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Effect of Crude Oil Price on Macroeconomic Variables: Evidence from Selected African OPEC Member Countries

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Abstract

This paper investigated the effect of crude oil price on macroeconomic variables from five selected OPEC African member countries which includes; Algeria, Congo, Equatorial Guinea, Gabon and Nigeria between the period of 1991-2018. The panel vector autoregressive model was applied to achieve the objective. The cointegration relationship among our variables was confirmed by the Johansen Fischer test for cointegration. The impulse response and variance decomposition analysis under the framework of panel VAR model revealed that rise in crude oil price appear to possess some positive influence on economic growth, inflation, money supply and the short-run exchange rate whereas negative influence on unemployment and long-run exchange rate in the case of these countries. These results have given us the chance to claim that all the macroeconomic series used were exposed to shocks in crude oil price. Therefore, we recommended that policy makers in these countries should diversify their economies in order to hinder the shocks of crude oil price variations and increase the contributions of non-crude oil sectors in their economies. Accordingly, there would be resistant to unpredicted shocks in these economies and will aid in achieving stability in the long-run. Again, there will be support in economic growth and confidence in domestic currencies that would ensure that rate of inflation is under control, provision of employment opportunities and ensure relative supply of money.

1. Introduction

The representations of crude oil as one of the most significant macroeconomic factors in the global economy and the countries' performance in terms of economic activities is extremely connected to the price of crude oil. When associated with the other bunch of traded goods worldwide, crude oil is regarded as the only input of production that can have both positive and negative impact on economic growth, and even that it might lead to an extent of making serious transformation in the economy. But the variation in crude oil price that affect the economic stability of the nation's either positively or negatively largely dependent on the types of the nation's economy [1]. There are bunch of literature worldwide that conclude on the effect of crude oil price on economic growth to be positive in case of various nations across the globe [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14] and [15]. Whereas some empirical literature also exists claiming negative impact of crude oil price on economic growth of different nations across the globe and these evidences can be found in the work of [16], [17], [18], [19], [20], [21], [22], [23], [24] and [25].

The evidence from empirical studies coming from both academic environment and government owned institutions suggested clearly that crude oil price causes rise in the growth of dull macroeconomic series via increase in the rates of inflation and unemployment while decreasing the values of financial and other assets in at least oil importing countries [26]. In case of developing nations, oil prices have negatively affected the economic growth, household's consumption balances, poor farmers in the rural areas as well as the urban area transporters [27]. But, in the areas of unemployment, oil price possesses some positive influence on those nations largely due to higher production cost which automatically lead to higher input costs and subsequently rises the rate of unemployment [28]. According to their term of trade, the transfer of wealth from the oil importing nations to oil exporting nations indicates an increase in the price of crude oil. The knowledge of the extent of dependence on either imported or exported crude oil, one can easily evaluate the magnitude of the direct influence of a specified rise in price on the level of countries' national income [29].

Given consideration to the above realities, it has become clear that fluctuations in crude oil price possess some excessive effect on the macroeconomic variables of selected African OPEC member countries. For this reason, we explore the effect of crude oil price on economic growth, money supply, exchange rate, inflation and unemployment in the case of five selected OPEC African member countries that include Algeria, Congo, Equatorial Guinea, Gabon and Nigeria. The key contribution of this paper is exploring the effect of fluctuations in crude oil price on five macroeconomic variables such as economic growth, money supply, exchange rate, inflation and unemployment using annual data for the 1991-2018 periods involving five selected African OPEC member countries of Algeria, Congo, Equatorial Guinea, Gabon and Nigeria. To the best of our knowledge, this research uniquely explored the influence of crude oil price on five selected macroeconomic variables in the case of five selected African OPEC member countries.

As a reminder this paper is structured as follows; following this section is section two which provides the review of the related literature on the relationship between crude oil price and macroeconomic variables; section three offered data description and research methodology; section four provides the empirical results and discussions of findings; section five presents the conclusion and recommendation.

1.1 Empirical Review

Starting with the work of [30] who explored the influence of distortion in crude oil price on the Algerian macroeconomic indicators for the period covering 1980-2011. The study applied VECM approach in analyzing the data, the results indicated that crude oil price have no significant influence on the majority of the series in the short-run with some few exceptions in inflation and real effective exchange rate where they exert positive and negative influence respectively. Moreover, in case of the Nigerian economy and through considering data for the period of 1970 to 2010, [31] studied the influence of shocks in crude oil price on the country's monetary policy. The study was done with the help of structural VAR approach and the results revealed that there is long-run connection among the interest series and unpredicted shocks in crude oil price is accompanied by decrease in exchange rate and interest rate together with increase in inflation rate respectively. But in the case of twenty sub-Saharan African nations for the period of 1986 to 2012 and applied pooled OLS and GMM approaches to analyzed the data, [32] studied the effect of variations in crude oil price on economic growth of the nations by categorizing the countries into oil exporting and non-oil exporting nations and the results of the study indicated that variations in crude oil price has positive influence on economic growth of oil exporting nations whereas it has an insignificant positive influence on the economic growth of non-oil exporting countries.

