Is Nigeria's economy progressing or backsliding? Implications from ARIMA models

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IS NIGERIA'S ECONOMY PROGRESSING OR BACKSLIDING? IMPLICATIONS FROM ARIMA MODELS

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Abstract

Using annual time series data on GDP per capita in Nigeria from 1960 to 2017, I model and forecast GDP per capita using the Box – Jenkins ARIMA technique. My diagnostic tests such as the ADF tests show that Nigerian GDP per capita data is I (1). Based on the AIC, the study presents the ARIMA (2, 1, 0) model. The diagnostic tests further reveal that the presented optimal model is stable and hence reliable. The results of the study indicate that living standards in Nigeria will tumble over the next decade, as long as the current economic policy stance is not reviewed. Indeed, Nigeria's economy is backsliding again!!! In order to improve the living standards of an ordinary Nigerian, this study has put forward four-fold policy prescriptions.

Key Words: GDP per capita, Forecasting, Nigeria

JEL Codes: C53, E37, O47

INTRODUCTION

Nigeria's overall economic under – performance since independence in 1960 is a self – inflicted phenomenon given her abundant human and natural resource endowment. Nigeria is actually too rich to be poor. Unfortunately, Nigeria is one of the world's economically backward countries. This is the reason why in Nigeria growth continuously takes the lion's share in the policy thrust of the federal government's development objectives (Nyoni & Bonga, 2018a). Sustainable economic growth mainly depends on a nation's ability to invest and make efficient and productive use of the resources at its disposal (Nyoni & Bonga, 2017f). To move Nigeria on a sustainable economic trajectory, policy makers should focus on those factors that determine economic growth in Nigeria. It is important to note that the federal government's policy response, especially in terms of macroeconomic reforms; with the hope of improving economic growth still remains disappointing and disturbing (Nyoni & Bonga, 2018a). Hence, a forecasting

framework is needed to effectively address the challenge of understanding the current state of economic activity for policy decisions (CBN, 2015).

The need for a more consistent and accurate GDP forecast for the conduct of forward-looking monetary policy is quite fundamental. This is because the availability of real-time data is crucial to determine the initial conditions of economic activity on latent variables such as the output gap to make policy decisions. Central banks use available monetary policy instruments to influence the volume and direction of monetary aggregates, consistent with predetermined output and price targets. In both developed and developing countries, a traditional central bank reaction function is characterized by price and output development. Thus, taking decisions about the monetary policy rate without an estimate of the output gap is tantamount to 'flying blind' and making unacceptably, large errors and revisions that are uncertain (CBN, 2015). This study employed the Box-Jenkins ARIMA technique to forecast GDP per capita for Nigeria to aid macroeconomic policy decisions.

LITERATURE REVIEW

Gupta (2007) analyzed the South Africa economy with VARs and VECMs using monthly data over the period 1970 to 2000 and found out that the Bayesian Vector Error Correction Model (BVECM) has the most accurate out of sample forecasts. In a Chinese study, Lu (2009), modeled and forecasted GDP based on ARIMA models using annual data from 1962 to 2008 and established that the ARIMA (4, 1, 0) model was the optimal model. In the USA, Camacho & Martinez-Martin (2014), looked at US GDP from the point of view of small-scale factor models and basically established the single-index dynamic factor model developed by Aruba & Diebold (2010) to construct an index of US business cycle conditions is also very useful for forecasting US GDP growth in real time. Maliki *et al* (2014), in Nigeria, forecasted GDP using Artificial Neural Networks (ANNs), employing quarterly data from 1990 to 2009 and found out that ANNs outperform regression analysis significantly. Dritsaki (2015) investigated real GDP in Greece basing on the Box-Jenkins ARIMA approach during the period 1980 – 2013 and found out that the ARIMA (1, 1, 1) model was the optimal model. In 2015, the Central Bank of Nigeria (CBN), employed a dynamic factor model to forecast GDP growth rate for Nigeria and basically found out that the persistence of growth contraction lasts about 7.4 months while the higher growth regime continued for approximately 4.6 months. In Kenya, Wabomba *et al* (2016) studied GDP using ARIMA models with an annual data set ranging from 1960 to 2012 and established that the ARIMA (2, 2, 2) model was the best for modeling the Kenyan GDP.

