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Analyzing the Effect of Petroleum Industry Shocks on the Nigerian Macro-economy

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ABSTRACT

Several studies explore the relationship between oil price shocks and macroeconomic indicators such as GDP, exchange rates, inflation, etc. These studies often assume that oil prices alone can account for the observable effects on the macro-economy of the country studied. This paper proposes that a multiplicity of local factors (including local petroleum industry shocks) would be required to fully explain the observable macro-economic effects. This is demonstrated by considering how inflation rate responds to variables within the Nigerian petroleum industry given the current monetary policy framework. Three variables were used to characterize the Nigerian petroleum industry – oil price, oil revenue and investment in exploration and drilling proxy as rig counts. The variables used to capture the effect of monetary policy are the growth of money supply and the foreign exchange rate of the Naira to the US Dollar. The model was formulated in a Structural VAR framework and revealed that the response of inflation to oil price shocks was insignificant; rather it was the industry factor (rig count) that significantly impacted on inflation rate within the prevailing monetary policy framework. This finding could have significant implication for strategic national policy formulation in general and petroleum industry governance in particular.

Keywords: Inflation, Monetary Policy, Petroleum Industry Shocks, Structural VAR.

1. BACKGROUND TO THE STUDY

Studies on international crude oil-price and inflationary pressures have indicated a positive regression between oil-price shocks and inflationary pressures in less developed oil-exporting economies *(Tatom, 1988; Kahn & Hamptom, 1990; Mork et al, 1994; Huntington, 1998; Hamilton, 2000; Hooker, 2002; Arinze, 2011; Bouchaour & Al-Zeaud, 2012; Adeniyi et al., 2012; Tural et al, 2016*). Several literature on the Nigerian economy have revealed that the country is largely dependent on commodity pricing in the petroleum industry (*Adeniyi, 2012; Monesa, 2013; Ani, Inyiama & Ike-Ekweremadu 2014; Alhassa, Abdulkareem & Kilishi, 2016; and Ikue-John & Anietie, 2019*). It has also been shown in the Nigerian Central Bank's Statistical Bulletin that Nigeria's oil receipts account for more than 70% of federal revenue as well as 90% of foreign exchange (*CBN, 2018*).

Hence, the over-reliance of the Nigerian economy on crude oil industry increases her chances of vulnerability to exogenous fluctuations of oil price, production volumes and other oil industry events. This has various severe attendant repercussions, including the inadvertent exposure to industry shocks of key macroeconomic fundamentals, especially inflationary pressure, reduction in government revenue, failure of fiscal responsibility, etc. This study explores the possibility that within the existing monetary policy framework, the keys to sustained economic growth may lie in a singular or multiplicity of industrial factors affecting oil production, rather than oil price alone. In so doing, the study focuses on how inflation rates responds to shocks in oil prices, oil revenue, monetary policy variables (Money supply and Exchange Rates) and industry factors (such as Rig Counts) in Nigeria from the 1st month of 1995 to the 6th month of 2019. The remaining sections of this paper are divided such that section two discusses some empirical works. Section three highlights the theoretical model. Section four gives the empirical results and the discussion of findings while the last sections proffers policy recommendations and also conclude the study.

1.1. Statement of Problem

There is a common assumption of a direct correlation between oil price and growth of the Nigerian economy and this assumption has largely influenced Government policies and response as well as Oil Industry Governance, howbeit with mixed results. It is possible that this assumption is wrong. Nigeria's economic growth may correlate better with oil revenue, rather than price, and production output may be a better determinant of Nigeria's economic fortunes. The keys to economic recovery and sustained economic growth may lie in a singular or multiplicity of industry factors affecting oil production output, rather than oil price.

