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Chapter

Impact of Oil Price Fluctuation on the Economy of Nigeria, the Core Analysis for Energy Producing Countries

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Abstract

The study aims to find the short-run empirical analyses of the impact of oil price fluctuation on the monetary instrument (Exchange rate, Inflation, Interest rate) in Nigeria. We explored the frequently used Toda–Yamamoto model (TY) model, by adopting the TY Modified Wald (MWALD) test approach to causality, Forecast Error Variance Decomposition (FEVD) and Impulse Response Functions (IRFs). The study covered the period 1995 to 2018 (monthly basis), and our findings from MWALD test indicated that there is a uni-directional causality of the log of oil price ($\ln oilpr$) to log of the exchange rate ($\ln exchr$) at 10% level of significance, also there is a contemporaneous response of log of consumer price index ($\ln cpi$) to log of exchange rate ($\ln exchr$) and log of interest rate ($\ln intr$), and jointly ($\ln oilpr$, $\ln cpi$ and $\ln intr$) granger cause $\ln cpi$. Also at 5% level of significance $\ln intr$ responded due to positive change in $\ln oilpr$ and $\ln exchr$, and jointly causes $\ln intr$ at 5% level of significance. This is complimented with our findings in FEVDs, and IRFs. The empirical analyses shows that oil price is a strong determining factor of exchange rate, cost of borrowing and directly influences inflationary or deflationary tendencies in Nigeria.

Keywords: oil Price, exchange rate, inflation, interest rate, Toda–Yamamoto

1. Introduction

Crude petroleum is one of the fundamental sources of energy in the world and plays an important role in economic growth and development of many economies. Because of the need for this product, the oil market is subjected to the market forces of demand and supply, which do lead to the fluctuation in the pricing. Hamilton [1], Blanchard and Gali [2], viewed, changes in the price of oil as an imperative source of economic fluctuations, in which the resultant effect led to global shock, capable of affecting many economic activities instantaneously. This shock is perceived generally to have a similar impact due to events like fall in growth rate, high unemployment rate, and high inflation rate, while the magnitude and the causes

of the effect of these shocks may differ. For import-based economy, hike in the oil price will lead to shock in the economy, vice versa for the export-based economy [1, 3].

There are many established empirical analyses on the macroeconomic consequence of oil price shocks to net exporting countries, this is based on the dependency between oil price and the business cycle which can be explained through the impact of the oil price shocks on aggregate demand. Practitioners opined that an increase in oil price reduces aggregate supply since high energy prices mean that firms will purchase less energy. As a consequence, the productivity of any given volume of capital and labor will decline and leads to potential output loss. This invariably will lead to a decline in factors of production and real wages ([4, 5], p. 23; [6, 7]).

To expatiate further the influence of the oil price shocks on aggregate demand, Riaz et al. [5] submitted that oil is one of the basic inputs in manufacturing industries, any positive oil price shock increases the cost of manufacturing. As the cost of manufacturing rises the profit margins on investments fall will influence investors to postpone their irrevocable investments. Reductions in investment causes cuts in production level, consequently exports of the country are negatively affected and economy has to face adverse balance of trade. So also the effect permeates into households, oil price fluctuation induces the consumers to reschedule their expenditures on durable goods. This suggested that oil price shocks have serious concerns for all types of economies as aggregate demand is reduced from both consumption and investment sides. Increase in both oil prices and uncertainty in oil prices is detrimental for the economy (p. 24).

The negative effects of oil price shocks are more on the net-exporters of oil of the developing economies, the effect could be attributed to over-dependence on oil revenue, importation of basic necessity and susceptibility of their tradable lagging sectors to Dutch disease syndrome, the consequences of externalities, and economic pass-through (inflation) [8–12].

In the submissions of Abeng [8], opined that theoretically, an increase in oil price should reflect more revenue dividend for oil-exporting countries as it is expected to enhance foreign exchange earnings and build reserve in the short-run. Conversely, for net-importers of refined petroleum products for instance Nigeria with domestic regulation of oil prices (subsidies), oil price increase may not transform to the anticipated economic advantage, due to fiscal difficulties, restraining government's ability to finance import in addition to meeting other international obligations (p.3). Nigerian has a deficit of ₦7114.49 and ₦8324.76 billion Naira for 2017 and 2018 periods for importation of non-oil products and spent about ₦2618.97 and ₦3833.82 billion on importation of refined petroleum product for the period of 2017 and 2018 [13]. These figures stress the vulnerability of the economy to the impulses of international oil price. The consequences may be unfavorable to economic growth arising from increased domestic production cost and decline in aggregate demand (p. 23).

In Ibrahim [14] remarks in studying the responses of non-oil productive sectors that is agriculture, manufacturing and service to shocks in change in oil price in Nigeria. In his submissions, the results obtained reveal that oil price impacted positively on aggregate output but negatively on agricultural, manufacturing and service sector suggesting that at the aggregate level, oil price is incline to increase aggregate output whereas an increase in oil price impacted negatively on the outputs of productive sectors as oil serves as an input factor in the production process of these sectors. This specifies that fluctuation in oil price creates uncertainty in the production capacity of the productive sectors and it also

destabilizes the effectiveness of the government fiscal management of crude oil revenue.

Also Ayadi [15] posited that the forecast errors in industrial production are credited to volatility in real exchange rates and that changes in oil prices are only slightly important in influencing industrial production in Nigeria. Moreover, oil price changes affect real exchange rates, which, in turn, affect industrial production. He remarked that it should be noted that the indirect effect of oil prices on industrial production is not statistically significant. Therefore, the implication of the results presented in his paper is that an increase in oil prices does not cause an increase in industrial production in Nigeria.

According to [16, 17], the economy of Nigeria was affected by the decline in the revenue due to a fall in the price of crude oil alongside production. They cited that in about twenty months, the oil price has nosedived rapidly from as high as about one hundred and thirty dollars per barrel to as low as twenty-eight dollars and quantity also dropped from 2.15 Mbpd to 1.81 Mbpd in the earlier months of 2016, this resulted to a recession.

The crude petroleum industry is among the largest contributors to the economic growth, before the recession experienced by the country, in 2016 the growth rate shrank by -13.65% , a more substantial decline than that in 2015 of -5.45% . This reduced the oil sectors share of real GDP to 8.42% in 2016, compared to 9.61% per cent in 2015, (NBS, Q4 [18]). Aside from the contribution to the growth rate, the industry affects monetary variable and high unemployment rate [2]. According to Nweze and Edeme [19], as quoted by Adedokun [16], CBN [20] opined that on average, 75% of government revenues and on average 93% of foreign earnings from trade in goods and services, in the last ten years come from oil export, which informs part of the major sources used in financing the country's imports.

2. Literature review

Fluctuate in the price of natural resources is a term more related to the oil shocks because the majority of the problems encountered concerning recession is aggravated by a change in oil price. Hamilton [1], in his abstract, he opined that historical oil price shocks were principally caused by physical disruptions of supply, the price hike of 2007–2008 was caused by supply not meeting the excessive world demand. The consequences of recession are very similar with significant effects on consumption. According to Hamilton (1983) as cited by Sabiu [21], opined that ten out of eleven economic recessions were preceded by a sharp increase in oil prices in the United States.

Although, In a more recent development in the investigation of the causes of oil price shocks, many practitioners do not see supply as the sole cause of oil price shocks. The neo-monetarist, the likes of Bernanke et al. [22] sees oil and energy costs as insignificant relative to total production costs to account for the entire decline in output that, at least some events, has followed increases in the price of oil, they foresee that the monetary policy taken during spikes in the price of oil as the major contributing factors to the economic shocks.

Kilian [23] opined that historically, the decompositions of fluctuations in the real price of oil shows that oil price shocks have been driven mainly by a combination of global aggregate demand shocks and precautionary demand shocks, rather than oil supply shocks.

In furtherance to clear the air on the causes of oil price fluctuations, which was generally believed to have outgrown the traditional demand and supply

factors, Humbatova and Hajiyev [24] made references, to the Er-Riad summit of 2007 where conclusions were reached on the oil market trend that, it is not related to OPEC decisions. They concluded that the current trend is due to financialisation factors, lack of production capacities in oil production, reduction in the world oil reserves, natural disasters, political events and processes.

The financialisation of oil market made oil a speculative commodity in the financial market contrary to the real commodity. This has been one among the major sources of oil price volatility [25, 26].

The exposure of the oil market to commodity market brought about the issue of speculation, that is investors' expectations about future oil supply and demand. This breeds in the issue of inventory, either below or above the ground since oil can be stored. Others factors are the price of dollars, for net oil importers appreciation of dollar mean lower consumption of oil whereas the net exporters mean more revenue from the sales of oil, the reverse is the case when dollar price depreciate [26, 27].

The most recent factor in the front burner affecting fluctuation of oil price is the improvement of shale-oil technology (the shale revolution in the United States). The technological innovations that decreased the liquid fuel consumption and influenced the global energy markets to the point that many countries that are solely dependent on the oil resource plunged into economic crisis in 2016 due to falling in oil demand [26, 28]. Davig et al. [29] added that the fall in demand led to shifts in precautionary demand in the mid-2014 to mid-2015, this played a fundamental role in driving oil prices lower due to market glut and exacerbate the oil crisis to net exporters in 2016.

