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TIME SERIES MODELING OF CRUDE OIL EXPORT IN NIGERIA: AN ITERATIVE APPROACH

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ABSTRACT

It has been argued in recent times that the quantity of crude oil export increases as the year increases as well as production of crude oil, yet Nigerian economy decreases as the year increases. Hence, there is need to evaluate or build a model in order to help policy makers forecast the quantity of crude oil export in Nigeria. The aim of this paper is to fit an appropriate model to the crude oil export in Nigeria. Therefore, we estimated the autoregressive integrated moving averages: ARIMA(1,1,1), ARIMA(2,11), ARIMA(1,12), ARIMA(2,1,2) SARIMA (1,1,1) $(1,1,1)_{12,}$ SARIMA(1,1,1)$(2,1,1)_{24}$ and their various autocorrelation function (ACF) and partial autocorrelation function (PACF). Based on Ljung-Box statistics, the ACF and PACF, we choose SARIMA(1,1,1)$(2,1,1)_{24}$ as the appropriate model. This model has also, the least mean squared Error (MSE). Therefore we forecasted Nigeria's crude oil export with SARIMA(1,1,1)$(2,1,1)_{24}$; the results indicate that Nigeria crude oil export will decrease in the long run therefore there is need for diversification of Nigeria economy.

INTRODUCTION

Nigeria's economy is basically an open economy with international transactions constituting an important proportion of her aggregate economic activities. Over the years, the degree of openness of the economy has grown considerable. Nigeria is also middle income, mixed economy and an emerging market, with expanding financial service, communications and entertainment sector. Before Nigeria gained her political independence in 1960, agriculture was the dominant sector in the economy, which provides both cash crops and food crops to the economy and accounted for the largest part of the foreign exchange of the country. But, the discovery of crude oil production in commercial quantities changed the structure of the economy. This led to the neglect of agricultural products, making the economy to depend heavily on production of crude oil. In 2000, oil and gas export accounted for more than 98% of export and about 83% of federal government revenue (Odularu 2008). Nigeria's proven oil reserves are estimated to be 35 billion barrels, natural gas reserves are 1000 trillion (2,800kmi) and its crude oil production was around 2.2 million barrels (350,000mi) per day (Odularu 2008). Due to mis-management, economic reforms of the past years have put Nigeria back on track towards achieving its full economic potentials.

Nwosu *et al* (2020) reviewed that, Nigeria economy is struggling to leverage the country's wealth in fossil fuel in order to displace the crushing poverty that affects about 57% of its population, also Nigeria's exports of oil and natural gas at a time of peak prices- have enabled the country to post merchandise trade and current account surplus in recent years. He also went further to say that 80% of Nigeria's energy revenue flow to the government, 16% covers operational costs, and the remaining 4% go to investors, however, the world bank has estimated that as a result of corruption 80% of energy revenues benefit only 1% of the population due to inflation per capital GDP today remains lower than in 1960 when Nigeria declared independence, about 57% of the population lives on less than us $ 1 per day

Crude oil exports positively contribute to economic growth through various ways; it promotes specialization in the production of export commodities when there is an increase in export which may also lead to an increase in the productivity of the export sector. Also increase in export may result to an efficient resource allocation since it encourages domestic resource allocation closer to international opportunity costs. Crude oil export that has comparative advantage would lead to the exploitation of economics of scale that are external in the non-export sector, but internal to the overall economy, through the increase of crude oil export, international market gives room to large capacity utilization and increase in world market's foreign demand. Exports may also give access to advanced technological improvement in the economy due to foreign market competition, it also helps in revenue generation, local expenditure, good and services, foreign exchange reserves and supply of energy to industry and commerce.

Many Scholars and professional bodies have researched and worked a lot in field of export and economic growth. The contribution of export growth to economic growth has been tested by different economists using different economic techniques. Akanni (2004), examines if oil exporting countries grow as their earnings on oil rents increases, using PC - GIVEIO, (ordinary least squares regression). The result shows that there is a positive and significant relationship between investment and economic growth and also on oil rents; in conclusion, oil rents in most rich oil developing countries in Africa do not promote economic growth.

Idowu (2005), using a causality approach examines that there is a relationship between crude oil export and economic growth in Nigeria. Using Johnson's multivariate cointegration technique, the result shows that there is stationary relationship between exports and gross domestic product (GDP) – There is feedback causality between crude oil exports and economic growth. Eshani, et al (2009), investigate the impact of income generated from oil exports on economic growth in Iran. Using Cobb-Douglas production function; the economy of Iran adjusts fast to shocks and there is progress in technology in Iran. Oil exports contribute to real income through real capital accumulation.

Odularu (2008), used Harrod–Domer theory and so low's theory of economic growth used ordinary least square regression and Cobb-Douglas production function were employed to test the impact of crude oil in Nigeria economic performance. The result shows that crude oil production contributed to economic growth but have no significant improvement on economic growth of Nigeria. Samad (2011), tested the hypothesis that there exists relationship between exports and economic growth in Algeria, using VEC Granger Causality and block exogeneity wald test. Augumented Dickey Fuller test was used to run the regression. The result shows that the variables are non- stationary. It was concluded that there is casual relationship between economic growth, exports and imports.

Elbeydi, *et al* (2010), tested if export enhanced economic growth in Libya Arab. Using co-integration with granger causality. The results show that income, exports and relative price are co- integrated. It was concluded that both export and growth are related to each other.