METHODOLOGY

ARIMA Models

ARIMA models are often considered as delivering more accurate forecasts then econometric techniques (Song *et al*, 2003b). ARIMA models outperform multivariate models in forecasting performance (du Preez & Witt, 2003). Overall performance of ARIMA models is superior to that of the naïve models and smoothing techniques (Goh & Law, 2002). ARIMA models were developed by Box and Jenkins in the 1970s and their approach of identification, estimation and diagnostics is based on the principle of parsimony (Asteriou & Hall, 2007). The forecasting equation for GDP per capita (Y) with ARIMA (p, d, q) models, where the p denotes the order of

the autoregressive part, the d the order of integration and the q the order of the moving average part of the model, can be given, in terms of the lag operator notation as:

$$\emptyset_p(L)\Delta^d Y_t = \theta_q(L)\mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

The Box – Jenkins Methodology

The first step towards model selection is to difference the series in order to achieve stationarity. Once this process is over, the researcher will then examine the correlogram in order to decide on the appropriate orders of the AR and MA components. It is important to highlight the fact that this procedure (of choosing the AR and MA components) is biased towards the use of personal judgement because there are no clear – cut rules on how to decide on the appropriate AR and MA components. Therefore, experience plays a pivotal role in this regard. The next step is the estimation of the tentative model, after which diagnostic testing shall follow. Diagnostic checking is usually done by generating the set of residuals and testing whether they satisfy the characteristics of a white noise process. If not, there would be need for model re – specification and repetition of the same process; this time from the second stage. The process may go on and on until an appropriate model is identified (Nyoni, 2018i).

Data Collection

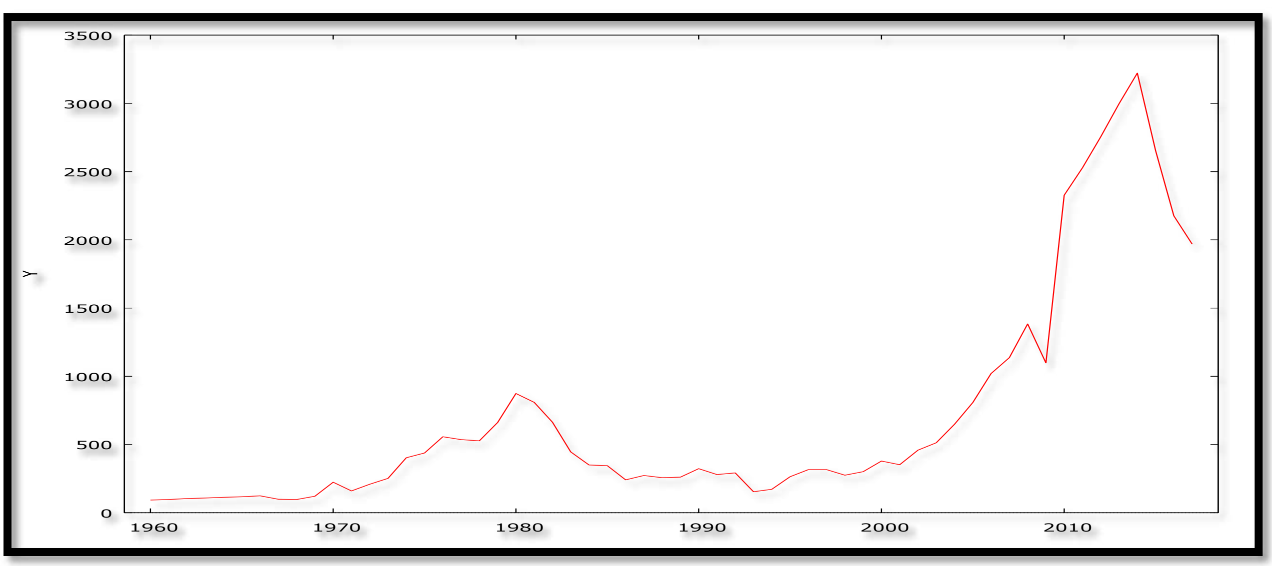
The present study is based on 58 observations of annual GDP per capita (Y) in Nigeria, from 1960 – 2017; whose data was collected from the World Bank online database which is well known for its integrity and credibility.

