Macroeconomic Aggregates and Oil Price Vagaries in Nigeria: An Impact Assessment

Abstract

This study investigated the impact of negative oil price changes on macroeconomic aggregates in Nigeria from 1981 to 2020 using the autoregressive distributed lagged (ARDL) and the vector error correction models. Evidence from the findings showed that unemployment, foreign direct investment, and real gross domestic product are important determinants of oil price vagaries. In addition, there is empirical support for a positive relationship between oil price and unemployment on the one hand and a negative relationship between oil price and imports, foreign direct investment, and real gross domestic product on the other hand in both the short and long run. This implies that any decline in oil price is associated with a decrease in foreign direct investment and imports, and an increase in unemployment thereby resulting to the worsening of real gross domestic product in Nigeria during the period. In view of the findings, the study recommends a culture of uninterrupted savings of oil proceeds during episodes of oil price boom and by implication boosting of foreign reserves to provide sufficient cover for imports during periods of oil price decrease. In addition to this recommendation is the continuous clamour for a properly diversified economy away from oil dependence. In periods of negative oil price shocks which discourages investment, the government should encourage investors through various incentives such as tax holidays and havens, reduce cost of funds using the appropriate agency of government and ensure the provision of enabling environment and infrastructure (such as power, security, and roads) for investments to strive and improvement in the ease of doing business in the country. This will result in job creation; reduce unemployment and poverty, thereby improving the gross domestic product.

Keywords: autoregressive distributed lagged model, macroeconomic aggregates, oil price vagaries, real GDP, total government expenditure, unemployment.

1. Introduction

Crude oil prices in Nigeria are externally determined and subject to the caprices of a cartel called the Organization of Petroleum Exporting Countries (OPEC) and other externalities. This pricing pattern makes prediction of price movement almost impossible and frustrates proper planning especially in Nigeria whose economy is largely dependent on oil and where the annual budget is benchmarked on crude oil price. Thus, during periods of negative oil prices, the country is exposed to both internal problems and external shocks. The internal problems could include inflation, unemployment, and unstable government revenue while the external shocks include foreign exchange fluctuations, unpredictable direction of foreign direct investment, unfavourable balance of payment position amongst others (Iyoha, 1997). The economy therefore remains vulnerable to oil price shocks. A careful perusal of the pattern of oil price changes revealed that the country has witnessed more of price decreases than increase. Thus, oil price that reached \$34/barrel in 1981 fell to \$29.04/barrel by 1983 and never recovered to its 1981 position except in 2005 when prices hit $50.59/barrel. Prices remained on the upward trajectory for just two years to $93.4/barrel in 2007 before dipping to $45.87/barrel by 2008. It recovered to $75.11/barrel in 2009 and hits the roof top during 2012 and 2013 when prices were $114.49 and $112.75/barrel, respectively. However, by 2014, oil prices crashed to $63.28/barrel and have never recovered since then. It was a mere $50.33/barrel in 2020. Fig. 1 shows a pictorial trend of oil price movements between the periods 1981 to 2020.

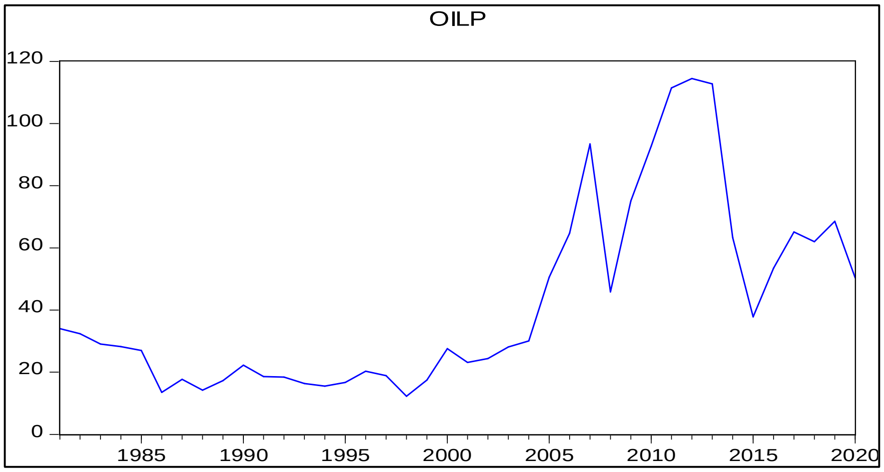

Figure 1: Trends in Oil Price Movement. 1981 – 2020.

In this study, we consider how vagaries in oil prices affects macroeconomic aggregates in Nigeria. The justification for this is premised on the fact that whenever there are oil price fluctuations, since the budgets are benchmarked on oil prices, economic aggregates suffer. Empirical evidence on oil price shocks especially in oil producing and developing economies usually examines either the positive oil price change resulting from an increase in crude oil price or a negative oil price shock through a downward trend in the price of crude. Their findings have shown that either way (positive or negative), the consequences if unplanned can be undesirable. For instance, Siok, Xue & Yen (2015) on inflation, Akpan (2009) on the macroeconomy (focusing on government expenditure, real GDP, Inflation, exchange rate and imports, Brini, Jemmali & Farroukh (2016) on inflation and exchange rate; Oriakhi and Iyoha (2013) on economy (focusing on variables in Akpan (2009) but introducing real money supply) and Eneji, Inusa & Drenkat (2016) on exchange rate, balance of payment, inflation, unemployment and gross domestic product, amongst others. However, this current study is concerned entirely with negative oil price changes and contributes to the existing literature in two respects. First, it is an up-to-date study and covers a larger period including 1981 to 2020, a period believed to be adequate for time series analysis of this nature. Based on the scope, the study can examine the long-run and short-run impact of a negative oil price change on macroeconomic aggregates in Nigeria. Second, the study introduced additional variables (unemployment and foreign direct investment) into the analysis.