Rahmaddi (2011), examine the exports and economic growth nexus in Indonesia employing vector autoregressive (VAR) Model. The findings indicate the significance of both exports and economic growth to economy of Indonesia as indicated in GIRF analysis. It was concluded that exports and economic growth exhibits bidirectional causal structure, which is export led growth in long-run and growth led export in short-run. Debel (2002), using co- integration and EMR correction approaches in the regression analysis examine the policies and test for the relationship between exports and economic growth. The result shows that export significantly affected economic growth in the short-run. There is causality run from exports to economic growth.

Nigeria the largest oil producing country in Africa has existed for over 50 years since her independence, yet she relies heavily on the export of crude oil for refinement. In recent times, it has been argued that the quantity of crude oil export increases as the year increases as well as production of crude oil, yet Nigerian economy decreases as the year increases. Although large proceeds are obtained from domestic sales and export of crude oil, its effect on the growth of the Nigerian economy as regards return and productivity is still questionable. Hence, there is need to evaluate or build a model in other to help policy maker forecast the quantity of crude oil export in Nigeria the need for ARIMA modeling is applied. Etuk (2012) applied SARIMA model of order $(0,1,1)\times(0,1,1)_7$ to forecast daily Naira/ Euro exchange rates.

METHODOLOGY

We used the autogressive integrated moving average (ARIMA) process to analyze the data. That is, an ARIMA model is fitted to the data. The data for this research work was collected from annual statistical bulletin of the Nigerian National Petroleum Corporation (NNPC). The data is made up of quantity of crude oil export in Nigeria between 2010 to 2019. In practice, many economic time series are non-stationary in mean and they can be modeled only by removing the non-stationary source of variation. Often this is done by differencing series. Suppose X_t is non-stationary in mean, the idea is to build an ARIMA model on the series W_t, definable as the result of the operation of differencing the series d times (in general d = 1): $W_t = \Delta^d X_t$. Hence, ARIMA models (where I stands for integrated) are the ARIMA models defined on the dth difference of the original process:

$$\phi(\beta)\Delta^d X_t = \theta(\beta)a_t$$

Where $\phi(\beta)\Delta^d$ is called generalized autogressive operator and $\Delta^d X_t$ is a quantity made stationary through the differentiation and can be modeled with an ARMA.

SEASONAL ARIMA

Often times, series possesses a seasonal component that repeats every S observation. For monthly observations S = 12 (12 in 1 year), for quarterly observation S = 4 (4 in 1 year). In order to deal with seasonality, ARIMA processes have been generalized; SARIMA models have then been formulated.

$$\phi(\beta)\Delta^d X_t = \theta(\beta)\alpha_t$$

Where α_t is such that

$$_s\theta(\beta)_s\phi(\beta^s)\Delta_s{}^D\Delta^d X_t = \theta(\beta)_s\theta(\beta^s)\alpha_\theta$$

and we write $X_t \sim$ ARIMA (p, d, q) x (P, D, Q)$_s$. The idea is that SARIMA are ARIMA (p, d, q) models whose residual α_t are ARIMA (P, D, Q), with ARIMA (p, D, Q) we intend ARIMA models whose operators are defined on β^s and successive powers.

AUTOCORRELATION FUNCTION (ACF) AND PARTIAL AUTOCORRELATION FUNCTION (PACF)

Autocorrelation and partial autocorrelation are measures of association between current and past series values and indicate which past series values are most useful in predicting values, with this knowledge we can determine the order of processes in an ARIMA model more specifically.

Autocorrelation function (ACF) at lag k is the correlation between series values that are k intervals apart which is given as;

$$\rho_k = \frac{y_k}{Y_o} = \frac{\text{covariance at lag k}}{\text{variances}}$$

Partial autocorrelation function (PACF) at lag k is the correlation between series values that are k interval apart, accounting for the values of the intervals between.

RESULTS

Time Series Plot of The Raw Data

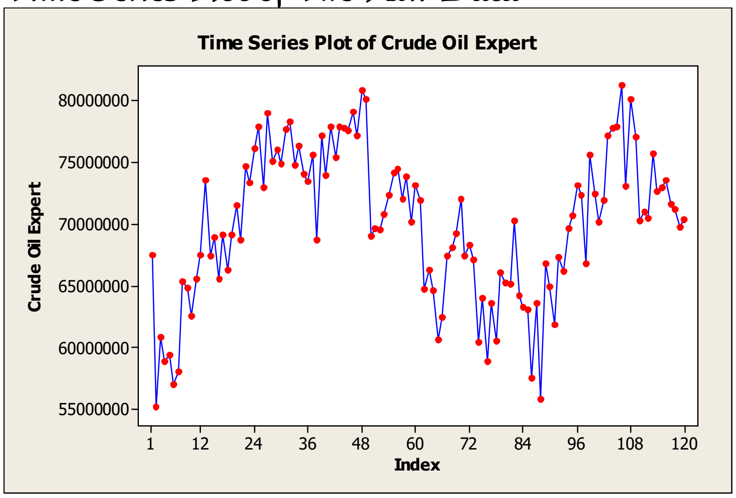

Chart 1.1 Time Plot of the crude oil export in Nigeria

Chart 1.1 displays the raw data of the crude oil export in Nigeria. The plot shows that there is seasonal variation in the data.