In another development from Algeria and by means of the same VAR analysis, [33] studied the collaboration between exports of crude oil and economic growth in the long-run by means of data

for the period of 1979 to 2013. The result of the analysis indicated that there is strong positive connection between revenue from crude oil exports and long-run economic growth alongside negative relationship between fluctuation in crude oil revenue and economic growth of the country. Also, in the same case of Algerian economy and considering data for the 1970-2012 period, [34] investigated the influence of fluctuation in crude oil price on the country's economic growth through the application of VAR approach. The investigation result revealed that the negative growth influence of crude oil price fluctuation has balanced the positive influence of crude oil boom.

Using the same panel structural VAR approach to analysis the data covering 1980-2015 periods, [35] explored the influence of shocks in crude oil price on the performance of macroeconomic indicators in the case of African crude oil exporting nations. The exploration results indicate that there is significant feedback from the indicators due to shocks in crude oil price within the study period and it has great influence on the performance of African crude oil exporting nations' economies with crude oil price transmission resulting in monetary medium. Furthermore, using structural VAR, EGARCH and granger causality in the case of Nigerian and Angolan economies and considering data on the interest series for the period under investigation, [36] explored the connection between volatility in the price of crude oil and the performance of macroeconomic series. Their exploration outcomes indicate that volatility in the price of crude oil has great influence on the economic growth of these nations while impulse response and variance decomposition results indicate that exchange rate response to shocks in crude oil price is the highest.

Using VAR approach to examine the interrelationship crude oil price and selected macroeconomic variables on a quarterly basis for the 1981-2016 periods, [37] revealed that fluctuations in crude oil price possess some harmful influence of unbalanced degrees on exchange rate volatility, real economic growth, government expenditure and external reserves respectively. Additionally, in the case of nations that make up the Gulf Cooperation Council, [38] examined the effect of fluctuations in crude oil price on stock market of GCC nations covering 2005-2015 periods. The investigation was done with the aid of granger causality and impulse response function using VAR framework and the results indicated that there is negative and significant effect of fluctuation in crude oil price on the stock markets of GCC from granger causality and impulse response function analysis. VAR results revealed that crude oil price largely displayed negative effect on stock returns.

[39] considered ECM and Granger causality approaches to explored the relationship between variations in crude oil price on economic growth using Nigerian economy by means of data on the interest variables for the 1980-2014 period. The results indicated that the series are cointegrated and that causal connection runs from crude oil price to all indicators of economic growth and these shows that crude oil price influenced economic growth in the country. In another development, [40] explored the asymmetric influence of crude oil price fluctuations on inflation in the case of four African oil producing nations within the period of 1975 to 2015 and panel ARDL approach for the short-and-long run effects. The result of their investigation revealed that both positive and negative crude oil price changes have influenced inflation and the influence was stronger in the presence of decline in crude oil prices. Again, exchange rate, money supply and economic growth were positively associated with inflation while food production is related negatively with inflation.

In the case of Algerian economy, [41] explored the connection between crude oil price and nominal exchange rate of local currency per US dollar for the 2008-2015 monthly periods and the study's empirical analysis was done with the aid of VECM approach. Their results indicated that the series exhibit cointegration relationship and there exists two-way feedback among crude oil price and exchange rate with crude oil price having negative influence on the Algerian currency exchange rate. Similarly using the same case of Algerian economy, [42] investigated the effect of crude oil price shocks on the Algerian currency exchange rate. The investigation was possible through the

utilization of VECM approach to data analysis in order to obtain the dynamic connection between these variables from 1980-2017 periods. His findings revealed that there is an existence of a negative influence between crude oil price changes and Algerian currency exchange rate.

Using the case of Africa's crude oil producing nations for the period covering 1980 to 2016 and applied panel structural VAR analysis in estimating the data, [43] investigated the effect of shocks from crude oil price on the performance of macroeconomic series. Their investigated results revealed that the response of each of macroeconomic variable to shocks in crude oil price is not the same, as structural inflation go together with sharp decrease in crude oil price than in monetary inflation, since there exists significant decline in both investment and outputs. Using same Nigerian economy as a case study, [44] investigated the influence of variations in crude oil price on the selected macroeconomic series for the period covering 1981-2016 and with the aid of ARDL approach, the result indicated that variations in crude oil price possessed some significant positive influence on government expenditure and revenue but there was no significant positive influence on domestic prices.

Again, using the same Nigerian economy, [45] shows that price of crude oil and exchange rate have significant positive influence on economic growth of the country in both short-and-long run periods when they studied the influence of crude oil price and exchange rate on the economic growth of the country for the period of 1982 to 2018 and data analysis was possible with help of ARDL approach. [46] studied the influence of crude oil price on African stock markets using the case of selected crude oil producing nations for the quarterly period of 2010: Q1-2018: Q4. The data on the interest series were analyzed using the technique of panel dynamic analysis. The result revealed that there exists an adverse influence of crude oil prices on the African stock markets due to the uneven and underdeveloped capital markets. Also, real economic growth exerts positive influence on the African stock markets thereby concluding that economic growth positively effect stock market returns in African stock markets.

[47] studied the influence of fluctuations in crude oil price on unemployment the rate in the case of the Nigerian economy for the quarterly periods of 1979-2018 and 1982-2018. The analysis was done with help of both ARDL and NARDL and the results indicated that fluctuations in oil prices exerts no significant influence on unemployment rate in the ARDL result while NARD result indicated that there is long-run asymmetric connection among the series and both increase and decrease in crude oil price have insignificant positive influence on unemployment the rate in the short-run. But in the long- run crude oil price increase worsen the situation of unemployment while the decrease possessed insignificant reducing effect. Using the same technique of ARDL, [48] studied the influence of crude oil price on exchange rate in the case of Nigerian economy for the sample period of 1983-2017. The results of their study revealed that crude oil price fluctuations have negative and significant influence on exchange rate in the short-run and long-run periods whereas oil revenue and economic growth have positive and significant influence on exchange rate within the sample period.

