust of trade policy has been the objective aimed at influencing trade process that can promote sustainable economic growth. However, attainment of the objective has so far remained very elusive (Yesufu, 1996). The main factor hindering the attainment of the objective is the volatility of government expenditure orchestrated by the boom and burst cycle of government revenue, which is derived mainly from single export commodity (crude oil), whose price is also volatile. To worsen the problem, the expenditures are not channeled to productive sectors of the economy (Yesufu, 1996).

However, most economic scholars are of the view that the problem of growth of the Nigerian economy has not been well understood and, thus, improperly managed. Most available studies have some conceptual and methodological inadequacies that undermine their accuracy and, thus, their efficacy for effective policy purposes, especially in the context of medium and long term predictions. The recent international economic crisis and the current economic recession in Nigeria have highlighted the need for effective monitoring and forecasting of real gross domestic product of the economy. For example, non-application of unit root test to reduce or, if possible, eliminate spurious regression due to non-stationary properties of the time- series, may all lead to biased inferences.

This paper employs Autoregressive Integrated Moving Average (ARIMA) model to forecast the real gross domestic product (RGDP) of Nigeria for the years 2020 - 2030. The paper has five sections, namely: (1) Section one is the introduction. (2) Section two is the literature review. (3) Section three discusses the methodology employed in the paper. (4) Section four is the analysis and discussion of findings. (5) Section five concludes the paper and proffers policy recommendations.

2. Literature Review

2.1 Conceptual Issues

Positive economic growth implies sustained increase in aggregate goods and services produced in an economy within a given time period. When expressed as the ration of a country's population, then economic growth is considered as per capita income, whereby aggregate production of goods and services in a given year is divided by the population of the country in the given period. Economic growth can also be stated in nominal or real terms. Hence, when the increase in the aggregate level of goods and services is deflated by the rate of inflation, the concept translates to real economic growth. It is nominal economic growth when aggregate values of goods and services produced in the economy is expressed without deflating same by the rate of inflation. However, the concept of economic growth has not been quite easy to grasp and measure in real terms.

Some authors have variously differentiated economic growth from "economic development". For authors like Lewis (1978), the mere increase in the aggregate level of production of goods and services in an economy tells us nothing about the "quality of life" of the citizenry, especially when threats of global pollution, abysmal lop-sided distribution of aggregate output and income, environmental degradation, prevalence of chronic and deadly disease, abject poverty and the absence of freedom and justice are taken into consideration. Therefore, some authors argue that attention should be focused not merely on the increase in aggregate output and income but also on the total quality of standard of living, noting that there is yet no satisfactory measure of "quality of life" that can be applied to quantitative measure of aggregate output and income which would be acceptable to all and sundry in the course of the time. Consequently, the term "economic growth" refers to a positive increase in the aggregate level of output within a given time period in a country while "economic development" is seen as sustainable increase in the aggregate level of output and incomes, with due consideration for quality of life which hopefully takes account of such issues as equal distribution of income, healthcare, education, environmental degradation, reduction in global pollution, freedom and justice, among others.

2.2 Theoretical Underpinnings

The anchorage for understanding growth over the long-term is rooted in two main theories that relate to possible sources of growth. These are the growth theory and growth accounting theory. Growth theory is concerned with the theoretical modeling of the interactions among growth of factor supplies, savings and capital formation, while growth accounting addresses the qualification of the contributions of the different determinants of growth. Three waves of interest have currently emerged in economic growth literature. The first is associated with the work of Harrod (1900-1978) and Domar (1914-1997); the integration of which translates to what has become known as the "Harrod-Domar Model". The theory presupposes that growth depends on a country's savings rate, capital-output ratio, and capital depreciation. However, the theory has been criticised for its assumption of exogeneity of all key parameters, negligence of technical change, and it does not allow for diminishing returns when one factor expands relative to another (Woodford, 2000; Essien, 2002).

The second begins with the neoclassical (Solow's) model, which contains the thinking that growth reflects technical progress and key inputs (labour and capital). It allows for diminishing returns, perfect competition but not externalities. In the neoclassical growth process, savings are needed to increase capital stock, capital accumulation has limits to ensure diminishing marginal returns, and capital per unit of labour is limited. It postulates that growth also depends on population growth rate and that growth rate amongst countries is supposed to converge to a steady state in the long-run. Despite the modifications, the basic problems associated with the neoclassical thinking are that it hardly explains the sources of technical change (Essien and Bawa, 2007).

The third is the newer alternative growth theory, which entrenches a diverse body of theoretical and empirical work that emerged in the 1980s. This is the endogenous growth theory. The theory distinguishes itself from the neoclassical growth model by emphasising that economic growth is an outcome of an economic system and not the result of forces that impinged from outside. Its central idea is that the proximate causes of economic growth are the effort to economise, and the accumulations of knowledge and capital. The theory emphasises that anything that enhances economic efficiency is also good for growth. Thus, the theoretical framework indigenised technological process through "learning by doing" or "innovation processes". It also introduces human capital, governance and institutions in the overall growth objectives (Romer, 1994; Essien, 2002).

