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Modeling of Internally Generated Revenue Using Autoregressive and Moving Average of a Time Series Models: A Case Study of Akwa Ibom State

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ABSTRACT: *Modelling of Internally Generated Revenue using error variances for model comparison was the main focused of this research. This procedure varies from the familiar information criteria used to compare alternative models. The autocorrelation and Partial autocorrelation function of the stationary series give basis for the choice of Autoregressive Integrated Moving Average, ARIMA (1 1 1), ARIMA (1 1 2) and ARIMA (2 1 1) for the revenue series. From the estimates, Akaike Information and Schwartz's Information Criteria (AIC and SIC) suggested ARIMA (2 1 1), while the error variance suggested ARIMA (1 1 2) respectively as the best model. The advantage in the use of error variance for model comparison is that the variance measures are positive. (not less than zero). The positive and negative signs in the AIC and SIC values are sometimes confusing, since absolute values are not considered in the BIC, SIC and AIC. Hence, this research relies on error variance for the model selection, which reputes ARIMA (1,1,2) to be the best model for the Akwa Ibom State Internally Generated Revenue Series.*

KEYWORDS*:* autocorrelation function, partial autocorrelation function, moving average error variance.

The development of any state or country is closely tied to what they could be able to generate within the state and how judicious or prudent the revenue generated is used. Apart from the federal government yearly statutory grant allocation to states in the federation, other expenses by the state lie at the mercy of what it would be able to generate internally. In fact, a general survey has proved that the high level of standard of living for any state is influenced by or determined by their ability to generate high revenue within such a state. For instance, states such as Lagos, Port Harcourt, Kano, Kaduna and other states with industrial and commercial centers generate large revenue (Internally) than other states. It is very clear that the populace in such a state enjoys good and qualitative basic amenities, such as standard education, constant electricity, good pipe borne water, good health care, good road, network, good communication network, etc. Internal revenue generations were fully maximized before the 1976 Local Government reform. Local government functions were dully discharged with little or nothing as assistance from the federal government. But with the introduction of statutory allocations after the 1976 reform, the internal revenue generation as a major means of financing local government was abandoned in preference to the revenue from the federal statutory allocation. This, according to Atakpa *et al.* (2012) was principally identified as the bane of internal revenue generation at local level of government. They concluded that unless the local governments look inwards to maximize their internal revenue sources it cannot be financially self-reliant. The reliance on statutory allocation to perform basic functions by some states in Nigeria is total. Many states rely almost exclusively on this handout from the federation account as basic operations cannot go on without the monthly allocations. This has partly helped government officials to pay little attention to growing the economic base that would help them to become independent (Agu, 2011). He went further to note that modern technology is yet to be incorporated in IGR planning and collection approaches. Officials rely mainly on physical visitation, memos and letters to notify tax payers. The taxes collected are mainly in cash thereby creating opportunities for embezzlement. These shortcomings often lead to multiple payments of tax and harassment that helps government officials to pay little attention to growing the economic base that would help them to become independent (Agu, 2011). The taxes collected are mainly in cash thereby creating opportunities for embezzlement. These shortcomings often lead to multiple payments of tax and harassments. The internally generated funds in local government councils are mainly used to offset the cost of governance by these third tiers of government. The cost of governance has gone up astronomically that capital projects are insignificant in proportion to recurrent expenditure. The central government regularly gives enough funds to these third tiers of government in order to provide infrastructural development to the citizens in the local areas, but according to Khalil and Adelabu (2011), these public revenues are being mismanaged by political leaders and local governments' officials. In their findings, less than 5% of the statutory allocations accruing to local governments under study were being expended on infrastructural development, while more than 10% were used for personnel expenditure. The choice of internal revenue collected by the states and local government councils do not help matters. This lopsidedness according to Egonmwan (1984), was compounded by the fact that the state governments have acquired the most lucrative, elastic and collectable revenue sources (e.g. motor vehicle license fees, building plan fees), leaving local governments with taxation with low ceilings, revenue which are administratively and politically difficult to exploit in an environment where the vast majority of the people are poor, self-employed and dispersed in rural areas. Coupled with this is the attitude of tax rate collectors in local governments, which falls short of expectation. Fraud and embezzlement were rampant in all revenue centers. In a study of how internally generated revenues of some selected local governments in Ogun state can be boosted, it was found out that rates, fines, fees, licenses and rent sources significantly influenced internally generated revenue (Olusola, 2011). Banabo and Koroye (2011) were of the opinion that Nigerian economy has to be diversified from a single oil revenue sustaining economy to a multiple revenue economy. The dependability on taxation alone by federal, states, and local governments may not be the way out of solving the consistently increasing capital and recurrent expenditures of the governments. They went further to assert that increasing cost of governance has forced some states to formulate other means of improving their revenue base due to dwindling oil revenue in 2009.

