MODELLING NIGERIA CRUDE OIL: A STRUCTURAL EQUATION MODELLING (SEM)

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ABSTRACT: *Crude oil markets have been subjected to shocks and consequently have been highly volatile. Demand and supply shocks cause large movements in oil prices, which are followed by a dynamic response in both energy demand and supply and in the energy exploration and development activities. Modeling crude oil markets is of paramount importance, not only because of the influence of energy on macroeconomic activity but also because of the role of energy in the investment plans of households and firms. Energy cost and efficiency have become a prime concern in these plans. The study attempted to model Nigeria crude oil on gross domestic product (GDP) using Structural Equation Modelling (SEM) for period 1979 to 2013. The time plot revealed that there was increase of crude oil price overtime. In the same vein, the plot for oil production indicates fluctuation and therefore instability. The time plot for oil export showed that there was sharp decline of export overtime. The plot for real gdp indicated that increase in the real gdp overtime, but an abrupt decline from 2010. To avoid spurious regression, the data were tested for stationarity using the Augmented Dickey-Fuller test and the test indicated that the variables were all stationary. This finding establishes that about 53.8% of the total variation in oil export is jointly explained by oil production, crude oil price and real gdp. In the model, oil production, price of crude oil and inflation rate were said to insignificant, while real gdp is statistically significant. Collectively, the all the variables are said to statistically significant. The Durbin-Watson statistic indicates that there is no serial autocorrelation among the variables. Oil export would continue to be under upward pressure so long inflation rate, real gross domestic product and oil production keep falling. The model was examined for long run relationship using cointegration techniques and the study indicates that there is long run disequilibrium (no long relationship).*

In conclusion, Oil export operates in the demand function and may arise from shocks to real GDP, and inflation rate. Oil production shocks operate in the supply function and may arise from shocks to actual or capacity output.

1. BACKGROUND OF THE STUDY

The crude oil market was exposed to shocks and hence was extremely unpredictable (Kilian, 2009). Demand and supply shocks trigger significant oil price changes, accompanied by a complex response in energy demand and supply, as well as in the energy exploration and production activities (Lee & Ni, (2002).

Modeling the demand for crude oil is of utmost importance, not only because of the impact of energy on macroeconomic activity but also because of the role of energy in households and firms' investment plans (Krichene, 2005). In these plans, energy prices and conservation became a prime concern.

The actions of both nominal and actual crude oil prices can be looked at over two distinct subperiods: 1918-73 and 1974-2004. Prices displayed a remarkable long-term stability in the initial phase, suggesting that crude oil demand and supply were moving in equilibrium, as markets cleared without substantial excess demand or supply that could have led to price jumps (Wirl, 2008). Moreover, the faster pace in the supply of natural gas has kept the emergence of excess demand for crude oil under control.

Since oil is a very important commodity for everyone in every corner of the world, changes in the price of oil and its causes are a topic of great interest to economists. Three schools of thought in relation to identifying the causes of shifts in oil prices, but none were completely accurate in forecasting the course of oil prices (Smith, 2009). The first school explores the relationship between demand and supply powers on the market when assessing fuel. Microeconomic theory notes that there will be upward pressure on prices as demand increases, or if there is a disturbance of supply. By the same token, there will be downward pressure on prices if demand declines or there is an oversupply of the commodity on the market. Crude oil inventories show the presence of excess supply or demand. Dicembrino and Scandizzo (2012) presents a short-term quarterly forecast model of the real World Trade Index (WTI) price reflecting both the position of OPEC and the physical oil supply of relative inventory rates, which the author includes as explanatory variables in his model OPEC quotas, overproduction and non-Organization of Economic Cooperation and Development (OECD) demand. He, Wang and Lai 2010) use relative rates of oil inventories to forecast oil prices.

The study aims at evaluating the impact of monetary policy on the crude oil market. To this end, the following objectives are sought: to present a Simultaneous Equations Model (SEM) of the crude oil markets in Nigeria; to attempt to create a relationship between oil prices, nominal effective exchange rates and interest rates in Nigeria and to identify demand shocks resulting from monetary policy

2. MATERIAL AND METHOD

The methodology for this study is the *simultaneous equations models* (SEM). As the name makes clear, the heart of this class of models lies in a data generation process that depends on more than one equation interacting together to produce the observed data.