Further, this current study differs from previous research in that it introduced two new variables (unemployment and foreign direct investment) but with a total of nine variables into its analysis to establish the effects of oil price movements on these variables. It also brings up to date the oil price studies. This differs from two different studies conducted on Nigeria by Akpan (2009) who introduced six (6) variables and Oriakhi and Iyoha (2013) who used seven (7) variables.

Following the introduction, the remaining part of the paper is structured as follows. Section 2 covers the literature review. Section 3 contains the data and methodology, while Section 4 discusses the empirical results. Section 5 concludes the study and presents policy recommendations.

2.1 Conceptual Literature

2.1.1 Nigeria Oil Industry and Oil Price Vagaries

Nigeria is well endowed and has huge deposits and reservoir of oil and gas. By its endowment, it is one of the largest producers of crude oil in Africa and a member of the Organization of Petroleum Exporting Countries (OPEC). Historically, oil exploration and production began in the country by the discovery of oil in Oloibiri, now in Bayelsa state in 1956. According to Otto (2014), about 245 tons of oil was first exported from the Oloibiri fields in 1958. Today, however, oil productions and exports have since increased. The country's average daily production of crude was 2.3 million barrels in 2006 and 22.6 million barrel by 2014 with the total volume of production rising to 869 million and 699 million barrels in 2006 and 2014, out of which 817.9 barrels in 2006 and 774 million barrels in 2014 were exported. From its 2014 position, oil production rose to 1748200 million barrels in 2015, falling below this level in 2017 to 1,535,600 but only marginally increased close to its 2015 position to 1,737,400 in 2019. At the end of 2010, Nigeria's proved oil reserves were estimated to be 37.2billion barrels, which amounts to 2.68 per cent of the world's reserves (Ajayi, 2013).

The industry is classified into both the upstream and the downstream sector. The downstream concerns petroleum marketing and distribution whereas the upstream activities include exploration and production activities. Major participants in the upstream sector include Shell, Exxon Mobil, Total, Chevron, Eni/Agip, etc. Ajayi (2013) described the crude oil produced in Nigeria as 'sweet' because it is largely Sulphur-free. 80 percent of production wells are in the Niger Delta region in South-South, Nigeria, with groundbreaking production platform projects such as the Egina and Obagi projects operated by Total, Afam Integrated Oil and gas project by Shell and the Bonga Deep Water project.

Baumeister and Peerman (2009) submitted that oil price shocks are not a new phenomenon. It has been a dominant feature in the oil market during the last two decades. Historically, several of such shocks have been documented in the literature including the first oil shock of 1970 – 1974; the second oil shock of between 1978 – 1981; the third oil shock of 1986; the oil price vagaries of 1990-1991; the price shock of 2003 – 2008 and the oil price collapse of mid-2014 – 2016. Whereas the oil price shocks of 1970 -1974 was that of price quadrupling, that of 1978-1981 was that of price doubling. The price shock of 1986 was that of a sharp price decline. The 1990/1991 shock witnessed a price rise, an oil boom was recorded during the 2003-2008 period and price fell drastically during the 2014-2016 oil shock.

One conclusion from the various oil booms is that the country and its citizens did not benefit much from them due to poor management of the economy and massive corruption. Economic indices did not improve much, poverty was rampant, inflation was high, and unemployment was growing. There were no savings, the growth rate was 8 percent, and oil assumed the mainstay of the economy accounting for 87 percent of exports receipts and 77 percent of government revenue, agriculture which hitherto was the major foreign exchange earner was abandoned.

As aptly described by Effodun (2015), by 1986 when the oil price fell, the country's economy nosedived. Per capita gross net product (GNP) plummeted reaching an all-time low of 4.8 per cent in 1987 resulting in the classification of the country as a low-income country by the World Bank. The country slipped into a negative annual growth of 0.7 percent, rising to 5 percent in 1989 but falling to 3.2 percent by the end of 1997. By the time the country recovered from the oil price collapse and entered another era of boom in 2003/2008, massive corruption, mismanagement, and high cost of running government eroded the gains, such that by 2014 when oil prices fell again, this time drastically, the economy was thrown into recession.

2.1.2 Factors responsible for oil price volatility

Several factors have been advanced as possible causes of oil price fluctuations including politically motivated factors (Hamilton, 2009), civil unrest (Aderoju, 2007), insecurity (Onime, 2018), supply disruption (Mabro 1991), the role of OPEC as a cartel (Smith, 2005), insufficient investment in new production, inability to meet new production quotas amongst others.