A number of endogenous growth is referred to in the literature as non-Schumpeterian growth. Schumpeter emphasised the importance of temporary monopoly power as a motivating force in the innovative process. The model further incorporates the fact that technological advancement comes from what people do, and the existence of monopoly rents discoveries. The emphasis on knowledge and technology in the Schumpeterian model raises question about the role of government in promoting growth. Government should be seen as a critical agent that provides key intermediate inputs, establishes rules, and reduces uncertainly by creating the right macroeconomic environment for growth (Contessi and Weinberger, 2009).

The newer growth theory (endogenous theory) fits the real world perfectly well and has important policy implications. This is because it traces growth of output per capita to two main sources: savings and efficiency. In other words, it is not only factor accumulation that drives growth but also efforts to utilise the factors so accumulated. An important economic policy implication of this thinking is that of achieving economic stability with low inflation and positive (real) interest rate that spurs saving, which is good for growth (Contessi and Weinberger, 2009). Consequently, anything that increases efficiency and savings is good for growth.

2.3 Theoretical Framework

Autoregressive Moving Average (ARMA) model developed by Box and Jenkins (1970) constitutes the theoretical framework in this paper. A time series variable, X, is said to follow an autoregressive moving-average process of order (p, q) or ARMA(p, q) process if current value of the time series variable, X_t, is a combination of lagged values of the time series variable to order p and lagged values of its error term to order q. It is a combination of autoregressive (AR) model and moving average (MA) model. Essentially, an ARMA model expresses the present value of a time series variable, X_t, as a linear function of its past stationary values or observations to order p; $X_{t-1}, X_{t-2}, \ldots, X_{t-p}$ and past forecast errors to order q; $\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots, \varepsilon_{t-q}$. Thus, the ARMA model is specified as follows:

$$X_t = \alpha_0 + \underbrace{\alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \ldots + \alpha_p X_{t-p}}_{AR(p)} + \varepsilon_t + \underbrace{\theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}}_{MA(q)} \;\ldots\ldots\; ARMA(p, q)$$

where current value of the error term, ε_t, is white noise. That is, ε_t has zero mean and constant variance.

Though autocorrelation function (ACF) and partial autocorrelation function (PACF), considered as two useful tools to characterise the ARMA processes, may approach zero at a geometric rate (Clements and Hendry, 1998), lag orders p and q for the ARMA model used in this paper are determined from visual inspection of correlograms and partial correlograms.

2.4 Some Empirical Studies

Husnain and Mete (2006) modelled and forecasted inflation in Pakistan. Various econometric approaches were implemented and the results were compared. In ARIMA models, additional lags for p and/or q necessarily reduced the sum of squares of the estimated residuals. Results showed that the VAR models do not perform better than the ARIMA (2, 1, 2) models and, the two factor model with ARIMA (2, 1, 2) slightly performs better than the ARIMA (2, 1, 2). Although the study focused on the problem of macroeconomic forecasting, the empirical results have more general implications for small-scale macro econometric models. Nanthakumar and Yahaya and (2010) forecasted international tourism demand for Malaysia. The study used an appropriate ARIMA model, otherwise known as Box-Jenkins model, to generate forecast of international tourism demand. The forecasts generated by the ARIMA model suggest that Malaysia will face increasing tourism demand for the period of 2009:Q1-2009:Q4.

A study by Ikechukwu and Adedoyin (2014) examined a univariate model in the form of ARMA model developed by Box and Jenkins and multivariate time series model in the form of Vector Autoregressive model to forecast inflation for Nigeria. The authors considered changes in monthly consumer price index obtained from the National Bureau of Statistics (NBS) and the Central Bank of Nigeria (CBN) for the years 2003 to 2012, in an attempt to predict movements in the general price level. The result aimed at enabling policy makers and businesses to track the performance and stability of key macroeconomic indicators using the forecasted inflation. Similarly, Adams and Awujola (2014) used a time series model to investigate consumer price index (CPI) in Nigeria's Inflation rate between 1980 and 2010, and provided five years forecast for the expected CPI in Nigeria. The study estimated Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) model as the best fitting ARIMA, and made five years forecasts which showed an average increment of about 2.4% between 2011 and 2015, with the highest CPI being estimated as 279.90 in the 4th quarter of the year 2015.

It is obvious that the literature is dearth in the areas of forecasting macroeconomic variables based on series models. Therefore, this paper is intended to contribute to bridging this observed knowledge gap in the literature by forecasting real gross domestic product of Nigeria for years 2017 – 2030, using autoregressive integrated moving average (ARIMA) model.

