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Effects of Oil Price Movement on Nigerian Macroeconomic Variables: Evidence from Linear near and Nonlinear ARDL Modelling

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Abstract

The study seeks to investigate both linear and nonlinear effects of oil price movement on critical macroeconomic variables (output, price and exchange rate) in Nigeria using ARDL modeling approach. Previous studies substantially relied on linear methods using VAR approach to unravel this links without a clear conclusion. In an attempt to seek better results in this study, we employ both linear and nonlinear ARDL modeling techniques that inherently allows for asymmetric effect. Based on the theoretical proposition of ARDL methods that does require that all data are either stationary at level or at first difference or the combination of the two. We perform unit root tests and other required econometrics tests. Consequently, linear and nonlinear ARDL estimation techniques were carried out. The results from linear and non-linear estimations indicate that oil price movement has statistical significant effects on critical macroeconomic variables in Nigeria (output, price and exchange rate) both in the short-run and long-run but there is evidence of asymmetric effect for output and exchange rate only. Therefore the study concludes there is no asymmetric effect of oil price movement on general price level in Nigeria but there are statistically significant asymmetric effects of oil price movement on output and exchange rate in the country.

Keywords: Macroeconomics, NARDL, Shock and Price.
JEL Classification: C00, C55, E32, E31.

1. Introduction

Several studies have examined the impact of oil price movement and its shocks on the macroeconomic performances of many oil exporting and importing countries including Nigeria with clear consensus that oil price

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has a big role to play in macroeconomic performances of these countries (Darby, 1982; Hamilton, 1983; Hooker, 1996; Jin, 2008; Zhu et al., 2016). What seem to be insufficient in literature are the evidences on asymmetric effect of oil price movement on key macroeconomic variables in many oil producing countries especially Nigeria. Definitely, it is worthy of empirical investigation to determine how positive oil price shock affects key macroeconomics variables with reasonable precision. And also determine the pattern of macroeconomic reactions to negative oil price shocks for effective macroeconomic management. This is the task the study intends to accomplish.

Generally, Nigeria as a country depends so much on oil for its economic survival. According to the 2016 BP Statistical Energy Survey, Nigeria had proven oil reserves of 37.1 billion barrels at the end of 2015 and that is roughly 2.2 % of the world's reserves. Also, the country has proven natural gas reserves of 5.1 trillion cubic meters which contributes to 2.7% of the world total at the end of 2015. On the average in 2015, Nigeria oil production was 2.1 barrel per day with refining capacity of 407,800 barrel per day. Also, the value of petroleum exports ‘kstands at 41,818 million dollars out of 45,365 million dollars total export value (OPEC annual statistical report 2016). This sector generates about 91% of foreign earnings and contributes 82% of government revenue. Despite its huge impact on foreign earning the contribution of the sector GDP is very low.

Like many other oil exporting countries, Nigeria government usually adopts an estimated oil price as a benchmark for annual budget in the country and this serves as a basis for government expenditure and other fiscal planning. Any price over and above this estimated price is considered as reserve. Unfortunately, there is no required fiscal discipline and political will to preserve this reserve as buffer for the economy. Also, during the curse of the fiscal year it is not unusual for oil price to go below this estimated price as witnessed more recently in year 2015 and 2016. When this happens, it throws the government and the entire economy off track. Thus, it is imperative to determine the impact of crude

oil price movement on key macroeconomic variables in Nigeria to guarantee proper fiscal planning.

More importantly, Nigerian economy is an import dependent economy and the economy depends largely on the proceeds from the sale of crude to finance this huge importation of both consumer and intermediate goods. Thus, any movement in the price of crude oil always impacts on both the supply and the demand side of the economy. And to maintain stability in this external sector, the country needs persistent and predictable flow of foreign reserve to guarantee stable exchange rate for the economy. To achieve this, oil price must be reasonably high at the international market and oil supply from the country must be stable. Unfortunately, these two variables (price and supply) are not in most cases determined endogenously by Nigerian economy. Based on this, the movement in the price of crude oil is so critical for serious macroeconomic planning in Nigeria thus it is crucial to examine the symmetric and asymmetric pass-through effect of oil price changes on key macroeconomic variables in the country for proper macroeconomic management.