The oil boom and a one-time Head of State of Nigeria's statement that not finance, but executive capacity, was the major bottleneck to Nigeria's economic growth and development, made this to be. Before that time, the percentage of internal revenue generated to the total revenue was as high as 85% for some local governments, between 1962 and 1983. With the decline in oil sale, it became imperative for internally generated revenue to stage a comeback to its preponderant position. The 1976 local government reforms made provisions for a fixed proportion of statutory allocation of revenue from the central government to local government councils. This was as a result of recommendations of the Aboyade Revenue Commission of 1977. The Revenue Mobilization Allocation and Fiscal Commission (RMAFC) charged with the responsibility of allocating revenue to the three tiers of governments was established to also monitor the accruals to and disbursement of revenue from the Federal Account and reviewing, from time to time, the revenue allocation formulae to ensure conformity with changing realities. Presently, the sharing formula stipulates that the federal government is to be given 52%, the states shall go with 26% while the local governments are given 20%. This is excluding the 13% derivation, which the oil producing states have to share. Time series analysis aims at identifying data patterns and trends as well as explaining data modeling and forecasting. Two principal approaches are adopted to maintain time series analysis, which depends on the time of the frequency domain. Several procedures are used to analyze data within these domains. A useful common technique is the Box-Jenkins ARIMA model, which can be used for univariate or multivariate data set analysis. The ARIMA technique uses moving averages (MA), Smoothing, and Regression methods to detect and remove data autocorrelation. Many statistical tests are used in time series models in order to make them Stationary series and Integrated; thus, Box-Jenkins procedures are used for the determination of ARIMA, and an Ordinary Least Squares method is used to estimate the model parameter. For ARIMA, the AR component represents the effects of previous data observations. The component represents trends, including seasonality. And the MA components represent the effects of previous random shocks (or errors). To fit an ARIMA model into a series, the order of each model component must be selected. Usually, a small integer value (usually 0, 1, or 2) is determined for each component.

Our main concern as regards this research is the time series modelling, especially, stationary time series which are characterized by autoregressive and moving average processes, the popularly known Information Selection Criteria include Akaike Information, Bayesian Information and Schwartz Information Criteria. The negative signs in the measures of the Information Criteria sometimes creates difficulties in model selection. The need for the use of error variance for the selection of model suffices. This is due to the fact that the error variance measures are positive and values are not less than zero, except where the parameter of the model exceeds unit value or the roots of the characteristic equation lie within the unit circle, which could result in truncation of duality of the original model. It is against this background that this research seeks to adopt error variance for model selection. In order to achieve the desirable goal of this research in this paper, the research intends to look at the following points, studying the behavior of the economic data for the period under study, fitting of different suggested time series models on the basis of autocorrelation and partial autocorrelation functions and compare model performances using error variance and information criteria.

METHODOLOGY

The method of analysis adopted in this study is the Box - Jenkins (1976) procedure for fitting autoregressive integrated moving average (ARIMA) model. The objectives of Box and Jenkins are to identify the data pattern, fit models and estimate parameters, carry out model diagnostic check and forecast future values of the time series. A general univariate model for ARIMA (p, d, q) process is given as shown below,

$$\varphi p(B)\,(1-B)\,dXt = \theta q(B)\varepsilon t \qquad (1)$$

Trend Analysis

The trend analysis of the time series data of internally generated revenue are as shown on figures below;

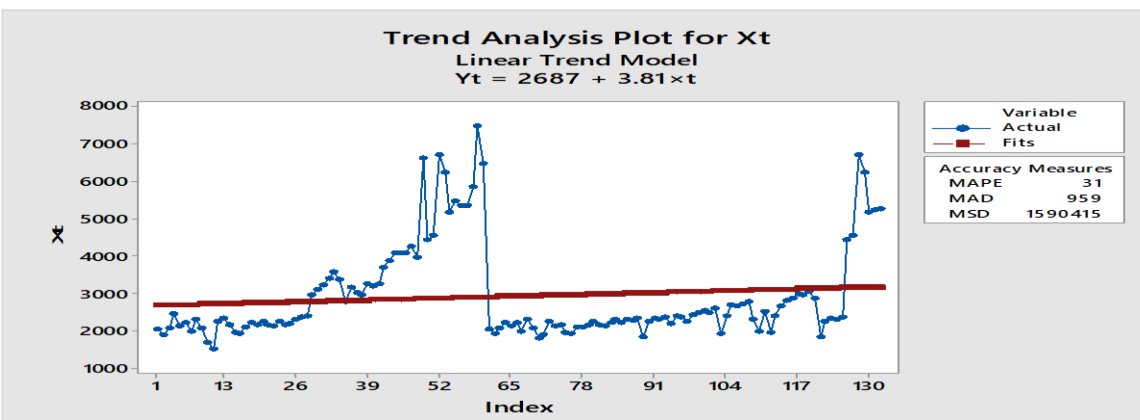

Figure 1: The trend analysis of original time series data of internally generated revenue