3. Methodology

3.1 Design, Data Source, and Model Specification

This paper uses univariate time series analysis design to forecast real gross domestic product of Nigeria for the years 2017 – 2030, based on Autoregressive Integrated Moving Average (ARIMA) model developed by Box and Jenkins (1970). The choice of ARIMA model is because it often permits the representation of an observed time series with fewer parameters than individual Autoregressive (AR) or Moving Average (MA) models and, thus, are practically parsimonious. Moreover, the parsimonious property makes ARIMA models more appropriate particularly for forecasting, specifically as sampling variation in parameter estimates has the potential to adversely affect prediction. More so, several studies attest to its ability and flexibility to capture variability in any single variable collected at regular intervals over a time period (McDowall et al. 1980; Hoff 1983; O'Donovan 1983; Pankratz 1983; Vandaele 1983; Melard 1984; Box et al. 1994; Enders 2004; Hossain et al. 2006).

We used ARIMA model of order (1, 2), i.e., ARIMA(1,2), for the forecasts in this paper. We plotted the correlogram and partial correlogram of the autocorrelation function (ACF) and

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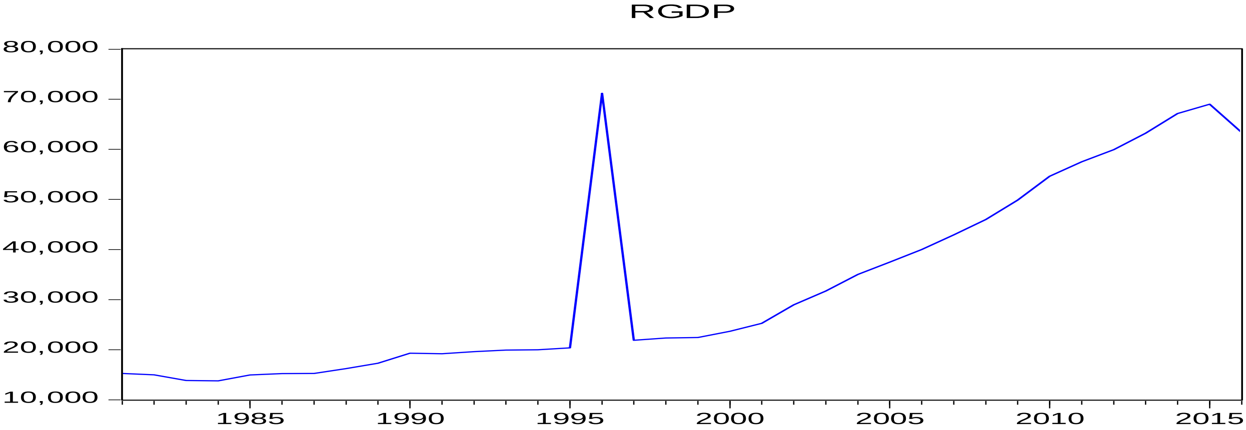
partial autocorrelation function (PACF) respectively, from which we determined the lag order (1, 2) of the ARIMA model by visual inspection of the correlograms. The correlograms showed stationarity in time series values of real gross domestic product data at first difference, while time series values of forecast error showed stationarity at second difference. We used Augmented Dickey-Fuller (ADF) unit root test to further confirm stationarity in the series. Hence, the justification for our choice of ARIMA(1, 2) model.

To forecast real gross domestic product (RGDP) of Nigeria, we extracted univariate time series data on this macroeconomic variable for the 36 years (1981 – 2016), from the Statistical Bulletin of the Central Bank of Nigeria (CBN, 2015, 2016). Thus, the data set consists of 36 observations on RGDP (in billions of naira), inflation-adjusted at 1990 constant price.

Graphical representation shows that the time series data follows conspicuous fluctuations, i.e., nonstationary, over the 1981-2016 period (Figure 1).

Figure 1: Graph of RGDP of Nigeria over the 1981-2016 period



Source: Authors' plot from RGDP of Nigeria (1981 – 2016)

As the series does not follow stationary pattern, we differenced log transformation of the data to ensure stationarity. Since time series values of real gross domestic product data was stationary at first difference while time series values of forecast error was stationary at second difference, and the interest in this paper is to forecast real gross domestic product of Nigeria for 2020, 2022 and 2030. As a basis for the objective of establishing the appropriate forecasting model for determining movements in the value of real gross domestic product in Nigeria, we specified the following random walk ARIMA(1, 2) model with drift, as well as logarithmic transformation:

$$\Delta \text{InRGDP}_t = \beta_0 + \beta_1 \Delta \text{InRGDP}_{t-1} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2}$$

where $RGDP_t$ is value of real gross domestic product in current year *t*, $RGDP_{t-1}$ is value of real gross domestic product in the immediate preceding year *t-1*, β_0 is intercept (i.e., drift parameter; Gugarati, 2013: 755) of the ARIMA model, β_1 is coefficient of log RGDP series value lagged one period, *In* is log operator for RGDP series value lagged one period, Δ is the first difference operator (Gujarati, 2013: 754). ε_t is error term in year t, ε_i $(i = 1, 2)$ are the respective lagged values of the error term, and θ_j $(j = 1, 2)$ are the respective coefficients of lagged values of the error term.