To this end, some empirical efforts have been made to unraveled the connection between oil price and Nigerian economy (Ayadi, 2005; Olomola, 2006; Akpan, 2011; Taiwo, Abayomi & Damilare, 2012; Omojolaibi, 2013; Iwayemi & Fowowe ,2011; Alley et al., 2014). In most of these studies, conflicting positions are noticeable but general findings show that while oil price changes have significant relationship with macroeconomic variables, it does not significantly affect output growth in Nigeria. Though most of the studies employ Vector Autoregression to estimate shocks and observe the reactions of macroeconomic variables to the oil price shocks but they did not give consideration to the issue of asymmetric effect. However, study by Mordi and Adebiyi (2010) examined the asymmetric effect of oil price on output and price with conclusion that impact of negative oil price shocks has greater effect than positive oil price shocks on the two variables (output and price) . To properly extend the frontier of knowledge in this

area, this study use both linear and non-linear ARDL modeling. This is very important as many studies in the past were not able to establish a statistically significant links between oil price and output growth in the country and this call for concern given the importance of the sector to foreign earning in Nigeria thus necessitate asymmetric investigation.

Other reason for asymmetry approach is rooted in the work of Shin, Yu and Greenwood-Nimmo (2011) where they developed procedures for generating cumulative sums of positive and negative shocks from series thus making it possible to measure the effect of positive and negative oil price separately on any variable of interest. This method has been empirically employed by similar studies elsewhere (Manshor, 2015; Brun-Aguerre et al., 2017). Thus, it imperative to adopt this method to unravel the nexus of oil price shocks and the performances of key macroeconomic variables (Output, Price and Exchange rate) in Nigeria.

Apart from this introductory section, the paper is divided into three sections. Section two discusses stylized facts of macroeconomic variables in Nigeria viz a viz oil price movement. Section three discusses empirical issues on oil price and economy while section four focuses on methodology. The last section of the paper gives attention to the results from the analysis and policy implications.

