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Intervention Model for Analysing the Impact of Gross Domestic Product in Nigeria

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Abstract: Every country has it policy, the economic variable stated in this study is fundamental in the policy of Nigeria. The study intervention model of gross domestic product in Nigeria utilizes the quarterly data from 1981 to 2015, sourced from Central Bank of Nigeria, Statistical bulletin. The intervention methods adopted in this study is quasi-experimental in nature and validity of modelling gross domestic product depends upon assumptions about the timing of the intervention stated in the study. The study yields an ARIMA (3,1,1) model without intervention and with intervention at the time 2002 last quarter which was adequate. The study reports intervention slope and the nature of the intervention is abrupt change. The researcher from theoretical and analytical methods recommends better empirical review on monetary policy that tends to influence gross domestic product in Nigeria.
Keywords: Intervention model, time series, gross domestic product.

INTRODUCTION

Nigeria economy in the past has seen one of its major economic indicators as gross domestic product, which is the measurement of a country's total output. The effect of this economic variable could be positive or negative. Gross domestic product (GDP) is the monetary value of all the finished goods and services produced within a country's borders in a specific time period. Intervention modeling was introduced by Box and Tiao [1].

Ever since, it has been widely applied by scholars, for instance Roberts *et al*. [2] used intervention analysis to show that household drinking water contamination contributed to diarrhea incidence in a refugee camp in Malawi. In the study intervention analysis of daily Yen/Naira exchange rates, Etuk *et al*. [3] states the basis for an intervention by the relatively ailing economy to salvage the situation for the period of study.

The applications of the ARIMA model with or without intervention analysis have been widely used in different aspects, such as flexible manufacturing system scheduling and simulation [4, 5] tourism forecasting [2]. Investigation and forecast of economic factors, Chung *et al*. [6] explains the impact analysis on air travel demand. Zuhaimy *et al*. [7] employed intervention model, particular pulse function of intervention model, in the first Bali bomb that occurred on October 12th, 2002 as an intervention of external factor that has affected the occupancy level of five star hotels in Bali metropolis, the results of this indicates that intervention model is used to describe and review the quantity and the length of the first Bali bomb effect.

Time series intervention in practice is used to ascertain the impact that one or more interventions have on a time series. Roy *et al.* [8] model and analysis the impact of financial crises on the manufacturing industry in the country called China using data collected from March 2005 to November 2008 by the China statistical database. The result shows that China's manufacturing industry may have to tolerate a significant negative effect caused by the global financial crises over a period of time. Intervention time series analysis/model in the spirit of Ender *et al.* [9], Mehanna and Shansub [10] and Sridharan *et al*. [11] evaluates the impact of an institutional policy intervention on performance. The research analysis can be seen in light of the education literature of Dobbie and Fryer [12], Pop-Elecher and Urquiola [13] who consider the effect of attending higher achievement high schools on achievement. Omekara *et al*. [14] in time series analysis of interest rate compared time intervention model and state space models, evidence showed intervention ARIMA model to be more adequate than ARIMA (without intervention) model. Therefore, the objective of this paper is to use time series intervention analysis to quantitatively model gross domestic product in Nigeria from 1981 to 2015. In other to achieve this or the desired goal, the central Bank of Nigeria, statistical bulletin was adopted for both data and monetary policy tools.

MATERIALS AND METHODS

A stochastic, time series ARIMA model is adopted for the study on the data for the period of 1981 to 2015. In analysing this data collected on the secondary source the descriptive and quantitative method of analysis was employed, charts such as time plots and tables were employed to aid in the proper actualization of the set objective. An approach initiated was to build an ARIMA based intervention model for gross domestic production which included the possibility of change of the form expected due to some external factors, involves inferences from a tentatively entertained model. Stationarity test was carried out on the variable by Augmented Dicky-Fuller test (Unit root test) of the integrated order 1 on the transformed log of the gross domestic product. The transformation was done to bring stability in the variable of interest. The paper in its analysis used the statistical packages like R-studio, E-view and SPSS.

Input Series of an Intervention Model

In the study of intervention analysis, there exist input series which can be dependent or independent observations of either pulse function or step function.