2. SOME EMPIRICAL WORKS

Production and the supply of oil do not seem to follow price trend closely but are rather affected more significantly by other factors such as political and technological development (*Iledare, et al., 2004*). Oil production in GoM responds positively to a positive price shock in the economy. However, the response of other macroeconomic indicators (unemployment, income, revenue) differs significantly across the Gulf States (*Iledare & Olatubi, 2004*). Blanchard & Gali (*2007*) observed that the effects of oil price shocks must have coincided in time with large shocks of a different nature. Given some partial identification strategy they could not identify other shocks. However, they provided some evidence that increase in other commodity prices were important in the 1970s and was unable to demonstrate the other shocks for the 2000s. The variance decomposition analysis shows that oil price shocks are a considerable source of volatility for the variables used in their study. For instance the growth of industrial production and oil price shocks combined with monetary shocks are the largest source of variation other than the variable itself (*Kumar, 2009*).

Cross & Nguyen (*2018*) noticed that positive energy price shocks are found to generate statistically significant reductions in real GDP growth and increases in inflation, with both sets of responses consistently declined over the sample period. They argued that interest rate responses are found to be consistently positive over the sample period. Akinleye & Ekpo (*2013*) found that the Dutch disease syndrome is pronounced both in the short and long run but that the long-run impact on GDP is more pronounced. Using multivariate GARCH, Abubakar (*2016*) proved that Nigeria and Gabon are more susceptible to the high volatility macroeconomic effects (exchange rate) of the Dutch disease than Angola in the short run. No long run relationship in Nigeria and Gabon, however, stable long run interactions in Angola. Adeniyi (*2011*) suggested thresholds beyond which the relationship becomes negligible.

Ayadi et al. (*2000*) found a strong correlation between oil output and the economy (inflation, unemployment, exchange rate, and interest rate). Oil prices have direct first order effects on government revenues and hence on government expenditures. They have negligible second order effects on economic growth as measured by GDP.

They may have significant second effects on exchange rates and hence inflation and hence cost of living index for import-dependent economies such as Nigeria. The studies on the relationship between oil price and price stability are numerous in economic and energy literatures. Various indicators, variables of oil price, revenue and price stability have been used in these demonstrations but little or no attention have been given to the role of industrial variables to this effect. Thus, this study examines this relationship by introducing an industrial factor or variable into the model.

3. METHODOLOGY

This study employed econometric tools, specifically the structural vector auto-regression (SVAR) model for analysing the data series. Six variables are employed from the January 1995 to June 2019. The variables entered in the models are Oil Price, Oil Revenue, Total Rig Counts, Inflation Rates, the Growth of Money Supply and Exchange Rates. Oil price data represent spot market prices of West Texas Intermediate (WTI) crude oil, measured in US dollar and obtained from the Thomson Reuter workbook. Rig counts, sourced from Y-Charts, is used in the model to capture industrial factor and is the proxy for investment in exploration and drilling in the oil industry. The required series on Growth of Money Supply, Exchange Rates, Inflation Rates (Headline, Core and Food measured in the November 2009 base period) were obtained from the 2018 Central Bank of Nigeria (CBN) Statistical Bulletin.

All variables are expressed in natural logarithmic form except inflation rates and total rig counts. Graphics are used to illustrate the behavior of the variables and the strategies developed by Dickey & Fuller (*1979*) and Philip & Perron (*1987*) are used for the test of stationarity. Co-integration is tested using the techniques of Johansson & Julius (*1995*). The techniques, strategies and models are well established in literatures. The results of stationarity behavior and co-integration are reported in Table I and Table II. The standard procedures for estimations of macro-econometric models are followed carefully and the Zivot (2000) conditions are equally observed for the selections of appropriate estimation techniques of SVAR.