Considering Nigerian economy as a case study to scrutinize the influence crude oil price and urbanization on environmental pollution, [49] applied ADRL to realize the short-and-long run relationships between the periods 1981 to 2016 on the interest series. The result revealed that there is cointegration among the series while in the long-run and short-run periods crude oil price and foreign direct investment exerts negative influence while urbanization is exerted positive influence on environmental pollution. With the aid of VECM approach to analyzed the data for the 1991-2018 period, [50] studied the influence of fluctuation in crude oil price on unemployment in the case of Nigerian economy and their analysis indicate that both population and economic growths have significant positive connection with unemployment but electricity consumption and crude oil price exerts significant negative impact on unemployment in the long-run with population growth being

the only significant series in influencing unemployment. Again, there is unidirectional causality between population growth and unemployment, population growth and economic growth, crude oil price and population growth, crude oil price and economic growth, electricity consumption and economic growth while variance decomposition indicated that population growth responded highly to shock in unemployment whereas impulse response function revealed that unemployment responded positively to shocks in economic growth and crude oil price while negatively to population growth and electricity consumption.

Therefore, from all the above empirical literature reviewed, majority of the studies if not all concentrated on a single country study and very few were on the panel studies. And even those on the country-based studies have reported conflicting findings. In line with this gap in the literature, the current paper examined the influence of crude oil price changes on the macroeconomic variables of five selected African OPEC member countries of Algeria, Congo, Equatorial Guinea, Gabon and Nigeria and applied panel VAR approach to analyze the data for the 1991-2018 period.

2.0 Methodology

This section focused on the description of the variables and this ranges from areas of description ranges from the extracted source, variables' definition and the description of the entire methodological aspect of this paper.

2.1 Data

For the empirical analysis in this paper, we have utilized the annual data for the period of 1991 to 2018 on economic growth (EG_{it}); crude oil price (OP_{it}); inflation (IF_{it}); exchange rate (EX_{it}); money supply (MS_{it}); unemployment (UN_{it}) for these countries of Algeria, Congo, Equatorial Guinea, Gabon and Nigeria. All the data on these five selected macroeconomic variables and their respective extracted sources are offered in Table 1.

Table 1: Data Description

Variables	Definitions	Sources
EG_{it}	GDP per capita (constant 2010 US$)	WDI (2020)
OP_{it}	Cushing, OK WTI Spot Price FOB (Dollars per Barrel)	IEA (2020)
IF_{it}	Consumer price index (2010 = 100)	WDI (2020)
MS_{it}	Broad money (% of GDP)	WDI (2020)
EX_{it}	Official exchange rate (LCU per US$, period average)	WDI (2020)
UN_{it}	Unemployment, total (% of total labor force) (modeled ILO estimate)	WDI (2020)

Note: World Development Indicators (WDI)
International Energy Agency (IEA)

2.2 Econometric Model

In this paper, we explored the effect of crude oil price on economic growth; inflation; exchange rate; money supply and unemployment for five selected African OPEC member countries by utilizing the analysis of impulse response functions and test of variance decomposition in the framework of panel vector autoregressive (PVAR) model. In the first section of the empirical analysis of the paper, we have tested the series' levels of stoppage using the panel stoppage tests such as Fisher-ADF and Fisher-PP as suggested by [51]. In the second section of the analysis, given the integration order of the variables, the cointegration tests were engaged ascertained the cointegration relationship among the variables and the cointegration tests employed in this paper is the [52] Fisher panel cointegration tests. Haven confirmed the existence of cointegration among the variables, the third section of the analysis applied the analysis of impulse response and variance decomposition under the PVAR procedure to explore the connection among the series. Due to the existence of cointegration relationship between the variables using [52], the efficient implication is employing the model of PVAR. Because the PVAR model is extensively utilized method in the same investigations, so we

don't need to described it in details. The Equations 1 to 5 gives the structure of the PVAR approach in the form of system of equation as follows.

$$\ln EG_{it} = \vartheta_0 + \sum_{j=1}^{k} \vartheta_1 \ln EG_{it-j} + \sum_{j=0}^{k} \vartheta_2 \ln EX_{it-j} + \sum_{j=0}^{k} \vartheta_3 \ln IF_{it-j} + \sum_{j=0}^{k} \vartheta_4 \ln MS_{it-j} + \sum_{j=0}^{k} \vartheta_5 \ln OP_{it-j} + \sum_{j=0}^{k} \vartheta_6 \ln UN_{it-j} + \mu_{1it} \quad (1)$$

$$\ln EX_{it} = \chi_0 + \sum_{j=1}^{k} \chi_1 \ln EX_{it-j} + \sum_{j=0}^{k} \chi_2 \ln EG_{it-j} + \sum_{j=0}^{k} \chi_3 \ln IF_{it-j} + \sum_{j=0}^{k} \chi_4 \ln MS_{it-j} + \sum_{j=0}^{k} \chi_5 \ln OP_{it-j} + \sum_{j=0}^{k} \chi_6 \ln UN_{it-j} + \mu_{2it} \quad (2)$$