1.2 Nigerian Macroeconomic Variables and Oil Price Movement

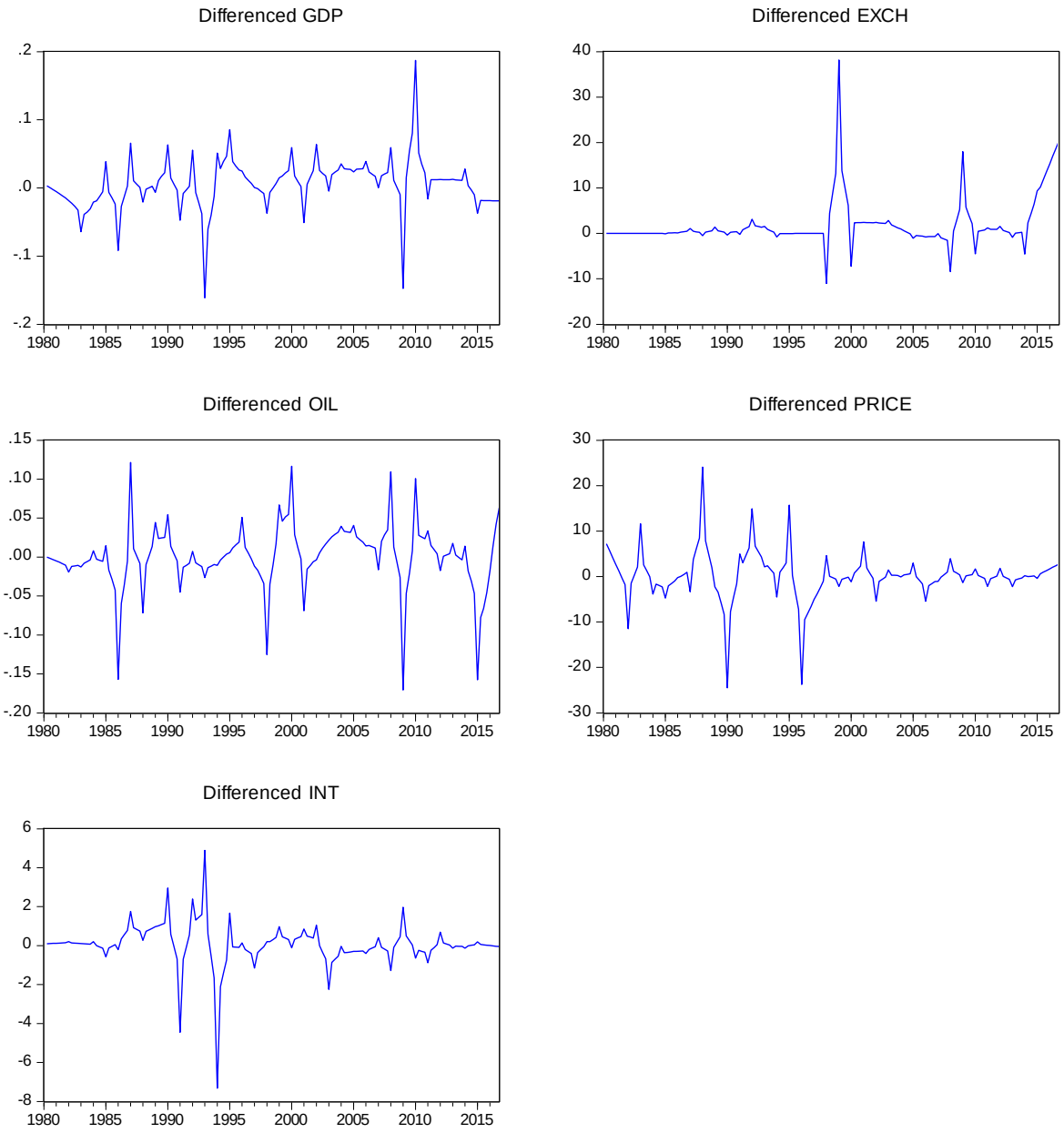

Figure 1: Oil Price Movement and Key Macroeconomic Variables in Nigeria

Figure 1 shows the graph of oil price movement and key macroeconomic variables in Nigeria. From the graphs it is observable that there is serious co-movement between change oil price and change in gross domestic product in Nigeria. A critical look at the two graphs indicates that most period of economic downturn in the country coincides with the period of fall in global oil price. Similarly, period of economic boom in the country also coincides with period of hike in global oil price thus this suggests that oil price is a very important determinant of economic performance in the country.

A look at the exchange graph shows that between 1981 and 1995 the variable was administratively managed thus there was a movement within a restricted bound which prevents proper interaction with the global oil price. Afterward, the variable demonstrates a reasonable interaction with global oil price especially during the period 2000, 2010 and 2015. The graphs of other variables (Inflation and interest rate) demonstrate similar trend with oil price especially inflation. Between 1980 and 1995, oil price show serious co-movement with inflation rate in the country suggesting oil wealth effect on public and private consumption which invariably bid up the general price level due to limited absorptive capacity of the economy. In an attempt to curb inflation in country the country interest rate also moves in the same direction. This can casually explain the link underlining the relationship of oil price, inflation rate and interest rate in Nigeria. But this relationship seems to break down from 1995 forward and this might be attributable to an improved macroeconomic management.

1.3 Literature Review

Oil price and macroeconomic variables nexus of both oil exporting and oil importing countries have been extensively explored in literature (Hamilton, 1996, 2008; Burbidge and Harrison, 1984; Gisser and Goodwin, 1986; Mork, 1989; Mory, 1993; Huntington, 1998). The earlier studies in this area focused more on linear relationship of negative oil price shock and macroeconomic variables (Mork, 1989; Hamilton, 1996).

Consequently, earlier empirical efforts in Nigeria adopted linear approach to oil price and macroeconomic variables analyses (Ayadi, 2005; Olomola, 2006; Chuku et al., 2011). The preference for linearity started to lose its relevance in the light of new development in time series econometrics. Mork (1989) hypothesized that unlike oil price increases, price declines has limited effect on the economy performance. He further attempted disaggregation of oil price into two variables for possible capturing of increase and decrease separately in attempt to test asymmetric responses of macroeconomic variables to oil price.

Based on Mork (1989) efforts other studies have worked along asymmetric direction to study relationship between oil price and macroeconomic variables (Mory, 1993; Lee et al., 1995; Huang et al., 2005; Sadorsky, 1999; Herrera et al., 2011). In the case of Lee et al. (1995), their study considered volatility of oil prices by capturing both the unanticipated component and the time-varying conditional variance of real oil price movement. Several studies have also emulated this procedure (Ratti, 1995; Federer, 1996; Kumar, 2009; Rodriguez and Sanchez, 2005; Mehrara, 2008; Mordi and Adebiyi, 2010; Salisu and Fasanya, 2013). As a result of this econometric shift, more recent empirical studies have employed different methods that provide opportunity for asymmetric investigation (Kilian, 2009; Moshiri, 2015; Ekong and Effiong, 2015; Abdulkareem and Abdulhakeem, 2016).