Diagnostic Tests & Model Evaluation

Stationarity Tests:

Graphical Analysis

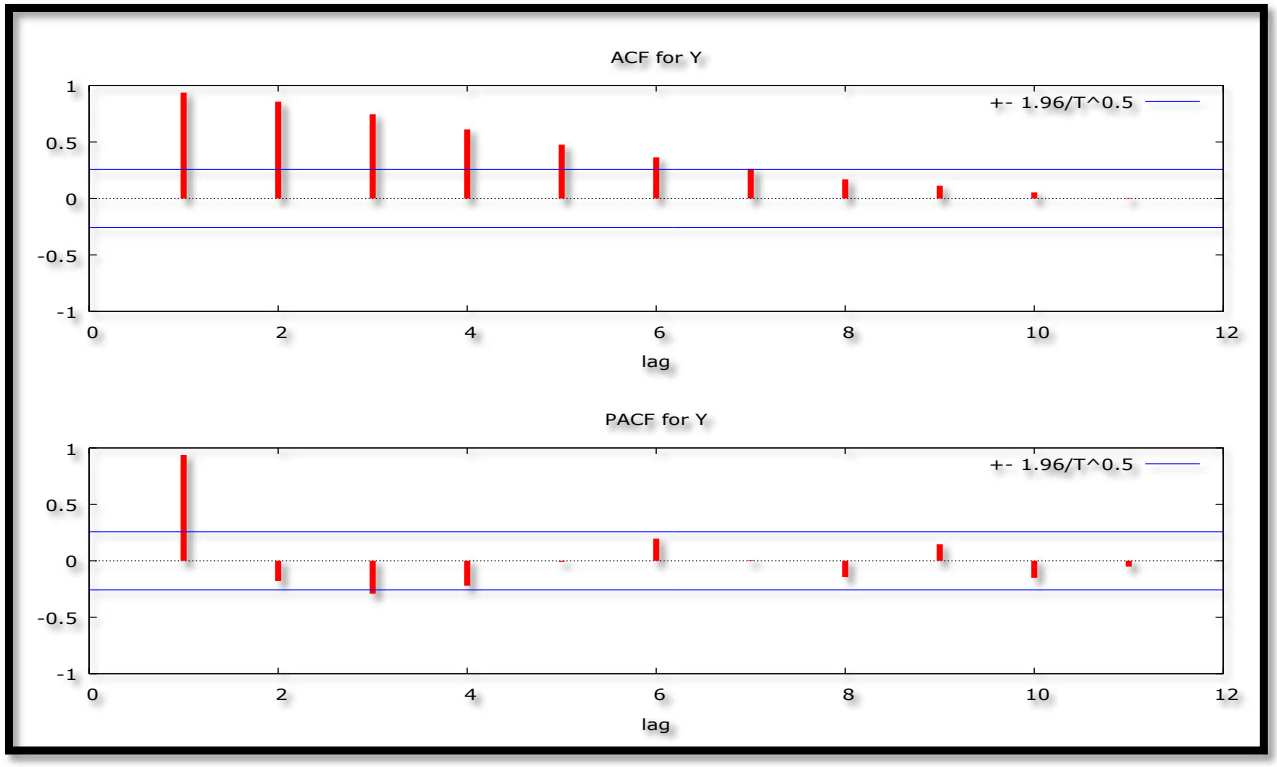
Figure 1



As shown in figure 1 above, the Y variable is not stationary since it is generally trending upwards over the period under study and this simply implies that the mean of Y is changing over time and hence its varience is not constant over time.