Fluctuation in the price of oil as a result of the aforesaid causes create the effect of uncertainty in the outputs of industries, not only to the manufacturing sector but also to the energy management sectors in process industries, that is oil and gas industries. According to Elder and Serletis [30] they posited that the theories of investment under uncertainty and real options predict that uncertainty about oil prices will tend to depress current investment. This uncertainty can be due to rise or fall in the oil prices.

Higher oil prices do come with a glade tidings for some industries. Apparently, they benefit oil and gas industries, but have both positive and negative multiplier effects to other components of an economy [31]. According to Hayes upstream firms face more hitches when oil prices fall since market forces is the determining factor at which oil is sold, and their costs of production are largely fixed. The higher the cost of production the higher the losses incurred by the producer. Downstream companies suffer a lesser consequences since they profit by purchasing crude oil and selling the refined products at a premium. Their earnings and profit margins always remain fairly stable even with fluctuating in oil prices. The submissions of Hayes is line with the suggestions of Jobert et al. [32] they posited that rise in the prices of oil are much desirable to the oil industries because they will make higher turnover, simultaneously, the rise in the oil prices correlate with waning outcomes for large capital expenditure projects for oil recovery. Large and capital-intensive drilling operations are hit harder in contrast to the smaller rigs, which can decide to shut down pending on when prices rise again.

Energy and the development of the shale oil is among the current drivers of US economy, new jobs opportunities has sprang up due to economy of scale (internal and external) for the Americans. Persistence, fall in oil price, could lead to folding up of operations for many onshore fracking wells that lack the working capital to continue drilling. Although the hydraulic fracturing is more expensive than typical

drilling, so shale gas companies will be among the first hit if the cost of production prevail over profits [33].

According to Adesina [34], he made references to the local key oil and gas corporation having a rough time due to the fall in oil price in the recent time with prices lower than local production in Nigeria. The local oil firms are fighting hard to survive as Crude and remains at the \$20, which means Nigeria's crude is being sold at a loss, coupled with the fact that oil demand has plummeted to the lowest level in more than a generation.

While on the other side Deloitte [35] views was on the impact of the oil price collapse on company accounts, fall in oil price tends to increase risk of loss of assets. They opined that lower oil price forecasts mean lower future profits from an asset. These leads to reduction in the present value of the asset, and the asset values on balance sheets cannot be fully recovered, this results in write-off, and tendencies of knock-on effect connected to deferring taxes and holding company investment balances.

In Nigeria one of the major contributing factors for 2016 recession was fall in the price of oil coupled with decreased in quantity of production, the recession was accompanied by high inflation rate on basic commodities (cost-push) [16]. Monetary policy on inflation is always been informed by the general price level. Before the recession, the inflation rate was at a single digit of 8.0% and 9.55% per cent for 2014 and 2015 [36]. During the recession, the inflation rate was about 18.55% per cent that is in 2016 and as expected, the monetary authority introduced a tight monetary policy by raising the cost of borrowing, the interest rate was steady at 14% from July 2017 to the first quarter of 2018 against 2016 which was 200 points higher. This is against the backdrop of relative improvement in the global economy.

Saban et al. [37] Investigated the responses of monetary policy variables of select emerging markets to oil market shocks. Using conventional and Fourier Toda Yamamoto methods. In their findings, the oil prices are sensitive to structural shifts and, the causality approach with gradual/smooth shifts indicates oil price shocks influencing the currencies of Indonesia and South Africa, interest rates in Brazil and India, and inflation in South Africa and Turkey.

Also in the summaries of Santos and Chris [38], used Johansen (1992) co-integration approach and the Toda and Yamamoto [39] causality testing procedure. Applying Wald coefficient test, the nominal interest rates, and expected inflation co-move together, in the long run, there is a uni-directional causality from expected inflation to nominal interest rates as suggested by the Fisher hypothesis in the closed economy context. While in the open economy context, the result showed that the expected inflation and international variables do not contain information that predicts the nominal interest rate.

In the empirical findings of Mohammed and Jauhari [40], they employed asymmetric causality test based on Toda and Yamamoto [39] causality approach to further the causal relationship between exchange rate and inflation differentials in Brunei, Malaysia, and Singapore. The results show the existence of Granger causality running from positive cumulative exchange rate shocks to shocks in inflation differentials for Brunei and Malaysia. Also, the asymmetric causality for Singapore runs from both positive and negative cumulative domestic inflation shocks to positive and negative exchange rate shocks respectively.

Chivalo et al. [41] in their submissions, they employed the Toda-Yamamoto approach to Granger causality to test for a causal relationship between inflation and trade openness in Zambia. They established a bi-directional causality between inflation and trade openness. Further, there exists a positive relationship between inflation and trade openness in Zambia.

3. Methodology and model specification

3.1 Methodology

This analysis aims at investigating the effect and the interrelations existing between the impact of oil price fluctuation on the monetary instrument (Exchange rate, Inflation, Interest rate). The data were sourced from the Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS) and Nigeria National Petroleum Corporation (NNPC). The data cover a period of 1995–2018 and the data is monthly. All our variables are in local currency. Therefore we used oil price, the interbank exchange rate as a proxy for exchange rate data, while the prime lending rate was used as a proxy for data on the interest rate and we used consumer price index for all commodity as a proxy for inflation.

A Toda and Yamamoto model (1995) (TY-VAR) was adopted in estimating the Modified WALD Granger Non-causality test (MWALD), Forecast Error Variance Decomposition (FEVD) and Impulse Response Function (IRF).

3.1.1 Toda and Yamamoto model (1995) and the modified Wald test statistic (MWALD)

According to Salisu [42], Sims [43] and Toda and Yamamoto (TY-VAR) [39], Vector auto-regressions (VARs) are one of the widely used classes of models in applied econometrics, used as tools both for prediction and for model building and evaluation. Its success lies on its flexibility and ease of application when dealing with the analysis of multivariate time series.

Practitioners have recently shown that the conventional asymptotic theory does not apply to hypothesis testing in levels VARs if the variables are integrated or co-integrated [39, 43]. And one of the deficiencies of the VAR application is the inability to ascertain the a priori expectation of the variables whether the variables are integrated, co-integrated, or (trend) stationary. This necessitates pretesting(s) for a unit root(s) and co-integration in the economic time series, as a requisite for estimating the VAR model, and also when the intentions are prioritized towards the estimation of cointegration and vector error correction model [44].

Conversely, the powers of the unit and also simulation experiments of Johansen tests for co-integrating are very sensitive to the values of the nuisance parameters in finite samples and hence not very reliable for sample sizes that are typical for economic time series [39, 45, 46].

To alleviate these problems, Toda and Yamamoto [39] as quoted by Shakya [47], Giles [48] proposes the augmented VAR modeling, that is the modified Wald test statistic (MWALD), which is more superior to the ordinary Granger - causality tests, the method is flexible and easy to apply, since one can test linear or nonlinear restrictions on the coefficients by estimating a levels VAR and applying the Wald criterion, paying little attention or circumventing the integration and cointegration properties of the time series data [42, 44]. However, the model is not a substitute for the conventional pre-testing in time series analysis, but as a complementary to the conventional VAR [49].

In estimating the MWALD test for Granger causality, it is prerequisite to determine the maximum possible order of the integration of the basic variables (d_{\max}). Although, the variables could be a mixture of I (0), I (1), and I (2), in such condition, $d_{\max} = 2$. The determination of the optimal lag length (k) is very

important, to avoid overstating or understating the true value of lag, to evade biased estimates of accepting the null hypothesis when it should be rejected, vice versa. By identifying d_{\max} and k , a level VAR model of order $(k + d_{\max})$ is estimated and zero restrictions test is conducted on lagged coefficients of the regressors up to lag k . This process certifies that the Wald test statistics have an asymptotical chi-square (χ^2) distribution whose critical values can be used to draw a valid inference and conclusion [39, 44].

3.2 Model specification

The model used in this research work borrowed a leave from the Toda and Yamamoto model (1995) as iterated in the work of Saban et al. [37], their model was adopted in this paper, to finding the inter-relationship between oil price and monetary variables. While they consider Granger Non-causality and structural shift, in our model we considered Granger Non-causality test, and substitute structural shift with Impulse Response Function (IRFs) and Forecast Error Variance Decomposition (FEVD). The TY-VAR is given by:

$$y_t = \alpha + \beta_1 y_{t-1} + \dots + \beta_{k+d} y_{t-(k+d)} + \varepsilon_t \quad (1)$$

Where y_t comprises of K endogenous variables, α is a vector of intercept terms, β are coefficient matrices, and ε_t is white-noise residuals.