Unlike the single-equation model in which a dependent (*y*) variable is a function of independent (*x*) variables, other *y* variables are among the independent variables in each SEM equation. The *y* variables in the system are jointly (or simultaneously) determined by the equations in the system.

Compare the usual single equation GDP,

$$y = \beta_0 + \beta_1 x_1 + \varepsilon,$$

to a simple, two-equation SEM:

$$y_1 = \alpha_0 + \alpha_1 y_2 + \alpha_2 x_1 + \varepsilon_1$$

$$y_2 = \gamma_0 + \gamma_1 y_1 + \varepsilon_2$$

Notice that the first equation in the system has a conventional *x* variable, but it also has a dependent variable (y_2) on the right-hand side. Likewise, the second equation has a dependent variable (y_1) as a right-hand side variable. In a simultaneous equations system, variables that appear only on the right-hand side of the equals sign are called exogenous variables. They are truly independent variables because they remain fixed. Variables that appear on the right-hand side and also have their own equations are referred to as endogenous variables. Unlike exogenous variables, endogenous variables change value as the simultaneous system of equations grinds out equilibrium solutions. They are endogenous variables because their values are determined within the system of equations.

Model Specification

A simultaneous demand and supply model for crude oil market is specified. Given the role of market information in determining supply behavior (Muth, 2005), the hypothesis of rational expectations is adopted.

Crude oil export: $y_1 + \delta_{12} y_2 + \gamma_{11} z_1 + \gamma_{14} z_4 = u_1$

Crude oil production: $y_1 + \delta_{22} y_2^e + \delta_{23} y_3 + \gamma_{22} z_2 + \gamma_{24} z_4 = u_2$

where the definitions below apply; output, prices, and real GDP are in logarithm form:

y_1= crude oil output, in millions of barrels per day;
y_2= crude oil nominal price, in U.S. dollars per barrel;
y_2^e = expected nominal price for crude oil, in U.S dollars per barrel;
z_1= real GDP index
z_4= dummy variable for large swings in oil prices;
z= a constant term.

Each residual $u_1$and $u_2$is assumed to be serially uncorrelated, independently and identically distributed with a mean of zero and standard error $\sigma_i, i = 1, 2$, and uncorrelated with the predetermined and exogenous variables. It may be further assumed that demand and supply disturbances are uncorrelated, implying $E(u_1 u_2) = 0$. The expected variables y_2^e and y_4^e are predetermined, and rationally form: $y_2^e = E_{t-1}(y_2 | I_{t-1})$ is the information set in period $t-1$ on which expectations $E_{t-1}(y_i | I_{t-1})$ were based. Demand for crude oil is a function of its price and an indicator for world economic activity, which here is approximated by the real GDP. The supply of crude oil is a function of its expected price at time $t-1$, the output of natural gas, and a dummy variable for shocks to oil prices. The demand for natural gas is a function of its price and real GDP. The supply of natural gas is a function of its expected price at time -1 , the output of crude oil, and a dummy variable for shocks to the natural gas price. Following McCallum (2002) the actual and expected prices are expressed as: $y_2 = y_2^e + \eta_2$,$\eta_2$is forecast errors that are uncorrelated with I_{t-1}.

The model is identified: no one equation can be obtained as a linear combination of two or more equations. Given the dynamics of adjustment in demand and supply, lagged variables have to be introduced. Tests on the length of the lag seem to indicate that the optimal lag would be three or four periods. The model is estimated by a two-stage least-squares method to obtain short-run estimates. To strengthen confidence in these estimates, the model is reestimated in an error correction model (ECM). Long-run elasticities are estimated with the help of the ECM and with cointegration analysis; these two methods are appropriate for finding long-run relations in each identified equation of the model.

3. DATA ANALYSIS

In view of different theories and literature reviewed in previous chapters of this study and different opinions and findings from various author, it can be seen that there is a need to establish the relationship between crude oil Production, crude oil export, and crude oil price. The data were collected from OPEC annual report and CBN statistical bulletin of relevant variables from year 1979-2013 which will be put to test accordingly for different objectives stated in the introductory part of this research work. Hence, the result of various estimations and consequent analysis of such findings for the purpose of the study is presented.