$$\ln MS_{it} = \delta_0 + \sum_{j=1}^{k} \delta_1 \ln MS_{it-j} + \sum_{j=0}^{k} \delta_2 \ln EG_{it-j} + \sum_{j=0}^{k} \delta_3 \ln EX_{it-j} + \sum_{j=0}^{k} \delta_4 \ln IF_{it-j} + \sum_{j=0}^{k} \delta_5 \ln OP_{it-j} + \sum_{j=0}^{k} \delta_6 \ln UN_{it-j} + \mu_{4it} \quad (3)$$

$$\ln OP_{it} = \partial_0 + \sum_{j=1}^{k} \partial_1 \ln OP_{it-j} + \sum_{j=0}^{k} \partial_2 \ln EG_{it-j} + \sum_{j=0}^{k} \partial_3 \ln EX_{it-j} + \sum_{j=0}^{k} \partial_4 \ln IF_{it-j} + \sum_{j=0}^{k} \partial_5 \ln MS_{it-j} + \sum_{j=0}^{k} \partial_6 \ln UN_{it-j} + \mu_{5it} \quad (4)$$

$$\ln UN_{it} = \theta_0 + \sum_{j=1}^{k} \theta_1 \ln UN_{it-j} + \sum_{j=0}^{k} \theta_2 \ln EG_{it-j} + \sum_{j=0}^{k} \theta_3 \ln EX_{it-j} + \sum_{j=0}^{k} \theta_4 \ln IF_{it-j} + \sum_{j=0}^{k} \theta_5 \ln MS_{it-j} + \sum_{j=0}^{k} \theta_6 \ln OP_{it-j} + \mu_{6it} \quad (5)$$

Here $\vartheta_0, \chi_0, \varphi_0, \delta_0, \partial_0, \theta_0$ are the respective drift parameters for each of the equations; ln is the natural logarithmic sign; the variables coefficients to be estimated are given by $\vartheta_i, \chi_i, \varphi_i, \delta_i, \partial_i, \theta_i$ respectively; $\sum$ is the summation sign; i represent five selected OPEC member countries; t stands for the time trend (1991-2018); k is the maximum lags; EG_{it} represent economic growth; exchange rate is represented by EX_{it}; IF_{it} stands for the inflation; MS_{it} represent money supply; OP_{it} denote crude oil price; UN_{it} is the unemployment and $\mu_{1it} \ldots . \mu_{6it}$ are stochastic error terms.

3.0 Results and Discussion

Firstly, the analysis kicked off with the graphical illustrations of all the series employed in the study for the five selected African OPEC member countries of Algeria, Congo, Equatorial Guinea, Gabon and Nigeria and the series utilized include crude oil price, exchange rate, economic growth, unemployment, money supply and inflation for the 1991-2018 period. The illustration is given in Figure 1. The graphical illustration of exchange rate indicated that countries like Congo, Equatorial Guinea, and Nigeria have the highest exchange rate mean values. But when it comes to economic growth, Nigeria, Equatorial Guinea and Gabon have the least mean values of economic growth among the five countries. Again, on the basis of unemployment, Gabon, Equatorial Guinea and Congo have the highest mean value of unemployment. Using the mean value of money supply, Equatorial Guinea has the least followed by Nigeria, Gabon, and then Congo while Algeria has the

highest. Similarly, in terms of inflation, countries like Equatorial Guinea, Congo, Gabon and Algeria have the highest mean values of inflation whereas Nigeria has the least.