The Correlogram in Levels

Figure 2



A shown by figure 2 above, the correlogram above confirms our analysis derived from the observation of the time series plot of Y. The autocorrelation coefficients are quite high especially for the first 6 lags. This is quite common in non – stationary time series data.

The ADF Test

Table 1: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
Y	-0.555293	0.8718	-3.550396	@1%	Not stationary
			-2.913549	@5%	Not stationary
			-2.594521	@10%	Not stationary

Table 2: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
Y	-1.466313	0.8297	-4.127338	@1%	Not stationary
			-3.490662	@5%	Not stationary
			-3.173943	@10%	Not stationary

Table 3: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
Y	0.292054	0.7670	-2.606163	@1%	Not stationary
			-1.946654	@5%	Not stationary
			-1.613122	@10%	Not stationary

The Correlogram (at 1st Differences)

Figure 3

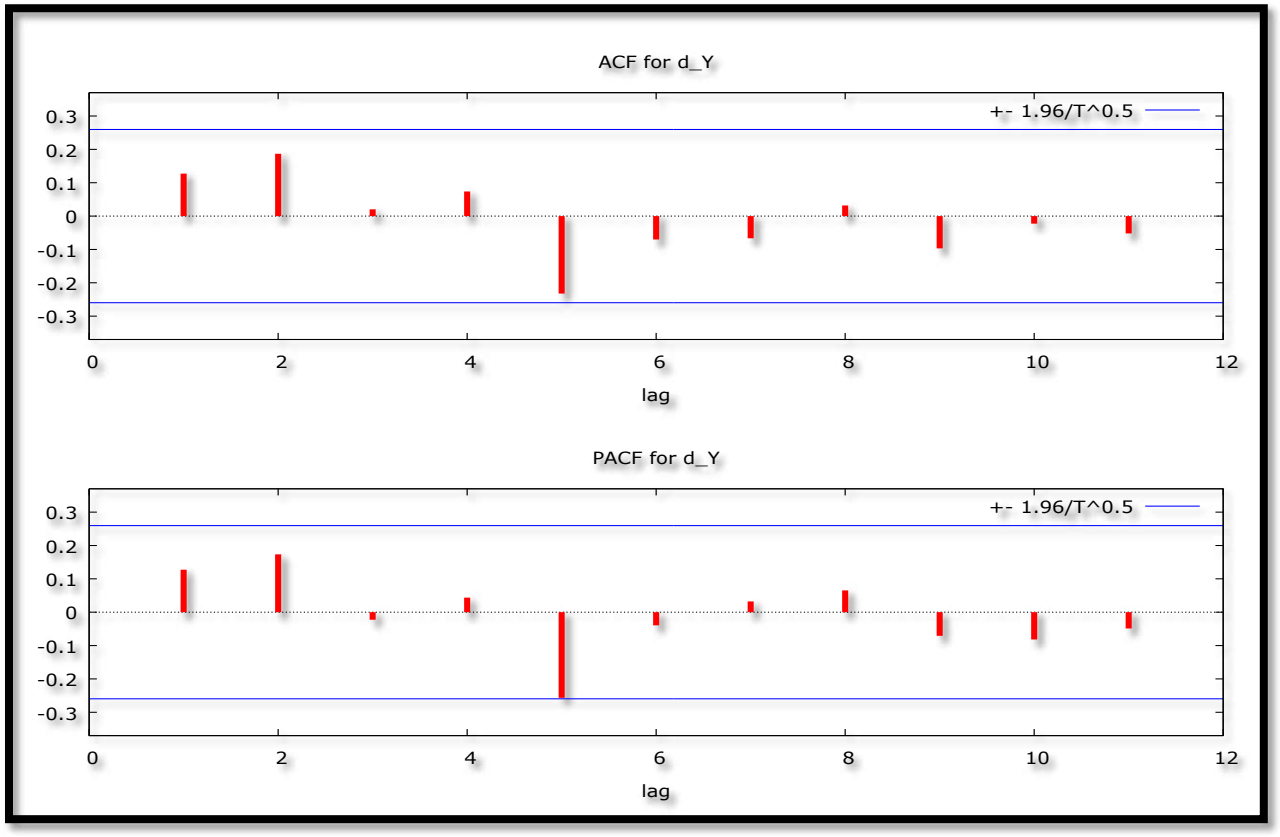


Table 4: 1st Difference-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
Y	-6.378392	0.0000	-3.552666	@1%	Stationary
			-2.914517	@5%	Stationary
			-2.595033	@10%	Stationary