3.1 Data Used

The data used in this project was obtained from OPEC Annual Statistical Bulletin 1999-2014, Statistical Bulletin of the Central Bank of Nigeria (CBN), Annual Abstract of Nigeria Bureau of Statistics, 2012, the data is presented in tabular form below:

Table 3.1: Macroeconomic and Crude Oil Statistics

Year	INF	RGDP	PRICE	OIL PRO	OIL EXP	EXCHANGE
1979	12.11	29948	17.25	2302	2210.1	0.5957
1980	23.18	31546.8	28.64	2058	1960.2	0.5464
1981	24.42	205222	22.51	1287	151.9	0.61
1982	7.16	199685	32.38	1235.5	162.1	0.6729
1983	23.22	185598	39.04	1388	151.2	0.7241
1984	40.71	183563	38.2	1498.9	160.2	0.7649
1985	4.67	201036	27.01	1466.6	135.2	0.8938
1986	5.39	205971	13.53	1323	136	2.0206
1987	10.18	204807	17.73	1340	135.2	4.0179
1988	56.04	219876	14.24	1716.3	154.8	4.5367
1989	50.47	236730	17.31	1726.7	214.2	7.3916
1990	7.5	267550	32.26	1893.1	257.2	8.0378
1991	12.7	265379	18.62	1957	242.8	9.9095
1992	44.81	271366	18.44	1893.1	218.9	17.2984
1993	7.17	274833	16.33	1957	220.3	22.0511
1994	57.03	275451	15.53	1905.2	108.4	21.8861
1995	72.81	281407	16.86	1820.9	161.3	21.8861
1996	29.29	293745	20.29	1842.6	193	21.8861
1997	10.67	302023	18.68	1876.7	192.5	21.8861
1998	7.86	310890	12.28	1939	113.6	21.8861
1999	6.62	312184	17.47	1781.5	131.1	92.6934
2000	6.94	329179	27.6	2053.6	88.6	102.1052
2001	18.87	356994	23.12	2017.6	227.8	111.9433
2002	12.89	433204	24.36	1801.7	307	120.9702
2003	14.03	477533	28.1	2166.3	307.4	129.3565
2004	15.01	527576	36.05	2327.5	341	133.5004
2005	17.85	561931	50.64	2365.9	388	132.147
2006	8.24	595822	61.08	2233.9	369.4	128.6516
2007	5.38	634251	69.08	2059.3	378.7	125.8331
2008	11.6	672203	94.45	2017.4	372.2	118.5669
2009	12.5	718977	61.09	1842	233	148.9017
2010	13.7	775526	77.45	2048	271	150.298
2011	10.8	37409.9	107.46	1974	311	156.7
2012	12.2	40544.1	109.45	1954	344	155.92
2013	8.5	42396.8	105.87	1753.7	385	155.738

3.2 Trend of Data

This section captures the first objective of the study, which is used to analyze the trend of crude oil production, crude oil export, crude oil price, and real gross domestics products (RGDP) from 1979-2013.

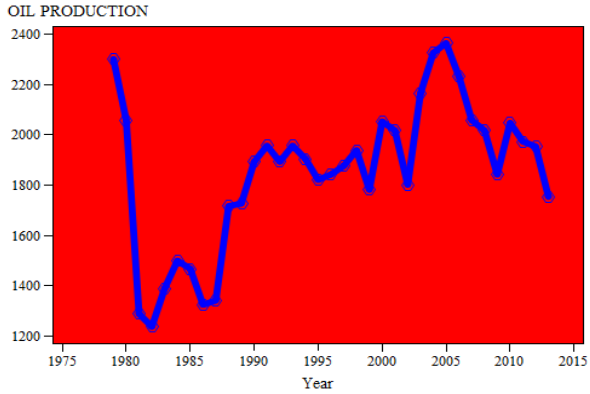

Fig.1 Domestics products (RGDP) from 1979-2013 with SAS9.3 software

The chart above shows the trend of crude oil production from 1979 to 2013. The chart revealed that there was a steady increase in the production of crude oil until 2010, while there has been continuous decline in the production of crude oil since 2011 till date.