Test for Normality (ADF) Unit Root Test (Anderson-Darling Test)

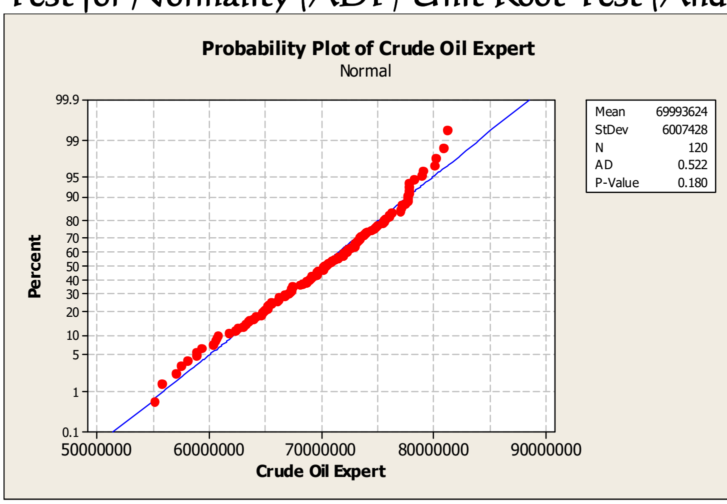

Chart 1.2 Unit root test for the raw data

By Chart 1.2 it can be deduced that the data came from a normally distributed population. (p>.180)

Table 1.1: Test Result

A^2	0.522
p-value	0.180

Since the p-value (0.180) displayed in table 4.3 is greater than the alpha value (0.05) therefore we conclude that the data came from a normally distributed population. Also looking at the chart we can see that the points are clustered around the trend line which is also an indication of normality.

Test for Stationarity

Table 1.2: Augmented Dickey-Fuller Unit Root Test

		t-Statistic	Prob.
Augmented Dickey-Fuller test statistic		-2.5107	0.1156
Test critical values:	1% level	-3.4892	
	5% level	-2.8872	
	10% level	-2.5805	

From table 1.2 it can be seen that the data is not stationary since the p-value is greater than the alpha, (0.1156>0.05) the null hypothesis cannot be rejected, so it may be concluded that there is unit root in the data – it is not stationary. The data is transsformed by differencing in order to make it stationary.

Time Series Plot of the Differenced Data

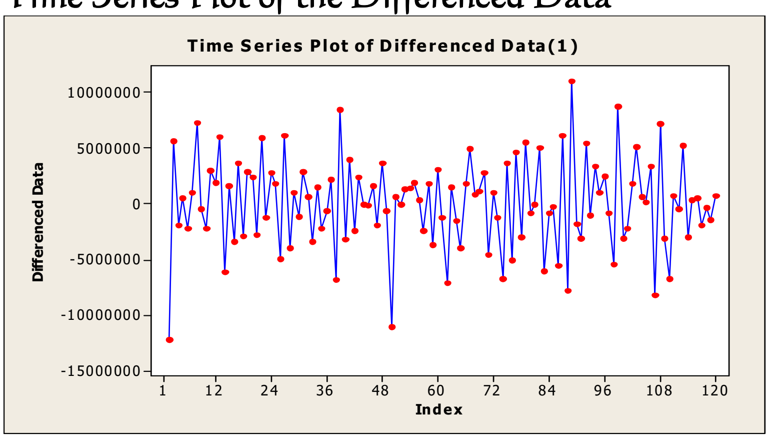

Chart 1.3 Time Plot of the Differenced Data

From chart 1.3 it can be observed that the 1st difference of the data of crude oil export are stationary. Going further to still test with the Augumented Dickey Fuller unit root test it is observed:

Test for Stationarity of the Differenced Data

Table 1.3: Augmented Dickey-Fuller Unit Root Test

		t-Statistic	Prob.
Augmented Dickey-Fuller test statistic		-4.1916	0.0011
Test critical values:	1% level	-3.4920	
	5% level	-2.8884	
	10% level	-2.5812	

Since the p-value is less than the alpha, the null hypothesis is rejected and it is concluded that there is no unit root in the data – it is stationary. Since the data is stationary, an appropriate model may be fitted to the data.

Fitting ARIMA Model to the Differenced Data

Table 1.4: ARIMA (1,1,1)

Final Estimates of Parameters				
Type	Coef	SE Coef	T	P
AR 1	0.5146	0.0778	-6.62	0.000
MA 1	0.9865	0.0038	261.53	0.000

Differencing: 1 regular difference
Number of observations: Original series 119, after differencing 118
Residuals: SS = 1370207106003356 (backforecasts excluded)
MS = 11812130224167 DF = 116

Table 1.5: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	35.3	63.2	98.0	122.8
DF	10	22	34	46
P-Value	0.000	0.000	0.000	0.000

Interpretation

The ARIMA(1,1,1) parameters had p-values of 0.000 and 0.000 respectively which indicates that it is significant. But the Ljung-Box statistics give significant p-values, indicating that the residuals appeared to be correlated. This means that the model is not adequate.