3.2 Statement of Hypothesis

With respect to the ARIMA(1, 2) model, we formulated and tested the hypotheses below, which actually satisfy the precondition for estimating the most parsimonious model to forecast real gross domestic product and, possibly, its future growth rates.

$H_0 1$: Real gross domestic product in current period, t, has no significant relationship with real gross domestic product in the immediate preceding period, (t-1). Mathematically, the hypothesis is: $H_0 1: \beta_1 = 0$ as against $H_0 1: \beta_1 \neq 0$

$H_0 2$: Real gross domestic product in current period t has no significant relationship with forecast error values in preceding two periods (t-2). Expressed mathematically, the hypothesis is: $H_0 2$: $\theta_2 = 0$ as against $H_0 2$: $\theta_2 \neq 0$.

4. Analysis Results and Discussion

4.1 Stationarity of the Series

Log of real gross domestic product series did not follow stationary pattern. Therefore, the data series has to be differenced once to make it stationary. Augmented Dickey-Fuller (ADF) unit root test further confirmed stationarity of the series. Correlograms of autocorrelation (AC) function and partial autocorrelation (PAC) function for first differenced log of real gross domestic product series were plotted, and the results are shown in Table 4.1.1. Correlograms of autocorrelation (AC) function and partial autocorrelation (PAC) function for preceding two periods random shocks for two-year lagged error term or residual are shown in Table 4.1.1.

Table 4.1.1: Correlograms of Autocorrelation (AC) Function and Partial Autocorrelation (PAC) Function for Real Gross Domestic Product of Nigeria (1981 – 2016)

Sample: 1981 2016
Included observations: 35

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>****| . |</td><td>****| . |</td><td>1</td><td>-0.478</td><td>-0.478</td><td>8.6949</td><td>0.003</td></tr>
<tr><td>. | . |</td><td>.**| . |</td><td>2</td><td>0.003</td><td>-0.292</td><td>8.6952</td><td>0.013</td></tr>
<tr><td>. | . |</td><td>.**| . |</td><td>3</td><td>-0.012</td><td>-0.212</td><td>8.7013</td><td>0.034</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>4</td><td>0.002</td><td>-0.158</td><td>8.7015</td><td>0.069</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>5</td><td>-0.037</td><td>-0.177</td><td>8.7618</td><td>0.119</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>6</td><td>0.062</td><td>-0.084</td><td>8.9322</td><td>0.177</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>7</td><td>-0.024</td><td>-0.065</td><td>8.9591</td><td>0.256</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>0.011</td><td>-0.035</td><td>8.9646</td><td>0.345</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>9</td><td>-0.025</td><td>-0.052</td><td>8.9947</td><td>0.438</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>10</td><td>0.003</td><td>-0.055</td><td>8.9952</td><td>0.533</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>0.024</td><td>-0.011</td><td>9.0272</td><td>0.619</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>-0.039</td><td>-0.053</td><td>9.1122</td><td>0.693</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>13</td><td>-0.036</td><td>-0.131</td><td>9.1873</td><td>0.759</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>14</td><td>0.036</td><td>-0.116</td><td>9.2694</td><td>0.813</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>15</td><td>0.026</td><td>-0.060</td><td>9.3143</td><td>0.861</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>-0.005</td><td>-0.034</td><td>9.3163</td><td>0.900</td></tr>
</table>

Source: Authors' computations (2017)

In Table 4.1.1, the correlograms of the autocorrelation (AC) function and partial autocorrelation (PAC) respectively, indicate that the differenced logged series of real gross domestic product is stationary at first differencing.

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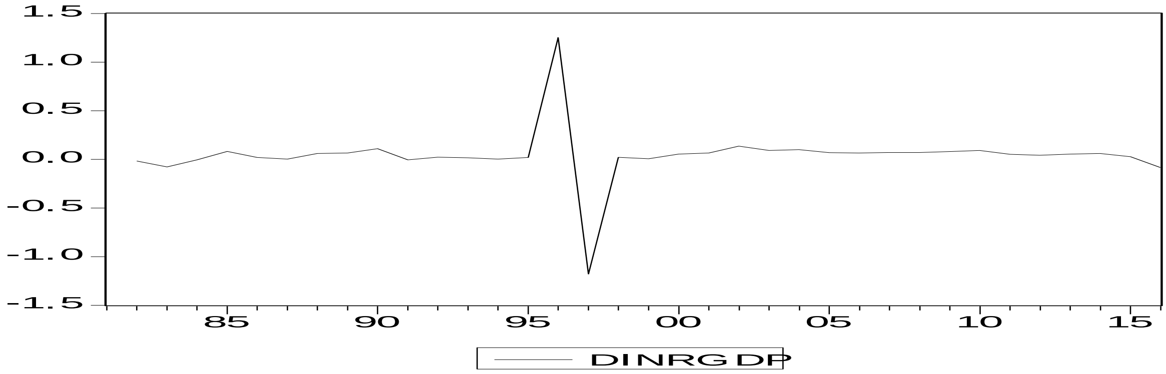
Figure 4.1.1: Graphical Illustration of Stationarity of First Differenced Log Real Gross Domestic Product of Nigeria (1981-2016)



Source: Authors' illustration plotted from Table 1.