Onime (2018) noted that insecurity affects oil production, exports, and oil revenue. According to him, due to insecurity in Nigeria, foreign inflows from oil experienced a significant drop from an increase of $99,878 in 2011 to a free fall of $45,365 in 2015, representing a 55 per cent decrease over the figure in 2011. Consequently, oil production also declined steadily from 1974.10 barrel per day in 2011 to 1748.2 in 2015. The overall effect of these is the inability of the country to meet its production quota which could trigger a price shock. Outside insecurity, other factors quite germane to changes in the price of oil are the political development in oil-producing countries, especially in the oil-producing Middle East. According to Marbo (1994), the 1973 oil crisis was the aftermath of the Yom Kippur war, the 1979 crisis followed the Islamic upheaval in Iran, the 1986 crisis precipitated in the wake of the Persian Gulf war and the 1990 crisis came about by the Iraqi invasion of Kuwait.

Another important factor driving oil pricing is OPEC’s influence on oil prices. OPEC sets production levels by allocating quotas to oil-exporting countries to meet global demand and often influence the price of oil and gas by either increasing or decreasing production. According to Nickolas (2018), OPEC vowed to keep the price of oil above $100 per barrel for the foreseeable future, but in mid-2014, the price of oil began to plunge. It nosedived from a peak above $100 per barrel to below $50 per barrel, this he attributed to OPEC’s responsibility for the low cost of oil due to the refusal of the oil cartel to reduce oil production resulting to the decline in prices. Other apropos factors influencing the global price of oil includes the forces of demand and supply, alternatives to oil such as solar energy, biofuel, fossil oil, electricity-powered machines etc. and weakening global demand. Further, uncertainty and reduced investment in the energy sector have also contributed to affect prices.

On the whole, prices of oil are highly unpredictable and subject to different external shocks. This makes planning unrealistic and unachievable especially for countries (like Nigeria) that bases revenue and expenditure projections on revenues from oil.

2.2 Theoretical & Empirical Literature

Theoretically, the effect of such negative oil price swings comes with painful consequences and affects macroeconomic aggregates, including a fall in government revenue with its attendant effect on government expenditure, reduction in foreign direct investment exacerbating unemployment, reduced foreign exchange and escalates interest rate. This is the same view shared by Anyanwu (2005) that any decline in oil prices usually triggers unprecedented crisis of immense dimension in an economy, leaving in its wake, falling external reserves, accumulated foreign and domestic debts, widening of government deficits, emergence of economic recession, rising prices and inflation, unemployment, and persistent balance of payment deficits. Consequently, following the collapse of oil prices during the wake of 2014 to 2016, certain economic aggregates immediately responded to this collapse. During the period, unemployment increased from 10 percent in 2013 to 14.2 percent in 2016. Conversely, foreign direct investment fell from 875.1million dollars in 2013 to 602.1million dollars by 2015. Exchange rate ballooned, rising from N157.26/dollar in 2013 to N305/dollar by end of 2016. Furthermore, imports only grew marginally from N9.4billion to N11.02 billion in 2015 (CBN, 2020).

Therefore, this study is premised on the threshold hypothesis associated with Mork (1989). According to the proponent, for every economy, there seems to be a period in which oil price shocks brings about improvement in economic activity but only up to a point (the threshold point), beyond this point, changes in oil prices might result to deterioration in economic activity. Attempts to validate the threshold hypothesis in the literature have been greeted with mixed results. For instance, Huang, et.al (2005) investigated the effects of an oil price variation on economic activities in United States, Canada, and Japan for the period 1970 to 2002 using multivariate threshold model and found that a threshold value does exist and concluded that the optimal threshold exists to the extent an economy is dependent on imported oil and its attitude in respect of energy-saving technology. Further, they postulated that oil price changes or its variability has a limited impact on the economy if the change is below the threshold level but above the threshold level, oil prices favours macroeconomic variables.

Further to threshold hypothesis of oil price changes, Alimi & Aflouk (2017) evaluated the effects of oil price shocks on economic growth in GCC economies over the period 1980 to 2015 using panel smooth transition regression model and observed that the relationship between economic growth and oil price shocks has a threshold effect and that the effect of an oil price change is larger below the threshold level. Similarly, Rasasi & Yilmax (2016) examined the impact of oil price changes on economic aggregates in Turkey for the period 1990 to 2011 and found the existence of a threshold effect. Specifically, they found that oil price changes affect economic growth negatively with a delay whereas higher oil prices are associated with higher inflation and a lower exchange rate.

Adeniyi, et.al (2011) in their study on oil price variation and economic growth in Nigeria during the period 1985 to 2008 submitted that oil price shocks do not account for a major percentage of adjustments in macroeconomic aggregates. Therefore, the nature of occurrence exists whether threshold effect is present.

Empirically, the literature on oil price instability is advanced. The directions of its effects have been examined in diverse ways by different scholars in economics and other allied sciences. Oriakhi and Iyoha (2013) examined the consequences of oil price volatility on the Nigerian economy between 1970 and 2010 and observed that oil price vagaries have a direct effect on real GDP, real money supply and inflation through other variables notably real government expenditure. Mork and Olson (1994) showed how a distinction can be made between the effects when oil price fluctuates. According to them, the effects on GDP for a price increase is likely to be negative unless the energy-producing sector accounts for a large portion of the country economy which is the case in most oil-exporting countries. Siok, Xue and Yen (2015) using the autoregressive distributed lagged model, studied the effects of oil price changes on inflation in high versus low oil dependency countries and submitted that oil price fluctuations have a direct relationship with domestic inflation in countries that are not too dependent on oil, but its impact is indirect in terms of affecting the domestic inflation in the high oil dependency country through changes in the exporter's production cost.