Table 5: 1st Difference-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
Y	-6.354822	0.0000	-4.130526	@1%	Stationary
			-3.492149	@5%	Stationary
			-3.174802	@10%	Stationary

Table 6: 1st Difference-without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
Y	-6.316635	0.0000	-2.606911	@1%	Stationary
			-1.946764	@5%	Stationary
			-1.613062	@10%	Stationary

Tables 1 – 3 confirm that the Y series is non-stationary in levels. Figure 3 and tables 4 to 6 portray the same information i.e., that the Y series is stationary in first differences.

Evaluation of ARIMA models (without a constant)

Table 7

Model	AIC	U	ME	MAE	RMSE	MAPE
ARIMA (1, 1, 1)	781.3676	0.99473	19.026	110.61	217.45	17.6
ARIMA (2, 1, 1)	782.1885	0.99296	17.075	110.58	215.1	17.43
ARIMA (3, 1, 1)	784.1817	0.99345	16.805	110.46	215.08	17.437
ARIMA (1, 1, 0)	780.7372	1.0007	27.473	115.15	220.16	17.759
ARIMA (2, 1, 0)	**780.2629**	**0.99231**	18.876	110.99	215.25	17.398
ARIMA (0, 1, 4)	780.4771	1.0475	11.292	107.59	207.29	18.16

A model with a lower AIC value is better than the one with a higher AIC value (Nyoni, 2018n). In this research, we rely only on the AIC in order to select the best model. Therefore, the ARIMA (2, 1, 0) model is chosen as the optimal model.

Residual & Stability Tests

ADF Tests of the Residuals of the ARIMA (2, 1, 0) Model

Table 8: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
ε_t	-6.302472	0.0000	-3.552666	@1%	Stationary
			-2.914517	@5%	Stationary
			-2.595033	@10%	Stationary

Table 9: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
ε_t	-6.346241	0.0000	-4.130526	@1%	Stationary
			-3.492149	@5%	Stationary
			-3.174802	@10%	Stationary

Table 10: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
ε_t	-6.361368	0.0000	-2.606911	@1%	Stationary
			-1.946764	@5%	Stationary
			-1.613062	@10%	Stationary

Tables 8, 9 and 10 indicate that the residuals of the ARIMA (2, 1, 0) model are stationary and thus possess the much needed features of a white noise process.