Table 4.1.2: Correlograms of Autocorrelation (AC) Function and Partial Autocorrelation (PAC) Function for Preceding Two Periods Random Shocks (Two-Year Lagged Error Terms)

Sample: 1983 2016
Included observations: 34

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. *| . |	. *| . |	1	-0.146	-0.146	0.7893	0.374
.**| . |	***| . |	2	-0.305	-0.333	4.3453	0.114
. | . |	. *| . |	3	-0.016	-0.142	4.3553	0.226
. | . |	.**| . |	4	-0.028	-0.191	4.3869	0.356
. | . |	. *| . |	5	-0.022	-0.148	4.4068	0.492
. | . |	. *| . |	6	0.061	-0.068	4.5678	0.600
. | . |	. *| . |	7	0.009	-0.069	4.5713	0.712
. | . |	. | . |	8	-0.010	-0.041	4.5762	0.802
. | . |	. *| . |	9	-0.030	-0.071	4.6212	0.866
. | . |	. | . |	10	0.004	-0.037	4.6221	0.915
. | . |	. | . |	11	0.016	-0.027	4.6363	0.947
. *| . |	. *| . |	12	-0.069	-0.112	4.9045	0.961
. *| . |	. *| . |	13	-0.058	-0.148	5.0992	0.973
. |* . |	. | . |	14	0.087	-0.054	5.5614	0.976
. | . |	. | . |	15	0.049	-0.042	5.7168	0.984
. | . |	. | . |	16	-0.008	-0.024	5.7207	0.991

Source: Authors' computations (2017)

The respective correlograms of the autocorrelation (AC) function and partial autocorrelation (PAC) shown in Table 4.1.2 indicate show that series of two-period lagged error term (random shocks) is stationary at second differencing.

Table 4.1.3: Results of ADF Unit Root Test on First Difference Log of Real GDP Series

Variable Series	Hypothesis	t-statistic	P*
First Difference of Log of Real GDP	First difference of log of real GDP has a unit root	-6.340571	-4.2605 -3.5514 -3.2081

*MacKinnon critical value for rejection of hypothesis of a unit root at 1%, 5%, and 10% respectively

Sources: Authors' computations (2017)

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The ADF unit root test results in Table 4.1.3, as well as R-squared value of 0.3458 and adjusted R-squared value of 0.3007 respectively in Table 4.2.1 each of which is less than the Durbin-Watson statistic value of 20.762, further confirm that first differenced log of real gross domestic product series for the 35 observations (1982 – 2016) followed stationary pattern and, thus, substantiated specification of the ARIMA(1, 2) model.

4.2 Estimates of Coefficients, and Estimated ARIMA(1, 2) Model

Coefficients of the ARIMA(1,2) model, with relevant statistics, are shown in Table 4.2. The estimated ARIMA(1, 2) model is shown from the results in Table 4.2.1.

Table 4.2.1: Estimates of Coefficients of AR(1) and MA(2) Terms

Predictor	Coefficient (β_1, θ_2)	Std. Error	t-statistic	P-value
Constant (β_0)	0.0852	0.0471	1.8103	0.0806
AR(1)	-0.7072*	0.1807	-3.9148	0.0005
MA(2)	-0.4505**	0.2056	-2.1914	0.0366
R-squared = 0.3458 Adjusted R-squared = 0.3007 Durbin-Watson statistic = 2.0762				

Note: AR = Autoregressive, MA = Moving Average, *P-Value < 0.01, **P-Value < 0.05.

4.3 The Estimated Model, Relevant Statistics, and Discussion

The estimated ARIMA(1, 2) model is:

$$DInRGDP_t = 0.0852 – 0.7072DInRGDP_{t-1} – 0.4505\varepsilon_{t-2}$$

Std. Error: (0.0852) (0.1807) (0.2056)

R-squared: 0.3458 Adjusted R-squared: 0.3007 Durbin-Watson Statistic: 2.0762

The hypothesis is that RGDP in current period t is not related to RGDP in (t-1) period. The result in Table 4.2.1 does not support this hypothesis. Instead, RGDP in current period t is found to have significant negative relationship with RGDP in immediate preceding period for this macroeconomic variable. Similarly, RGDP in current period t is found to have significant negative relationship with random shock in (t-2) periods. Therefore, the result does not support the hypothesis that RGDP in current period t is not related to random shock in (t-2) periods. The implication is that RGDP in current period t is not related to random shock in (t-1) period, but is strongly related to random shock in (t-2) periods. This shows that RGDP random shock of immediate preceding two periods should be taken into consideration in forecasting RGDP of Nigeria, while less emphasis should be placed on RGDP of immediate preceding one period.