Brini, Jemmali & Farroukh (2016) analyzed the impact of oil price shocks on inflation and real exchange rate during the period January 2000 to July 2015 on six countries of Tunisia, Morocco, Algeria, Bahrain, Saudi Arabia, and Iran using a structural VAR model. They found that in the long run, oil price shock has more impact on the real exchange rate compared to inflation. In the same vein, Ani, et.al (2014) investigated the links between oil prices and macroeconomic variables in Nigeria during the period 1980 to 2010 using Granger causality and the ordinary least squares (OLS) approach. They found that in the short term, variations in gross domestic product are not affected by oil price changes. They also found that a positive but insignificant relationship exists between oil price, gross domestic product, and exchange rate.

Akpan (2009) examined the nexus between oil price variability and major economic variables in Nigeria through the vector autoregressive approach. The study found a positive correlation between oil price fluctuations and real government expenditures. However, the outcome of the study only identified a minimal impact of oil price fluctuations on industrial output growth. In a similar study, Olomola (2006) examined the effect of oil price changes on aggregate economic activity in Nigeria using quarterly data from 1970 to 2003. The results showed that oil price variability has no significant effect on output and inflation in Nigeria but exerts significant consequence on the real exchange rate.

3. Material and Method

3.1 Data

Annual time-series data were employed for the period 1981 to 2020. Nine variables were used for the study. Data for total government expenditure (TGE), exchange rate (EXR), Imports (IMP), oil prices (OILP) foreign direct investment (FDINV) and interest rate (INTR) were sourced from statistical bulletin of the Central Bank of Nigeria (CBN). Data for inflation up to the year 2019 were sourced from the Federal Reserve Bank Economic database while the 2020 data was obtained from statista.com. Similarly, data for real gross domestic product (RGDP) up to 2019 were from the statistical bulletin of the CBN while the one for 2020 was sourced from statista.com. The unemployment data up to the year 2019 was obtained from the National Bureau of Statistics (NBS) while that of 2020 was gotten from Trading Economics.

3.2 Method

This study relied on the autoregressive distributed lag (ARDL) and the vector error correction model (VECM) for the analysis of data. The autoregressive distributed lag specification was popularized by Pesaran and Shin (1999) but advanced further in Pesaran et al. (2001). The ARDL model incorporates a blend of independent and dependent variables which includes the lagged values of the dependent variable and that of the current and lagged values of regressors as explanatory variables (Adeleye, 2018). Consequently, Hassler and Jurgen (2005) suggested the general form of the autoregressive distributed lag (ARDL) model as shown in equation 1.

$$\boldsymbol{Yt = yo + \sum_{i=1}^{p} aiY\,t-1 + \sum_{i=o}^{q} C'iX\,t-1 + \mathcal{E}t} \;\ldots\ldots(\mathbf{1})$$

Where Yt is a vector representing either the dependent or independent variables, Xt are variables which must be stationary only at order zero I(0), order I(1) or cointegrated (this is so because, within the ARDL specification, the series should not be integrated of order two, I(2) as this order of integration renders the f-statistics invalid), ai's & Ci's are the coefficients to be estimated, yo is a constant; p, q are lag length where p is lag used for the dependent variable and q is used for the independent variables. The Ɛt is the stochastic error term.

Following from the above, the basic form of the empirical model to be estimated is specified in equation (2). Theoretically, in the model specified, oil price is a function of total government expenditure, inflation, exchange rate, imports, unemployment, foreign direct investment, real gross domestic product, and interest rate.

$$\mathbf{OILP} = \mathbf{f}(\mathrm{TGE, INF, EXR, IMP, UMP, FDINV, RGDP, INTR}) \quad \ldots\ldots\ldots..(\mathbf{2})$$

Linear estimation of equation (2) by adding an intercept and a stochastic error term results in the following transformation.

$$\mathrm{OILP} = \beta0 + \beta1\mathrm{TGE} + \beta2\mathrm{INF} + \beta3\mathrm{EXR} + \beta4\mathrm{IMP} + \beta5\mathrm{UMP} + \beta6\mathrm{FDINV} + \beta7\mathrm{RGDP} + \beta8\mathrm{INTR} + \varepsilon t \quad \ldots\ldots\ldots.(\mathbf{3})$$

$$\boldsymbol{\beta 1 - \beta 4} < \mathbf{0};\ \boldsymbol{\beta 5}\ \&\ \beta\mathbf{8} > 0\ \beta\mathbf{6}\ \&\ \beta\mathbf{7} < \mathbf{0};$$

Where the variable in the model includes oil price (OILP), total government expenditure (TGE), inflation (INF), exchange rate (EXR), Imports (IMP), unemployment (UMP), foreign direct investment (FDINV), real gross domestic product (RGDP) and interest rate (INTR).