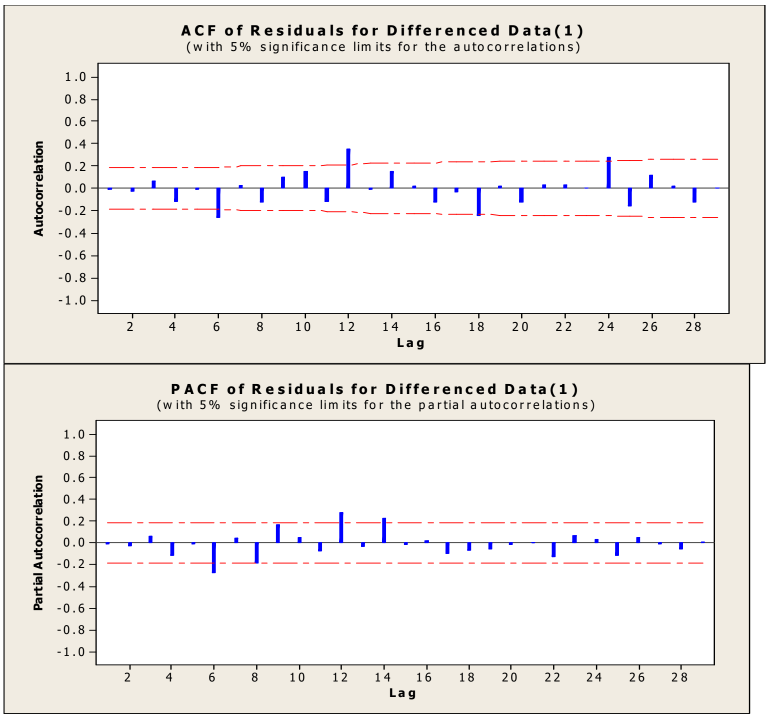

Chart 1.4 Correlogram of the differenced series

The ACF and PACF of the residuals corroborate the interpretation made above. There are still spikes in the ACF and PACF that did not die down rapidly. The ARIMA(1,1,1) model appears not to fit well so it cannot be used to make forecasts. Hence a different model is investigated.

Table 1.6 ARIMA (2,1,1)

Final Estimates of Parameters				
Type	Coef	SE Coef	T	P
AR 1	-0.5574	0.0902	-6.18	0.000
AR 2	-0.0970	0.0894	-1.09	0.280
MA 1	0.9874	0.0029	341.74	0.000

Differencing: 1 regular difference
Number of observations: Original series 119, after differencing 118
Residuals: SS = 1357321389374404 (backforecasts excluded)
MS = 11802794690212 DF = 115

Table 1.7: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	37.2	68.4	103.6	130.3
DF	9	21	33	45
P-Value	0.000	0.000	0.000	0.000

Interpretation

The ARIMA (2,1,1) parameter had a p-value of 0.280 which indicates that it is not significant. A different model is now investigated.

Table 1.8: ARIMA (1,1,2)

Final Estimates of Parameters				
Type	Coef	SE Coef	T	P
AR 1	-0.8199	0.1033	-7.94	0.000
MA 1	0.3441	0.1318	2.61	0.010
MA 2	0.6429	0.0997	6.45	0.000

Differencing: 1 regular difference
Number of observations: Original series 119, after differencing 118
Residuals: SS = 1665867717192665 (backforecasts excluded)
MS = 14485806236458 DF = 115

Table 1.9: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	98.2	164.1	235.5	281.7
DF	9	21	33	45
P-Value	0.000	0.000	0.000	0.000

Interpretation

The ARIMA(1,1,2) parameter had a p-value of 0.000 as shown in table 1.8 which indicates that it is significant, while Ljung-Box statistics give significant p-values in table 1.9, indicating that the residuals appeared to be correlated. This shows inadequacy of the model.

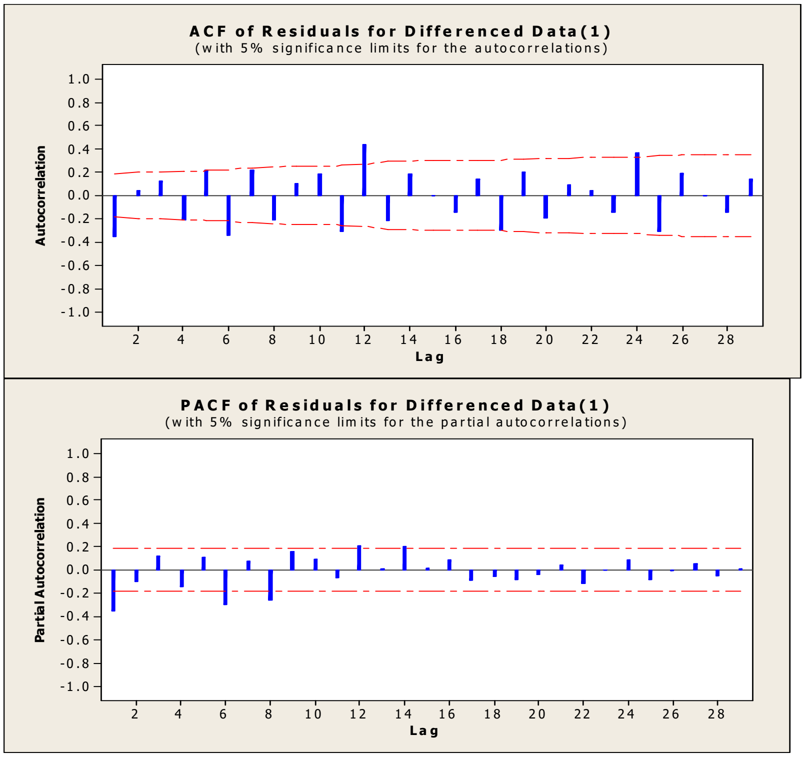

Chart 1.5 Correlogram of the residuals of the ARIMA(2,1,2) model

The ACF and PACF of the residuals substantiate the interpretation made above because there are still spikes in the ACF and PACF that did not die down rapidly. The ARIMA (1,1,2) model appears not to fit well so it cannot be used to make forecasts. A different model shall be tried.