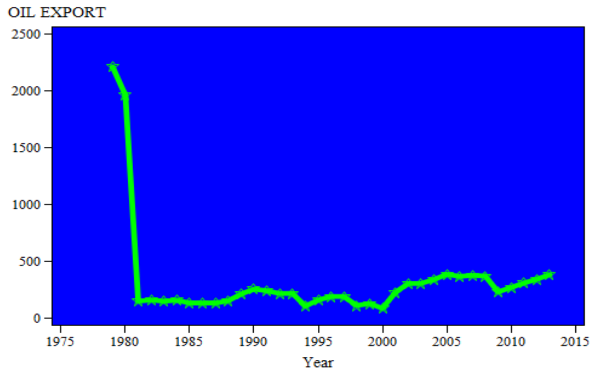

Fig.2 Oil Export

According to the chart above, it was clearly shown that apart from the significant drop of crude oil exported in 1981, there has been a steady increase in the volume of crude oil been exported yearly.

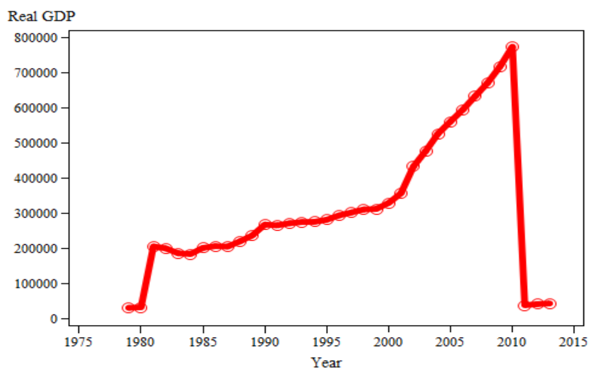

Fig.3 Real GDP

Figure 3 above present the trend of rgdp, it clearly shows that there have been a steady growth in the rgdp annually until 2011 when there was a sharp decline in the rgdp of the nation, this equally show an equal sign of significant decline that occurred in the crude oil production.

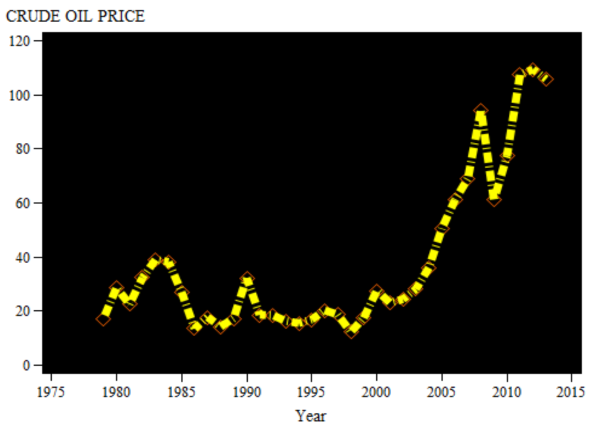

Fig.4 Crude Oil price

Figure 4 above, showed that the price of crude oil was increasing virtually every year, though on a contrary, decreased in the year 2013.

3.3 Stationarity Test

Since unit root problem is a common feature of most time series data. Time series properties of all variables used in estimation were examined in order to obtain reliable result. Thus, this exercise was carried out through Augmented Dickey Fuller (ADF) test as articulated by Engel. The ADF was used to determine the order of integration, that is, the number of times a variable has to be differentiated before it becomes stationary. For this paper, we applied unit root test to check the stationarity of the variables. The null hypothesis in the ADF test was that there is the presence of unit root. Table 3.1 and 3.2 below report the results of ADF.