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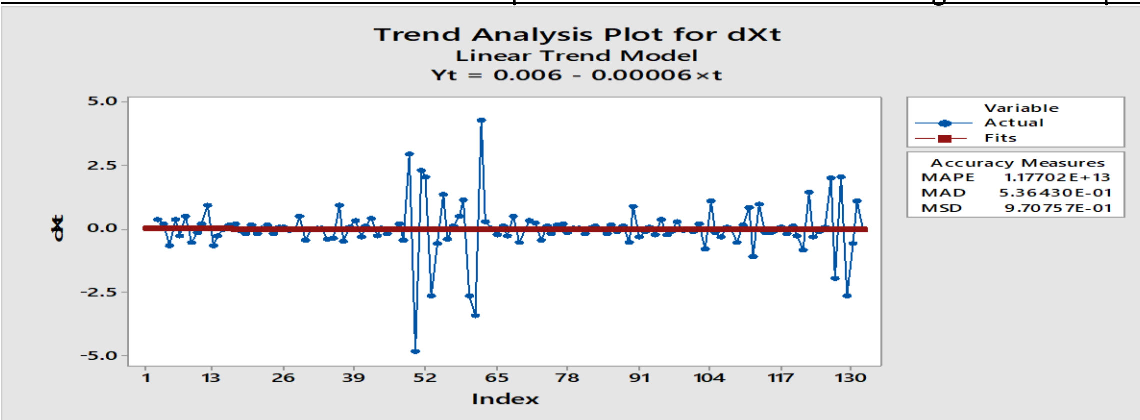

Figure 2: The trend analysis of the stationary internal generated revenue

The ACF and PACF of Internally Generated Revenue

The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots displays serial correlation in data that changes over time. It gives a pictorial summary of correlation at different periods of time as shown in figures 3 and 4 for internally generated revenue. In figures3 and 4, there are significant cut-off at lag 1 in both the ACF and PACF of the stationary time series data of internally generated revenue as shown below.