3.2.1 VAR modified Wald test (MWALD)

The analysis aims at establishing the interrelationship that exist among the variables; i.e. oil price (\lnoilpr), and monetary policy variable i.e. exchange rate (\lnexchr), interest rates (\lnintr), and inflation (\lnncpi). The specification considers each variable expressed as independent in the model as a function of its lag and the lag of other variables in the model. Here the exogenous error terms $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}$, are independent and are interpreted as structural innovations. The realization of each structural innovation is known as capturing unexpected shocks to its dependent variable (respectively), which are uncorrelated with the other unexpected shocks (ε_t). Equations for the Modified Warld Test model are presented as follows;

$$\begin{aligned} \lnoilpr = & \alpha_1 + \sum_{i=1}^{k+dm} \beta_{1i} \lnoilpr_{t-1} + \sum_{i=1}^{k+dm} \gamma_{1i} \lnexchr_{t-1} + \sum_{i=1}^{k+dm} \delta_{1i} \lnncpi_{t-1} \\ & + \sum_{i=1}^{k+dm} \theta_{1i} \lnintr_{t-1} + \varepsilon_{1t} \end{aligned} \quad (2)$$

$$\begin{aligned} \lnexchr = & \alpha_2 + \sum_{i=1}^{k+dm} \beta_{2i} \lnexchr_{t-1} + \sum_{i=1}^{k+dm} \gamma_{2i} \lnoilpr_{t-1} + \sum_{i=1}^{k+dm} \delta_{2i} \lnncpi_{t-1} \\ & + \sum_{i=1}^{k+dm} \theta_{2i} \lnintr_{t-1} + \varepsilon_{2t} \end{aligned} \quad (3)$$

$$\begin{aligned} \lnncpi = & \alpha_3 + \sum_{i=1}^{k+dm} \beta_{3i} \lnncpi_{t-1} + \sum_{i=1}^{k+dm} \gamma_{3i} \lnoilpr_{t-1} + \sum_{i=1}^{k+dm} \delta_{3i} \lnexchr_{t-1} \\ & + \sum_{i=1}^{k+dm} \theta_{3i} \lnintr_{t-1} + \varepsilon_{3t} \end{aligned} \quad (4)$$

$$\begin{aligned} \ln intr_t = & \alpha_4 + \sum_{i=1}^{k+dm} \beta_{4i} \ln intr_{t-1} + \sum_{i=1}^{k+dm} \gamma_{4i} \ln oilpr_{t-1} + \sum_{i=1}^{k+dm} \delta_{4i} \ln exchr_{t-1} \\ & + \sum_{i=1}^{k+dm} \theta_{4i} \ln cpi_{t-1} + \varepsilon_{1t} \end{aligned} \quad (5)$$

Where $\ln oilpr$, $\ln exchr$, $\ln cpi$, $\ln intr$ are the log of oil price, exchange rate, inflation rate and interest rate, while $\ln oilpr_{t-1}$, $\ln exchr_{t-1}$, $\ln cpi_{t-1}$ and $\ln intr_{t-1}$ are the lag variables of oil price, exchange rate, inflation rate and interest rate in logs.

4. Empirical results and analysis

4.1 Stationarity tests

Although, the Toda-Yamamoto model, the MWALD test was introduced for ease of estimation by circumventing the presence of unit roots pre-testing problem, nevertheless, there is the need to determine the maximum order of integration of the variables, which is necessary for estimation of The MWALD test for Granger causality by Toda and Yamamoto [39]. Therefore, we ran the test for the Augmented Dickey-Fuller (ADF) test, Phillips – Perron (PP) test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root test, to ascertain the stationarity of the variables [45, 50–54].

From **Tables 1** and **2**, the unit-roots tests confirmed all our process to be considered integrated at the first difference and 1% level of significance using Augmented Dickey-Fuller (ADF) test and Phillips – Perron (PP).

While Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) in **Table 3** is in contrast to ADF and PP which indicated that the variables are at levels. This corroborates with the work of Yakubu and Abdul Jalil in their test of stationarity. A quick check on the line graphs in **Figure 1** indicated that all the variables are at first difference I (1). Therefore, we stick to ADF and PP, and agree that $d_{\max} = 1$.

4.2 Modified Wald (MWALD) test for Granger causality

The Modified Wald (MWALD) Test for Granger Causality requires the determination of optimal lag which is presented in **Table 4**. By default, we use LR: sequentially modified LR test statistic, FPE: Final prediction error, AIC; Akaike

Variable	ADF							
	Level				First Difference			
	Constant	Prob.	Constant & Trend	Prob.	Constant	Prob.	Constant & Trend	Prob.
$\ln oilpr$	-1.2206	0.6663	-2.3779	0.3904	-14.3220***	0.0000	-14.3037***	0.0000
$\ln exchr$	0.3070	0.9784	-1.5899	0.7949	-11.6443***	0.0000	-11.6786***	0.0000
$\ln cpi$	-1.4401	0.5626	-5.3282***	0.0000	-13.3181***	0.0000	-13.3666***	0.0000
$\ln intr$	-1.8216	0.3696	-2.3214	0.4250	-16.2688***	0.0000	-16.2400***	0.0000

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively. ADF test the null hypothesis of 'not stationary' against the alternative of 'stationary'. Source: E-views Version 9 software was used in the estimation.

Table 1.
ADF stationarity tests.

Variable	PP							
	Level				First Difference			
	Constant	Prob.	Constant & Trend	Prob.	Constant	Prob.	Constant & Trend	Prob.
Inoilpr	-1.2921	0.6340	-2.3897	0.3841	-14.3491***	0.0000	-14.3312***	0.0000
Inexchr	1.0660	0.9972	-1.5040	0.8271	-9.8974***	0.0000	-9.8872***	0.0000
Incpi	-1.7664	0.3968	-5.5627***	0.0000	-13.2950***	0.0000	-13.3455***	0.0000
Inintr	-1.9316	0.3175	-2.4972	0.3294	-16.2641***	0.0000	-16.2351***	0.0000

Note: Just like the ADF, the PP unit root test has the null hypothesis of 'not stationary' against the alternative, which is 'stationary'. *, ** and *** indicate the level of significance at 10%, 5% and 1% respectively. Source: E-views Version 9 software was used in the estimation.

Table 2.
PP stationarity tests.

Variable	KPSS							
	Level				First Difference			
	Constant	Prob.	Constant & Trend	Prob.	Constant	Prob.	Constant & Trend	Prob.
Inoilpr	1.8432***		0.2905***		0.0615		0.0359	
Inexchr	1.7493***		0.2035**		0.1959		0.0771	
Incpi	0.2299***		0.1406*		0.2440		0.1035	
Intr	0.9826***		0.1353*		0.0457		0.0454	

Note: In contrast to ADF and PP, KPSS unit root test has the null hypothesis of 'stationarity' against the alternative, 'not stationary'. ***, ** and * represent 1%, 5% and 10% level of significance respectively. Source: E-views Version 9 software was used in the estimation.

Table 3.
KPSS stationarity tests.

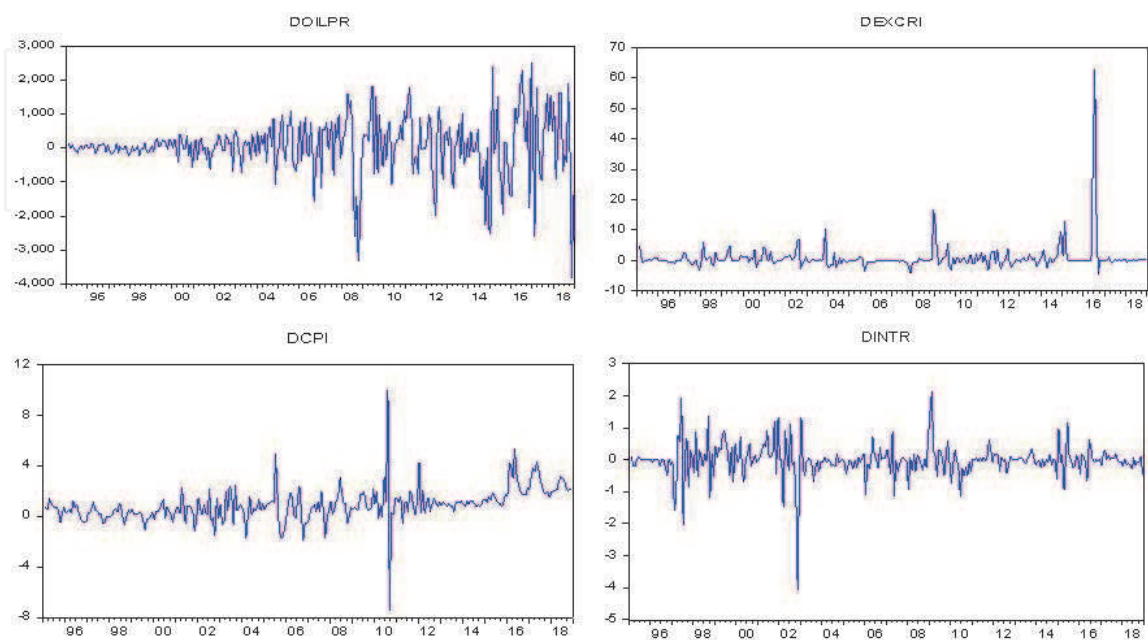


Figure 1.
Graphical representation of original series at $I(1)$ for oil price (doilpr), exchange rate (dexcri), CPI (dcpi) and interest rate (dintr).

information criterion, SBC: Schwarz information criterion and Hannan-Quinn information criterion to determine the optimal lag for the estimation of VAR system. The SC and HQ minimize its value at lag 2 while LR and FPE minimizes at lag 3. According to Liew [55], Asghar and Abid [56] Estimating the lag length of the autoregressive process for a time series is imperative in econometrics. The selection is done to minimize the chance of underestimation while at the same time maximizing the chance of recovering the true lag length. Another important aspect of the lag selection criteria is to overcome the structural break. Though, studies indicated that HQC is found to surpass the rest by correctly identifying the true lag length. In contrast, AIC and FPE are better choices for a smaller sample. In **Table 4** out of the two criteria, we propose three lags (lag 3) as the optimal lag.