More recently, Shin, Yu and Greenwood-Nimmo (2011) developed procedures for generating cumulative sums of positive and negative shocks from series. This econometric break- through provides another handy tools to investigate asymmetric effect both in short-run and long-run. This method has been extensively embraced and employed in different areas of applied econometrics. This development has reinvigorated the energy of empirical researchers to further investigate the asymmetric effect of oil price on key macroeconomic variables. Country specific studies using with this method is expanding in both developed and developing countries (Karamelikli, 2015; Raza et al., 2016; Bayramoglu and Yildirim, 2017). But there seem to be a scarce literature

of studies employing this new method in oil exporting countries especially sub-Saharan Africa. This is the gap this study seeks to fill.

1.4 Methodology

1.4.1 Model Specification

Following Pesaran, Shin, & Smith (1999), the conventional linear ARDL (*p*,*q*) model can be summarily constructed thus,

$$y_t = \sum_{j=1}^{n} \lambda_i \, y_{t-j} + y_t + \sum_{j=1}^{q} \delta_i \, x_{t-j} + \varepsilon_t \qquad (1)$$

In equation (1) above, y_t represents the dependent variable and x_t represents the vector of the dependent variable. Similarly λ_t and δ_t represent the coefficient of vectors for scalars and exogenous variables and ε_t is a disturbance term. The error correction of the model can be presented as follow:

$$\Delta y_t = \phi \, y_{t-1} + \beta_t^{*} x_t + \sum_{j=1}^{n-1} \lambda_t^{*} \Delta \, y_{t-i} + = \sum_{j=1}^{q-1} \delta_t^{*} \Delta \, x_{t-i} + \varepsilon_t \qquad (2)$$

Inserting both dependent and independent variables required for linear ARDL estimation in equation (2):

$$\Delta Output_t = \lambda_0 + \sum_{j=1}^{n1} a_{j_i} \Delta Oil_{t-j} + \sum_{j=1}^{n2} b_{j_i} \Delta Investment_{t-j} + \sum_{j=1}^{n3} c_{j_i} \Delta Openness_{t-j} + \theta_1 Oil_{t=1} + \theta_2 Investment_{t=1} + \theta_3 Opennes_{t=1} + \varepsilon_t \qquad (3)$$

$$\Delta \ln Exch_t = \lambda_0 + \sum_{j=1}^{n1} d_{j_i} \Delta Oil_{t-j} + \sum_{j=1}^{n2} e_{j_i} \Delta Investment_{t-j} + \sum_{j=1}^{n3} f_{j_i} \Delta Openness_{t-j} + \theta_1 oil_{t=1} + \theta_2 Investment_{t=1} + \theta_3 Openness_{t=1} + \varepsilon_t \qquad (4)$$

$$\Delta \Pr ice_t = \lambda_0 + \sum_{j=1}^{n1} g_{j_i} \Delta Oil_{t-j} + \sum_{j=1}^{n2} h_{j_i} \Delta Money_{t-j} + \sum_{j=1}^{n3} K_{j_i} \Delta Openness_{t-j} + \theta_1 oil_{t=1} + \theta_2 Money_{t=1} + \theta_3 Openness_{t=1} + \varepsilon_t \quad (5)$$

Regrouping error correction in equation (2):

$$\Delta y_t = \phi(y_{t-1} + \theta_t^* x_t) + \sum_{j=1}^{n-1} \lambda_t^* \Delta y_{t-i} + = \sum_{j=1}^{q-1} \delta_t^* \Delta x_{t-i} + \varepsilon_t \quad (6)$$

where $\theta = \left(\frac{\beta}{\phi}\right)$ Shows the long-run among y_t and x_t. λ_t^* and δ_t^* are the short-run coefficients while ϕ is the error correction term. This equation principally includes both short-run (first-differenced) and long-run (one-period-lagged level) variables. For the short-run coefficients, each lag length n is chosen by minimizing the Akaike Information Criterion (AIC), and each model is estimated at these optimum lags.