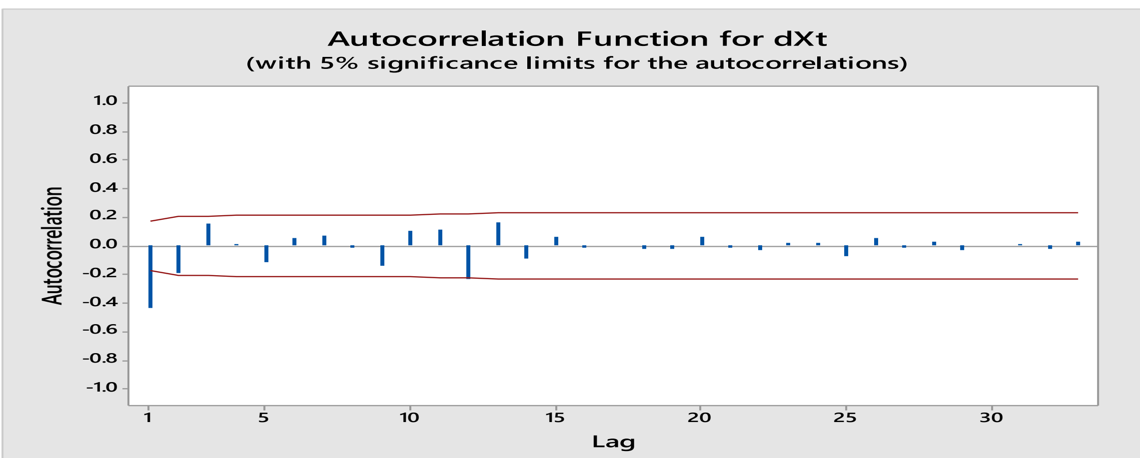

Figure 3: The autocorrelation function of the stationary time series data

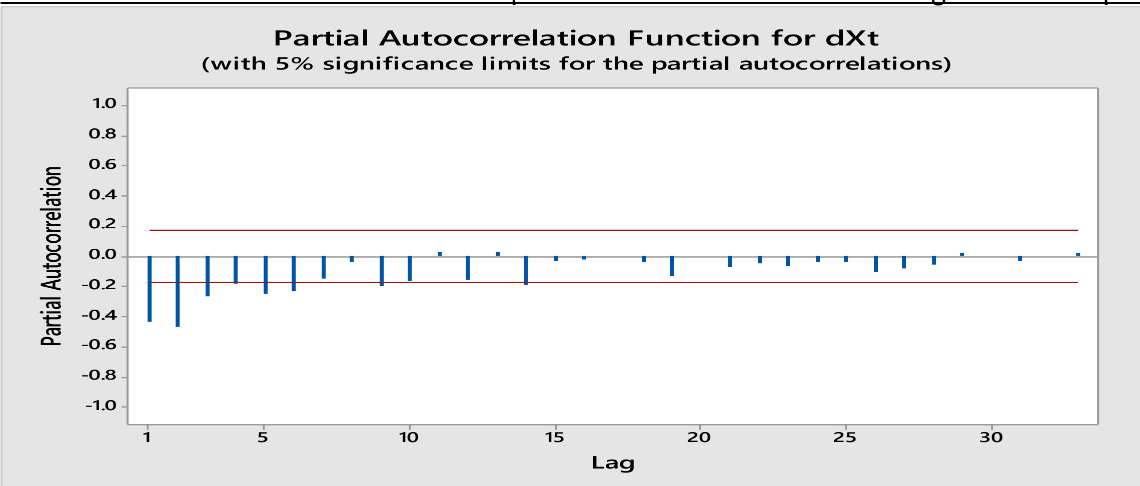

Figure 4: The partial autocorrelation function of the stationary time series data

Thus, from figures 3 and 4 the following models are suggested; ARIMA (1 1 1) ARIMA (1 1 2) ARIMA (2 1 1) The variances and the error variances of the three suggested models used in this work are derived as shown below.

Model Presentation

ARIMA (1, 1,1) Model

$$X_t = \varphi_1 X_{t-1} + \varepsilon_t - \theta\varepsilon_{t-1} \quad (2)$$

Where X_t is a stationary process, ε_t is a moving average process, $\varepsilon_t \sim N\ (0, \sigma^2)$

ARIMA (1, 1, 2) Model

$$X_t = \varphi_1 X_{t-1} + \varepsilon_t - \theta_1\varepsilon_{t-1} - \theta_2\varepsilon_{t-2} \quad (3)$$

Where X_t is a stationary process, ε_t is a moving average process, $\varepsilon_t \sim N\ (0, \sigma^2)$

ARIMA (2, 1, 1)

$$X_t = \varphi_1 X_{t-1} + \varphi_2 X_{t-2} - \theta_1\varepsilon_{t-1} + \varepsilon_t \quad (4)$$

Where X_t is a stationary process, ε_t is a moving average process, $\varepsilon_t \sim N\ (0, \sigma^2)$

Variances and Error of the Models
ARIMA (1 1 1) Model
Given,
$$X_t = \varphi_1 X_{t-1} + \varepsilon_t - \theta\varepsilon_{t-1} \quad (5)$$

Variance of X_t is as follows;
Multiply (5) by X_t

$$X_tX_t = (\varphi_1 X_{t-1} + \varepsilon_t - \theta\varepsilon_{t-1})(\varphi_1 X_{t-1} + \varepsilon_t - \theta\varepsilon_{t-1})$$

$$X_t^2 = \varphi_1^2 X_{t-1}^2 + \varphi_1 X_{t-1}\varepsilon_t - \varphi_1\theta X_{t-1}\varepsilon_{t-1} + \varphi_1 X_{t-1}\varepsilon_t + \varepsilon_t^2 - \theta\varepsilon_t\varepsilon_{t-1} - \varphi_1\theta X_{t-1}\varepsilon_{t-1} - \theta\varepsilon_t\varepsilon_{t-1} + \theta^2\varepsilon_{t-1}^2$$

Taking Expectation,

$$E(X_t^2) = \varphi_1^2 E(X_{t-1}^2) + \varphi_1 E(X_{t-1}\varepsilon_t) - \varphi_1\theta E(X_{t-1}\varepsilon_{t-1}) + \varphi_1 E(X_{t-1}\varepsilon_t) + E(\varepsilon_t^2) - \theta E(\varepsilon_t\varepsilon_{t-1}) - \varphi_1\theta E(X_{t-1}\varepsilon_{t-1}) - \theta E(\varepsilon_t\varepsilon_{t-1}) + \theta^2 E(\varepsilon_{t-1}^2)$$

$$\gamma_0 = \varphi_1^2\gamma_0 - 2\varphi_1\theta_1\sigma_{et}^2 + \sigma_{et}^2 + \theta_1\sigma_{et}^2$$

$$\gamma_0(1 - \varphi_1^2) = \sigma_{et}^2(1 - 2\varphi_1\theta + \theta^2)$$

$$\gamma_0 = \frac{\sigma_{et}^2(1 - 2\varphi_1\theta + \theta^2)}{(1 - \varphi_1^2)} \qquad (6)$$

$$\sigma_{et}^2 = \frac{\gamma_0(1 - \varphi_1^2)}{1 - 2\varphi_1\theta + \theta^2} \qquad (7)$$