Table 3.2: Augmented-Dickey Fuller (ADF) Test

Variables/ Coefficients	**ADF Values**	**Mackinnon Critical Values**	**Order of Integration**	**Conclusion**
Oil export	-6.0384*	-3.6394	I(0)	Stationary
Oil production	-4.9478*	-3.6463	I(1)	Stationary
Oil price	-6.4793*	-3.6463	I(1)	Stationary
Log(rgdp)	-5.7135*	-3.6463	I(1)	Stationary
Inflation	-7.1883*	-3.6394	I(0)	Stationary
Exchange rate	-5.4342*	-3.6463	1(1)	Stationary

Source: Author's computation, 2015. *E-Views7*

Note: One, two and three asterisk denotes rejection of the null hypothesis at 1%, 5% and10% respectively based on Mackinnon critical values. N.S. Means Not Significant at All Order Of Integration

The above results that is the ADF showed that Oil export and inflation are stationary at level while the other variables oil production, oil price, log(rgdp) exchange rate are stationary at first difference

3.4 The Co integration Analysis Results and Interpretation

Table 3.3: Johannsen Co-integration

Hypothesized no. of CE(s)	**Eigen value**	**Max-Eigen value**	**Critical value at 5 percent**	**Trace statistics**
None *	0.9907	154.2581	40.0776	95.7537
At most 1 *	0.6153	31.5239	33.8769	69.8189
At most 2	0.4444	19.3846	27.5843	47.8561
At most 3	0.2802	10.8511	21.1316	29.7971
At most 4	0.1899	6.9488	14.2646	15.4947
At most 5	0.0383	1.2894	3.8414	3.8415

From table 3.3 above, we can conclude that there is co-integrating vectors, the trace statistic is greater than the critical value and also both trace test statistic and the max-eigen value test indicates 2 co-integrating equation at 5% level of significance
Based on the evidence above, we can safely reject the null (H_0) which says there is no co-integration and conveniently accept the alternative hypothesis of the presence of co-integrating vectors. Thus, we can conclude that a long run relationship exists among the variables. This result means that in Nigeria's case, the hypothesis of no co-integration among the variables should be rejected.

3.5 The Simultaneous Equation Modelling of Macroeconomic and Crude Oil

This section provides the result of objective two which is used to determine the Multi-linear equation of crude oil production, crude oil export, crude oil price, Inflation, exchange rate, and RGDP.

3.5.1 Data Analysis for Two-Stage Least Square Estimation (1979-2013)

Oil Export=β_0 + β_1 oil Production + β_2 Oil Price + β_3 log(RGDP) + β_4Inflation + ε_t ...... (eqn 1)
Oil Production= α_1 Oil Export + α_2 Exchange Rate........... (eqn 2)
Model 1: TSLS, using observations 1979-2013 (T = 35)
Dependent variable: OIL_EXP
Instrumented: OIL_PRO
Instruments: const EXCHANGE PRICE l_RGDP INF

Table 3.4 Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variable Label
Intercept	1	3730.930	904.6106	4.12	0.0003	Intercept
Oil_Pro	1	0.396640	0.348095	1.14	0.2635	Crude Oil Production
Price	1	-3.15912	2.250758	-1.40	0.1707	Price Of Crude Oil
log_rgdp	1	-733.740	157.1385	-4.67	<.0001	Log (RGDP)
Inf	1	-3.39593	3.416362	-0.99	0.3282	Inflation

Mean dependent var	335.2657		S.D. dependent var	447.3463
Sum squared resid	3216551		S.E. of regression	327.4422
R-squared	0.538011		Adjusted R-squared	0.476413
F(4, 30)	5.607774		P-value(F)	0.001711
Log-likelihood	-542.9766		Akaike criterion	1095.953
Schwarz criterion	1103.730		Hannan-Quinn	1098.638
Rho	0.575205		Durbin-Watson	0.574985

Source: SAS9.3 software

Interpretation of Result of The Table Above

Co-efficient of determination

R-squared

Looking at the result of the R-square of the model above, it showed that the variables in the model really represent the model and the goodness of fit is high, having 53.8% and that the independent variables can account for 53.8% of the total variation in the dependent variable and the other percentage that cannot be accounted for are always the error term. This shows that the model really fit the equation though not on a high precision.

Adjusted R-squared

The adjusted R-Squared which is always used to penalize those variables that are not really affecting the model, but in this model it shows that all the variables are important in the model for us to have the Adjusted R-Squared to be 47.64% which is clearly different from the R-Squared of the model. Thus, with the entire variable inculcated in the model the variables cannot be relied upon to explain total variations in the model.