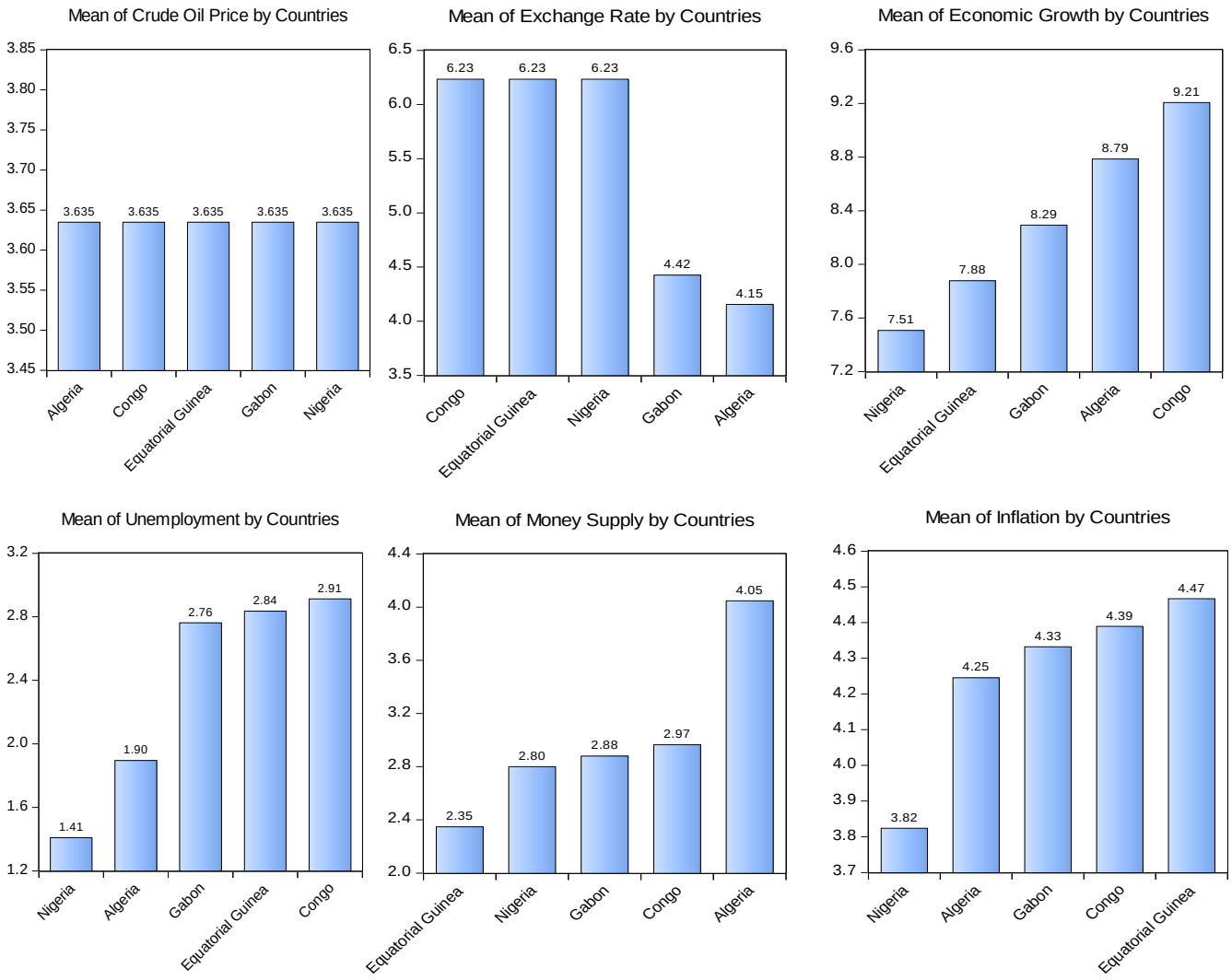

Figure 1: Trends of crude oil price and macroeconomic variables in 5-African OPEC member countries.

After checking the properties of the series utilized in the study via graphical presentations in Figure 1, the properties regarding the stationarity of the variables employed in the paper was examined with the help of panel unit root tests of Fisher-ADF and Fisher-PP and their outputs are reported in Table 2. As it can be observed from the unit root result in Table 2, majority of the series were not stationary at level but became stationary after first differencing the exception of exchange rate and inflation under the two tests. Therefore, all these variables that were not stationary at level are said to be integrated of order one or more formally known as I(1) variables while the other ones that were stationary at level are said to be integrated of order zero or commonly known as I(0) variables under the two panel unit root tests. This panel unit root result has given us the guarantee to test for the cointegration relationship among our variables.

Table 2. Unit Root Tests Results

	Level		First Difference	
Variables	**Constant**	**Trend**	**Constant**	**Trend**
Fisher-Augmented Dickey Fuller				
$lnEG_{it}$	6.236	10.495	26.985***	22.459***
	(0.795)	(5.409)	(0.002)	(0.001)
$lnEX_{it}$	33.286***	19.224**	41.947***	35.497***
	(0.000)	(0.037)	(0.000)	(0.000)
$lnIF_{it}$	22.963**	42.947***	40.424***	45.812***
	(0.010)	(0.000)	(0.000)	(0.000)
$lnMS_{it}$	4.356	17.912	50.657***	36.592***
	(0.929)	(0.056)	(0.000)	(0.000)
$lnOP_{it}$	4.036	7.629	58.446***	43.048***
	(0.945)	(0.664)	(0.000)	(0.000)
$lnUN_{it}$	6.731	8.596	23.325***	15.328***
	(0.750)	(0.570)	(0.009)	(0.120)
Fisher-Philip Perron				
$lnEG_{it}$	8.164	5.409	39.632***	30.903***
	(0.612)	(0.862)	(0.000)	(0.000)
$lnEX_{it}$	26.161***	10.434	68.614***	57.799***
	(0.003)	(0.403)	(0.000)	(0.000)
$lnIF_{it}$	39.803***	28.276***	41.723***	34.115***
	(0.000)	(0.001)	(0.000)	(0.000)
$lnMS_{it}$	3.863	11.878	73.997***	88.835***
	(0.953)	(0.293)	(0.000)	(0.000)
$lnOP_{it}$	3.083	4.998	57.494***	39.954***
	(0.979)	(0.891)	(0.000)	(0.000)
$lnUN_{it}$	3.287	4.064	40.047***	30.986***
	(0.973)	(0.944)	(0.000)	(0.000)

Note. *** Significance at 1 percent
** Significance at 5 percent
* Significance at 10 percent

After knowing the order of integration of each variable utilized in this study as given in Table 2, it becomes necessary to determine the cointegration relationship among the interest variables and before doing that it is recommended at first optimum lag or best lag should be determined and the lag determined must be free from all the regressions problems and that will give an efficient estimation. In order to determine this lag, we have utilized PVAR model consisting of economic growth ($lnEG_{it}$) as an endogenous series where as others such as $lnEX_{it}$, $lnIF_{it}$, $lnMS_{it}$, $lnOP_{it}$ and $lnUN_{it}$ are the exogenous variables. The randomly selection of lag interval and lag interval determination test was engaged to the residuals and the specifics of the test were reported in Table 3. Based on the result of this test, it revealed that the optimum lag used in this paper is 6 this is because lag 6 is indicated by three different criteria.