By extension, following the work of shin *et al* (2011) nonlinear asymmetric cointegration regression can be written thus;

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t \quad (7)$$

$$x_t = x_0 + x_t^+ + x_t^- \quad (8)$$

In the equation 7 above, β^+ and β^- are the long-run parameters of x_t^+ and x_t^- as decomposed in equation 8. x_t^+ and x_t^- are the partial sum of positive and negative changes in x_t which can be defined as:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0) \quad (9)$$

$$x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \max(\Delta x_j, 0) \quad (10)$$

For a detailed exposition of the method, see Shin et al. (2011) and Katrakilidis & Trachanas (2012). To specify the nonlinear version of our model, equation 3 to 5 will be restated with slight modifications such that they cater for partial sum of positive and negative changes.

$$\Delta Output_t = \lambda_0 + \sum_{j=1}^{n1} a_{ji}^{+} \Delta oil_{t-j}^{+} + \sum_{j=1}^{n2} a_{ji}^{-} \Delta oil_{t-j}^{-} + \sum_{j=1}^{n3} b_{ji} \Delta Investment_{t-j} + \sum_{j=1}^{n4} c_{ji} \Delta Openness_{t-j} + \theta_1 oil_{t-j}^{+} + \theta_2 oil_{t-j}^{-} + \theta_3 Investment_{t=1} + \theta_4 Opennes_{t=1} + \varepsilon_t \quad (11)$$

$$\Delta \ln Exch_t = \lambda_0 + \sum_{j=1}^{n1} d_{ji}^{+} \Delta oil_{t-j}^{+} + \sum_{j=1}^{n2} d_{ji}^{-} \Delta oil_{t-j}^{-} + \sum_{j=1}^{n3} e_{ji} \Delta Investment_{t-j} + \sum_{j=1}^{n4} f_{ji} \Delta Openness_{t-j} + \theta_1 oil_{t-j}^{+} + \theta_2 oil_{t-j}^{-} + \theta_3 Investment_{t=1} + \theta_4 Opennes_{t=1} + \varepsilon_t \quad (12)$$

$$\Delta \mathrm{Pr}ice_t = \lambda_0 + \sum_{j=1}^{n1} g_{ji}^{+} \Delta oil_{t-j}^{+} + \sum_{j=1}^{n2} g_{ji}^{-} \Delta oil_{t-j}^{-} + \sum_{j=1}^{n2} h_{ji} \Delta Money_{t-j} + \sum_{j=1}^{n3} K_{ji} \Delta Openness_{t-j} + \theta_1 oil_{t-j}^{+} + \theta_2 oil_{t-j}^{-} + \theta_3 Money_{t=1} + \theta_4 Openness_{t=1} + \varepsilon_t \quad (13)$$

where oil_{t-j}^{+} and oil_{t-j}^{-} indicate positive and negative change in the price of crude oil

1.4.1 Econometric Properties of Data

The theoretical propositions of both linear and non-linear ARDL require that all our data are either stationary at level or first difference. In some cases, the combination of level and first difference. Base on this requirement, unit root tests were performed on the variables to ascertain

their stationarity status. To this end, both Dickey Fuller and Philip Perron unit root tests were performed and the results are presented in table one and two. The results from both ADF and PP show that the our variables are either stationary at level or at first difference though most of the variables behaved like a typical time series variable as they are mostly stationary at first difference. With these results, the variables are conformable for ARDL analyses.

Table 1: Augmented Dickey Fuller Unit Test

Variables	Level			First Difference		
	Intercept	Trend&Intercept	None	Intercept	Trend&Intercept	None
Oil_N	1.580	-1.511	3.734	-8.952***	-9.258***	-7.932***
Oil_P	3.156	-2.511	5.365	-13.345***	-13.957***	-3.241***
Output	-0.27	-2.81	0.85	-3.80***	-4.05***	-3.70***
Investment	-1.37	-3.71	0.23	-2.47	-3.04**	-2.47**
Interest	-2.406	-2.209	-0.21	-3.01**	-3.17*	-3.00***
Price	5.372	1.904	8.274	-9.809***	-11.408***	0.854
Exch	1.646	-0.893	1.878	-12.535***	-12.680***	-12.384***
CV 1%	-3.490	-4.043	-2.586	-3.490	-4.043	-2.586
CV 5%	-2.887	-3.451	-1.943	-2.887	-3.451	-1.943
CV 10%	2.580	-3.150	-1.614	-2.580	-3.150	-1.614