Mathematically;

$$P_t^{(t_o)} = \begin{cases} 0 \; if \; t \neq t_0 \\ 1 \; if \; t \neq t_0 \end{cases}$$

$$S_t^{(t_o)} = \begin{cases} 0 \; if \; t < t_0 \\ 1 \; if \; t \geq t_0 \end{cases}$$

The ARIMA model states:

$$Y_t = c + \frac{\omega_i(B)B^b}{\delta_i(B)} I_{GDP_{t-1}} + N_t,$$

$t = 1,2, \ldots n$ - - - 2.1

Where

B is the backshift operator in time series notation (Box et al 1994),
b is the pure delay,
N_t is an error term,
$\omega(B)$ is an moving average operator of polynomial form
$\delta_i(B$ is an auto-gressive operator of polynomial for
$\omega_i(B) = \omega_0(B) + \omega_1(B) + \omega_2(B^2) + \cdots + \omega_S(B^S)$
$\delta_i(B) = 1 + \delta_1(B) + \delta_2(B)^2 + \cdots + \delta_s B^s$
Y_t is the dependent series.

The time series Y_t, for $t < T$ is called the pre-intervention data for the variable GDP

Table-2.1: The GDP Intervention Transfer Function

TRANSFER FUNCTION	TYPES OF IMPACT	INTERVENTION VARIABLE
ω_i	I_t	**Permanent, Abrupt**

See [1] for evidence

The estimation approach has the following steps.

- Use the data before the intervention point to determine the ARMA model for the GDP.
- Use that ARIMA model to forecast values for the period after the intervention.
- Calculate the differences between actual values after the intervention and the forecasted values
- Examine the differences in step 3 to determine a model for intervention effect.

Model Selection Criterion/Adequacy

Gebhard and Jurgen [15] state to estimate the system the order p i.e. the maximal lag of the system was to be determined, so the Akaike information criterion (AIC) is given by

$$AIC\ (P) = ln\left|\Sigma_{\hat{u}\hat{u}(p)}\right| + (K + Pk^2)\frac{2}{T} \qquad 2.2$$

Where $\left|\Sigma_{\hat{u}\hat{u}(p)}\right|$ the determinant of the variance covariance matrix of the estimated residuals and q is the number of diffuse initial value. The root mean square error for the variable is presented as

$$RMSE = \sqrt{\frac{1}{t}\sum_{i=1}^{t}(e_i^2)} \quad - \quad - \quad 2.3$$

Where t the number of is forecast and e is the error. For any event study is appropriate to evaluate AIC and RMSE, the minimum value denote better model.

A diagnostic check is employed to validate the model assumption and to check whether the model is adequate or not. This check whether the hypothesis made on the residuals is true or not. The residual must be a white noise series via checking the autocorrelation patter of the residuals.

The equation 2.1 can be reduced to

$Y = w_0 I_t + N_t$ - - - 2.3

The understanding in the overall estimation process is the basic ARIMA model and the intervention effect. The Box – Jenkins (ARIMA) process state the general form of ARIMA (p, d, q) written as

$$\left(1 - \emptyset_1 B - \emptyset_2 B^2 - \cdots - \emptyset_p B^p\right)(1 - B)^d x_t = \left(1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_q B^q\right)\varepsilon_t \quad - \quad 2.4$$

and that the process of analysis are based on model identification, estimation, diagnostic check and forecasting. In recent study the use of computer software like SPSS, SAS and R-studio are available in obtaining the estimates of this model.

RESULTS AND DISCUSSIONS

This paper presents the evidence report of the analysis. Table 3.1 indicates the descriptive statistics of the economic variable (GDP) without intervention for the period of 1981 to 2015. The table 3.2 and 3.3 shows the descriptive statistics of the pre-intervention and intervention period of the estimated gross domestic product respectively. Fig 1 is the time plot of the quarterly gross domestic product data for the period of 1981 to 2015 (without intervention). This suggests an intervention point on the last quarter of 2002 to 2005. Adopting the procedures in section 2.2 evidently model the intervention model in table 3.6 fig 2 shows the time plot of actual values and forecast value for the intervention period of gross domestic with estimated slope.

Fig 3, 4 and 5 displays the partial autocorrelation function and autocorrelation function of the indicator variable gross domestic product at first difference level display of residual ACF with standardized model adequacy without intervention and P-value, residual ACF with standardized model adequacy of gross domestic product intervention respectively.