Equation (6) and (7) are variances of X_t *and* ε_t *respectively*.

ARIMA (1 1 2) Model

Given,

$$X_t = \varphi_1 X_{t-1} + \varepsilon_t - \theta_1\varepsilon_{t-1} - \theta_2\varepsilon_{t-2} \qquad (8)$$

Variance of X_t is as follows;

Multiply (8) by X_t

$$X_tX_t = (\varphi_1 X_{t-1} + \varepsilon_t - \theta_1\varepsilon_{t-1} - \theta_2\varepsilon_{t-2})(\varphi_1 X_{t-1} + \varepsilon_t - \theta_1\varepsilon_{t-1} - \theta_2\varepsilon_{t-2})$$

$$X_t^2 = \varphi_1^2 X_{t-1}^2 + \varphi_1 X_{t-1}\varepsilon_t - \varphi_1\theta_1 X_{t-1}\varepsilon_{t-1} - \varphi_1\theta_2 X_{t-1}\varepsilon_{t-2} + \varphi_1 X_{t-1}\varepsilon_t + \varepsilon_t^2 - \theta_1\varepsilon_t\varepsilon_{t-1} - \theta_2\varepsilon_t\varepsilon_{t-2} - \varphi_1\theta_1 X_{t-1}\varepsilon_{t-1} - \theta_1\varepsilon_t\varepsilon_{t-1} + \theta_1^2\varepsilon_{t-1}^2 - \theta_1\theta_2\varepsilon_{t-1}\varepsilon_{t-2} - \theta_2\varphi_1 X_{t-1}\varepsilon_{t-2} - \theta_2\varepsilon_t\varepsilon_{t-2} + \theta_2\theta_1\varepsilon_{t-1}\varepsilon_{t-2} + \theta_2^2\varepsilon_{t-2}^2$$

Taking Expectation,

$$E(X_t^2) = \varphi_1^2 E(X_{t-1}^2) + \varphi_1 E(X_{t-1}\varepsilon_t) - \varphi_1\theta_1 E(X_{t-1}\varepsilon_{t-1}) - \varphi_1\theta_2 E(X_{t-1}\varepsilon_{t-2}) + \varphi_1 E(X_{t-1}\varepsilon_t) + E(\varepsilon_t^2) - \theta_1 E(\varepsilon_t\varepsilon_{t-1}) - \theta_2 E(\varepsilon_t\varepsilon_{t-2}) - \varphi_1\theta_1 E(X_{t-1}\varepsilon_{t-1}) - \theta_1 E(\varepsilon_t\varepsilon_{t-1}) + \theta_1^2 E(\varepsilon_{t-1}^2) - \theta_1\theta_2 E(\varepsilon_{t-1}\varepsilon_{t-2}) - \theta_2\varphi_1 E(X_{t-1}\varepsilon_{t-2}) - \theta_2 E(\varepsilon_t\varepsilon_{t-2}) + \theta_2\theta_1 E(\varepsilon_{t-1}\varepsilon_{t-2}) + \theta_2^2 E(\varepsilon_{t-2}^2)$$

$$\gamma_0 = \varphi_1^2\gamma_0 - 2\varphi_1\theta_1\sigma_{et}^2 + \sigma_{et}^2 + \theta_1^2\sigma_{et}^2 + \theta_2^2\sigma_{et}^2$$

$$\gamma_0(1 - \varphi_1^2) = \sigma_{et}^2(1 - 2\varphi_1\theta_1 + \theta_1^2 + \theta_2^2)$$

$$\gamma_0 = \frac{\sigma_{et}^2(1 - 2\varphi_1\theta_1 + \theta_1^2 + \theta_2^2)}{(1 - \varphi_1^2)} \quad (9)$$

$$\sigma_{et}^2 = \frac{\gamma_0(1 - \varphi_1^2)}{1 - 2\varphi_1\theta_1 + \theta_1^2 + \theta_2^2} \quad (10)$$

Equation (9) and (10) are variances of X_t and ε_t $respectively$.