Stability Test of the ARIMA (2, 1, 0) Model

Figure 4

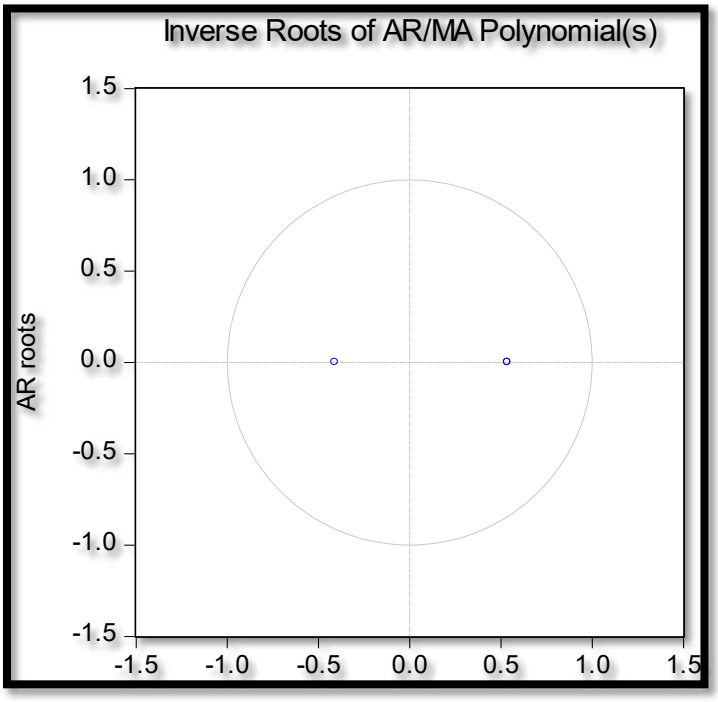


Figure 4 above indicates that the ARIMA (2, 1, 0) model is very stable because the corresponding inverse roots of the characteristic polynomial lie in the unit circle.

RESULTS & DISCUSSION

Descriptive Statistics

Table 11

Description	Statistic
Mean	701.40
Median	347.50
Minimum	93
Maximum	3222
Standard deviation	821.27
Skewness	1.7996
Excess kurtosis	2.0352

As shown in table 11 above, the mean is positive, i.e 701.4. The minimum GDP per capita in Nigeria is 93 and was realized in 1960 while the maximum GDP per capita is 3222 and was realized in 2014. The maximum GDP per capita realized in 2014 in Nigeria could be attributed to the leadership of former President of Nigeria, Mr. Goodluck Jonathan; under his administration, over the period 2011 – 2014; Nigeria's economy grew at a rate of approximately 5.2% per annum. Over the same period, Nigeria's GDP per capita sharply increased as shown in figure 1 above, hence living standards of Nigerians changed for the better. The skewness is 0.38767 and the most striking feature is that it is positive, indicating that the Y series is positively skewed and

non-symmetric. Nyoni & Bonga (2017h) note that the rule of thumb for kurtosis is that it should be around 3 for normally distributed variables and yet in this study, kurtosis has been found to be -1.2029; indicating that the Y series is not normally distributed.

Results Presentation[1]

Table 12

ARIMA (2, 1, 0) Model:

$\Delta Y_{t-1} = 0.123562\Delta Y_{t-1} + 0.211775\Delta Y_{t-2}$ ……[2]

P: (0.3417) (0.1186)

S. E: (0.129967) (0.135)

Variable	Coefficient	Standard Error	z	p-value
AR (1)	0.123562	0.129967	0.9507	0.3417
AR (2)	0.211775	0.135	1.561	0.1186