Table 3.5 presents the parameter estimate of ARIMA (p, d, q) of the indicator variable without intervention. The ARIMA (3, 1, 1) models for both with and without intervention was estimated. The Akaike information criterion (AIC) reports the minimum value of the chosen model in both models. The study observed that the model adequacy was achieved this could be seen in fig 4 and fig 5 for the display of p-value, residual act and standardized model adequacy where all the points lie within the limit at least 95%. There is need to test or report the effect of both models by estimating the slope i.e. changes with time of study. The model without intervention happens to be an upward trend with a significant slope of 0.010, also in the case of model with intervention with a negative slope, clearly indicate a sign that needs an urgent attention towards the policy of recovery index. For every time series analysis, the check for stationarity is necessary. This paper reports the stationarity index base on the Augmented Dicky-fuller test statistics of -4.6777, with p-value of 0.010 at bag 5 with a 5% level of significant which is statistical significant.

The table 3.6 of the estimated gross domestic product intervention was significant as the p-value of the indicator (I_t) variables (w_0) at 5% level of significant. The intervention has an abrupt change. Hence the gross domestic product intervention ARIMA (3, 1, 1) model is

$$Y_t = 0.0073 - 0.9265X_{t-1} - 0.8227X_{t-2} - 0.8264X_{t-3} + 0.6749\varepsilon_{t-1} \quad - \quad - \quad 3.1$$

and

with intervention ARIMA (3,1,1) model is

$$Y_t = -0.0038 - 0.9563X_{t-1} - 0.0857X_{t-2} - 0.8448X_{t-3} + 0.7525\varepsilon_{t-1} + -0.003I_{GDP} \quad 3.2$$

Fig 4 shows the Acf residuals of the intervention model.

APPENDIX

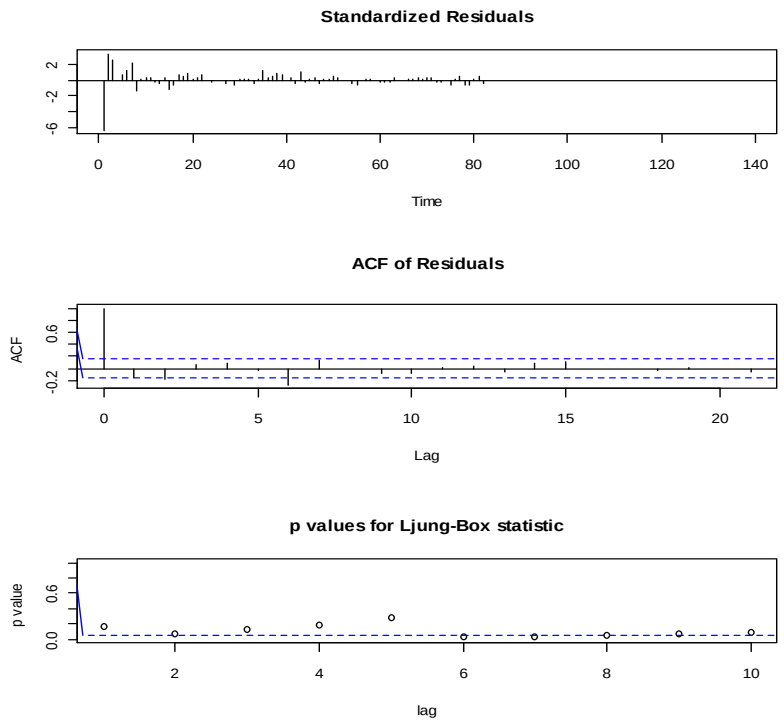

Fig-1: Display of p-value, residual ACF and standardized model adequacy of gross domestic product intervention