Generally the SVAR model is casted as

$$A_1 x_t = A_1 x_{t-1} + \ldots A_p x_{t-p} + \mu_t \quad (1)$$

$$x_t = A_1^{-1} x_{t-1} + \ldots A_1^{-1} A_p x_{t-p} + A_1^{-1} \mu_t \quad (2)$$

$$x_t = B(L) x_t + \mu_t \quad (3)$$

Where

$$B(L) x_t = A_0^{-1} A_1(L) \; with \; A_0 \mu_t \mu_t = \varepsilon_t \quad (4)$$

The residual μ_t is the reduced form of VAR and assumed to be *iid* as stated in (1). $A_1(L)$ is a matrix of polynomial in the lag operator (see explanations of SVAR Zivot, 2000; Enders, 2004; Park et al., 2011). The paper employed only short-run restrictions on the contemporaneous relations because the structural VAR based on short-run restrictions perform better (see *Christiano et al., 2007*). The short-run restrictions primarily control the contemporaneous feedback effects among the variables in the model. The identification in the equation is obtained by imposing restrictions on contemporaneous relation among variables included in SVAR. The identification restrictions are motivated by the following economic reasoning: first, Nigeria is a net oil exporter and a developing economy, and it is price takers in the oil market.

Since the price of oil is determined by the global demand and supply conditions, the domestic output level, inflation rates and the exchange rates in our sample country will have a negligible effect on it. Therefore, the oil price is assumed to be exogenous.

Thus, the reduced error term for the shocks can be expressed as follow:

$$\mu_{oilp} = \varepsilon_{oilp} \quad (5)$$

Equation (5) shows that the error term of oil shocks (price, revenue and industrial factor) will be equal to its structural error term. However, in case of other variables in our model, a change in oil shocks (price, revenue and industrial factor) can have a contemporaneous effect on them as an increase (decrease) in oil shocks (price, revenue and industrial factor) can raise (reduce) the cost of production because oil is used as one of the important inputs in the production as well as the distribution of goods and services. Second, we assume that the output does not respond contemporaneously to any changes in the domestic variables. Third, the domestic price level is assumed to be influenced by all the variables except the monetary policy. Finally, we do not impose any restrictions with respect to the monetary policy variables, suggesting that the monetary variables respond to changes in all variables. The reduced form error terms of the domestic variables (inflation, rig count, the growth of money supply and exchange rates) are as follows:

$$\mu_y = \varphi_{21}\mu_{oilp} + \varepsilon_y \quad (6)$$

$$\mu_y = -\varphi_{31}\mu_{oilp} - \varphi_{32}\mu_y + \varepsilon_\pi \quad (7)$$

$$\mu_y E_\pi = -\varphi_{41}\mu_{oilp} - \varphi_{42}\mu_y - \varphi_{43} + \varepsilon_\pi E_\pi \quad (8)$$

Estimation of Equations 6–8 allows us to measure the influence of petroleum shocks (price, revenue and rig count) on the macroeconomic fundamental of the Nigerian Economy.