Table 2: Phillips-Peron (PP) Unit Root Test

Variables	Level			First Difference		
	Intercept	Trend&Intercept	None	Intercept	Trend&Intercept	None
Oil_N	2.08	-1.32	4.96	-8.99***	-9.19***	-8.03***
Oil_P	2.64	-2.44	7.06	-13.48	-14.00***	-11.26***
Output	0.17	-2.44	1.16	-6.45***	-6.09***	-6.58***
Investment	-0.99	-2.22	0.12	-5.70***	-5.75***	-5.72***
Price	-2.96**	-3.14*	-1.85*	-5.80***	-5.77***	-5.82***
Exch	1.74	-0.86	3.10	-4.61***	-4.90***	-4.34***
CV 1%	-3.490	-4.021	-2.586	-3.490	-4.043	-2.586

CV 5%	-2.887	-3.441	-1.943	-2.887	-3.451	-1.943
CV 10%	2.580	-3.140	-1.614	-2.580	-3.150	-1.614

1.4.2 Estimation Results

To achieve the objective of this study as stated in the background, linear and non-linear ARDL were estimated for each macroeconomic variable investigated in this study. The macroeconomic variables are output proxy by (GDP), price level proxy by Inflation and exchange rate proxy by parallel market rate. In the case of linear ARDL, each macroeconomic variable was introduced as dependent variable and oil price introduced as independent variable with other variables as control variables (investment and interest rate). Similarly, this approach was adopted for NARDL estimation.

The results as presented in table 3 show the results of both linear and non-linear ARDL in separate column for output. The estimate from linear ARDL show that oil price has significant positive effect on output in Nigeria. Specifically, 1% increase in the price of crude oil at the international market all other things being equal will increase the output in Nigeria by 0.67% in the short-run which will rise to 3.2% in the long-run and this effect is statistically significant both in the short-run and long- run. This outcome basically conforms to other studies in this area. Majorly, further investigation is in the area of asymmetric effect which provides additional information on how differently output responds to positive and negative change to oil price movement.

The results from NARDL show that positive movement in oil price has more influence on output in Nigeria than negative movement in oil price in the short-run. Categorically, 1% increase in the price of crude oil will increase output by 0.087% while similar decrease in the price of crude oil will decrease the output by 0.027% in the short-run. The effect of positive movement in oil price is statistically significant on output but that of negative movement is statistically insignificant. In the long-run, the

effect of 1% positive movement in oil price still remains 0.087% and it is significant. Contrarily, negative movement in oil price has negative relationship with output in long-run and this suggests that a decrease in oil price can increase output in Nigeria in long-run.

Furthermore, the results from both linear and non-linear ARDL estimated show evidence of co-integration in the two models as their critical value is greater than upper band of ARDL bound tests. Diagnostic tests of the two models reject the hypotheses of heteroskedasticity, and serial correlation as shown by Pagan heteroskedasticity and Portmanteau tests. Also, the test of Ramey RESET test show the model has a reasonable level of stability.

In table 4, the results as presented show the effect of global oil price movement on price level proxy by inflation in Nigeria both in linear ARDL model and NARDL. The results from linear ARDL indicate that increase oil price will decrease general price level in Nigeria this is not surprising because the country is a net exporter of oil and the revenue from oil is largely used to build foreign reserve required to defend local currency. This will consequently makes imported goods cheaper especially intermediate goods needed for production of consumables. The results specifically show that 1% increase in the price of oil at the international market will decrease the price level by 2.3% in the short-run and 1.24% in the long-run. The results are also statistically significant both in the short-run and long-run.

Apart from difference in magnitude, the results from asymmetric ARDL in third column in table 4 is the same in term of the nature of relationship that exist between the two variables. The results indicate that 1% positive movement in oil price will decrease general price by 0.11% in short-run and 0.8% in the long-run. The results are statistically significant at 1% significant level both in the short-run and long-run. Similarly, 1% decrease in the same variable will increase general price level by 0.16% in the short-run and approximately 1.1% in the long-run. This implies that negative movement of oil price has more impact on general price level than positive movement of oil price. However, the

results from asymmetric tests reject the hypothesis of no asymmetric effect only in long-run which implies that the effect of positive price movement in oil price is only statistically different from negative movement in oil price in the long –run not short-run.