Table 1.10: ARIMA(2,1,2)

Final Estimates of Parameters

Type	Coef	SE Coef	T	P
AR 1	-1.2394	0.1250	-9.91	0.000
AR 2	-0.4888	0.0877	-5.57	0.000
MA 1	0.3058	0.1222	2.50	0.014
MA 2	0.6747	0.0991	6.81	0.000

Differencing: 1 regular difference
Number of observations: Original series 119, after differencing 118
Residuals: SS = 13172464948433o8 (backforecasts excluded)
MS = 115547938144l5 DF = 114

Table 1.11: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	28.6	53.1	82.6	106.1
DF	8	20	32	44
P-Value	0.000	0.000	0.000	0.000

Interpretation: Table 1.10 ARIMA(2,1,2) parameters had p-values of 0.000 and 0.000 respectively which indicates that they are significant, but the Ljung-Box statistics give significant p-values that indicate that the residuals appeared to be correlated, and this implies inadequacy of a model.

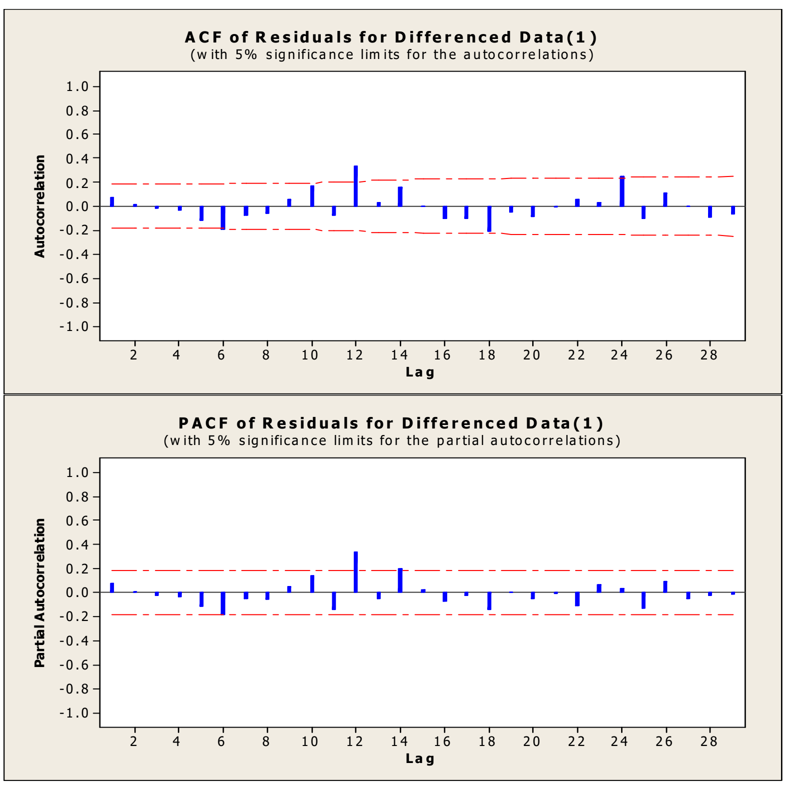

Chart 1.6 Correlogram of residuals of the ARIMA(2,1,2) model

The ACF and PACF of the residuals are in-line with our interpretation as they show spikes that did not die down. So no forecasts will be made using this model because it did not fit well. Another model is tried.

Table 1.12: SARIMA(1,1,1)(1,1,1)$_{12}$

Final Estimates of Parameters

Type	Coef	SE Coef	T	P
AR 1	-0.3049	0.1013	-3.01	0.003
SAR 12	-0.2626	0.1206	-2.18	0.032
MA 1	0.8986	0.0484	18.56	0.000
SMA 12	0.7716	0.1016	7.59	0.000

Differencing: 1 regular, 1 seasonal of order 12
Number of observations: Original series 119, after differencing 106
Residuals: SS = 771455861085528 (backforecasts excluded)
MS = 7563292755740 DF = 102

Table 1.13: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	9.9	26.1	28.9	37.1
DF	8	20	32	44
P-Value	0.272	0.162	0.623	0.760

Interpretation: The SARIMA (1,1,1)(1,1,1)$_{12}$ parameters are all significant as shown in table 1.12. The Ljung-Box statistics give non-significant p-values in table 1.13; these indicate that the residuals appeared to be uncorrelated, which implies that the model is adequately fit.