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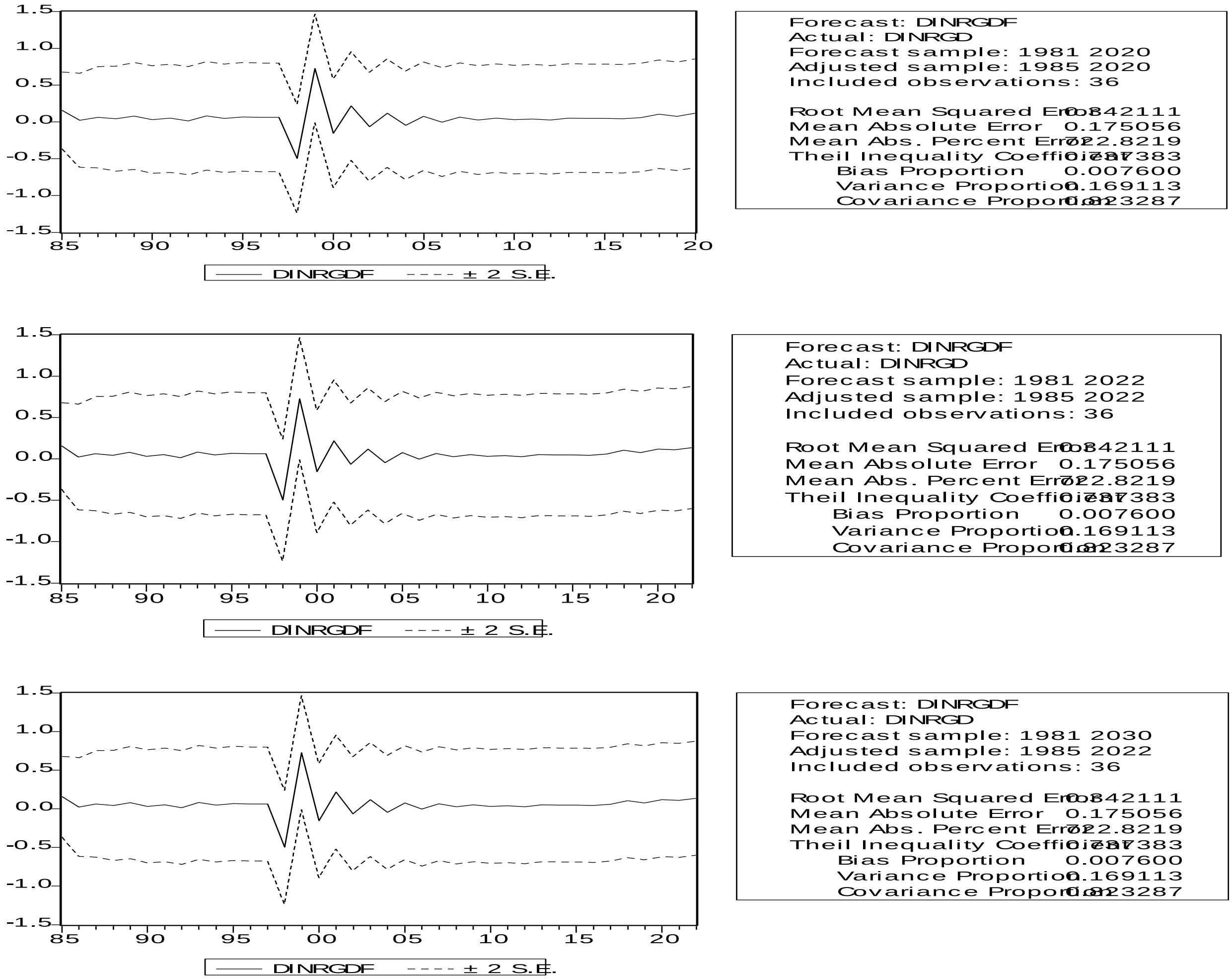
Figure 4.3.1: Graphical Representation of Real Gross Domestic Product Forecasts for Nigeria (2020, 2022, 2030)



Source: Authors' plots (2017) based on Nigeria RGDP (1981 – 2016)

4.4 Forecasting Real GDP of Nigeria for 2017 – 2030 Based on the Estimated ARIMA(1, 2) Model

In time modeling with univariate time series data, researchers are interested in producing forecasts with minimum error possible. Therefore, our interest at this point is to use the estimated ARIMA(1, 2) model to forecast the real gross domestic product of Nigeria for the years 2020, 2022 and 2030, as a means of assessing the forecasting performance of the model. Box-Jenkins approach is considered to be effective in handling many in real life. The approach has been shown to outperform the Holt-Winters and stepwise auto-regression forecasts (Newbold and Granger, 1974). Moreover, Naylor, Seaks and Wichern (1972) showed that the Box-Jenkins method give better forecasts that traditional econometric methods. We computed forecasts from the estimated ARIMA(1, 2) model by replacing future values of the error term with zero, and obtain the forecasts for 2017 – 2030 shown in Table 4.4.1.