3.3 Estimation Procedures

To understand the behaviour of the time-series data used in this study, the analysis started with conducting preliminary diagnostic tests to establish the statistical properties of the variables as well as their correlation coefficients. As shown in the first part of Table 1, the maximum value of total government expenditure is 10164.6 billion naira while the minimum is 9.6 billion naira. The maximum value of oil price stood at $114.5 per barrel, while its lowest value is $12.3 per barrel. For unemployment, the maximum value is 33% while its lowest value stood at 3.4%. The average values of Oil price are $42.1 per barrel, N2244 billion for total government expenditure and 19.1% for inflation, respectively. Further, the calculated averages for some of the variables differ from that of the median values suggesting some level of skewness in the model. Especially, all the variables were observed to be positively skewed. In respect of kurtosis, all the variables are leptokurtic with kurtosis greater than three, representing a distribution that is longer with fatter tails and higher peak**.** This observation is expected for time series variables that are easily subjected to drift. Therefore, an attempt to use the data at levels might produce misleading results and policy outcomes. The computed standard deviation shows that some of the variables departed from their mean and may thus need differencing to make them stationary. The lower part of table 1 presents the correlation matrix of the variables, which shows that oil price is positively correlated with government expenditure, imports, unemployment, and real gross domestic product, while it is negatively correlated with inflation, foreign direct investment, and interest rate.

Table 1: Descriptive Statistics and Correlation Matrix, authors' computation from E-view 10

Variables	**OILP**	**TGE**	**INF**	**EXR**	**IMP**	**UMP**	**FDINV**	**RGDP**	**INTR**
Mean	42.128	2244.04	18.9697	104.1719	4442620	11.9193	2375.99	3853826	17.454
Median	28.62	982.845	12.54	111.75	1171601	9.92	695	24477.91	17.528
Maximum	114.49	10164.6	72.8	381	24153674	33.3	29660.3	69799942	29.8
Minimum	12.28	9.64	5.38	0.6369	5983.6	3.4	22.2	13779.26	7.75
Std. Dev.	29.9715	2821	16.8801	104.8529	6200045	6.52942	5451.78	14089634	4.6032
Skewness	1.1295	1.29646	1.8229	0.924287	1.611824	1.25588	3.76364	3.64801	0.2382
Kurtosis	3.1871	3.79308	5.15227	3.071334	4.990078	4.50609	17.6812	15.37227	3.6191
Jarque-Bera	8.56341	12.2537	29.8734	5.703852	23.92053	14.2954	453.663	343.8417	1.0172
Probability	0.01382	0.00218	0	0.057733	0.000006	0.00079	0	0	0.6013
OILP	1								
TGE	0.6593	1							
INF	-0.38192	-0.3155	1						
EXR	0.574	0.94321	-0.3385	1					
IMP	0.62279	0.98849	-0.2883	0.903695	1				
UMP	0.54582	0.79331	-0.2212	0.807947	0.778458	1			
FDINV	-0.21256	-0.1675	0.48691	-0.20667	-0.14767	-0.1246	1		
RGDP	0.17031	0.66456	-0.1113	0.594876	0.687959	0.59092	-0.0422	1	
INTR	-0.15254	-0.12	0.33953	-0.01471	-0.13776	-0.0103	0.36054	-0.06678	1

Further test conducted includes the classical regression whose result revealed an R-square of 72 percent and low Durbin Watson statistic of 1.44, an indication that the probability of a spurious regression cannot be rejected. The outcome of this preliminary diagnostic test is a necessary condition for carrying out a unit root test to establish the stability property and hence stationarity of the variables in the model.

4 Results and Analysis

4.1 Test for Unit Root

The procedure for the unit root test involves using the Phillip-Perron (PP) test popularized by Pierre Perron and Peter Phillips (1988) to determine the order of integration of the variables in the model. The unit root results using the Phillip-Perron test shows in absolute terms that out of the nine (9) variables in the model, five (TGE, EXR, IMP, FDINV and INTR) expressed in levels were stationary while the remaining four were not. However, when the four variables (INF, UMP, OILP and RGDP) were first differenced, there was evidence as shown in Table 2 that they became stationary**.**

Table 2: Unit Root Tests - Phillips-Perron test, authors' computation using E-view 10

Variable	Level (Trend)	5% critical level	Level (Trend & Intercept)	5% critical level	1st Difference (Trend)	5% critical level	1st Difference (Trend &	5% critical level	Order of Integration
TGE	4.639	2.939	1.222	3.533	4.015	2.941	5.479	3.529	I(0)
INF	2.826	2.939	2.909	3.533	10.026	2.941	10.726	3.529	I(1)
EXR	4.733	2.939	0.578	3.533	4.834	2.941	5.389	3.529	I(0)
IMP	4.214	2.939	0.558	3.533	5.630	2.941	6.686	3.529	I(0)
UMP	1.301	2.939	3.204	3.533	6.623	2.941	6.744	3.529	I(1)
OILP	1.586	2.939	2.309	3.533	6.195	2.941	6.068	3.529	I(1)
FDINV	4.041	2.939	4.133	3.533	21.048	2.941	21.098	3.529	I(0)
RGDP	2.183	2.939	2.839	3.533	9.733	2.941	11.185	3.529	I(1)
INTR	3.449	2.939	3.195	3.533	9.563	2.941	10.035	3.529	I(0)

As the variables in the model are integrated of different orders (that is follows I(0) and I(1) series) and none is integrated of order I(2), the autoregressive distributed lag (ARDL) model can be specified and estimated. However**, t**he first step in the estimation is to conduct a cointegration test to determine if a long-run correlation existed between the variables or not. To do this, the bounds test associated with Pesaran, Shin and Smith (2001) were used. The null hypothesis (H0) in respect of this test is that there is no cointegration among the variables while the alternative hypothesis (H1) is that the null hypothesis is not true, implying there is cointegration among the variables. The result of the bounds test is presented in Table 3.