4.3 Correlation matrix for TY-VAR

The orthogonal impulse response are based on recursive causal ordering, if the ordering is reversed different sets of structural shocks will be identified, and this gives a different impulse response function (IRF) and forecast error variance decomposition (FEVD), except if the error terms contemporaneous correlations are low [57]. According to Lutkepohl [58] given a sample size of T, the determinant of the reordering of the variables is given by $\pm 1.96\sqrt{T}$.

The ordering of variables suggested by Sims (1981, 1980) as iterated in the work of Yakubu and Abdul Jalil [44], Duasa [46], is to start with the most exogenous variables in the system and ended by the most endogenous variable. **Table 5** shows the residual correlation matrix result, the result shows that there is no instantaneous correlation between the variables because the variables are not significantly different from zero (at a 5% level of significance) [59]. This is based on the sample size in this analysis, we need at least a correlation of 31% that is above 5% level of significance to satisfy the call for reordering of the variables. Since there is no strong correlation among the variable we assumed the arrangement of our variables are in order.

4.4 VAR residual serial correlation LM tests

Before the estimation of the Causality Test, Forecast Error Variance Decomposition (FEVD) and Impulse Response Functions (IRFs). The VAR residual serial correlation test is needed to verify the adequacy of the lag selection criterion used in

Endogenous variables: LNOILPR LNEXCHR LNCPI LNINTR						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1024.270	NA	8.68e-09	-7.210389	-7.158863	-7.189729
1	3293.435	4458.148	1.05e-15	-23.13382	-22.87619	-23.03052
2	3342.568	95.13951	8.35e-16	-23.36797	-22.90424*	-23.18203*
3	3364.257	41.38540*	8.02e-16*	-23.40817*	-22.73834	-23.13959
4	3375.620	21.36093	8.29e-16	-23.37540	-22.49947	-23.02418
5	3381.763	11.37514	8.89e-16	-23.30575	-22.22371	-22.87189

*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 and HQ: Hannan-Quinn information criterion. Source: E-views Version 9 software was used in the estimation.

Table 4.
VAR lag order selection criteria.

	LNOILPR	LNEXCHR	LNCPI	LNINTR
LNOILPR	1.000000			
LNEXCHR	0.156275	1.000000		
LNCPI	0.025236	0.038583	1.000000	
LNINTR	0.052056	0.144681	-0.057944	1.000000

Source: Estimation was compiled using E-views Version 9 software.

Table 5.
 Correlation matrix for TY-VAR.

Lags	LM-Stat	Prob
1	13.85744	0.6093
2	8.875657	0.9184
3	15.67327	0.4760
4	12.71378	0.6936

Probs from chi-square with 16 df.

Source: Estimation was compiled using E-views Version 9 software.

Table 6.
 TY-VAR residual serial correlation LM tests.

the estimation of a chosen multivariate model, it is applied to test a set of restrictions on a model that is unrestricted, and it is based on the restricted maximum likelihood test (ML) [42, 60, 61]. From the TY-VAR estimated output for the residual serial correlation test in **Table 6**, the null hypothesis for the test is that there is no serial correlation. The result submits that there is no evidence of serial correlation. Which indicate the acceptance of the null hypothesis that the restriction (lags) place on the model is adequate.

4.5 Test for normality of TY-VAR residuals

In the test for normality, to examine whether the residuals are normally distributed. We employed the null hypothesis H_0 : residuals are normally distributed. From **Table 7** we rejected the null hypothesis of normality of residuals of each equation as well as all the equations combined at 5% level of significance since p-value of all the variables are zero. Hence, we concluded that residuals are not normally distributed [62].

Component	Jarque-Bera	df	Prob.
1	15.36714	2	0.0005
2	4572.449	2	0.0000
3	389.0131	2	0.0000
4	382.0722	2	0.0000
Joint	5358.902	8	0.0000

*df and Prob stands for the degree of freedom and probability. Source: Estimation was compiled using E-views Version 9 software.

Table 7.
 Jarque-Bera normality test result.

Although, the credibility of Jarque-Bera test of normality with application to VAR has been questioned specifically for an I(1). Jarque-Bera normality of the series does not guarantee normality of distributions, it only signifies normality of the first four moments of a distributions [58]. According to Lutz and Ufuk [63] in their remarks, they posited that Jarque-Bera test based on asymptotic critical values can be very unreliable. In their submissions, they gave the asymptotic critical values of 1–100% in their Monte Carlo analysis of VAR. They presented that the size distortions of the asymptotic test persevere even for sample sizes as large as 5000 observations.

4.6 Modified Wald test for Granger causality test (M(WALD))

From **Table 8** we have the lnoilpr as the dependent variable, at 5% level of significance, we accept the null hypothesis that there is no causality between, the lnexchr, lncpi and lnintr on the dependent variable. Also, the combination of all the independent variables do not granger caused changes in the dependent variable. This indicates the exogeneity of oil price which is been determined by many factors that are exogenous to both net importers and exporters of oil, Nigerian inclusive. According to Humbatova and Hajiyevev [24] posited that the determinants of oil price range from financial factors, lack of production capacities in oil production, the decline in the world oil reserves, natural disasters, political events and processes, and no one country has the monopoly of determining oil price.

From **Table 9** we have the lnexchr as the dependent variable, at 10% level of significance, we reject the null hypothesis that there is no causality between loilpr and lnexchr. The exchange rate plays a significant role in determining the oil price both to net exporters and net importers. Specifically, oil is priced in U.S. dollars. According to Farley [64] submissions, each decrease and increase in the dollar or the price of the commodity (oil) generates an instantaneous realignment between

Excluded	Chi-sq	df	Prob.
LNEXCHR	0.297326	3	0.9605
LNCPI	2.517571	3	0.4721
LNINTR	2.072927	3	0.5574
All	5.503884	9	0.7884

Source: Estimation was compiled using E-views Version 9 software. Note: significance at 10% and 5% levels of significance respectively.

Table 8.

Granger causality test WALD test for Eq. (2) for the dependent variable: LNOILPR.

Excluded	Chi-sq	df	Prob.
LNOILPR	6.426225*	3	0.0926
LNCPI	2.889761	3	0.4089
LNINTR	1.567570	3	0.6668
All	11.29767	9	0.2559

Source: Estimation was compiled using E-views Version 9 software. Note: significance at 10% and 5% levels of significance respectively.

Table 9.

Granger causality test WALD test for Eq. (3) for the dependent variable: LNEXCHR.

the US dollar and other currencies. These correlated is more significant in countries with significant oil reserves that depend largely on crude exports and they experience more economic damage than those with more diverse resources. In the presentations of Bützer [65], he established that oil Net exporters tend to respond against depreciation pressures by running down foreign exchange reserves, particularly after oil demand shocks, but also global demand shocks (which also decrease oil prices). This is sometimes supplemented by a nominal depreciation of exchange rates. These invariably indicate that oil demand shocks are a relevant factor for their exchange rates. While we accept the null hypothesis that there is no causality between, the ln_{cpi} and ln_{intr} on the dependent variable. Also, the combination of all the independent variables do not Granger cause changes in the dependent variable.

Also from **Table 10** we have the ln_{cpi} as the dependent variable, at 10% level of significance, we reject the null hypothesis and accept the alternative hypothesis that there is causality from ln_{exchr} and ln_{intr} to ln_{cpi} . Exchange rate plays a vital role in determining prices in Nigeria, as an economy that has some element of a Dutch disease syndrome, and relied heavily on importation of basic necessity, when we factor out oil exportation from the total export, the non-oil balance of trade approximately stood at negative 7114 billion for 2017 as stated in our introduction. Therefore, appreciation in the exchange rate can cause inflation (ln_{cpi}) (Katz, 1973). The interest rate is one of the instruments used by the monetary authority to regulate the economy either during inflation or deflationary periods, the interest rate affects the demand and allocation of the available loanable funds the level, and pattern of consumption and investment ([66] p. 15). Before 2016 recession in Nigeria, the inflation rate was at a single digit of 9.55% in 2015, during the recession, the inflation rate was at double-digit 18.55% in 2016 and the central bank introduced a tight monetary policy, by raising the interest rate steady at 14 per cent from July 2017 to the first quarter of 2018 against 2016 which is 200 points higher [36].

Also, the combination of all the independent variables (ln_{oilpr} , ln_{exchr} and ln_{intr}) does Granger cause changes in the dependent variable ln_{cpi} at 5%, but ln_{exchr} and ln_{intr} are more pronounced in the causality. While we accept the null hypothesis that ln_{oilpr} do not granger cause ln_{cpi} .