To forecast the InRGDP of Nigeria for the years ahead, we integrated the first differenced series (i.e., we "undid" the first-difference transformation that we had used to obtain the changes in lnRGDP (Gujarati, 2013: 794). Given zero mean and constant variance property for

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stationarity of series, therefore, we re-wrote the ARIMA(1, 2) model as follows for the 2017 – 2030 years, respectively:

$InRGDP_{2017} - InRGDP_{2016} = \mu + \beta_1\mu_{2016} + \theta_2\varepsilon_{2015} + \mu_{2017}$: (Forecast value of Nigeria InRGDP in 2017)

$RGDP_{2018} - InRGDP_{2017} = \mu + \beta_1\mu_{2017} + \theta_2\varepsilon_{2016} + \mu_{2018}$: (Forecast value of Nigeria InRGDP in 2018)

$RGDP_{2019} - InRGDP_{2018} = \mu + \beta_1\mu_{2018} + \theta_2\varepsilon_{2017} + \mu_{2019}$: (Forecast value of Nigeria InRGDP in 2019)

$RGDP_{2020} - InRGDP_{2019} = \mu + \beta_1\mu_{2019} + \theta_2\varepsilon_{2018} + \mu_{2020}$: (Forecast value of Nigeria InRGDP in 2020)

$RGDP_{2021} - InRGDP_{2020} = \mu + \beta_1\mu_{2020} + \theta_2\varepsilon_{2019} + \mu_{2021}$: (Forecast value of Nigeria InRGDP in 2021)

$RGDP_{2022} - InRGDP_{2021} = \mu + \beta_1\mu_{2021} + \theta_2\varepsilon_{2020} + \mu_{2022}$: (Forecast value of Nigeria InRGDP in 2022)

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$RGDP_{2030} - RGDP_{2029} = \mu + \beta_1\mu_{2029} + \theta_2\varepsilon_{2028} + \mu_{2030}$: (Forecast value of Nigeria InRGDP in 2030)

Where: $\mu_{2017} = \mu_{2018} = \mu_{2019} = ... = \mu_{2030}$ is assumed.

The ARIMA(1, 2) forecast series values of real gross domestic of Nigeria for the years 2017 – 2030 are shown in Table 4.4.1.

Table 4.4.1: ARIMA(1, 2) Forecast Values of Real GDP for Nigeria (2017 – 2030)

Time Series Forecast Model: ARIMA(1, 2)	Forecast: InRGDP	Forecast: RGDP (₦'Billion Inflation-Adjusted at 1990 Constant Prices)
$InRGDP_{2017} - InRGDP_{2016} = \mu + \beta_1\mu_{2016} + \theta_2\varepsilon_{2015} + \mu_{2017}$	$InRGDP_{2017} = e^{11.120520}$	$RGDP_{2017} = 67543.02$
$InRGDP_{2018} - InRGDP_{2017} = \mu + \beta_1\mu_{2017} + \theta_2\varepsilon_{2016} + \mu_{2018}$	$InRGDP_{2018} = e^{11.128486}$	$RGDP_{2018} = 68083.22$
$InRGDP_{2019} - InRGDP_{2018} = \mu + \beta_1\mu_{2018} + \theta_2\varepsilon_{2017} + \mu_{2019}$	$InRGDP_{2019} = e^{11.136452}$	$RGDP_{2019} = 68627.73$
$InRGDP_{2020} - InRGDP_{2019} = \mu + \beta_1\mu_{2019} + \theta_2\varepsilon_{2018} + \mu_{2020}$	$InRGDP_{2020} = e^{11.144418}$	$RGDP_{2020} = 69176.60$
$InRGDP_{2021} - InRGDP_{2020} = \mu + \beta_1\mu_{2020} + \theta_2\varepsilon_{2019} + \mu_{2021}$	$InRGDP_{2021} = e^{11.152384}$	$RGDP_{2021} = 69729.87$
$InRGDP_{2022} - InRGDP_{2021} = \mu + \beta_1\mu_{2021} + \theta_2\varepsilon_{2020} + \mu_{2022}$	$InRGDP_{2022} = e^{11.16035}$	$RGDP_{2022} = 70287.55$
$InRGDP_{2023} - InRGDP_{2022} = \mu + \beta_1\mu_{2022} + \theta_2\varepsilon_{2021} + \mu_{2023}$	$InRGDP_{2023} = e^{11.168316}$	$RGDP_{2023} = 70849.70$
$InRGDP_{2024} - InRGDP_{2023} = \mu + \beta_1\mu_{2023} + \theta_2\varepsilon_{2022} + \mu_{2024}$	$InRGDP_{2024} = e^{11.176282}$	$RGDP_{2024} = 71416.34$
$InRGDP_{2025} - InRGDP_{2024} = \mu + \beta_1\mu_{2024} + \theta_2\varepsilon_{2023} + \mu_{2025}$	$InRGDP_{2025} = e^{11.184248}$	$RGDP_{2025} = 71987.52$
$InRGDP_{2026} - InRGDP_{2025} = \mu + \beta_1\mu_{2025} + \theta_2\varepsilon_{2024} + \mu_{2026}$	$InRGDP_{2026} = e^{11.192208}$	$RGDP_{2026} = 72562.82$
$InRGDP_{2027} - InRGDP_{2026} = \mu + \beta_1\mu_{2026} + \theta_2\varepsilon_{2025} + \mu_{2027}$	$InRGDP_{2027} = e^{11.200174}$	$RGDP_{2027} = 73143.17$
$InRGDP_{2028} - InRGDP_{2027} = \mu + \beta_1\mu_{2027} + \theta_2\varepsilon_{2026} + \mu_{2028}$	$InRGDP_{2028} = e^{11.208140}$	$RGDP_{2028} = 73728.15$
$InRGDP_{2029} - InRGDP_{2028} = \mu + \beta_1\mu_{2028} + \theta_2\varepsilon_{2027} + \mu_{2029}$	$InRGDP_{2029} = e^{11.216106}$	$RGDP_{2029} = 74317.82$
$InRGDP_{2030} - InRGDP_{2029} = \mu + \beta_1\mu_{2029} + \theta_2\varepsilon_{2028} + \mu_{2030}$	$InRGDP_{2030} = e^{11.224072}$	$RGDP_{2030} = 74912.20$
Where $where\mu_{2017} = where\mu_{2018} = where\mu_{2019} = ... = where\mu_{2030}$ *is assumed*		