As shown from the result of the bounds test, since the computed value of F-statistic (5.108) is higher than the I(1) bound value (3.8) at the 10% and (4.6) at the 5% level of significance, we conclude there is cointegration and that a long-run relationship exist among the variables in the model.

Table 3: F-Bounds Test, author's computation from E-view 10

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.107743	10%	3.8	3.8
k	0	5%	4.6	4.6

Therefore, since the variables in the model are cointegrated, we specify and estimate both the short-run and the Long-run model. However, before this can be done, the appropriate lag length to use in the model must be determined scientifically. The outcome shown in Table 4 revealed the lag length to be one across all the information criteria.

Table 4: Lag Order Selection Criteria, author's computation from E-view 10

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-154.7915	NA	413.9189	8.853597	9.245442	8.99174
1	-147.3131	10.91446*	292.7458*	8.503411*	8.938795*	8.656904*
2	-146.4519	1.210365	296.3514	8.510913	8.989835	8.679755
3	-146.1686	0.382877	309.8446	8.549652	9.072112	8.733844
* 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						

Consequently, having found evidence of cointegration relationship in the model, the study estimated both the long-run and short-run model using a maximum lag length of one (1).

4.2 Long-Run Model Specification & Estimation

The long-run estimates of the oil price model derived from equation 4 are presented in Table 5.

$$OilPt = \beta 0 + \beta 1OilPt-1 + \beta 2TGEt-1 + \beta 3INFt-1 + \beta 4EXRt-1 + \beta 5IMPt-1 + \beta 6UMPt-1 + \beta 7\,FDINVt-I + \beta 8RGDPt-1 + \beta 9INTRt-1 + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

The R-squared of the model is high and statistically significant (p=value of F-statistic is less than 0.05), explaining about 80 per cent systematic variations of the independent variables on the dependent variable. This shows that the model is adequate in explaining oil price changes in Nigeria. Out of the eight independent variables, five conformed to expected sign. Thus, a negative relationship exists between oil price and exchange rate (conforming to result obtained in Mork & Olson (2014) and Rasasi & Yilmax (2016), imports, foreign direct investment, and real gross domestic product (as demonstrated in the studies by Oriakhi & Iyoha (2013). A fall in the price of oil is associated with a decrease or worsening of the variables during the period under study, though these relationships were not significant. Similarly, the relationship between oil price and unemployment is positive, indicating that a fall in the price of oil is associated with an increase in the unemployment position during the period. This relationship is equally significant, easily passing the significance test at the 10 percent level of significance.

Table 5: Estimated Long-Run Model, computed by authors from E-view 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.69517	11.81771	-0.143443	0.8869
OILP(-1)	0.633063	0.177489	3.566767	0.0013
TGE(-1)	0.011757	0.01209	0.972478	0.3389
INF(-1)	0.05365	0.185708	0.288893	0.7747
EXR(-1)	-0.016457	0.120859	-0.136169	0.8926
IMP(-1)	-4.86E-06	3.81E-06	-1.276415	0.2119
UMP(-1)	1.548075	0.800336	1.934281	0.0629
FDINV(-1)	-0.000166	0.000548	-0.302089	0.7647
RGDP(-1)	-2.14E-07	2.90E-07	-0.73863	0.4661
INTR(-1)	-0.176941	0.659326	-0.268367	0.7903
R-squared	0.804333	Mean dependent var		42.33641
Adjusted R-squared	0.743609	S.D. dependent var		30.33388
S.E. of regression	15.35957	Akaike info criterion		8.51791
Sum squared resid	6841.578	Schwarz criterion		8.944464
Log likelihood	-156.0992	Hannan-Quinn criter.		8.670954
F-statistic	13.2457	Durbin-Watson stat		2.043477
Prob(F-statistic)	0.000000			

Specifically, from the long run estimates (presented in Table 5), the coefficient of total government expenditure has a positive sign but insignificant at the 5 percent critical level. The reason for this result could be due to government's alternative means of financing its expenditure (especially through borrowing) whenever there is a shortfall in oil proceeds**.** Further, the coefficient of foreign direct investment and real gross domestic product conformed to apriori expectation, an indication that a fall in the price of oil will result to a decline in foreign investment and economic growth. For instance, a 1 percent decline in the price of oil will result to a 0.02 percent and 2.14 percent decrease in foreign investment and real gross domestic product, respectively. The overall effect of this as shown by the long run estimates is an increase in unemployment rate by 1.55 percent and inflation by 5.3 percent.