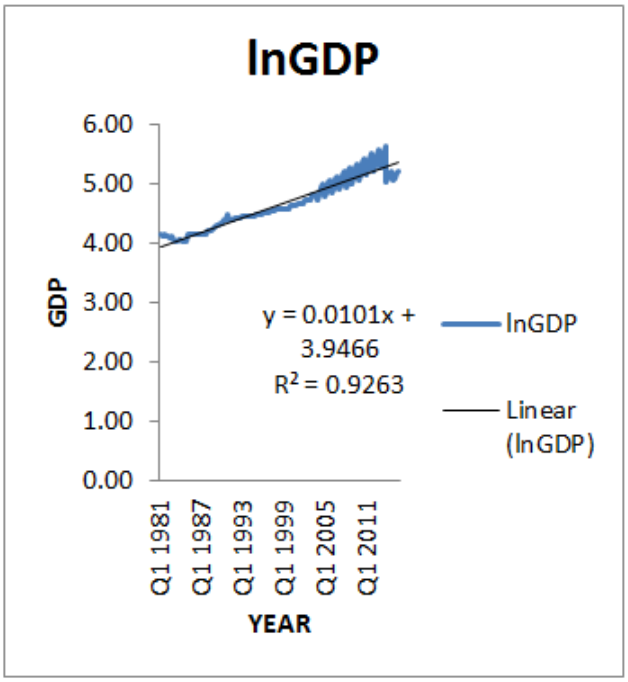

Fig-2: least square estimation graph of gross domestic product from 1981 to 2015

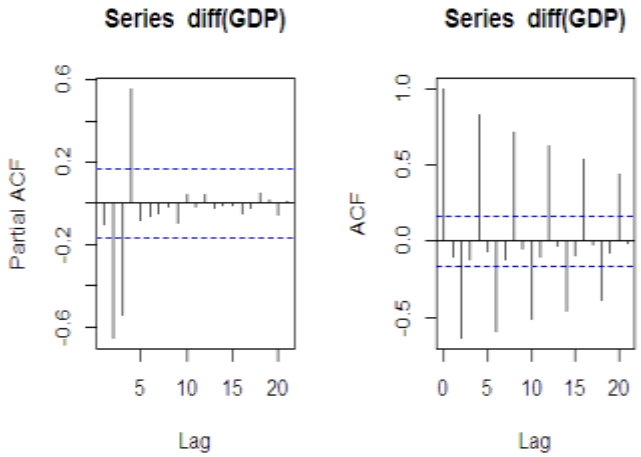

Fig-3: Display of partial autocorrelation function and autocorrelation function of the indicator variable gross domestic product at first difference level

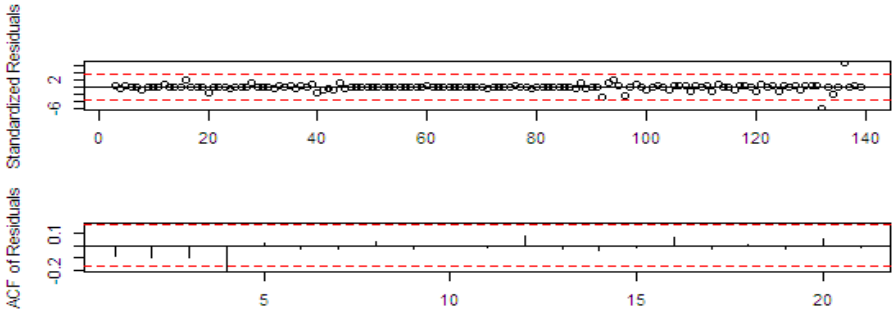

Fig-4: Display of residual ACF and standardized model adequacy of gross domestic product without intervention

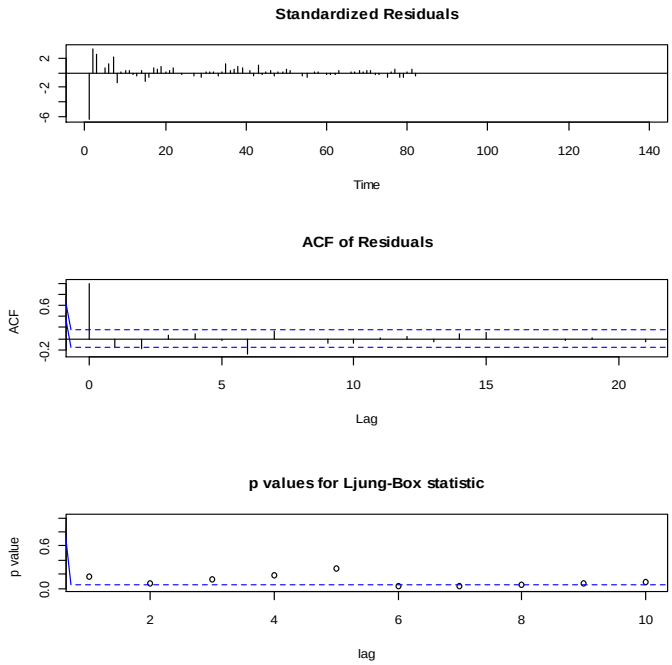

Fig-5: Display of p-value, residual ACF and standardized model adequacy of gross domestic product intervention