Source: Authors' forecasts (2017)

5. Conclusion and Policy Recommendations

In this paper, real gross domestic product (RGDP) of Nigeria has been forecasted for fourteen years (2017 – 2030) based on autoregressive moving average (ARIMA) model fitted to 1981-2016 data. The forecast time series values of the macroeconomic variable for the years ahead indicate the possibility of sustained increases in real gross domestic product of Nigeria. The forecast shows no obvious fluctuations or downturns in the economy, thereby depicting the possibility increasing economic activities via appropriate real output-inducing investments in key sectors of the economy in particular and the entire economy in general. The forecast is impressive since coefficients of the respective autoregressive (AR) and moving average (MA) components of the model series are statistically significant. Moreover, the model is parsimonious as evidence of its being effective to forecast real gross domestic product of Nigeria for the years ahead.

However, the caveat is that requisite macroeconomic environment, political climate, social cohesiveness and investment cum business processes are germane for the attainment of at least the forecast real gross domestic production of the country in the years ahead. This entails appropriate policy mix and initiatives on the part of the government and other stakeholders in the Nigerian economy. Essentially, the policy implication is that diversification of economic base of the country is *sine quo none* for any economic programme aimed at achieving sustainable aggregate real output growth in the years ahead, especially from the year 2020, to be effective in channeling real output growth of the country in the desired direction.

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APPENDIX 1
Augmented Dickey-Fuller Unit Root Test

ADF Test Statistic	-6.340571	1% Critical Value*	-4.2605
		5% Critical Value	-3.5514
		10% Critical Value	-3.2081

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INRGDP,2)
Method: Least Squares
Date: 01/26/18 Time: 12:31
Sample(adjusted): 1984 2016
Included observations: 33 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INRGDP(-1))	-1.938339	0.305704	-6.340571	0.0000
D(INRGDP(-1),2)	0.305183	0.177348	1.720817	0.0959
C	0.058220	0.104461	0.557338	0.5816
@TREND(1981)	0.001625	0.004940	0.328911	0.7446

R-squared	0.765831	Mean dependent var	-0.000203
Adjusted R-squared	0.741607	S.D. dependent var	0.528520
S.E. of regression	0.268659	Akaike info criterion	0.322468
Sum squared resid	2.093158	Schwarz criterion	0.503863
Log likelihood	-1.320720	F-statistic	31.61405
Durbin-Watson stat	2.136999	Prob(F-statistic)	0.000000

APPENDIX 2
Results of Estimated ARIMA(1, 2) Model

Dependent Variable: DINRGD
Method: Least Squares
Date: 01/26/18 Time: 13:45
Sample(adjusted): 1982 2016
Included observations: 35 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.085197	0.047062	1.810300	0.0806
DINRGD(-1)	-0.707235	0.180657	-3.914803	0.0005
RES(-2)	-0.450520	0.205583	-2.191430	0.0366

R-squared	0.345769	Mean dependent var	0.047681
Adjusted R-squared	0.300650	S.D. dependent var	0.311642
S.E. of regression	0.260618	Akaike info criterion	0.237536
Sum squared resid	1.969726	Schwarz criterion	0.374949
Log likelihood	-0.800574	F-statistic	7.663424
Durbin-Watson stat	2.076168	Prob(F-statistic)	0.002129