4.3 Short Run Model Specification

The short-run estimates of the oil price model derived from equation 5 are presented in Table 6.

$$\Delta OilPt = \beta 0 + \sum_{i=1}^{p} \beta 1i\Delta\, OilPt-1 + \sum_{i=1}^{q} \beta 2i\Delta\, TGEt-1 \sum_{i=1}^{q} \beta 3i\Delta\, INFt-1 + \sum_{i=1}^{q} \beta 4i\Delta\, EXRt-1 + \sum_{i=1}^{q} \beta 5i\Delta\, IMPt-1 + \sum_{i=1}^{q} \beta 6i\Delta\, UMPt-1 + \sum_{i=1}^{q} \beta 7i\Delta\, FDINVt-1 + \sum_{i=1}^{q} \beta 8i\Delta\, RGDPt-1 + \sum_{i=1}^{q} \beta 9i\Delta\, INTRt-1 + \lambda ECMt-1 + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

An examination of the estimated short-run regression result shows that the coefficient of the error correction term (ECM) is well-behaved as it appeared rightly signed and significant (p = 0.0235) at the 5 percent critical level. This is a proof of the presence of a stable long run relationship between oil price and all the independent variables put together. The ECM of 0.932 in absolute terms is the speed of adjustment from the short run to long-term equilibrium. This implies that 93.2 percent of the error is corrected in each period. This high speed of adjustment shows that it will take approximately one year to correct errors/deviations in the economy caused by changes in oil prices. Given the value of the R-Squared, it can be concluded that the eight independent variables employed in the model jointly accounted for about 32 percent of the systematic variations in oil price during the period under study. The equation's standard errors are quite small while the Durbin-Watson statistic of 1.98 which is close to the traditional 'rule of thumb' of two is indicative of a clear absence of serial correlation in the model.

Table 6: Estimated Short-Run Model, computed by authors from E-view 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.03254	3.018574	-0.342062	0.735
D(OILP(-1))	0.533653	0.316113	1.688171	0.1029
D(TGE(-1))	0.009913	0.011967	0.82831	0.4148
D(INF(-1))	0.049839	0.176009	0.283163	0.7792
D(EXR(-1))	0.024886	0.159835	0.155695	0.8774
D(IMP(-1))	-3.70E-06	3.27E-06	-1.130571	0.2682
D(UMP(-1))	1.860641	0.71502	2.602224	0.0149
D(FDINV(-1))	-5.24E-05	0.000426	-0.12302	0.903
D(RGDP(-1))	-1.14E-07	2.48E-07	-0.457864	0.6507
D(INTR(-1))	0.149629	0.645027	0.231974	0.8183
ECM(-1)	-0.932192	0.388318	-2.400591	0.0235
R-squared	0.324172	Mean dependent var		0.472368
Adjusted R-squar	0.073865	S.D. dependent var		16.10133
S.E. of regression	15.49527	Akaike info criterion		8.556144
Sum squared resi	6482.788	Schwarz criterion		9.030182
Log likelihood	-151.5667	Hannan-Quinn criter.		8.724803
F-statistic	1.295097	Durbin-Watson stat		1.983124
Prob(F-statistic)	0.282095			

In terms of the coefficients of the variables in the short run model estimates, five of the eight variables used in the model conformed to theory. For instance, the coefficient of imports is negative but insignificant (with p = 0.2682). A decline in oil price is associated with a decrease in imports. This is because oil proceed increases foreign exchange earnings and by implication, foreign reserves that serves as a buffer or cover for imports. Unemployment was observed to be positively related to a decline in oil price. This is expected as a decrease in oil price reduces investment in the oil sector, which ultimately affects employment creation. This relationship is equally significant (with p = 0.0149), easily passing the significance test at the 5 percent level. Thus, a 1 percent decrease in the price of oil is associated with a 1.86 percent increase in the unemployment rate. Foreign direct investment and oil price are negatively related. A decrease in the price of oil is associated with a reduction in oil and gas investments as investors reduce their investment due to lower returns.

The relationship between oil price decrease and real gross domestic product (RGDP) is negative as expected. Though this relationship is not significant (p = 0.6507), any fall in the price of oil ultimately result to a decline in gross domestic product. This finding agrees with the views of Mork and Olson (1994) who reported a negative relationship between oil price and gross domestic product but at variance with those of Oriakhi and Iyoha (2013) who found a positive relationship between oil price and gross domestic product. In respect to interest rate, a positive correlation was found to exist between oil price and interest rate as expected. A decrease in the price of oil is associated with an increase in interest rate. The possible explanation for this is clear. A decline in oil price which will result to a drop in oil revenue, affect government expenditure. In a bit to finance its expenditure, government normally resorts to borrowings both locally and internationally. An increase in borrowing will increase the cost of funds.

Therefore, we can deduce from the performance of the coefficient of the variables that evidence exist supporting the existence of a positive relationship between oil price, unemployment, and interest rate while a negative but insignificant relationship exists between imports, foreign direct investment, and real gross domestic product.

4.4 Diagnostic and Stability Tests

The study authenticated the empirical result by subjecting the model to some diagnostic tests. Table 7 presents the result of the test on the possible presence or otherwise of serial correlation, heteroskedasticity and misspecification of the model used for this study. Using the Breusch-Godfrey test for serial correlation, since the p-value of 0.89 is greater than the 5 percent significance level; we reject the null hypothesis and conclude that the model is free from serial correlation. Further, using the Breusch-Pagan-Godfrey test for heteroskedasticity, we again reject the null hypothesis of heteroskedasticity and conclude that the model is homoscedastic in the model since the p-value of 0.06 is greater than 5 percent significance level. To confirm if the model used in the analysis was properly specified and devoid of misspecification, the Ramsey Reset test was used. The result of the test shows the model was properly specified as the p-value of 0.165 easily passed the significance test at the 5 per cent level of significance. The conclusion therefore is that the model is properly specified and can be used for policy making.