Table-3.1: Descriptive Statistics of the Economic Indicators without intervention

Statistics	$lnGDP$
Mean	4.656199
Median	4.575991
Maximum	5.649075
Minimum	4.029985
Std. Dev.	0.424143
Skewness	0.392414
Kurtosis	2.121245
Probability	0.017443
Sum	651.8678
Sum Sq. Dev.	25.00571
Observations	140

Table-3.2: Descriptive Statistics of the Pre-intervention Indicators

Statistics	$lnGDP$
Mean	4.372006
Median	4.430418
Maximum	4.730288
Minimum	4.029985
Std. Dev.	0.207716
Skewness	-0.097585
Kurtosis	1.718692
Probability	0.047610
Sum	380.3646
Sum Sq. Dev.	3.710563
Observations	87

Table 3.3: Descriptive Statistics of the Intervention Indicators

Statistics	$lnGDP$
Mean	3.468006006
Standard Error	0.021637446
Median	3.442489154
Standard Deviation	0.157522985
Sample Variance	0.024813491
Kurtosis	-0.666151687
Skewness	0.113542073
Range	0.620705964
Sum	183.8043183
Count(N)	53

From Table 3.2 explains the pre-intervention periods of the economic indicators. The gross domestic product periods start from 1981 to third quarter of 2002.

The Table 3.3 presents the descriptive summary statistics of the period of intervention of the economic variables. The intervention periods of gross domestic product, starts from last quarter of 2002 to 2015.

Table-3.4: Model fit of the estimated gross domestic product

Statistics	Without I_t	with I_t
	ARIMA(3,1,1)	ARIMA(3,1,1)
AIC	-387.26	-96.16
RMSE	1.0466	0.3456
Slope	0.010	-0.001

Table-3.5: Parameters Estimate of ARIMA (p, d, q) Model Without Intervention

INDICATOR	GDP
P, D, Q	ARIMA (3, 1, 1)
INTERCEPT	0.0073
AR1	-0.9265
SE(AR1)	0.0569
AR2	-0.8227
SE(AR2)	0.0578
AR3	-0.8265
SE(AR3)	0.0458
MA1	0.6749
SE(MA1)	0.0908
MA2	-
SE(MA2)	-
σ^2	0.0032
LOG LIKELIHOOD	199.63

Table 3.5 indicates the univariate ARIMA, without intervention, for the economic indicators at ARIMA order and difference at (d=1) for all estimation procedure. The AR(1), AR(2), AR(3), MA(1), MA(2) are the first, second, third autoregressive, first moving and second moving average order respectively. The SE represents the standard error of the variables, δ^2 indicates the variance and log likelihood, all where estimated.

Table-3.6: Parameters Estimate of ARIMA (p, d, q) Model Intervention

INDICATOR	GDP
P, D, Q	ARIMA (3, 1, 1)
INTERCEPT	-0.0038
AR1	-0.9563
SE(AR1)	0.0857
AR2	-0.8464
SE(AR2)	0.0861
AR3	-0.8448
SE(AR3)	0.0636
MA1	0.7525
SE(MA1)	0.1800
σ^2	0.00683
LOG LIKELIHOOD	54.08

Table 3.6 indicates the estimates of the economic indicators for the intervention period stated

CONCLUSION

Data of potential value in the formulation of public and private policy like economic indicator frequently occur in the form of time series of observation at regular time interval. The event study called intervention analysis is used to assess the impact of gross domestic product over time, from 1981 to 2015. In this study the intervention point occurred at the last quarter of 2002. The theoretical and empirical study on the intervention model was stated. The reason for the suspected cyclical natural of the gross domestic product was caused by the policy introduced by the governing body of monetary policy, the so called central bank of Nigeria and the ministry of finance at the stated period. This paper utilizes the quarterly data of gross domestic product from central bank of Nigeria for the period of 1981 to 2015. The data was transformed to bring stability in the analysis. The analysis yields an intervention ARIMA (3, 1, 1) for with intervention and without intervention, with the aid of R software. The study reports intervention slope which is negative and further state that the nature of the intervention is abrupt changes.

The researcher, in general from theoretical and analytical method recommend that government, policy makers and central bank of Nigeria via the ministry of finance revisit our monetary policies and monitor its implementation. The

researcher also give an opportunity for further research related to time series model that contains regime change, caused by intervention.

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