The results from table 5 show the response of another critical macroeconomic variable in Nigeria to oil price movement. In the same way, the results for both linear and non-linear ARDL are presented in the same table. The results of linear ARDL as presented in second column of the table indicate that oil price movement has positive relationship with exchange rate movement in the short-run and negative relationship in the long-run. The relationship in short-run is a bit counterintuitive because one would ordinary expects increasing global oil price to reduce rate at which local currency is exchanged for dollar (naira appreciation). But this relation does hold in the long-run as increasing global oil price brings about appreciation of naira as expected. This might suggest administrative management of exchange rate in the country.

The results from non-linear ARDL are different from linear ARDL in the short-run. The results show that 1% positive movement in global oil price will reduce the exchange rate by 0.05% (appreciation) and similar negative movement will increase the exchange rate by 0.12% (depreciation) in the short run. This indicates that negative movement has more influence on exchange rate in the short-run. In long-run, the relationship is complicated. While positive movement of oil price will reduce exchange rate by 1. 3% (appreciation), negative movement of oil price will also reduce the exchange rate by 2.9% (appreciation) suggesting that negative oil price movement is beneficial to local currency in the long-run maybe as a result of diversification. The results from asymmetric tests reject the hypothesis of no asymmetric effect both in the short-run and long-run which implies that the effect of positive price movement in oil price is statistically different from negative movement in oil price on exchange rate in the short-run and long-run.

Table 3: Output - Oil: Asymmetry and Symmetry ARDL

Variables	Symmetry	Asymmetry
Short Run		
Output.(-1)	1.51(0.00)***	-0.098(0.00)***
Oil	0.67(0.00)***	
Oil_P		0.087(0.00)****
Oil_N		0.027(0.27)
D(Output.(1))		0.562(0.00)***
D(Oil_P)		0.448(0.00)***
D(Oil_P)(-1)		-0.240(0.03)***
D(Oil_N)		0.563(0.004)***
D(Oil_N)(-1)		-0.381(0.00)***
Investment	-0.09(0.139)	0.069 (0.41)***
Interest Rate	-0.005(0.02)***	-0.001(0.00)***
Long Run		
Oil	3.28(0.05)**	
Oil_P		0.88(0.00)***
Oil_N		-0.27(0.25)
Test of Asymmetry		
Long-Run		47.81(0.00)***
Short-Run		0.62(0.43)
Diagnostic Tests		
Portmanteau test up to lag 40 (chi2)		37.83(0.56)
Breusch/Pagan heteroskedasticity test (chi2)	4.51(0.00)***	47.59(0.00)***
Ramsey RESET test (F)	0.51(0.47)	2.03 (0.10)
Cointegration test	6.6 ***	6.87 (0.00)***
Jarque-Bera test on normality (chi2)	220.29(0.00)***	351.2(0.00)***

Table 4: Oil -Price: Asymmetry and Symmetry ARDL

Variables	Symmetry	Asymmetry
Short Run		
Price.(-1)	1.40(0.00)***	-0.14(0.00)***
Oil	-2.30(0.00)***	
Oil_P		-0.11(0.03)**
Oil_N		-0.16(0.05)*
D(Price.(1))	1.80(0.02)***	0.47(0.00)***
D(Oil_P)		-1.54(0.01)***
D(Oil_P)(-1)		0.88(0.06)
D(Oil_N)		-0.60(0.09)
D(Oil_N)(-1)		24.67(0.09)*
Interest Rate	-1.82(0.00)***	0.001(0.95)
Long Run		
Oil	-1.24(0.02)***	
Oil_P		-0.79(0.04)**
Oil_N		1.07(0.017)*
Test of Asymmetry		
Long-Run		1.40(0.23)
Short-Run		2.11(0.14)
Diagnostic Tests		
Portmanteau test up to lag 40 (chi2)		30.84(0.85)
Breusch/Pagan heteroskedasticity test (chi2)	2.91(0.03)***	1.06 (0.30)
Ramsey RESET test (F)	8.53(0.00)***	1.45 (0.22)
Cointegration test	8.20(0.00)***	7.65***
Jarque-Bera test on normality (chi2)	92.94(0.00)***	399.3(0.00)***