In **Table 11** we have ln_{intr} as the dependent variable, we reject the null hypothesis and accept the alternative hypothesis that at 5% levels of significance that there is a causality which is from ln_{oilpr} and ln_{exchr} to the endogenous variable ln_{intr} , while there is no any causality with the log of ln_{cpi} on the dependent variable. Also, the combination of all the independent variables Granger cause changes in the dependent variable at a 5% level of significance. The relationship of ln_{oilpr} and ln_{intr} may not be exclusive but via the exchange rate, in the boom period the net exporter of oil has more dollars to expend, vice versa during deflationary periods, both periods has a direct link to economic growth. To avoid these inflationary or

Excluded	Chi-sq	df	Prob.
LNOILPR	1.151935	3	0.7646
LNEXCR	6.824049*	3	0.0777
LNINTR	7.771454*	3	0.0510
All	14.75625**	9	0.0979

*Source: Estimation was compiled using E-views Version 9 software. Note: * and ** show significance at 10% and 5% levels of significance.*

Table 10.
 Granger causality test WALD test for Eq. (4) for the dependent variable: LN_{CPI} .

Excluded	Chi-sq	df	Prob.
LNOILPR	14.66233**	3	0.0021
LNEXCR	10.44319**	3	0.0152
LNCPI	3.488718	3	0.3222
All	31.49615**	9	0.0002

Source: Estimation was compiled using E-views Version 9 software. * and ** show significance at 10%, 5% and 1% levels of significance.

Table 11.

Granger causality test WALD test for Eq. (5) for dependent variable: LNINTR.

deflationary tendencies, the central bank may engage in the sterilization process through open market operation, by manipulating the short-term interest rate, that is by increasing interest rates to discourage borrowing during inflationary periods or decrease the interest rate to encourage borrowing during deflationary periods. The relation is said to be inverse and this shows how oil price and exchange rate influences the monetary policy of net oil exporters.

4.7 Forecast error variance decomposition (FEVD) and impulse response functions (IRFs)

From the estimated TY-VAR, we compute forecast error variance decompositions (FEVD and impulse response functions (IRF), which serve as means for evaluating the dynamics of the interrelationship, interactions, and strength of causal relations among the variables in the system. The impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR [10, 46].

In simulating FEVD and IFRs, the VAR innovations can be contemporaneously correlated. That is a shock in one variable can work through the contemporaneous correlation with innovations in other variables. The responses of a variable to innovations in another variable of interest cannot be adequately represented in isolation, due to the facts that shock to individual variables cannot be separately identified due to contemporaneous correlation [46].

In our analyses, we applied Cholesky approach which uses the inverse of the Cholesky factor of the residual covariance matrix to orthogonalise impulses (innovations) as recommended by Sims (1980) as quoted by Duasa [46] and (Breitung, Bruggemann, and [58]) to solve this identification problem. The strategy requires a pre-specified causal ordering of the variables, which we estimated in **Table 5** for the correlation matrix. The results of FEVD are displayed in **Tables 12–15**, while the IRFs represented in **Figures 2–17** in appendix 1, respectively.

4.7.1 Forecast error variance decomposition (FEVD)

We explored the Cholesky factorization in the E-Views software and forecast the interrelationship of the variables up 48 months equal to 4 years. **Table 10** is the Table for FEVD for lnoilpr as a dependent variable for 48 periods (4 years) forecast. In forecasting a variable, shocks in the residual of the forecasted variable contribute more to its variance than the shocks in other variables in the first period. The shocks in oil price-output contributed more to its variance, from 100% in the first period down to 70.58% in the 48 period (4th year) of the forecast period. This is followed

Period	S.E.	LNOILPR	LNEXCHR	LNCPI	LNINTR
1	0.039283	100.0000	0.000000	0.000000	0.000000
2	0.059667	99.56602	0.007555	0.357862	0.068566
3	0.074387	99.31622	0.077847	0.518729	0.087200
4	0.087239	99.17720	0.135794	0.615055	0.071949
5	0.099720	99.16728	0.123200	0.650960	0.058563
6	0.112282	99.16645	0.102858	0.650544	0.080151
12	0.191020	98.36406	0.104402	0.630791	0.900743
18	0.276129	96.71609	0.060657	0.908562	2.314688
24	0.366613	94.33976	0.064427	1.477383	4.118426
30	0.457642	91.03687	0.223173	2.331971	6.407984
36	0.541764	86.40256	0.693518	3.520289	9.383636
42	0.611323	79.78047	1.802594	5.120937	13.29600
43	0.621214	78.43050	2.090483	5.429983	14.04904
44	0.630655	77.00398	2.418306	5.749531	14.82819
45	0.639696	75.50135	2.790808	6.077919	15.62992
46	0.648412	73.92544	3.212962	6.412711	16.44889
47	0.656906	72.28230	3.689787	6.750497	17.27741
48	0.665310	70.58226	4.226078	7.086683	18.10498

Note: SE refers to the total variance error in forecasting LNOILPR. Other columns represent the percentage of the variance attributable to shocks in the residual of the respective variables. Sources: Compiled using Eviews version 9.

Table 12.
Variance decomposition of LNOILPR.

by lnintr that contributed 4.11% in the 24th period to about 18.11% in the 48 period (4th year). This followed by lncpi that contributed 1.48% at the 24th period to 7.09 at the 48 periods and last is the lnexchr contributions from 0.06% in the 24th period to 4.22% in the 48 periods. This shows monetary policy influences the fluctuation inherent with the oil price and in the future, it shows that lnintr will respond highly to oil price shocks. While the contemporaneous relationship between the oil prices as the endogenous variables (lncpi and lnexchr) in our model are very insignificant. This is an indication that it will take a longer time into the future, for variables other than lnintr to influence the impact of oil prices.

Table 13, is the Variance Decomposition for dependent variable lnexchr, the contributions to itself were 97.56% in the 1st period, to about 57.82% in the 48 period (4th year) into the future. This followed by the contributions of lnoilpr with 28.28% at the 24th period and 39.31% at the 48th period. While lncpi and lnintr contributed 2.58% and 0.02% all at the 48th period. The error variance in forecasting lnexchr from lnoilpr is high, which indicates that shocks in the residuals of lnoilpr will have much effect in determining the lnexchr in the future.

Table 14 is forecast error variance decomposition of LNCPI as the predictant, the predictant contributes 99.81%, 54.73%, 3.18% in the 1st, 12th and 48th periods to itself, which indicates that the contributions of lncpi to itself declined in 4 years. While lnexchr contributes more to the error variance in forecasting lncpi, contributing about 43.40% up to 82.74% for the periods 12th and 36th then declined to 71.74% in the 48th period (4th year). While lnoilpr contributions started from 24th period with 2.47% and keep increasing up to 25.02% in the 48th period. Whereas

Variance Decomposition of LNEXCHR:					
Period	S.E.	LNOILPR	LNEXCHR	LNCPI	LNINTR
1	0.008667	2.442191	97.55781	0.000000	0.000000
2	0.016018	1.303029	98.47056	0.226099	0.000307
3	0.020768	0.793908	98.43015	0.646775	0.129165
4	0.024011	0.693289	97.87271	1.034284	0.399717
5	0.026961	0.553215	97.54321	1.309243	0.594331
6	0.030343	0.647208	97.17916	1.485892	0.687736
12	0.059365	4.366737	92.68622	2.025025	0.922015
18	0.109801	12.31598	84.79549	2.160683	0.727839
24	0.199812	21.01359	76.31208	2.242682	0.431654
30	0.358345	28.27847	69.15410	2.361025	0.206413
36	0.633138	33.57260	63.83346	2.514318	0.079625
42	1.103690	37.11351	60.17595	2.683471	0.027067
43	1.209424	37.56150	59.70328	2.711909	0.023305
44	1.324903	37.97407	59.26509	2.740223	0.020615
45	1.451006	38.35307	58.85970	2.768351	0.018878
46	1.588692	38.70034	58.48544	2.796232	0.017984
47	1.739007	39.01764	58.14072	2.823810	0.017829
48	1.903092	39.30669	57.82396	2.851035	0.018316

Note: SE refers to the total variance error in forecasting LNEXCHR. Other columns represent the percentage of the variance attributable to shocks in the residual of the respective variables. Source: Estimation was compiled using E-views Version 9 software.

Table 13.
Variance decomposition of LNEXCHR.

lnintr contributions are insignificant. This has brought a clearer picture that lnexchr and lnoilpr are the major determinant of inflation in the economy.

Table 15 illustrated the forecast error variance decomposition of lnintr, contributing to its future error variation of 97.41%, 42.01% and 54.34% for the 1st, 12th and declined to 3.70% at the 48th period (4th year), this is followed by lnexchr which contributes 1.91%, 10.19% for the 1st and 6th periods, it declined for some periods and pick up again and continue rising to 82.81% in the 48th period (4th year).