Table 3: Lag selection test **Information criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-457.785	NA	0.000	9.005	9.159	9.067
1	557.378	1892.343	0.000	-10.007	-8.932*	-9.572
2	613.071	97.328	0.000	-10.389	-8.394	-9.581*
3	654.203	67.089	0.000	-10.489	-7.573	-9.308
4	688.756	52.332	0.000	-10.461	-6.624	-8.907
5	736.606	66.897	0.000	-10.691	-5.933	-8.764
6	792.476	71.600*	0.000*	-11.077*	-5.398	-8.777

* indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

Additionally, the reliability tests were involved in order to replied on the estimated coefficients and these tests include the langrage multiplier (LM) test for serial correlation, white test for heteroscedasticity problem and stability test using AR root test and their results are represented in Table 4 and Figure 1 respectively. The result of serial correlation indicated that at lag 6 the p-value is greater than 0.05. Therefore, we accept the null hypothesis that there is no serial correlation in the model. The white test result also indicated that the p-value of the test Chi-Square is insignificant which implies the acceptance of the null hypothesis that errors are homoscedastic in the PVAR model and the rejection of alternative hypothesis that errors are heteroscedastic. The stability of the PVAR model was also reported in Figure 2 and it indicated that inverse roots of AR characteristic polynomial are within the circle and this is an indication of stability in our PVAR model.

Table 4: Lagrange Multiplier Test Results

Lags	LM statistics	P-Values
1	93.491	0.000
2	40.676	0.272
3	32.810	0.621
4	41.074	0.257
5	31.548	0.680
6	35.183	0.507
7	47.481	0.095
8	29.899	0.753
White test outcome		
Chi-Square	1577.825	0.116

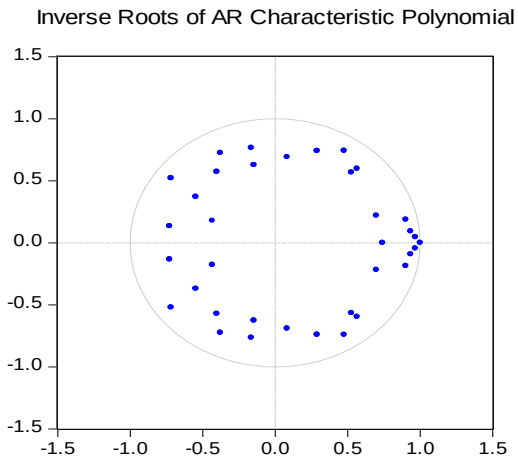

Figure 2: Inverse roots of AR characteristic polynomial

To ascertained the level of cointegration relationship of our series, we have employed the Johansen Fisher panel cointegration test and the result is reported in Table 5. The result from trace statistic indicated five cointegrating equations while that of max-eigen test statistics indicated four cointegration equations. This is a strong indication for the existence of cointegration among our interest variables. It is therefore in line with this result that we employed PVAR model particularly in the areas of impulse response function and variance decomposition analysis in order to examined the association between our variables. Again, we employed the reliability tests to the residual of the PVAR and the result is offered in Table 6.

Table 5. Johansen Fisher Panel Cointegration Test Result

Hypothesized No. of CE(s)	Fisher Stat. (Trace Test)	P-values	Fisher Stat. (Max-Eigen Test)	P-values
C = 0	149.7***	0.000	86.83***	0.000
C ≤ 1	77.20***	0.000	28.77***	0.001
C ≤ 2	54.18***	0.000	29.31***	0.001
C ≤ 3	32.88***	0.000	22.34**	0.013
C ≤ 4	19.60**	0.033	16.79	0.079
C ≤ 5	16.46	0.087	16.46	0.087

Note. *** Significance at 1 percent
** Significance at 5 percent

From Table 6, it can be noticed that the residuals of PVAR have no associated issues with the serial correlation, instability and heteroscedasticity problems. Therefore, the specifications of the estimated residuals have successfully passed the residuals reliability checks and this an indication that our estimation results are robust.

Table 6: Panel VAR Diagnostic Tests Results

Tests	chi-square	P-values
A. Serial correlation	41.438	0.245
B. Heteroskedasticity	1796.611	0.288
C. Normality	53.119***	0.000

A. Serial Correlation LM Tests
B. Heteroskedasticity Tests
C. Jarque-Bera

After all these tests, to understand the influence oil price shocks on these variables, we have applied the impulse response function analysis and the result is illustrated in Figure 2. That is, through this analysis, we can confidently notice which of the variable is influenced by the shocks plus the feedbacks specified by other variables. Therefore, it is within this room that we intended to detect the feedbacks of interest variables against any shock in crude oil price with the sole aim of evaluating the influence of crude oil price on the selected macroeconomic variables in the case of five selected African OPEC member countries.

The feedbacks of macroeconomic variables to crude oil price shocks for 10 years prediction horizons are illustrated in Figure 3. Clearly, the feedback of economic growth ($lnEG_{it}$) to 1-standard deviation shock to the crude oil price is positive throughout the time horizon. This is an indication that rise in crude oil price resulted in growing economic growth of these countries over the time horizon. This is similar to the findings of [53], [54] and [55]. Similarly, the inflation ($lnIF_{it}$) response was also positive due to shocks in crude oil price increase until it attends a stable stage. This implies that increasing crude oil price is linked with the level of inflation in these countries for the time period. But the response of unemployment ($lnUN_{it}$) to shocks in crude oil price is negative from the first period to the last period and this implies that rising crude oil price creates employment opportunities through infrastructural development in these countries. However, the response of exchange rate ($lnEX_{it}$) due to shocks in the crude oil price was negative from the first year to around fourth year and from there the response was positive for the remaining time period. This is an implication that crude oil price instability plays some role in the exchange rate fluctuations in the case of these countries. On the other hand, the response of money supply ($lnMS_{it}$) due to shocks in in crude oil price was positive throughout the entire time period.