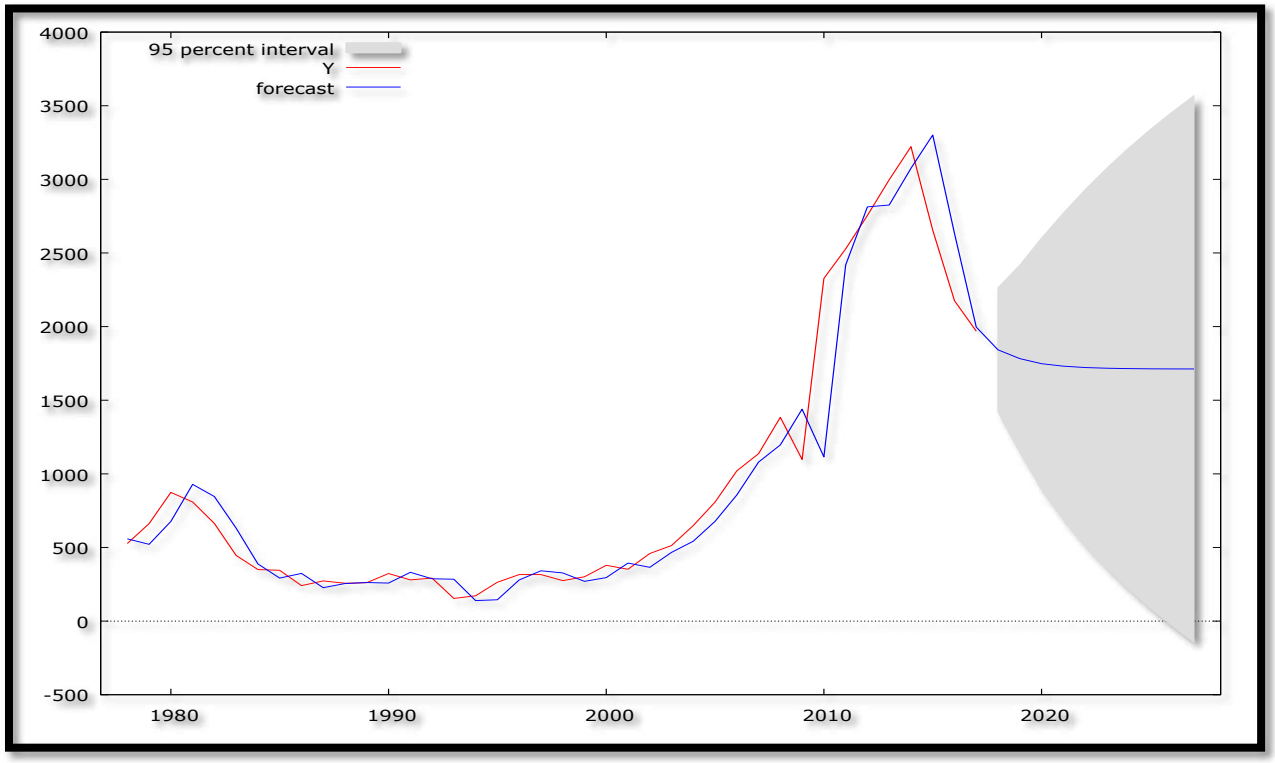
Interpretation of Results

Both AR components (i.e the AR (1) and AR (2) coefficients) are positive as conventionally expected, although statistically insignificant. The statistical insignificance of the coefficients could be attributed to the fact that ARIMA models are limited in terms of predicting turning points. The most striking feature of this model has already been outlined in table 7 – it's the optimal model. That's what's important about this model.

Forecast Graph

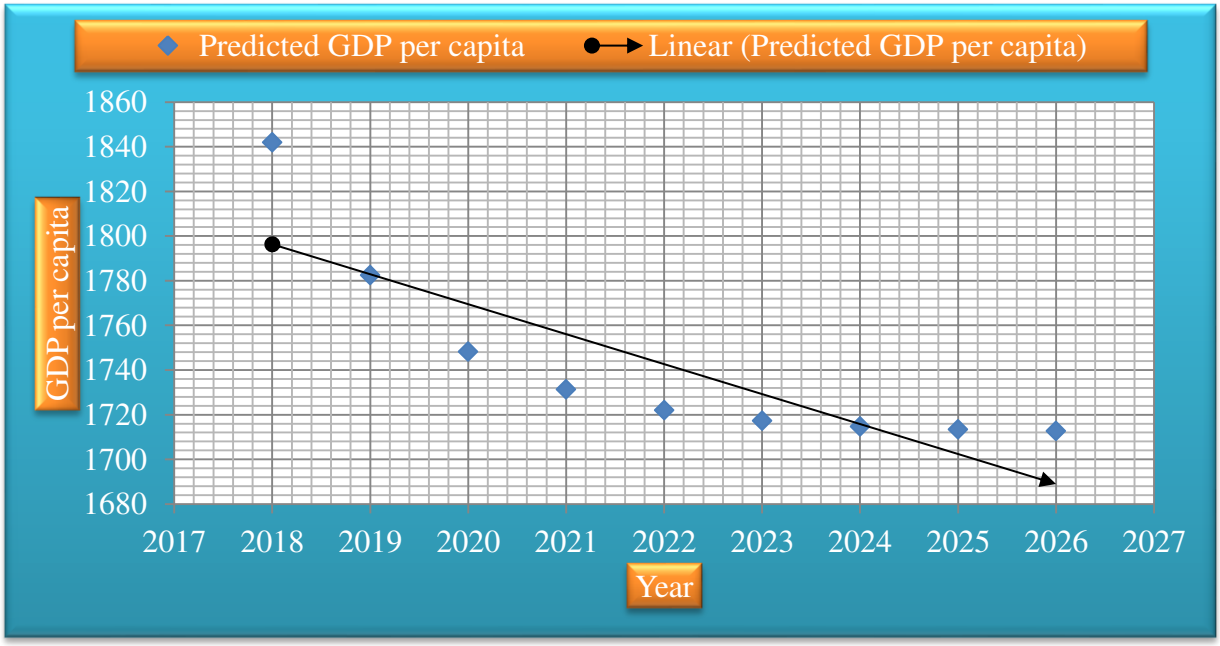
[1] *The *, ** and *** means significant at 10%, 5% and 1% levels of significance; respectively.*