This is trailed behind by lnoilpr, contributing 4.32% and 43.37% in the 6th and 12th, 75.25% at 24th period and started declining up to 12.41% at the 48th period (4th year). This indicates also a strong relationship into the future. The forecast error variance decomposition of the variables estimates also coincides with the result we obtained in the estimates we derived in **Table 11**, which also indicates that our estimates are good to go with for future implementation of policies.

4.7.2 Response functions (IRFs)

In **Figure 2**, from appendix 1, the Oil price (lnoilp) responded contemporaneously by the change in its own shocks, which is positive and not dissipating. The implication is that hick in the price of oil may mean high revenue, but the

Variance Decomposition of LNCPI:					
Period	S.E.	LNOILPR	LNEXCHR	LNCPI	LNINTR
1	0.006843	0.063687	0.122994	99.81332	0.000000
2	0.010614	0.111687	1.169617	97.78015	0.938541
3	0.013902	0.104867	1.709240	96.72400	1.461890
4	0.016436	0.118843	2.348794	96.05369	1.478675
5	0.018494	0.094052	3.766938	94.89832	1.240691
6	0.020348	0.110542	6.716716	92.14406	1.028684
12	0.034150	0.390382	43.39555	54.73213	1.481945
18	0.058790	0.800621	71.63000	26.51978	1.049596
24	0.102887	2.477121	83.86813	13.27275	0.382003
30	0.182422	6.425699	86.02039	7.403793	0.150115
36	0.326127	12.33701	82.73589	4.811637	0.115460
42	0.583692	18.92647	77.30909	3.668364	0.096074
43	0.642926	19.99991	76.35470	3.554354	0.091028
44	0.708053	21.05415	75.40480	3.455500	0.085552
45	0.779631	22.08580	74.46447	3.369987	0.079739
46	0.858270	23.09198	73.53809	3.296234	0.073694
47	0.944635	24.07026	72.62936	3.232858	0.067521
48	1.039451	25.01867	71.74135	3.178651	0.061323

Note: SE refers to the total variance error in forecasting LNCPI. Other columns represent the percentage of the variance attributable to shocks in the residual of the respective variables. Source: Estimation was compiled using E-views Version 9 software.

Table 14.
 Variance decomposition of LNCPI.

consequences is, as an import based economic of non-oil goods and refined petroleum product, with domestic regulation of prices (subsidies), the policy will confine government's ability to finance the import bills as well as meet other international obligations [8]. While the response of oil price (lnoilpr) to change in Exchange rate (lnexchr) is insignificant in **Figure 3**. Inflation (lncpi), and Interest rate (lnintr) in **Figures 4**, and **5** showed some level of positive response.

In **Figure 6**, there is a slightly positive response of Exchange (lnexchr) to change Oil price (lnoilpr) in the sixth lag period. This show how influential oil is in determining exchange rate, since high price of oil means more revenue (foreign income), also Exchange (lnexchr) responded instantaneously, a positive response, to change in its self (**Figure 7**). In **Figure 8**, there is slight positive response of lnexchr to change in lncpi and **Figure 9** showed a small inverse response of lnexchr to change in lnintr.

In **Figures 10** and **13**, Inflation (lncpi) did not show a meaningful response to orthogonal change in the price of oil (lnoilpr) and Interest rate (lnintr). While **Figure 11**, showed a positive response in Inflation (lncpi) to change in the Exchange rate (lnexchr), that is from the second lag period up to the tenth lag period in increasing order, this indicate that inflation will continue since the response is not dissipating unless there is a policy to induce deflation. Whereas in **Figure 12** there is an instantaneous response of Inflation (lncpi) to change in Inflation (lncpi) in a

Variance Decomposition of LNINTR:					
Period	S.E.	LNOILPR	LNEXCHR	LNCPI	LNINTR
1	0.011298	0.270981	1.911153	0.411721	97.40614
2	0.015682	1.162856	3.384292	0.236829	95.21602
3	0.019164	0.778732	7.551086	0.251113	91.41907
4	0.021868	1.545252	10.35243	0.690563	87.41175
5	0.024147	4.317860	10.80310	1.548061	83.33098
6	0.026278	8.517769	10.19189	2.639437	78.65090
12	0.042469	43.36535	7.083532	7.537991	42.01312
18	0.068739	68.22092	7.817425	6.432329	17.52932
24	0.105922	75.25005	13.09986	4.196117	7.453977
30	0.154692	69.22610	23.97069	2.633864	4.169344
36	0.219876	52.16768	42.34294	1.710601	3.778773
42	0.320347	28.71560	65.93762	1.220443	4.126342
43	0.343392	25.06914	69.62387	1.173901	4.133092
44	0.369026	21.71282	73.04019	1.136972	4.110024
45	0.397622	18.71892	76.11686	1.109481	4.054735
46	0.429590	16.14604	78.79614	1.091170	3.966652
47	0.465375	14.03524	81.03610	1.081687	3.846977
48	0.505456	12.40799	82.81296	1.080569	3.698485

Cholesky Ordering: LNOILPR LNEXCHR LNCPI LNINTR. Note: SE refers to the total variance error in forecasting LNINTR. Other columns represent the percentage of the variance attributable to shocks in the residual of the respective variables. Source: Estimation was compiled using E-views Version 9 software.

Table 15.
Variance decomposition of LNINTR.

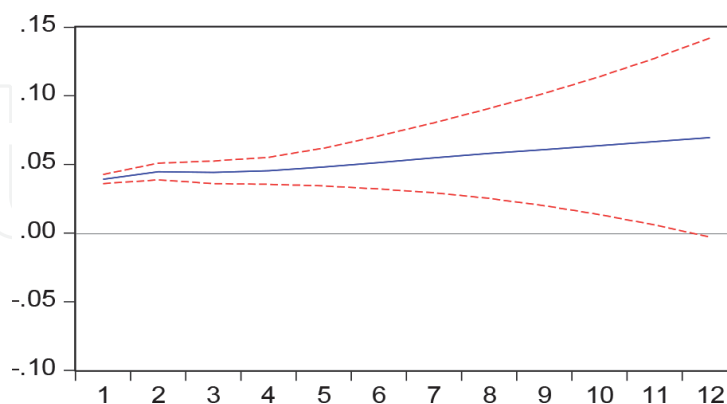


Figure 2.
Impulse response function of lnoilpr to lnoilpr.

high positive level, with a slight drop towards the tenth period which indicates tendencies of achieving normality in the future.

Figure 14, showed that there is an inverse response of Interest rate (lnintr) to one standard deviation change in the price of oil (lnoilpr) from the second lag period in an increasing order up to the tenth period, this is expected because the assumption is that interest rate has an inverse relationship with the oil price. Also

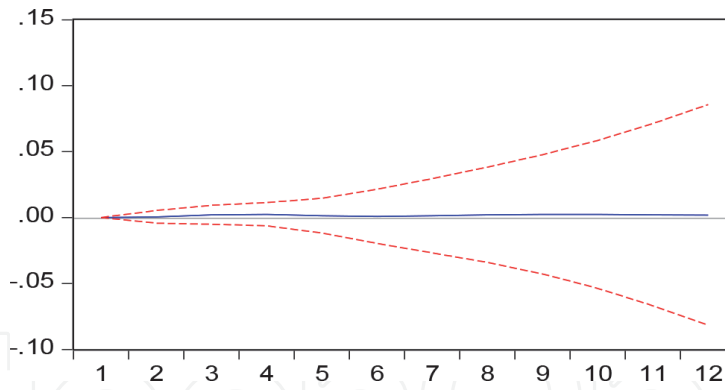


Figure 3.
 Impulse response function of lnoilpr to lnexchr.

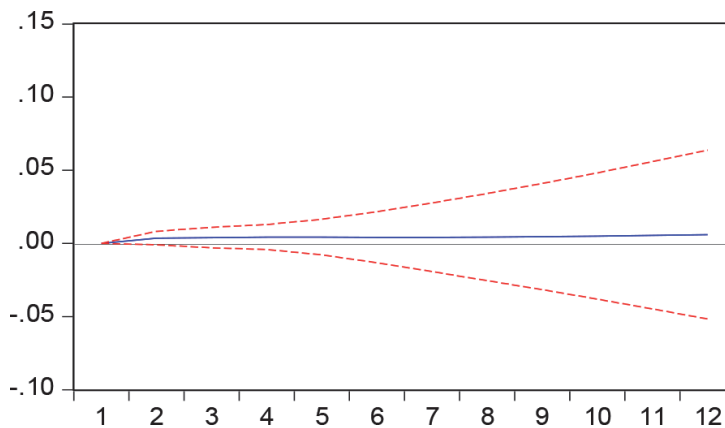


Figure 4.
 Impulse response function of lnoilpr to lncpi.

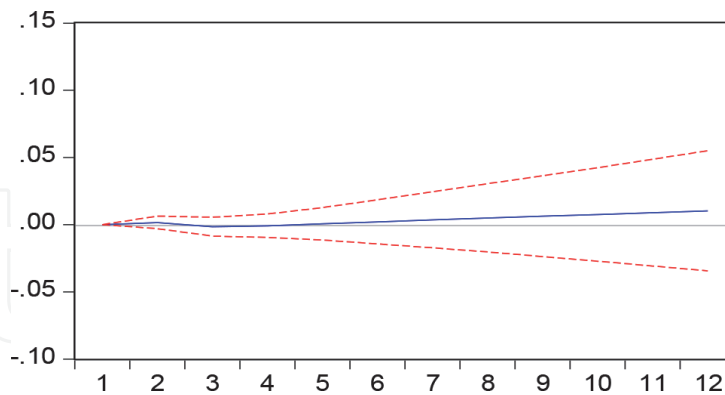


Figure 5.
 Impulse response function of lnoilpr to lnintr.