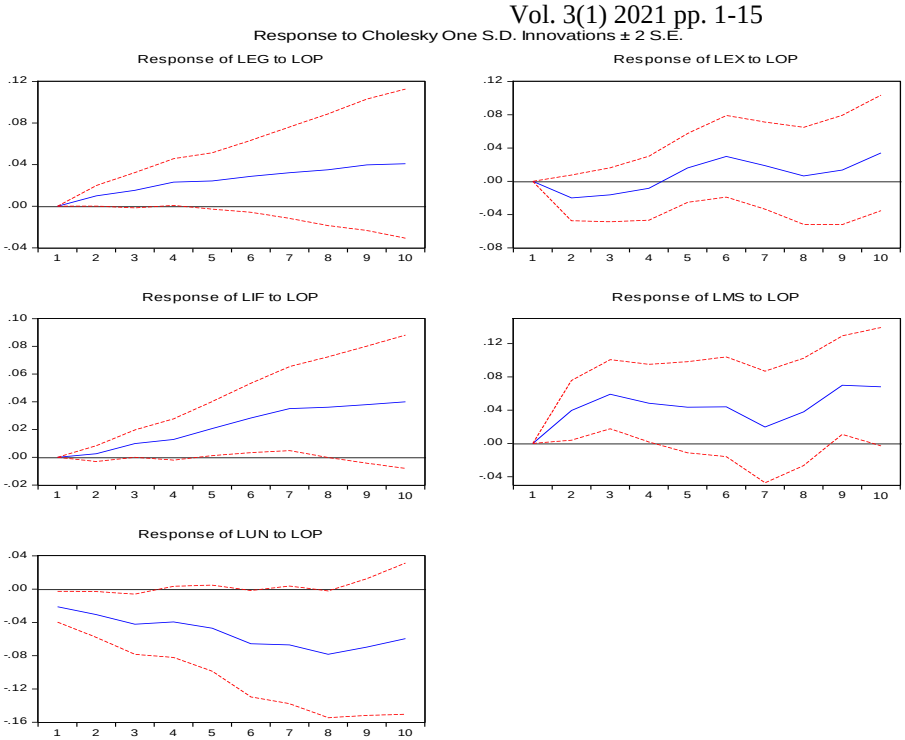

Figure 3: Impulse Response Function Analysis

Lastly, we have utilized the analysis of variance decomposition with the sole aim of witnessing the effect of crude oil price on the selected macroeconomic variables. The result of the prediction analysis of variance decomposition of economic growth ($lnEG_{it}$), inflation (lnIFit), unemployment ($lnUN_{it}$), exchange rate ($lnEX_{it}$) and money supply ($lnMS_{it}$) over the time period of 10 years is reported in Table 7. In the variance decomposition of $lnEG_{it}$, shocks in crude oil price describe about 6.908 percent variation in $lnEG_{it}$. The variance decomposition of $lnEX_{it}$ indicated that shocks in crude oil price explained about 5.010 percent variation in EX_{it}. The variance decomposition of $lnIF_{it}$, $lnMS_{it}$ and $lnUN_{it}$ revealed that shocks in crude oil price for the period of 10 years explained about 11.256 percent, 20.697 percent and 18.489 percent variations in $lnIF_{it}$, $lnMS_{it}$ and $lnUN_{it}$ respectively.

In summary, crude oil price possessed some positive effect on economic growth, money supply, inflation and exchange rate in the five selected countries and this is a clear indication that rise in crude oil price bring about increasing economic growth, inflation, money supply and appreciation in exchange rate in these countries. While crude oil price has negative effect on unemployment and exchange rate in the long-run. This is because increasing crude oil price led to higher oil revenue and increase in the inflow of foreign currency, as a result of this, massive inflow of foreign currency caused decline in exchange rate and increased the value of domestic currency. The results are consistent with the expectations for these countries as rich oil exporters.