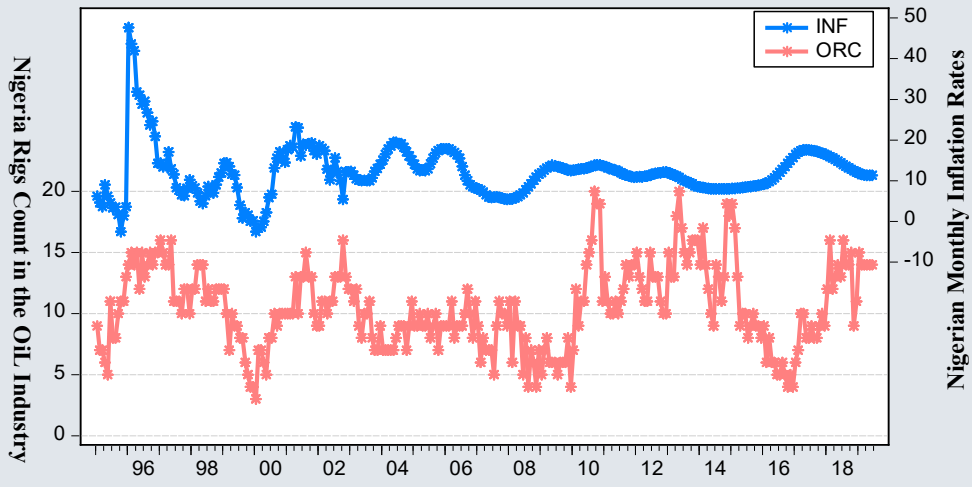

Figure 1: Graphical Illustration of INF and ORC in Nigeria, 1995M01 - 2019M06

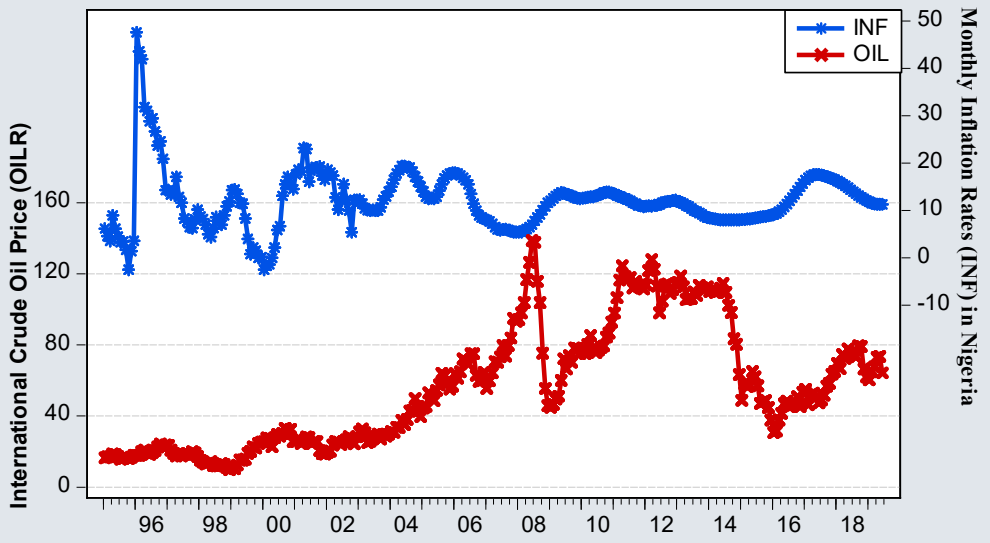

Figure 2: Graphical Illustration of INF and OILP in Nigeria, 1995M01 - 2019M06

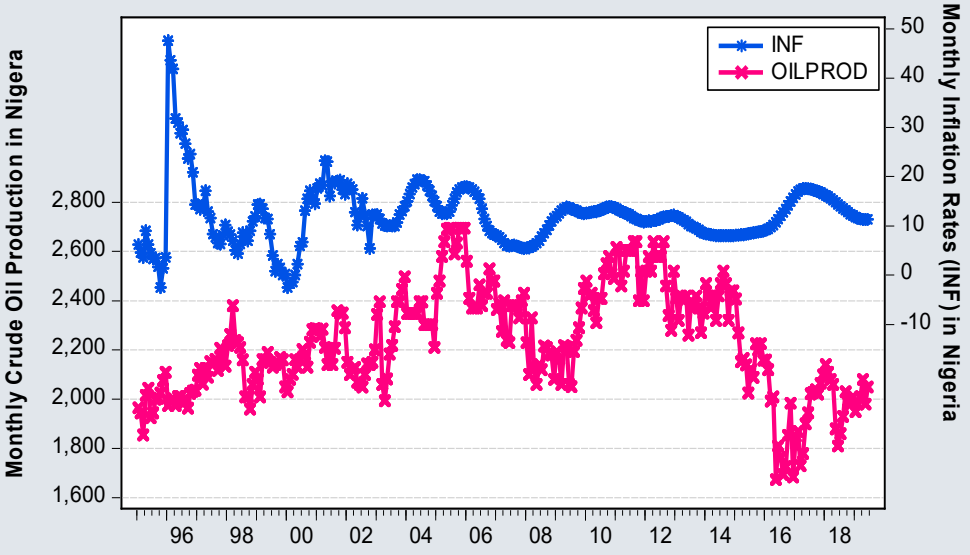

Figure 3: Graphical Illustration of INF and OILPROD in Nigeria, 1995M01 - 2019M06