Figure 15 indicated an instantaneous positive response of interest rate (lnintr) to change in the Exchange rate (lnexchr), in the third and fourth period, before it dying off which indicates that there is propensities of achieving normality in the long run. In **Figure 16** Interest rate (lnintr) responds contemporaneously to change in Inflation (lncpi), with a positive increase from the fourth period and finally, in **Figure 17** Inflation (lncpi) responded significantly to change Inflation (lncpi). The impulse response functions further complement the Forecast Error Variance Decomposition by given a portrait of the direction of the inter-relationships of variables.

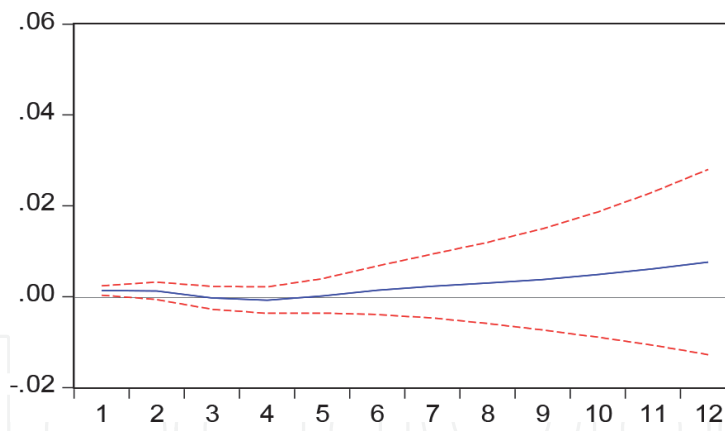


Figure 6.
Impulse response function of lnexchr to lnoilpr.

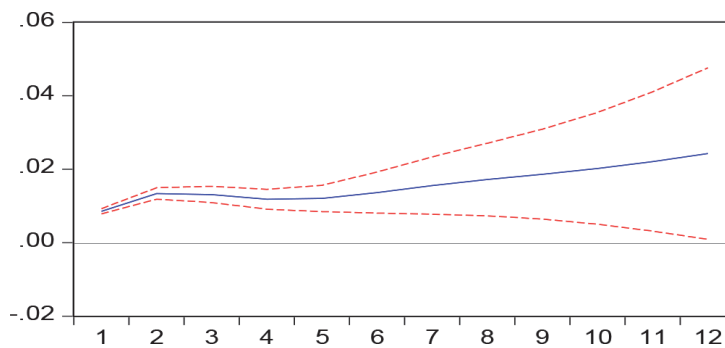


Figure 7.
Impulse response function of lnexchr to lnexchr.

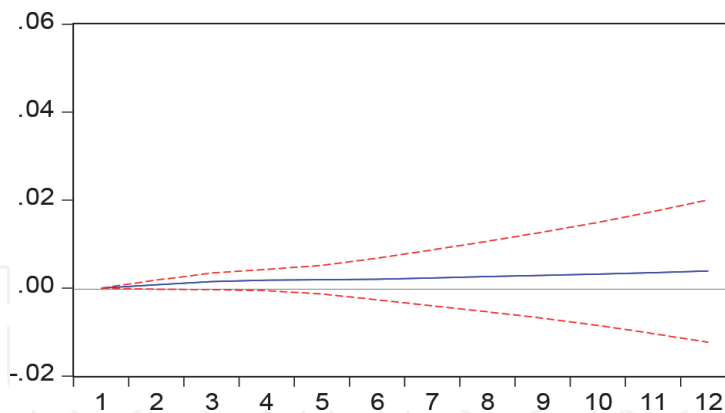


Figure 8.
Impulse response function of lnexchr to lncpi.

5. Conclusion and recommendation

In this research work, we explored the Toda-Yamamoto Modified Wald Test (MWALD) to examine the impact of oil price fluctuation on the monetary instrument in Nigeria, by looking at their causal relationships. The study covered the period 1995 to 2018 and the data are monthly data, to establish the contemporaneous relationships between these macroeconomic indicators. Among other analyses are the Granger Causality, FEVD and IRFs.

The review showed the direction of causality and FEVD into the future for 48 months equivalent to four years (short-run), between oil price, Exchange rate, Inflation, and Interest rate.

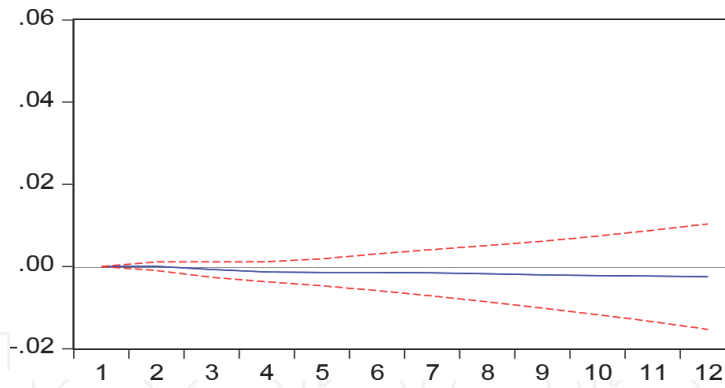


Figure 9.
 Impulse response function of \ln_{exchr} to \ln_{intr} .

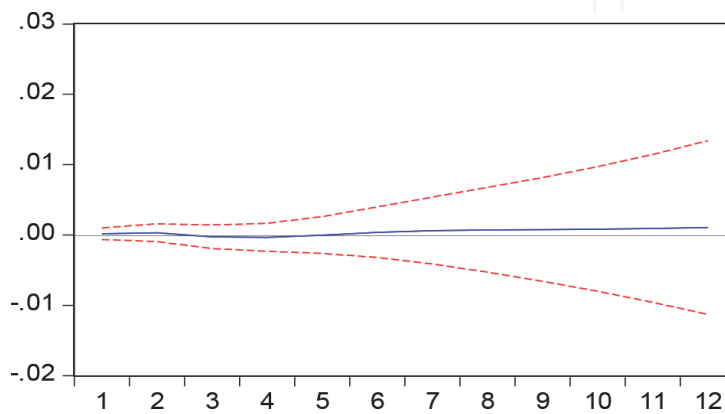


Figure 10.
 Impulse response function of \ln_{cpi} to \ln_{oilpr} .

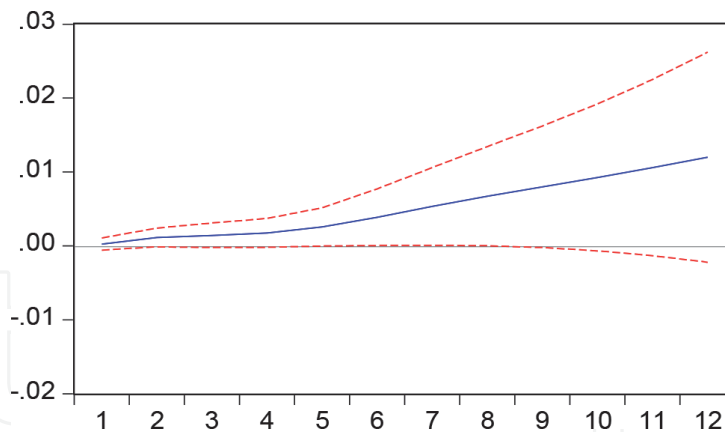


Figure 11.
 Impulse response function of \ln_{cpi} to \ln_{exchr} .

From the analyses of Toda-Yamamoto Granger Causality WARD Test, the review presented that there is unidirectional causality from \ln_{oilpr} to \ln_{exchr} in **Table 9**. This is consistency with the result we obtained in the estimation forecast error variance decomposition of \ln_{exchr} (**Table 13**) as the predictant, where the predictant contributes 97.56% in the 1st period, to about 57.82% in the 48 period (4th year) into the future. This was followed by the contributions of \ln_{oilpr} with 28.28% at the 24th period and 39.31% at the 48th period. While \ln_{cpi} and \ln_{intr} contributed 2.58% and 0.02% all at the 48th period. This was also complemented by for IRFs in **Figure 7** in the appendix.