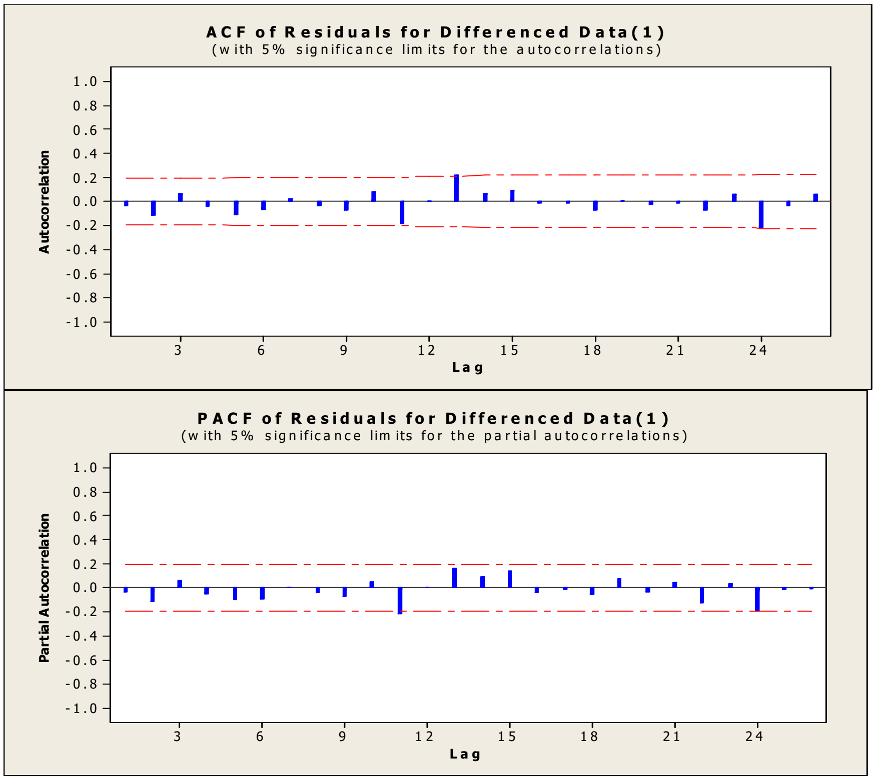

Chart 1.7 Correlogram of the residuals of the SARIMA $(1,1,1)(1,1,1)_{12}$ model

The ACF and PACF of the residuals are in-line with our interpretation as they show spikes that are within the bounds, though the spike at lag 11 is a bit out which may be judged to be due to random event. So forecasts shall not be made yet, but some other models shall be investigated to select the one with the best fit.

Table 1.14: SARIMA $(1,1,1)(2,1,1)_{24}$

Final Estimates of Parameters

Type	Coef	SE Coef	T	P
AR 1	-0.2626	0.1012	-2.60	0.011
SAR 12	-0.3554	0.1203	-2.95	0.004
SAR 24	-0.4219	0.1240	-3.40	0.001
MA 1	0.9135	0.0443	20.61	0.000
SMA 12	0.6810	0.1202	5.67	0.000

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Differencing: 1 regular, 1 seasonal of order 12
Number of observations: Original series 119, after differencing 106
Residuals: SS = 716453968241680 (backforecasts excluded)
MS = 7093603645957 DF = 101

Table 1.15: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	7.8	14.7	21.9	34.3
DF	7	19	31	43
P-Value	0.351	0.740	0.886	0.827

Interpretation: The SARIMA $(1,1,1)(2,1,1)_{24}$ parameters in table 1.14 are all significant. The Ljung-Box statistics which gave non-significant p-values as displayed in table 1.15 implies that the residuals are uncorrelated and that the model is well fit.

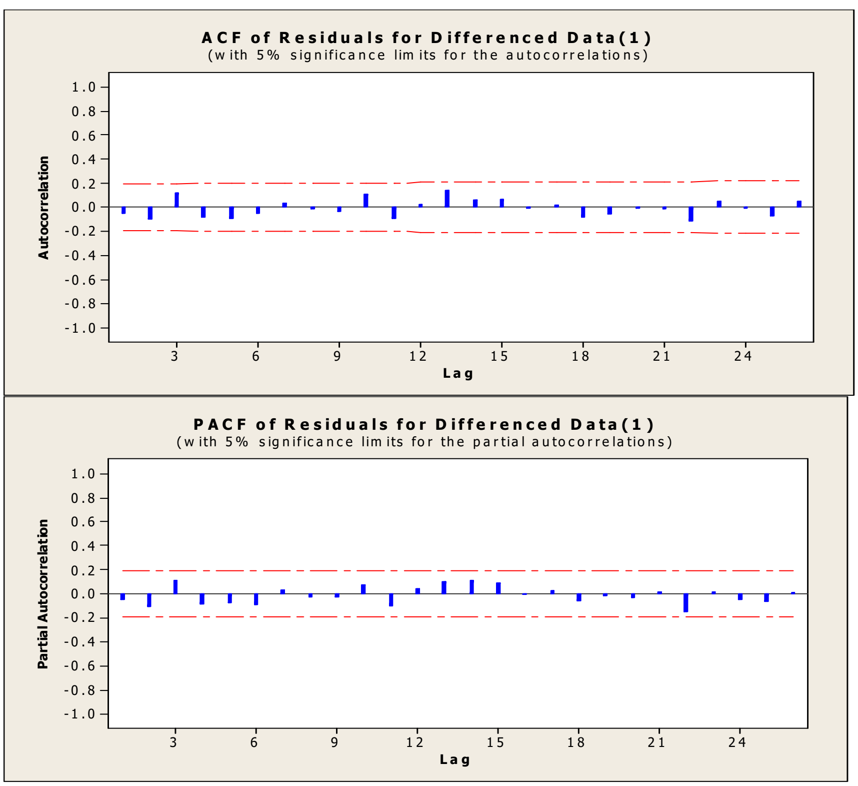

Chart 1.8 Correlogram of the residuals of the SARIMA $(1,1,1)(2,1,1)_{24}$ model

The ACF and PACF of the residuals in contrast with that of SARIMA $(1,1,1)(1,1,1)_{12}$ have spikes that are all within the bounds and died down to zero. This model is adequate. After the comparison below, forecasts with the SARIMA $(1,1,1)(2,1,1)_{24}$ model shall be made.