F-statistic

Furthermore, the model specified have F-statistic value of 5.608, this implies that the overall model is statistically significant at 1% and 5% levels of significance, this is because the F statistics calculated is greater than the F-statistics tabulated and it is significant at 1% and 5% respectively. Hence, all the explanatory variables in the model simultaneously explain the variations in the oil export. In order words, the independent variables can explain the endogenous variable to some extents at 95% confidence interval

Individual Tests of Significance (Student T-Test)

Decision Rule: if $T_{Cal} > T_{Tab}$ - reject H_0 and accept H_1 or when the P-value is less than 5%

$T_{Cal} < T_{Tab}$ - accept H_0 and reject H_1 or when the P-value is greater than 5%

Critical Values: $T_{0.01} = 2.457$, $T_{0.05} = 1.697$ and $T_{0.1} = 1.310$

The T-statistics for log(rgdp) was greater than all the tabulated value i.e (4.6694) and therefore it can be concluded, that, it is significant at any significance level, while on the contrary, other independents variables are not significant at level of significance at 5%,10% and 1%.

Based on the outcome of the above research, the trend revealed clearly that, the reason the model were not significant at any level is as a result of the sudden shock in crude oil hike that happened in the year 2011 to 2013. Therefore, the research considered a time frame of 1979-2010 for appropriate and unit root free data for modelling the simultaneous equation.

3.5.2 Data Analysis for Two-Stage Least Square Estimation (1979-2010)

Oil Export=β_0 + β_1 oil Production + β_2 Oil Price + β_3 log(RGDP) + β_4Inflation + ε_t ...... (eqn 1)

Oil Production= α_1 Oil Export + α_2 Exchange Rate........... (eqn 2)

Model 2: TSLS, using observations 1979-2010 (T = 32)

Dependent variable: OIL_EXP

Instrumented: OIL_PRO

Instruments: const PRICE INF EXCHANGE l_RGDP

Table 3.6 Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variable Label
Intercept	1	6638.052	610.4118	10.87	<.0001	Intercept
Oil_Pro	1	1.023960	0.151016	6.78	<.0001	Crude Oil Production
Price	1	7.604161	1.821231	4.18	0.0003	Price of Crude Oil
log_rgdp	1	-1541.13	110.9237	-13.89	<.0001	Log(RGDP)
Inf	1	-1.98077	1.715753	-1.15	0.2584	Inflation

Mean dependent var	334.1969		S.D. dependent var	468.3830
Sum squared resid	725340.5		S.E. of regression	163.9038
R-squared	0.904738		Adjusted R-squared	0.890626
F(4, 27)	55.92042		P-value(F)	1.12e-12
Log-likelihood	-461.8206		Akaike criterion	933.6411
Schwarz criterion	940.9698		Hannan-Quinn	936.0704
Rho	0.204464		Durbin-Watson	1.888918

Hausman test -
Null hypothesis: OLS estimates are consistent
Asymptotic test statistic: Chi-square(1) = 14.3487
with p-value = 0.000151882
Weak instrument test -
First-stage F-statistic (1, 27) = 20.8122
Source: SAS9.3 software

Interpretation of Result of The Table Above

Hausman's Test
The chi-square test statistic of Hausmann test indicate that ordinary least square (OLS) are consistent and the entire instrument are valid. With p-value=0.000151882.

Co-efficient of determination

R-squared
Looking at the result of the R-square of the model above, it was clearly shown that the variables in the model really represent the model and that the goodness of fit is high as 90.47% and that the independent variables can account for 90.47% of the total variation in the dependent variable. This shows that the model really fit the equation with a high precision.

Adjusted R-squared
The adjusted R-Squared which is always used to penalize those variables that are not really affecting the model, but in this model it shows that all the variables are important in the model for us to have the Adjusted R-Squared to be 89.06% which is not really different from the R-Squared of the model so with all the variable inculcated in the model the variables are still very able to explain 89.06% of the total variations in the model. It is good fit so the model can be relied upon.