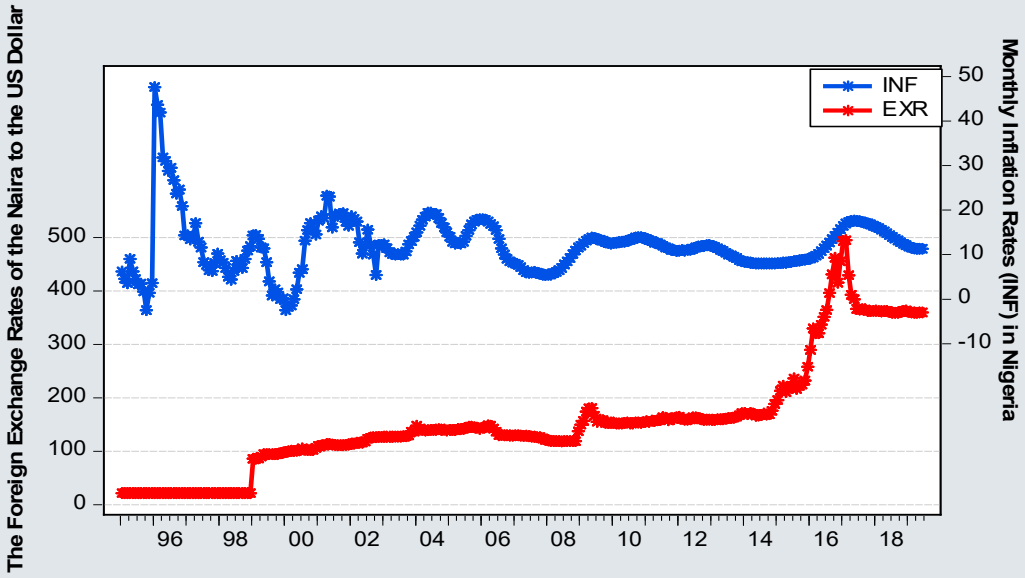

Figure 4: Graphical Illustration of INF and EXR in Nigeria, 1995M01 - 2019M06

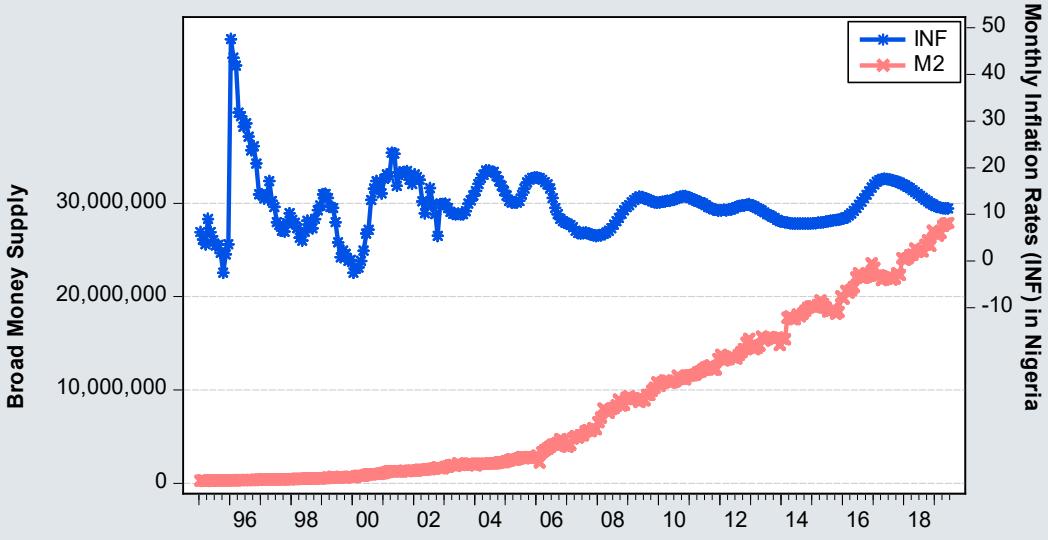

Figure5: Graphical Illustration of INF and M2 in Nigeria, 1995M01 - 2019M06

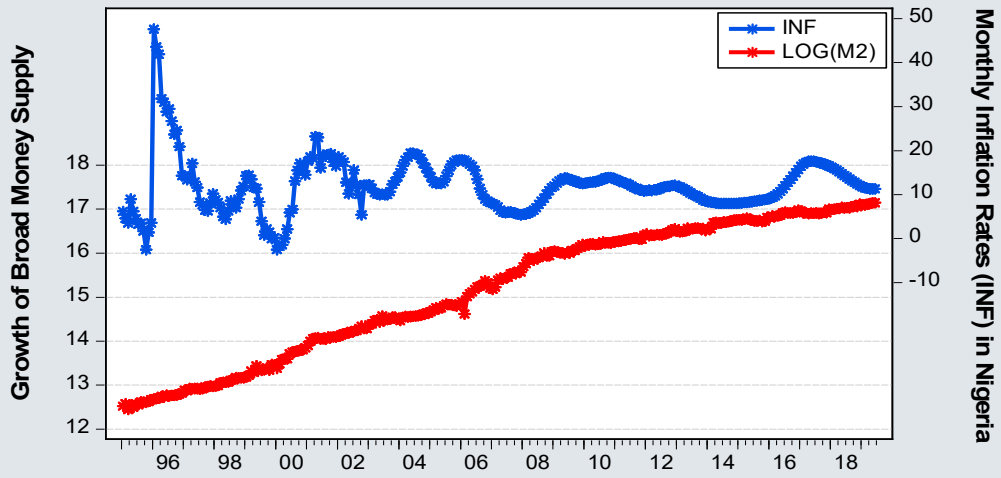

Figure6: Graphical Illustration of INF and log(M2) in Nigeria, 1995M01 - 2019M06

5. RESULTS AND DISCUSSIONS

The most volatile series in the figures above are rig counts and oil production (Fig. 1 and Fig. 3 respectively). The inflation rates tend to follow the behaviours of these series. The movement of inflation rates and other variables or series in the model tend to be independent. The variables in the models were tested for possible long-term relationship as summarized in Table II. Trace statistics and Maximum Eigenvalue indicated at least two co-integrating relationships among the variables in the models.

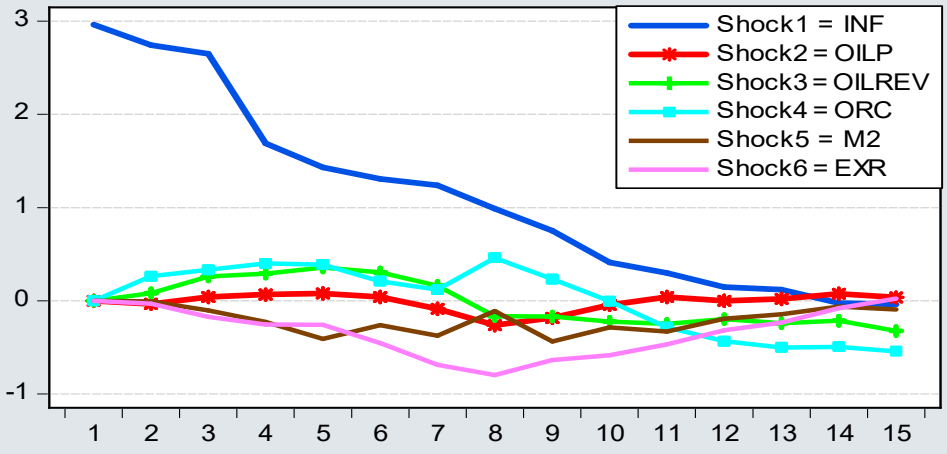

Figure 7: Response of INF to Structural One S.D. Innovations

To understand the transmission among oil stocks, shocks from monetary policy variables on inflation rates in Nigeria, the structural impulse response functions for each period is computed. The impulse response functions traces the transmission of a one period unit standard deviation shock to one variable on the current and future values of the endogenous variables. Results from the impulse response functions and forecast error variance decompositions are usually sensitive to the ordering of the endogenous series in the system. Thus, one approach of selecting an ordering in a SVAR model is to order the variables according to their order of impacts on each variable in the model. The study finds that the relative ordering of variables does matter given the economic condition. Hence, the ordering process was fixed by arranging the series as follows: inflation rates, oil price, oil revenue, rig counts, the growth of money supply and the Foreign Exchange Rate.