Comparison of the Models

Table 1.16: Test Statistics

MODELS	MSE
ARIMA(1,1,1)	11812130224167
ARIMA(2,1,1)	11802794690212
ARIMA(1,1,2)	14485806236458
ARIMA(2,1,2)	11554793814415
SARIMA$(1,1,1)(1,1,1)_{12}$	7563292755740
SARIMA$(1,1,1)(2,1,1)_{24}$	7093603645957

Although we have made comparisons using the Ljung-Box statistics, the ACF and PACF for each model, it is still necessary to compare the MSE of the models. Table 1.16 above shows the MSE of each of the models. From the table, the MSE of the SARIMA$(1,1,1)(2,1,1)_{24}$ model is the smallest, showing that it remains the most adequate among the models; therefore, we shall make forecasts using the SARIMA$(1,1,1)(2,1,1)_{24}$ model.

The forecasting model is given by

SARIMA $(1,1,1)\ (2,1,1)_{24}$

$= (1 - \theta_1\beta)(1 - \lambda_1\beta^{24})(1 - \beta)(1 - \beta^{24})y_t = (1 - \theta_1\beta)(1 - \lambda_1\beta^{24})e_t$

Expanding, we have for the left hand side

$= (1 - \lambda_1\beta^{24} - \theta_1\beta + \lambda_1\theta_1\beta^{25})(1 - \beta)$

$= (1 - \lambda_1\beta^{24} - \theta_1\beta + \lambda_1\theta_1\beta^{25})-(\beta - \lambda_1\beta^{25} - \theta_1\beta^{25} - \lambda_1\theta_1\beta^{26})$

$= (1 - \lambda\beta^{24} - \theta\beta + \lambda_1\theta_1\beta^{25} - \beta + \lambda_1\beta^{25} + \theta_1\beta^{2} - \lambda_1\theta_1\beta^{26})(1 - \beta^{24})$

$= (1 - \lambda\beta^{24} - \theta_1\beta + \lambda_1\theta_1\beta^{24} - \beta + \lambda_1\beta^{25} + \theta_1\beta^{2} - \lambda_1\theta_1\beta^{26} - \beta^{24} + \lambda\beta^{48} + \theta_1\beta^{25} - \lambda_1\theta_1\beta^{49} + \beta^{25} - \lambda_1\beta^{49} - \theta_1\beta^{26} + \lambda_1\theta_1\beta^{50})y_t$

$Y_t - \lambda\beta^{24}y_t - \theta_1\beta yt + \lambda_1\theta_1\beta^{25}y_t - \beta y_t + \lambda_1\beta^{25}y_t + \theta_1\beta^{2}y_t - \lambda_1\theta_1\beta^{26}y_t - \beta^{24}y_t + \lambda_1\beta^{48}y_t + \theta_1\beta^{25}y_t - \lambda_1\theta_1\beta+^{49}y_t + \beta^{25}y_t - \lambda_1\beta^{49}y_t - \theta_1\beta+^{26}y_t + \lambda_1\theta_1\beta+^{50}y_t = (e_t - \lambda_1\beta^{24}e_t - \theta_1\beta e_t + \lambda_1\theta_1\beta^{25}e_t)$

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$$Y_t = \lambda_1\beta^{24}y_t + \theta_1\beta y_t - \lambda_1\theta_1\beta^{26}y_t + \beta y_t - \lambda_1\beta^{25}y_t - \theta\beta^2 y_t - + \lambda_1\theta_1\beta^{26}y_t + \beta^{24}y_t - \lambda_1\beta^{48}y_t - \theta\beta^{25}y_t + \lambda_1\theta_1\beta+^{49}y_t - \beta^{25}y_t - \lambda_1\theta_1\beta+^{49}y_t + \theta_1\beta^{26}y_t - \lambda_1\theta_1\beta^{50}y_t + e_t - \lambda_1\beta^{24}e_t - \theta_1\beta e_t + \lambda_1\theta_1\beta^{25}e_t$$

Recall that $\beta = Y_{t-1}, \beta^2 = Y_{t-2}, \ldots \beta^n = Y_{t-n},$

Therefore,

$$Y_t = \lambda_1 y_{t-24} + \theta_1 y_{t-1} - \lambda_1\theta_1 y_{t-25} + y_{t-1} - \lambda_1 y_{t-25} - \theta_1 y_{t-2} + \lambda_1\theta_1 y_{t-26} + y_{t-24} - \lambda_1 y_{t-48} - \theta_1 y_{t-25} + \lambda_1\theta_1 y_{t-49} - y_{t-25} + \lambda_1 y_{t-49} + \theta_1 y_{t-26} - \lambda_1\theta_1 y_{t-50} + e_t - \lambda_1 e_{t-24} - \theta_1 e_t + \lambda_1\theta_1 e_{t-25}$$

$$Y_t = (1 + \theta_1)\, y_{t-1} - \theta_1 y_{t-2} + (1 + \lambda_1)\, y_{t-24} - (\theta_1 + \lambda_1 - 1 + \lambda_1\theta_1)\, y_{t-25} + (\theta_1 + \lambda\theta_1)\, y_{t-26} - \lambda_1 y_{t-48} + (\lambda_1 + \lambda_1\theta_1)\, y_{t-49}\ \lambda_1\theta_1 y_{t-50} + e_t - \theta_1 e_{t-1} - \lambda_1 e_{t-24} + \lambda_1 e_{t-24} + \lambda_1\theta_1 e_{t-25}$$