Table 7: **Diagnostic Tests,** Authors analysis from eview10.

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.115148	Prob. F(2,25)	0.8917
Obs*R-squared	0.346854	Prob. Chi-Square(2)	0.8408
RAMSEY RESET TEST			
t-statistic	1.428519	26	0.165
F-statistic	2.040667	(1, 26)	0.165
Likelihood ratio	2.871254	1	0.0902
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	2.096923	Prob. F(10,27)	0.0615
Obs*R-squared	16.61129	Prob. Chi-Square(10)	0.0834
Scaled explained SS	16.60532	Prob. Chi-Square(10)	0.0836

To test for the stability of the model, the Cumulative sum of recursive residual (CUSUM) and cumulative sum squares recursive residual (CUSUM squares) were used. The outcomes of the test are displayed in Figure 2 and 3. In respect of CUSUM, the estimated model is stable as the critical line lies throughout within the 5 percent boundary.

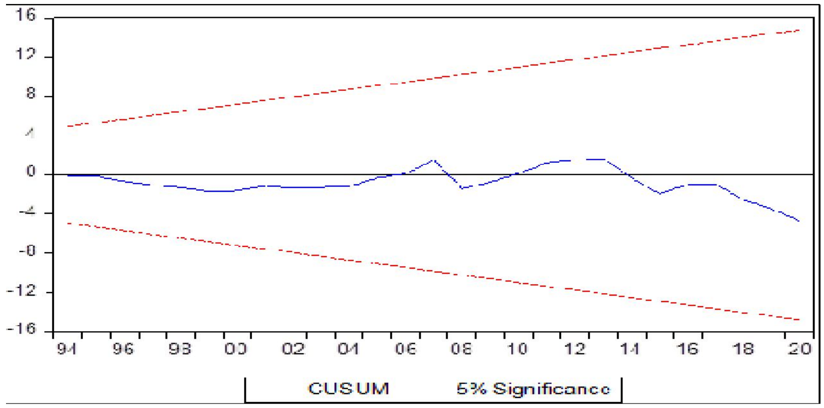

Figure 2: Plot of Cumulative Sum of Recursive Residual

For CUSUM Squares, the result shows that the estimated model are relatively stable the critical line in the graph lie within the 5 per cent boundary except for minor structural breaks in between 2002 and 2007.

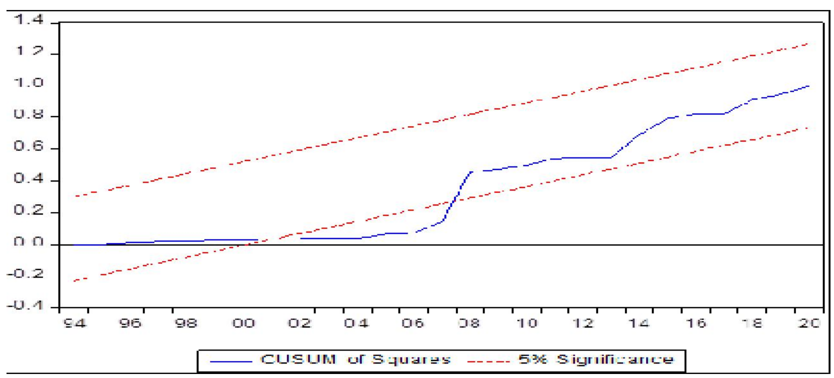

Figure 3: Plot of Cumulative Sum Squares Recursive Residual

The conclusion therefore from the stability test is that the model appeared stable, an indication that the results of the regression coefficients are suitable for policymaking.

5 Conclusions

This study empirically examined the impact of a decrease in oil price on some macroeconomic aggregates in Nigeria using time series data for the period 1981 to 2020, the autoregressive distributed lag (ARDL) and the vector error correction model. Findings from the ARDL bounds test result confirms that a long run co-integrating relationship exist between all the variables in the model while the vector error correction model validated the existence of a short run relationship among the variables. Specifically, imports, foreign direct investment and real gross domestic product were found to be negatively related to oil price in both the short and the long run while unemployment was observed to be positively correlated with oil price in the short and long run. Thus, a decline in the price of oil will result in a decline in foreign direct investment, imports and unemployment which ultimately will result to a fall in real gross domestic product.

Based on the findings, the study recommends uninterrupted savings of oil proceeds during episodes of oil price boom and by implication boosting of foreign reserves to provide sufficient cover for imports during periods of oil price decrease. In addition to this recommendation is the continuous clamour for a properly diversified economy away from oil dependence. In periods of negative oil price shocks which discourage investments, the government should encourage investors through various incentives such as tax holidays, tax havens, and other related rebates, reduce cost of funds using the appropriate agency of government and ensure the provision of enabling environment and infrastructure for investments to strive (such as power, security, and roads) and improvement in the ease of doing business in the country. This will result in job creation, thereby reducing unemployment and poverty and improving the gross domestic product.

Overall, this study being a macro-level study contributes to the several other existing body of knowledge in this regard by using up to date data set, expanding the sample size and introducing two additional variables (unemployment and foreign direct investment), thereby filling existing gap in this respect. But again, like many studies before it, failed to examine micro-level impact of oil price. This should therefore be in important area for further research.

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