Table 7. Variance Decomposition Analysis

Period	S.E.	$lnEG_{it}$	$lnEX_{it}$	$lnIF_{it}$	$lnMS_{it}$	$lnOP_{it}$	$lnUN_{it}$
(i)	**Variance Decomposition of $lnEG_{it}$**						
1	0.043	100.000	0.000	0.000	0.000	0.000	0.000
2	0.066	95.173	1.338	0.150	0.308	2.277	0.751
3	0.089	88.940	1.176	1.600	2.495	4.158	1.628
4	0.114	82.539	1.248	3.175	4.097	6.606	2.332
5	0.144	80.592	1.312	4.833	3.730	7.047	2.483
6	0.175	75.778	1.717	5.472	5.006	7.428	4.595
7	0.205	73.608	1.562	6.010	5.576	7.909	5.331
8	0.232	71.708	1.573	6.914	5.460	8.414	5.927
9	0.261	69.852	1.701	7.590	5.271	8.993	6.590
10	0.289	67.876	1.919	8.466	5.357	9.343	7.036
(ii)	**Variance Decomposition of $lnEX_{it}$**						
1	0.105	2.833	97.166	0.000	0.000	0.000	0.000
2	0.125	2.047	89.617	5.655	0.167	2.511	0.000
3	0.138	3.161	87.010	5.196	0.492	3.483	0.655
4	0.157	4.218	75.441	13.053	0.517	2.968	3.800
5	0.167	4.098	74.591	11.646	0.683	3.551	5.428
6	0.175	3.863	73.655	10.645	0.732	6.155	4.948
7	0.184	3.470	72.550	12.086	0.665	6.541	4.685
8	0.194	3.218	72.493	13.361	0.614	6.033	4.278
9	0.203	3.318	72.640	13.426	0.689	5.923	4.001
10	0.213	3.427	71.213	12.994	0.649	7.927	3.787
(iii)	**Variance Decomposition of $lnIF_{it}$**						
1	0.023	0.216	1.506	98.276	0.000	0.000	0.000
2	0.039	0.222	4.369	94.723	0.017	0.421	0.245
3	0.056	0.380	7.908	88.210	0.061	3.223	0.215
4	0.074	0.554	7.840	86.495	0.133	4.847	0.128
5	0.092	0.786	7.475	82.700	0.770	8.180	0.086
6	0.110	1.055	7.013	78.546	0.886	12.398	0.099
7	0.130	1.408	6.688	74.867	0.917	16.038	0.079
8	0.150	1.657	6.170	73.490	0.757	17.717	0.206
9	0.170	1.703	5.918	72.422	0.610	18.817	0.528
10	0.189	1.620	6.050	71.268	0.495	19.662	0.902
(iv)	**Variance Decomposition of $lnMS_{it}$**						
1	0.121	4.257	0.208	1.953	93.580	0.000	0.000
2	0.157	2.752	0.143	2.740	83.599	6.388	4.375
3	0.179	3.894	0.120	3.098	72.339	15.754	4.791
4	0.194	3.754	0.539	5.826	66.169	19.506	4.203
5	0.207	3.362	0.773	9.608	59.490	21.595	5.168
6	0.224	2.898	1.477	10.547	51.359	22.333	11.383
7	0.231	2.770	1.460	13.263	49.004	21.701	11.800
8	0.240	2.575	1.352	15.880	46.703	22.516	10.971
9	0.257	2.506	1.208	18.190	41.425	27.065	9.604
10	0.277	2.782	1.133	22.479	35.893	29.416	8.293
(v)	**Variance Decomposition of $lnUN_{it}$**						
1	0.084	0.010	0.432	4.532	1.385	6.381	87.257
2	0.114	0.063	0.317	4.044	0.782	10.592	84.200
3	0.150	0.055	0.192	2.901	2.506	14.104	80.240
4	0.184	0.040	0.142	2.161	5.953	13.922	77.779
5	0.213	0.046	0.113	1.704	8.468	15.261	74.404
6	0.254	0.144	0.146	1.324	9.277	17.382	71.725
7	0.282	0.309	0.119	1.083	11.276	19.802	67.408
8	0.314	0.692	0.107	0.960	11.227	22.129	64.882
9	0.340	1.020	0.127	0.982	11.240	23.125	63.503
10	0.357	1.218	0.117	1.054	11.469	23.701	62.438

Note. Cholesky Ordering: $lnEG_{it}$ $lnEX_{it}$ $lnIF_{it}$ $lnMS_{it}$ $lnOP_{it}$ $lnUN_{it}$

4.0 Conclusion and Policy Recommendation

The effect of crude oil price on the macroeconomic variables is one of the greatest areas of concern in the case of crude oil rich nations since crude oil impact directly on the performance of the economy. One research aspect dedicated to the above-mentioned issue is the effect of crude oil price within a particular nation on macroeconomic variables. In this case, this study explored the effect of crude oil price on the macroeconomic variables such as economic growth, exchange rate, inflation, money supply and unemployment in the case of five selected African OPEC member countries of Algeria, Congo, Equatorial Guinea, Gabon and Nigeria. For this reason, PVAR model was utilized between the periods 1991-2018.

After testing the variables for unit root using panel unit root tests of Fisher-ADF and Fisher-PP the results indicated that majority of the series were stationary at first difference. Again, Johansen Fisher panel cointegration test indicated that all the variables were cointegrated and they move together in the long-run. After confirming the cointegration relationship among our variables, we engaged the impulse response and variance decomposition analyses under the framework of PVAR model. The result of the estimation showed that increase in crude oil price appear to possessed some positive effect on economic growth, inflation, money supply and short-run exchange rate whereas negative effect on unemployment and long-run exchange rate in the case of these countries. These results have given us the chance to claimed that the utilized macroeconomic series are exposed to shocks in crude oil price.

Therefore, based on these findings, we recommended that policy makers in these countries of Algeria, Congo, Equatorial Guinea, Gabon and Nigeria should diversify their economies in order to hinder the effect of shocks in crude oil price variations and increases the contributions of non-crude oil sectors. Hence, there would be resistant to unpredicted shocks in these economies and would aid in achieving stability in the long-run. Again, there would be support in economic growth and confidence in domestic currencies that would help in ensuring the rate of inflation is under control, provision of employment opportunities and relative supply of money is guaranteed.

Conflict of Interest

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