Table 5: Oil- Exchange Rate: Asymmetry and Symmetry ARDL

Variables	**Symmetry**
Short Run	
Exchange.(-1)	1.33(0.00)***
Oil	0.32(0.00)***
Oil_P	
Oil_N	
D(Exchange.(1))	
D(Oil_P)	
D(Oil)	-0.40(0.00)***
D(Oil_P)(-1)	
D(Oil_N)	
D(Oil_N)(-1)	
Price	-0.0009(0.08)**
Long Run	
Oil	-13.83(0.61)
Oil_P	
Oil_N	
Test of Asymmetry	
Long-Run	
Short-Run	
Diagnostic Tests	
Portmanteau test up to lag 40 (chi2)	
Breusch/Pagan heteroskedasticity test (chi2)	1.05(0.35)
Ramsey RESET test (F)	1.81(0.18)
Cointegration test	2.45
Jarque-Bera test on normality (chi2)	2705(0.00)***

1.4.3 Asymmetric Adjustment Paths

Figure 2-4 indicate the response of output, price level and exchange rate to unitary positive or negative shock to oil price. These curves provide information about the long-run asymmetric adjustment to positive and negative shocks at forecasting horizons respectively. Figure 2 shows the cumulative effect of oil price on GDP within 40 periods and it indicates that output increases due to positive shocks in crude oil price and it stabilizes in the tenth quarter into new long-run equilibrium. To the contrary, output declines in response to negative oil price shock and it normalizes in 12^{th} quarter and attains a new long-run equilibrium after the initial negative shocks.

Similarly figure 3 shows the response of general price level to long-run asymmetric adjustment to positive and negative shocks of oil price at 150 period forecasting horizons. A unitary positive shock in oil price reduces the general price level instantaneously but it assumes new equilibrium with before the 10^{th} period and stay on the equilibrium throughout the period. Similar negative oil price shock increases the general price level assumes new equilibrium before 10^{th} period. This is not surprising because Nigeria is a producing country that uses proceeds of increased oil price to stabilize exchange rate thus reduce the exchange rate pass-through to general price level.

Figure 4 shows similar results for exchange rate. Positive shock in oil price reduces the exchange rate (appreciate) and the effect was persistent till 50^{th} quarter before stabilizing into new equilibrium. Similar negative oil price shock increases the exchange rate (depreciate) and settle into new equilibrium around 50^{th} quarter. Unlike other macroeconomic variable investigated, the magnitude of response from exchange rate is much and this suggests that exchange rate is a major conduit through which oil price impacts on other macroeconomic variables.

1.5.1 Conclusions

In the case of oil price- output performance nexus, oil price change affects output performance both in linear and nonlinear case. It is conceivable that increase in the price of crude oil improves output

performance in the Nigeria both in the short-run and long-run but there is only evidence of asymmetric effect in the long-run. The study also establishes output performance shows higher response to negative oil price movement compared to positive oil price movement and this align with (Mordi & Adebiyi, 2010). More importantly, there is evidence from the study that negative movement in oil price will not perpetually worsen the output performance in country.

In the case of oil price-price level nexus, there is evidence of pass-through which indicates that positive movement in oil price reduces the general price in Nigeria while negative oil price movement increases it and this relationship holds both in linear and nonlinear case in the short-run. In the long-run, the same pattern of relationship is replicated in the two cases except for negative movement in oil price and general price level that demonstrates evidence of threshold effect which requires further investigation. However, there is no evidence of asymmetric effect both in the short-run and long-run.

The case of oil price-exchange rate nexus seems to be different from two previous in term of evidence from linear and nonlinear estimation. In the short-run, evidence from linear estimation indicates that positive movement of oil price increases the exchange rate (depreciation) in the country but this does not hold in the long-run. This suggests that inverse relationship between oil price and exchange rate in the country only valid in the long-run. However, the evidence from non-linear supports the validity of the inverse relationship both in the short-run and long-run and the model supports the existence of asymmetric effect both in the short-run and long-run.

Generally, it can be concluded from the study that oil price impacts on macroeconomic performance in Nigeria irrespective of the approach but nonlinear investigation is more appropriate in the case of output and exchange rate empirical investigations.

1.5.2 Policy Implications

Going by the degree of impact, exchange rate can be considered is a conduit through which oil price influences other macroeconomic variables in the country thus macroeconomic management team should ensure decoupling of exchange rate from oil price through aggressive policies of intensive and extensive economic diversification. Also, the team should be forward looking by developing appropriate model that forecast oil price with reasonable precision. This provides opportunity to initiate appropriate policy reactions capable of mitigating the effect of negative movement of oil price beforehand.

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