Also from granger causality of \ln_{cpi} as a dependent variable in **Table 10** there is unidirectional causality from \ln_{exchr} and \ln_{intr} to \ln_{cpi} , also the combination of all

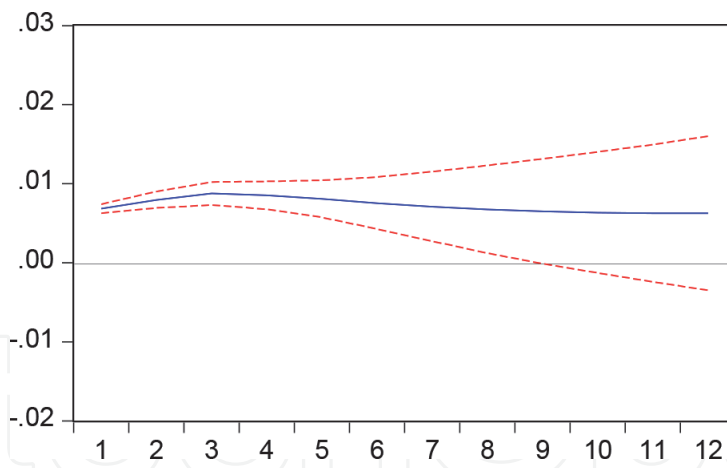


Figure 12.
Impulse response function of *lncpi* to *lncpi*.

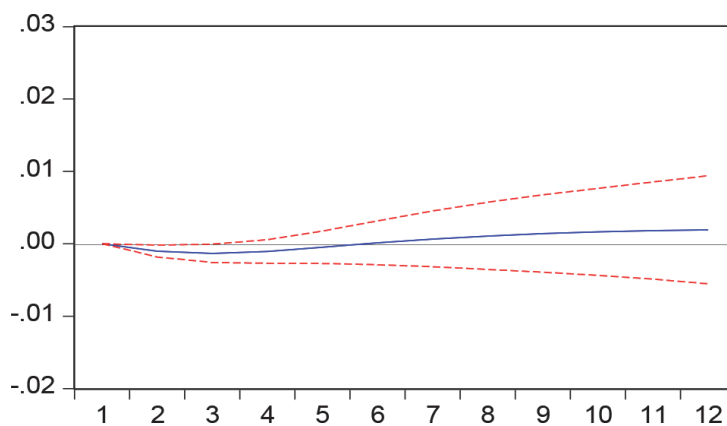


Figure 13.
Impulse response function of *lncpi* to *lnintr*.

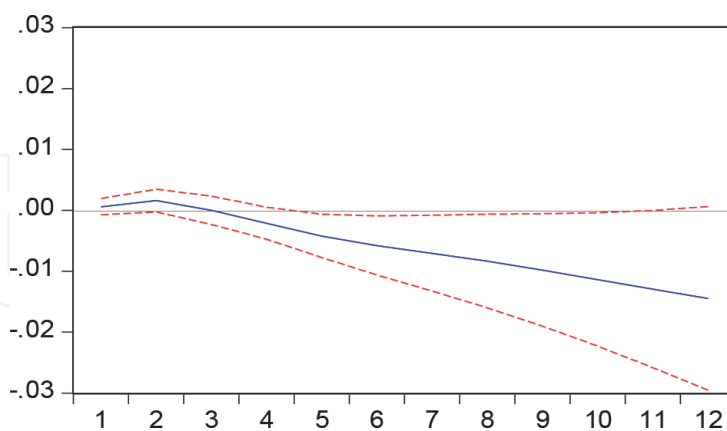


Figure 14.
Impulse response function of *lnintr* to *lnoilpr*.

the three independent variables (*lnoilpr*, *lnexchr* and *lnintr*) granger cause *lncpi* but *lnexchr* and *lnintr* have more contributions. This is also in tandem with the result of FEVD for dependent variable *lncpi* in **Table 14** where the dependent variable contributions to itself were 99.81%, 54.73%, 3.18% in the 1st, 12th and 48th periods, which indicates that the contributions of *lncpi* to itself declined in 4 years. While *lnexchr* contributes more to the error variance in forecasting *lncpi*, contributing about 43.40% up to 82.74% for the periods 12th and 36th periods (3rd years) then declined to 71.74% in the 48th period (4th year). While *lnoilpr* contributions started

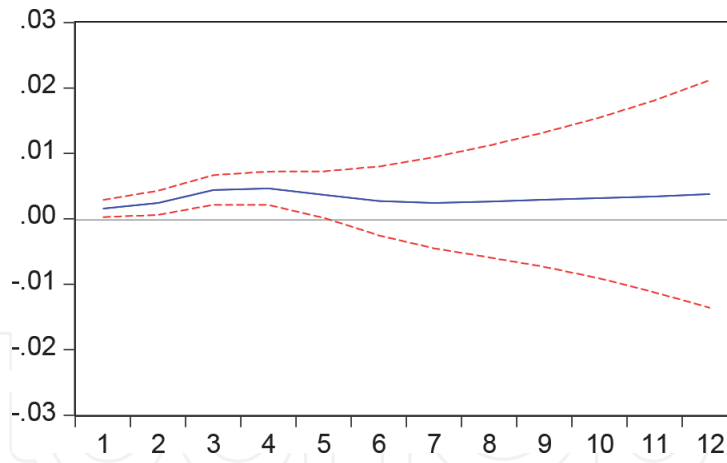


Figure 15.
 Impulse response function of \lnintr to \lnexchr .

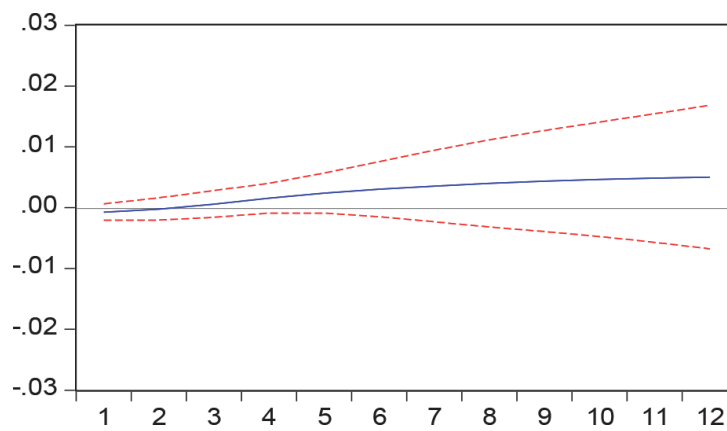


Figure 16.
 Impulse response function of \lnintr to $lncpi$.

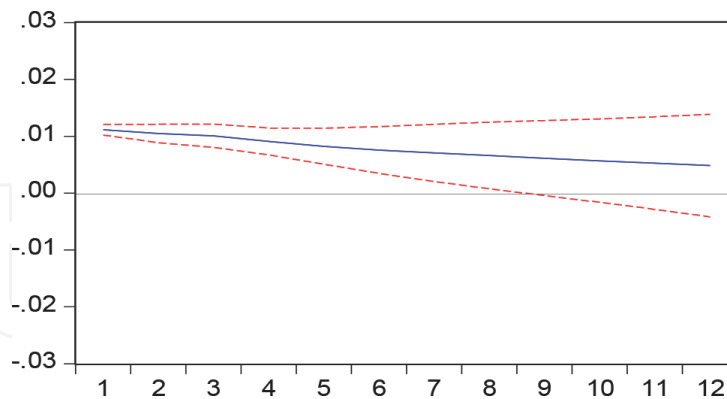


Figure 17.
 Impulse response function of \lnintr to \lnintr .

from 24th period with 2.47% and keep increasing up to 25.02% in the 48th period (4th year). This is also affirmed in **Figure 11** in the appendix.

Similarly in the estimation of Granger Causality WALD Test for \lnintr , it responded positively to change in \lnoilpr and \lnexchr . This is also in agreement with the estimation of forecast error variance decomposition of \lnintr as an endogenous variable, contributing to its future error variation of 97.41%, 42.01% and 54.34% for the 1st, 12th periods and declined to 3.70% at the 48th period (4th year), this is followed by \lnexchr which contributes 1.91%, 10.19% for the 1st and 6th periods, it declined for some periods and pick up again and continue rising to 82.81% in the

48th period (4th year). This is trailed behind by $lnoilpr$, contributing 4.32% and 43.37% in the 6th and 12th, 75.25% at 24th period and started declining up to 12.41% at the 48th period (4th year). This indicated that the major determinant factors of interest rate policy in Nigeria are change in price of oil and exchange rate in the long run. This also conforms to the outcome of the IRF in **Figure 14**, which specified further that the relation between $lnintr$ and $lnoilpr$ is an inverse relationship, while $lnexchr$, $lnpci$ and $lnintr$ in **Figures 15–17** are positive.

The object of this work is to establish a direct link between oil price and some selected monetary instruments in Nigeria, and our a priori expectations were achieved, we were able to establish that oil price has a direct influence on the exchange rate, interest rate and inflation rate. It is known facts that Nigeria is an oil-producing economy and at the same time also an import-based economy of non-oil products. The major sources of financing the import come from oil revenue. As an oil-producing economy, there are tendencies of having Dutch disease syndrome and economic pass-through [9]. Both in theory and empirical analyses one can conclude that oil price is a strong determining factor of the rate of exchange, it has a direct link to inflationary or deflationary tendencies and also influences the monetary policies in Nigeria in terms of cost of borrowing.

Therefore, in implementation of monetary policy by the policymakers, attention should be drawn to price level of import from the external market, that is by concurrently monitoring the domestic market and the economy of the country's trading partners. On a general note, there should be diversification of the economy from oil to the non-oil economy to avoid the Dutch disease syndrome.

Additional classifications

JEL classifications: *Q1, Q3, Q41, Q47*


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