ARIMA (2 1 1) Model
Given,

$$X_t = \varphi_1 X_{t-1} + \varphi_2 X_{t-2} - \theta_1\varepsilon_{t-1} + \varepsilon_t \quad (11)$$

Multiply equation (11) by X_t and take expectation

$$\mathrm{E}(X_tX_t) = E[(\varphi_1X_{t-1} + \varphi_2X_{t-2} - \theta_1\varepsilon_{t-1} + \varepsilon_t)(\varphi_1X_{t-1} + \varphi_2X_{t-2} - \theta_1\varepsilon_{t-1} + \varepsilon_t)]$$

$$\begin{aligned}\mathrm{E}(X_tX_t) = E[(&\varphi_1^2X_{t-1}^2 + \varphi_1\varphi_2X_{t-1}X_{t-2} - \varphi_1\theta_1X_{t-1}\varepsilon_{t-1} + \varphi_1X_{t-1}\varepsilon_t + \varphi_2\varphi_1X_{t-2}X_{t-1} \\ &+ \varphi_2^2X_{t-2}^2 - \varphi_2\theta_1X_{t-2}\varepsilon_{t-1} + \varphi_2X_{t-2}\varepsilon_t - \theta_1\varphi_1\varepsilon_{t-1}X_{t-1} + \theta_1\varphi_2\varepsilon_{t-1}X_{t-2} \\ &+ \theta_1^2\varepsilon_{t-1}^2 - \theta_1\varepsilon_{t-1}\varepsilon_t + \varphi_1X_{t-1}\varepsilon_t + \varphi_2X_{t-2}\varepsilon_t - \theta_1\varepsilon_{t-1}\varepsilon_t + \varepsilon_t^2)]\end{aligned}$$

$$\sigma_{xt}^2 = \varphi_1^2\sigma_{xt}^2 + \varphi_2^2\sigma_{xt}^2 - \varphi_1\theta\sigma_{et}^2 - \varphi_1\theta\sigma_{et}^2 + \theta^2\sigma_{et}^2 + \sigma_{et}^2$$

$$\sigma_{xt}^2 - \varphi_1^2\sigma_{xt}^2 - \varphi_2^2\sigma_{xt}^2 = \sigma_{et}^2 + \theta^2\sigma_{et}^2 - 2\varphi_1\theta\sigma_{et}^2$$

$$\sigma_{xt}^2\{1 - \varphi_1^2 - \varphi_2^2) = \sigma_{et}^2(1 + \theta^2 - 2\varphi_1\theta)$$

$$\sigma_{xt}^2 = \frac{\sigma_{et}^2(1+\theta^2-2\varphi_1\theta)}{\{1-\varphi_1^2-\varphi_2^2)} \quad (12)$$

$$\sigma_{et}^2 = \frac{\gamma_0\{1-\varphi_1^2-\varphi_2^2)}{(1+\theta^2-2\varphi_1\theta)} \quad (13)$$

Equation (12) and (13) are variances of X_t and ε_t $respectivel$

Model Selection Criteria
The following model selection criteria are used in this research.

1. Akaike Information Criterion (AIC)
   $AIC = \ln(\frac{RSS}{n}) + (\frac{2k}{n})$

where RSS = residual sum of squares, n = number of observations, k= number of parameters in the model.

2. Schwartz's Information Criterion (SIC)

$$SIC = ln\left(\frac{RSS}{n}\right) + \left(\frac{k}{n}\right)\ln(n)$$

Where RSS, n and k are as defined as above

Numerical Verification

ARIMA (1 1 1) Model

The error variance of ARIMA (1, 1, 1), is given by

$$\sigma_{et}^2 = \frac{\gamma_0(1-\varphi_1^2)}{1-2\varphi_1\theta_1+\theta_1^2}$$

Where $\hat{\gamma}_0$ =0.989084, $\varphi_1 = -0.4399$, $\varphi_1^2 = 0.1935, \theta_1 = 0.9800$, $\theta_1^2 = 0.9604$

Therefore,

$$\sigma_{et}^2 = \frac{0.9891(1-0.1935)}{1-2(-0.4399)(0.9800)+0.9604}$$

$$\sigma_{et}^2 = \frac{0.7977}{2.8226}$$

$$\sigma_{et}^2 = 0.2826$$

Table 1 Coefficients Estimates of Parameters

Model	Coef	SE. Coef	T- Value	P- Value
ARIMA (1 1 1)				
CONSTANT	0.000614	0.003839	0.16	0.873
AR (1)	-0.4339	0.0804	-5.40	0.000
MA (1)	0.9800	0.0131	74.80	0.000