Figure 7 demonstrates the response of inflation rates to combine shocks from crude oil activities and monetary policy variables for a period of 15 months. The impulse response function indicates that inflation responds significantly positive to shock in the industry factor within the first 10 months; thereafter it became negative and not reverting. The respond of inflation to oil price was insignificantly positive within the first six month, the respond to oil price shocks become negative for 4 months and reverses to positive in the 11th and 15th month. Like rig count, oil revenue was significantly positive in the early stages and negative in the later stages but was mean reverting throughout the forecast horizon. The figure also reveals that inflation rate responds to the shocks from monetary variables significantly negative but the response of inflation to the growth of money supply was more stable than that of its response to shocks from foreign exchange rates. The weak response of inflation to shocks due to oil price indicates that international oil prices have contributed little to the fluctuations in general price levels in Nigeria. Rather, the model demonstrates that what contributes to the instabilities in the general price level of commodities in Nigeria is the happenings in the oil industrial (productions factor). The industry factor used in this paper shows a strong significant effect on inflation rates.

Hence, local oil industry shocks is what leads to the macroeconomic instability in Nigeria and not necessarily oil price volatility alone as postulated by most of existing literature. As an alternative way of checking the dynamics of transmission among the variables, Table III shows the forecast error variance decompositions of inflation rates, oil price, oil revenue, rig counts, growth of money supply and Foreign Exchange Rate in Nigeria. The results for the forecast horizons is presented in two-monthly intervals (that is, periods 1, 3, 5, 7, 9, 11, 13 and 15 months). The fraction of the forecast error variance for inflation rates due to innovations in the industry factor and exchange rates is the highest and they are 4.73% and 6.60% respectively at 15th forecast horizon. The results in Table III reveals that there is compelling reasons to attribute the growth in inflation rates in Nigeria to the shocks occasioned by factors in the local petroleum industry as measured by oil rig counts in this paper.

Table I: Unit Roots Test

Panel I: Test None Intercept and Trend							
	Augmented Dickey-Fuller			Philip-Perron			
Variables	Levels	1st Diff.	5%	Levels	1st Diff.	5%	Decision
INF	-1.903	-16.73**	-1.942	-1.800	-16.84**	-1.942	I(1)
OILP	0.396	-14.19**	-1.942	-0.608	-12.31**	-1.942	I(1)
ORC	-0.913	-22.87**	-1.942	-0.806	-25.40**	-1.942	I(1)
EXR	1.632	-16.36**	-1.942	1.540	-16.41**	-1.942	I(1)
M2	6.471	-19.49**	-1.942	7.038	-19.70**	-1.942	I(1)
OILREV	0.741	-15.25**	-1.942	0.651	-15.26**	-1.942	I(1)
Panel II: Test Intercept Only							
	Augmented Dickey-Fuller			Philip-Perron			
Variables	Levels	1st Diff.	5%	Levels	1st Diff.	5%	Decision
INF	-4.674**	-16.701**	-2.871	-4.403**	-16.81**	-2.871	I(0)
OILP	-1.670	-14.19**	-2.871	-1.858	-12.30**	-2.871	I(1)
ORC	-4.030**	-22.84**	-2.871	-5.092**	-25.38**	-2.871	I(0)
EXR	-1.534	-16.53**	-2.871	-1.544	-16.54**	-2.871	I(1)
M2	-1.705	-21.96**	-2.871	-1.949	-22.53**	-2.871	I(1)
OILREV	-1.620	-15.25**	-2.871	-1.699	-15.27**	-2.871	I(1)
Panel III: Test Intercept and Trend							
	Augmented Dickey-Fuller			Philip-Perron			
Variables	Levels	1st Diff.	5%	Levels	1st Diff.	5%	Decision
INF	-4.685**	-16.68**	-3.425	-4.410**	-16.78**	-3.425	I(0)
OILP	-1.896	-14.19	-3.425	-2.138	-12.29**	-3.425	I(1)
ORC	-4.035**	-22.79**	-3.425	-5.111**	-25.32**	-3.425	I(0)
EXR	-1.934	-16.53**	-3.425	-2.055	-16.54**	-3.425	I(1)
M2	-0.367	-22.09**	-3.425	-0.229	-23.133	-3.425	I(1)
OILREV	-1.410	-15.26**	-3.425	-1.640	-15.26**	-3.425	I(1)