F-statistic
Furthermore, the model specified have F-statistic value of 55.92, this implies that the overall model is statistically significant at 1% and 5% levels of significance, this is because the F statistics calculated is greater than the F-statistics tabulated and it is significant at 1% and 5% respectively. Hence, all the explanatory variables in the model simultaneously explain the variations in the oil export. In order words, the independent variables can explain the endogenous variable very well at 95% confidence interval

Individual Tests of Significance (Student T-Test)
Decision Rule: if $T_{Cal} > T_{Tab}$ - reject H_0 and accept H_1 or when the P-value is less than 5%
$T_{Cal} < T_{Tab}$ - accept H_0 and reject H_1 or when the P-value is greater than 5%
Critical Values: $T_{0.01} = 2.457$, $T_{0.05} = 1.697$ and $T_{0.1} = 1.310$
The T-statistics for oil production was greater than all the tabulated value i.e (6.7805) and therefore it can be concluded that it is significant at any significance level, also, the t-statistics of oil price remained significant at all level of significance as it's t-calculated is 4.1753 which is greater that all the critical values, as the impact of log(rgdp) was also significant because it's calculated value was greater than the tabulated value as it's 13.8939. Only inflation was not significant in the model because it's t-statistics was less than the tabulated value at all level of significance.

Durbin Watson statistics
The value is 1.89 which implies that there is no form of any autocorrelation in the model specified. These shows that the error correction model is free from the problem of serial correlation due to its value of 1.89. It is still within the range of 1.6 to 2.4. As a result of this, our model estimated can be confidently relied upon for making inferences.
In a bid to carry out the necessary empirical analysis, the following hypothesis were formulated and tested.

3.6 Discussion of Result
This section captions the third and the last objective of this research work by establishing the relationship between RGDP, inflation, exchange rate, oil prices, oil export and oil production.
The co-efficient of oil production signifies that there is a positive significant relationship between the crude oil that was produced and exported. As 1.0239 increases in crude oil production will lead to 1 unit increase in crude oil export, remembering that there is an intra relationship in them. They both affect each other simultaneously. Crude oil price is another significant variable that contribute positively to oil export this implies that a 7.60416 unit increase in crude oil price will lead to1 unit increase in 1 unit volume increase of crude oil exportation and it is significant at all level of significance, On a contrary, despite the significant impact of real gdp of oil export, there exists a negative relationship between the real gdp and oil export, as the model fitted shows that 669.306 unit decrease in the real gdp led to 1 unit increase in the oil exportation. Finally, the impact of inflation on the crude oil exportation was not significant, as much as the relationship between the two variables are negative, as 1.98 unit decrease in the inflation rate will lead to 1 unit increase in the crude oil exportation.

CONCLUSION

The study attempted to model Nigeria crude oil on gross domestic product (GDP). The time plot revealed that there was increase of crude oil price overtime. In the same vein, the plot for oil production indicates fluctuation and therefore instability. The time plot for oil export showed that there was shape decline of export overtime. The plot for real gdp indicated that increase in the real gdp overtime, but an abrupt decline from 2010. To avoid spurious regression, the data were tested for stationarity using the Augmented Dickey-Fuller test and the test indicated that the variables were all stationary. This finding establishes that about 53.8% of the total variation in oil export is jointly explained by oil production, crude oil price and real gdp. In the model, oil production, price of crude oil and inflation rate were said to insignificant, while real gdp is statistically significant. Collectively, the all the variables are said to statistically significant. The Durbin-Watson statistic indicates that there is no serial autocorrelation among the variables. Oil export would continue to be under upward pressure so long inflation rate, real gross domestic product and oil production keep falling.

The SEM, being a structural model, has many potential applications for industry analysts and policymakers. It could simulate over time the impact of a change in an exogenous variable via dynamic multipliers. It can also simulate the impact of random shocks to production and export of crude oil. This, however, would require an identification scheme to define shocks. Oil export operates in the demand function and may arise from shocks to real GDP, and inflation rate. Oil production shocks operate in the supply function and may arise from shocks to actual or capacity output.

Given the stability and reliability of the elasticity estimates, a forecast of oil export using SEM could provide realistic and relevant information for oil market traders. Because the model is estimated in structural form, sensitivity analysis can be performed on one or more structural parameters.

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