Table 2 Modified Box-Pierce (Ljung-Box) Chi-Square Statistic

Model				
ARIMA (1 1 1)				
Lag	12	24	36	48
Chi- Square	51.2	54.0	56.0	58.0
Df	9	21	33	45
P- Value	0.000	0.000	0.007	0.098

ARIMA (1 1 2) Model

The error variance of ARIMA (1, 1, 2), is given by;

$$\sigma_{et}^2 = \frac{\gamma_0(1-\varphi_1^2)}{1-2\varphi_1\theta_1+\theta_1^2+\theta_2^2}$$

Where $\hat{\gamma}_0$ =0.989084, $\varphi_1 = -0.7780,\ \varphi_1^2 = 0.60528, \theta_1 = 0.3176\ , \theta_1^2 = 0.1008, \theta_2 = 0.6840, \theta_2^2 = \ 0.4679$

Therefore,

$$\sigma_{et}^2 = \frac{0.989084(1-0.60528)}{1-2(-0.7780)(0.3176)+0.1008+0.4679}$$

$$\sigma_{et}^2 = \frac{0.3904}{2.0628}$$

$$\sigma_{et}^2 = 0.1893$$

Table 3: Coefficients Estimates of Parameters

Model	Coef.	SE. Coef.	T- Value	P- Value
ARIMA (1 1 2)				
CONSTANT	0.002642	0.002745	0.96	0.338
AR (1)	-0.7780	0.2740	-2.84	0.005
MA (1)	0.9176	0.3120	1.02	0.311
MA (2)	0.6840	0.3046	2.25	0.027

Table 4 Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Model				
ARIMA (1 1 2)				
Lag	12	24	36	48
Chi- Square	54.4	59.9	62.0	63.5
Df	8	20	32	44
P- Value	0.000	0.000	0.001	0.029

ARIMA (2 1 1) Model

The error variance of ARIMA (2, 1, 1), is given by

$$\sigma_{et}^2 = \frac{\gamma_0\{1-\varphi_1^2-\varphi_2^2)}{(1+\theta^2-2\varphi_1\theta)}$$

Where $\hat{\gamma}_0$ =0.989084, $\varphi_1 = -0.4766,\ \varphi_1^2 = 0.2271,\ \varphi_2 = -0.3332,\ \varphi_2^2 = 0.1110,\ \theta_1 = 0.9999\ , \theta_1^2 = 0.9998,$

Therefore;

$$\sigma_{et}^2 = \frac{0.989084\{1-0.2271-0.1110))}{(1+0.9998-2(-0.4766)(0.999))}$$

$$\sigma_{et}^2 = \frac{0.6447}{2.9529}$$
$$\sigma_{et}^2 = 0.2183$$

Table 5 Coefficients Estimates of Parameters

Model	Coef	SE. Coef	T- Value	P- Value
ARIMA (2 1 1)				
CONSTANT	-0.000049	0.001426	-0.03	0.973
AR (1)	-0.4766	0.0907	-5.89	0.000
AR (2)	-0.3332	0.0812	-4.10	0.000
MA (1)	0.9999	0.0018	780.16	0.000

Table 6 Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Model				
ARIMA (2 1 1)				
Lag	12	24	36	48
Chi- Square	23.9	30.2	32.7	35.1
Df	8	20	32	44
P- Value	0.002	0.066	0.434	0.529

Numerical Presentation of Model Selection Criteria
ARIMA (1 1 1)
Akaike Information Criterion (AIC),
This is given by;

$$AIC = Ln\left(\frac{RSS}{n}\right) + \left(\frac{2k}{n}\right)$$
$$AIC = Ln\left(\frac{104.691}{130}\right) + \left(\frac{2*2}{130}\right)$$

$$Ln(0.8053) + (0.0307)$$
$$AIC = -0.1858$$

ARIMA (1 1 2)
Akaike Information Criterion (AIC),
This is given by;

$$AIC = Ln\left(\frac{RSS}{n}\right) + \left(\frac{2k}{n}\right)$$

$$AIC = Ln\left(\frac{123.778}{130}\right) + \left(\frac{2*3}{130}\right)$$

$$= Ln(0.9521) + (0.0462)$$
$$AIC = -0.0029$$

ARIMA (2 1 1)
Akaike Information Criterion (AIC),
This is given by;

$$AIC = Ln\left(\frac{RSS}{n}\right) + \left(\frac{2k}{n}\right)$$
$$AIC = Ln\left(\frac{83.3139}{130}\right) + \left(\frac{2*3}{130}\right)$$

$$= Ln(0.6409) + (0.0462)$$

$$AIC = -0.3987$$

Similarly,

The Schwartz's Information Criterion (SIC) is given by;