Source: Author Computations from E-view Results. Note, ** indicates significance of 5% (**≤0.05 level of significance)

The unit root method was used for the test of stationary of the time series. The variables were tested showing the random walk properties of the time series (i.e., None, Intercept, Trend and Intercept), the results are summarized in table 1. It shows that all the series in the model exhibit random walk. Thus, we included in the model the intercept and trend assumption.

Table II Summary of Cointegrating

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.129341	116.8169	95.75366	0.0008
At most 1 *	0.102239	76.51195	69.81889	0.0132
At most 2	0.073015	45.12711	47.85613	0.0882
At most 3	0.045270	23.06399	29.79707	0.2429
At most 4	0.030491	9.582820	15.49471	0.3142
At most 5	0.001963	0.571720	3.841466	0.4496

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.129341	40.30494	40.07757	0.0471
At most 1*	0.132239	41.98484	41.27687	0.0364
At most 2	0.073015	22.06312	27.58434	0.2171
At most 3	0.045270	13.48117	21.13162	0.4090
At most 4	0.030491	9.011100	14.26460	0.2852
At most 5	0.001963	0.571720	3.841466	0.4496

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

Table III: Forecast Error Variance Decomposition

Variance Decomposition of INF:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6
1	2.96	100.00	0.00	0.00	0.00	0.00	0.00
3	4.86	98.74	0.01	0.329	0.76	0.05	0.13
5	5.42	95.97	0.04	0.98	1.66	0.79	0.56
7	5.81	93.30	0.07	1.20	1.62	1.31	2.50
9	6.08	89.35	0.34	1.25	2.19	1.76	5.11
11	6.17	87.20	0.35	1.50	2.34	2.20	6.43
13	6.24	85.51	0.33	1.72	3.43	2.31	6.71
15	6.30	83.96	0.34	2.08	4.73	2.30	6.60

6. CONCLUDING REMARKS

The aim of this paper was to examine the response of inflation rates to activities in the oil industry in Nigeria, using monthly data from 1995 to June 2019. Six variables were used in the paper and analyzed using the SVAR method. The results shows that fluctuations in price stability in Nigeria are independent of the dynamics of international oil prices but dependent on various local industry factors. Consequently, this paper concludes that the major factor that affects macroeconomic stability in Nigeria, as typified by inflation rates, is the level of stability in the petroleum industry. In addition to external shocks such as OPEC cuts and international oil prices, shocks can also be introduced into the Nigerian petroleum industry through instability causes such as unfavorable fiscal and regulatory regimes, uncertainty in policy directions, frequent sabotage and damage of oil installations, general unrest in the operating environment, political instability, etc. It is a combination of these internal and external industry shocks that impact the most on the Nigerian economy. Government and Policy Makers should therefore pay particular importance to petroleum industry governance and enact policies that provide stability and confidence as well as encourage investment and growth of the industry.

7. CONTRIBUTIONS TO KNOWLEDGE

This paper stands out from most of the existing literature by introducing local petroleum industry factor into the modelling equations and demonstrating that these local shock factors account for the vulnerability experienced in the Nigerian economy, rather than oil price volatility as erroneously assumed by most of the current literature.

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