Therefore,

$$Y_t = (1 + \theta_1)\, y_{t-1} - \theta_1 y_{t-2} + (1 + \lambda_1)\, y_{t-24} - (\theta_1 + \lambda_1 - 1 + \lambda_1\theta_1)\, y_{t-25} + (\theta_1 + \lambda\theta_1)\, y_{t-26} - \lambda_1 y_{t-48} + (\lambda_1 + \lambda_1\theta_1)\, y_{t-49} - \lambda_1\theta_1 y_{t-50} + e_t - \theta_1 e_{t-1} - \lambda_1 e_{t-24} + \lambda_1\theta_1 e_{t-25}$$

5-YEAR PERIOD FORECAST

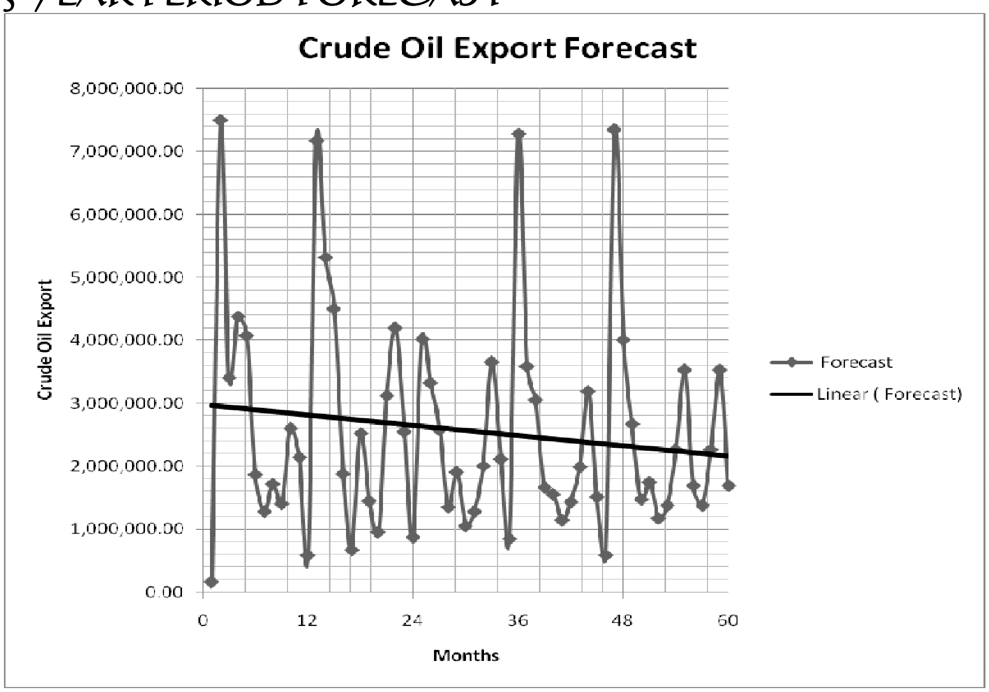

Chart 1.9

DISCUSSION OF RESULTS

From the Ljung-Box statistics, the ACF and PACF, and the MSE for each of the model tested, we discovered that SARIMA $(1,1,1)(2,1,1)_{24}$ model has the smallest, statistics as shown in Table 1.12, 1.13 and chart 1.8. Showing that it remains the most adequate among the models; therefore, we shall make forecasts using the SARIMA $(1,1,1)(2,1,1)_{24}$ model. Because this model is the most appropriate, the forecast was made using it.

CONCLUSION AND RECOMMENDATIONS

The SARIMA$(1,1,1)(2,1,1)_{24}$ model was adopted as the best model that fit the data, since it has the least or minimum MSE and all its parameter in table 1.14 are all significant, the ljungs-box gave non-significant p-values as displayed in table 1.15. Also the ACF and PACF have spikes that are all within the bounds and died down to zero. Therefore we conclude that SARIMA $(1,1,1)(2,1,1)_{24}$ is adequate, and most preferred model that can be fitted into the Nigeria crude oil export data out of all that was tested. Based on the findings of this study, we recommend that the Nigeria National Petroleum Corporation (NNPC) should diversify its export basket through downstream production; this will enhance the refined petroleum for export. The Government should encourage more private company participation so that better equipped refineries can be built and the cost of refining crude oil will be reduced. Security should be boosted on the high sea where crude oil products are being smuggled; this will help reduce the loss from illegal export of crude oil products. Government should give immediate attention to the ingenious of the region where crude oil is being extracted form; this will reduce the unrest in the region. Government should improve on fighting corruption, arrest and prosecute public corrupt office holders.

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