$$SIC = ln\left(\frac{RSS}{n}\right) + \left(\frac{k}{n}\right)\ln(n)$$

ARIMA (1 1 1)
Schwartz Information Criterion (SIC),

This is given by;

$$SIC = ln\left(\frac{104.691}{130}\right) + \left(\frac{2}{130}\right)\ln(130)$$

$$= \ln(0.8253) + (0.0153)(4.8673)$$

$$SIC = -0.1420$$

ARIMA (1 1 2)
Schwartz Information Criterion (SIC),

This is given by;

$$SIC = ln\left(\frac{123.778}{130}\right) + (\frac{3}{130})\ln(130)$$

$$= \ln(0.9521) + (0.0231)(4.8673)$$
$$SIC = -0.0054$$

ARIMA (2 1 1)
Schwartz Information Criterion (SIC),

This is given by

$$SIC = ln\left(\frac{83.3139}{130}\right) + (\frac{3}{130})\ln(130)$$

$$= \ln(0.6409) + (0.0231)(4.8673)$$

$$SIC = -0.3348$$

Model Information Criteria Table
Table 7

Models	AIC	SIC
ARIMA (1 1 1)	-0.1858	-0.1420
ARIMA (1 1 2)	-0.0029	-0.0054
ARIMA (2 1 1)	-0.3987	-0.3348

From Table 4.7, it can be seen that ARIMA (2 1 1) is the best model with the least value of AIC and SIC.

RESULTS

This work initially presented trend analysis of Internally Generated Revenue as shown in Fig 1. The trend analysis exhibited upward trend for the original time series data. This was followed with the plot of stationarity of data as shown in Fig 2. As a procedure for the selection of the order of different ARIMA models, autocorrelation and partial autocorrelation functions were plotted. Figs. 3 and 4 displayed the autocorrelation and partial autocorrelation functions for Stationarity of the time series data. With the aids of ACF and PACF, as shown in Figs 3 and 4, different forms of ARIMA models were suggested for the time series data of internally generated revenue. The suggested models, were ARIMA (1 1 1), ARIMA (1 1 2) as well as ARIMA (2 1 1. The work also witnessed the derivation of the error variance of each of the suggested models in order to obtain the best models. The error variance of each of the suggested models were obtained, and it was clearly seen that ARIMA (1 1 2) outperformed the other two models and was adjudged the best model with a minimum variance of 0.1893

Parameter Estimates were carried out for all the models suggested. It was discovered that in ARIMA (1 1 1), the AR (1) and MA (1) were significant, which can be seen in their P-Values of 0.000 and 0.000 respectively as shown in Table 4.1. For ARIMA (1 1 2), it was discovered that AR (1) and MA (2) are significant with the P-Values of 0.05 and 0.027 as indicated in Table 3. And in ARIMA (2 1 1), all the parameters, AR (1), AR (2) and MA (1) were significant with p-values of 0.000, respectively as shown in Table 5

The model information criteria such as Akaike Information (AIC) and Schswartz Information criteria, (SIC) were employed in order to ascertain the best models among all the suggested models. From table 7, it can be seen that ARIMA (2 1 1) model has the least values of AIC as well as SIC and as such, was fit to be the best model that can be used to model internally generated revenue in Akwa Ibom State.

Comparing the two best models as per error variance and information criteria, it has been discovering that ARIMA (2 1 1) is the best model as it has a good forecast when comparing it with the original time series data of internally generated revenue.

CONCLUSION

Modelling of time series data of internally generated revenue was the main focus of this project. There is no gain saying the fact that changes in the amount accrued to the state from the federation account at any given time have multiplier effects on different economic sectors. It also affects the purchasing power of local goods and services in the Nigerian markets as well as the spending power. The use of Autoregressive Moving Average models to analyze the time series data of internally generated revenue was to investigate the preceding period effects of amount generated in the state. The ordinary least squares method was used to estimate the parameters of the variable. The parameter estimates revealed significant contributions of the variable of the autoregressive and moving average components of the models. On the whole, the best suitable model for the internally generated revenue is very adequate in view of the forecasting power of it.

Given the declining allocations from the federation account, the Akwa Ibom State government should continue to improve its overall revenue, primarily from domestically generated revenue base. This will enable them to construct more road, infrastructure in their territory. Maximum funding should be allocated to the State's educational Sector, infrastructural development for proper development. Emphasis for diversification of the Nigerian economy which has become a major challenge, concern and discourse by Nigerian government and stakeholders should still gain prominent priority and remain policy trust of government towards making every economic sector a major driver of sustainable economic development in Nigeria.

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