Figure 5



Predicted GDP per capita (for the next decade)

Figure 6



Figures 5 and 6, with a forecast range of 10 years; clearly indicate that Nigerian GDP per capita is set to further decline over the next decade, especially if the current economic policy stance is not revised! By the end of the year 2020, GDP per capita in Nigeria is expected to be somewhere around 1748.2 USD, which clearly confirms that Nigeria is surely being headed to the wrong direction! If the current gross macroeconomic mismanagement continues, by 2024; Nigeria's GDP per capita will be as low as 1714.74 USD, something which is immeritorious. Therefore, it's high time for policy makers in Nigeria to change their attitude towards policy formulation and implementation.

Currently, the economic blueprint slogan is "Vision 2020", and is mainly aimed at making Nigeria one of the biggest economies in the world by the year 2020 (Nyoni & Bonga, 2018a). Vision 2020 will fail! This is "bad news" for all Nigerians but that's the reality. Living standards of ordinary Nigerians will continue to deteriorate, unless there are serious policy changes in Nigeria. While some Nigerians expect His Excellency Honourable Muhammadu Buhari to improve the economic fortunes of Nigerians, Nyoni & Bonga (2018a); have clearly noted that under the President's watch, economic growth, so far; has fallen from 2.7% in 2015 to 2.5% in 2016 and further down to approximately 2.1% in 2017. Figure 1 also shows that the coming in of President Buhari saw the falling of GDP per capita in Nigeria, from 3222 USD in 2014 to 2655 USD in 2015 and further down to 1969 USD in 2017. It is quite clear now, where Nigeria is being headed to and figure 6 above is just a reminder on what is likely to happen in Nigeria if nothing is done to economically exonerate Nigeria.

POLICY IMPLICATIONS

i. The way the Boko Haram issue is being handled leaves a lot to be desired (Nyoni, 2018f). The need for political stability in Nigeria should not be undermined.
ii. Nigerian political leaders and public office holders should walk their talk on corruption (Nyoni, 2018f) if Nigerian living standards are to be improved any time soon.
iii. While Nigerian policy makers are well-known for coming up with good economic blueprints, what really matters this time around is the implementation of such blueprints. Nigeria's Vision 2020 will fail as clearly shown by perpetually falling GDP per capita. The failure is mainly attributed to lack of seriousness on the area of implementation as well as lack of political will.
iv. Successive governments should thrive to facilitate meaningful and gainful interactions between domestic and foreign investors (Nyoni & Bonga, 2018a). In this regard, a friendly investor policy framework is recommended.

CONCLUSION

Nigeria needs serious policies – policies with clear objectives, realistic strategies towards implementation and measurable targets not the current ones which are mere statements of wishful thinking (Nyoni & Bonga, 2018a). This study showed that the ARIMA (2, 1, 0) model is the optimal model to model and forecast GDP per capita in Nigeria. The study indicates that GDP per capita of Nigeria is expected to further deteriorate in the next decade, as long as nothing is done to improve the performance of the Nigerian economy. This study is an eye-opener to policy makers in Nigeria and the next thing is that they should act accordingly.

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