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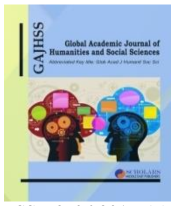

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Review Article

Oil Price Shocks and Economic Growth in Nigeria under President Bola Ahmmed Tinubu: COVID-19 Intervention

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Abstract: The impact of oil price shocks on the economy during emergency of Coronavirus has occupied the attention of researchers for almost four years. Though, most Nigeria-based studies are not like this, this paper explores alternative measures of oil price shocks that have been developed in the literature with a view to ascertaining the extent to which conclusions about oil price-growth depends on the definition of shocks adopted during pandemic. The relatively recent regime dependent logic regression threshold autoregressive model, together with impulse response functions and forecast error variance decomposition adopted in this study. One third data spanning from 2020 to 2024 was used, a non-linear model of oil price shocks and economic growth during the event of Coronavirus is estimated. The study findings indicate that oil price shocks are unaccounted for significant proportion of observed movements in macroeconomic aggregates during the Coronavirus pandemic. This pattern persists despite introduction of threshold effects by government. This implied the enclave nature of Nigeria's oil sector with strong linkages to other sector. Therefore, the need to spend oil revenue productively is imperative if favourable effect on real output growth is envisaged in post COVID-19 period.
Keywords: Oil Price Shocks, Economic Growth and Covid-19 Intervention.

1. INTRODUCTION

The provision of plausible explanations for the relationship between oil price movements and macroeconomic performance has occupied the attention of economists over the last four decades. This interest stems in part from the observed linkage between oil price realisations and episodes of recession [1]. The bulk of pioneering studies on oil price-macroeconomy interactions were targeted at establishing causal links owing to the fact that the oil price episode was viewed as a permanent increase with the attendant effects on recessions in oil dependent economies (Hamilton, 2013; Gisser and Godwin, 2016; Burbidge and Harrisson, 2014, Nasseh

[1] Hamilton (2013), in his seminal paper, pointed to this association on the premise that all but one of the post-war recessions in the United States were an aftermath of oil price increases. See Mork (2014) for a detailed discussion of developments in the literature on this subject especially after the first major oil shock in 1973.

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and Elyasiani, 2014; Lillien, 2012; Loungani, 2016; Dohner, 2011; and Darby, 2012). The success of these efforts with regard establishing causation was minimal although their empirical evidences demonstrated that unanticipated rises in the price of oil have a negative impact on output growth. Subsequent oil price episodes have resulted in the evolution of the perception of these price changes and thus a number of alternative explanations have been proffered for the influence of oil price increases on real activity. First, output declines less since agents typically delay decisions with regard consumption and investment due to the expected temporary nature of the oil price increase. Second, the novel episodes of oil price declines experienced around the mid-2010s diverted thinking towards the existence of asymmetries in this relationship (Mork, 2019; Bernanke *et al*., 2017; Hooker, 2019). Finally, recent attempts have focused on exploiting the possibility of non-linearities [[2]], and critical thresholds in the oil price- macroeconomy nexus. Huang *et al*., (2005) and Huang (2008) investigate the role of threshold effects by taking into account differences in speed of adjustment to oil price shocks across countries. These differentials with respect to tolerance are opined to be partly driven by country specificities in terms of energy efficiency, energy dependence and level of economic sophistication.

However, the preponderance of extant studies has examined this linkage for the net oil-importing industrial economies especially the United States and Organisation for Economic Cooperation and Development (OECD) countries. The role of oil price shocks in the booms and busts experienced by net oil-exporting developing countries has not been sufficiently covered in the literature. Specifically, studies are rare, as far as we know, on Nigeria that have taken explicit account of potential non-linearities in the oil price-macroeconomy relationship to COVID-19. Also, most of the studies that look at threshold effects typically have a cross-sectional orientation. Hence, the present study further attempts to determine the impact of such effects in an oil dependent economy like Nigeria during COVID-19 period. Inline with this background information, this study therefore, seeks plausible answers to the following questions; (i) What is the impact of oil price shocks during Coronavirus pandemic on output growth in the Nigerian economy? (ii) Are there potential linear linkages in this relationship? (iii) What influence do critical thresholds during Coronavirus pandemic have on the extent to which decline/fall in oil price drive real output movements with the country?

The general objective of this study is to offer an empirical analysis of the impact of oil price shocks during Coronavirus pandemic on the Nigerian economy. It thereby adds to the scant literature on the effects of oil price changes on output in oil exporting developing countries [[3]]. I work on this goal by using a augmented vector autoregressive (VAR) model considering its advantage in terms of the simultaneous modelling of equilibrium growth trends as well as the dynamic response of the Nigerian macroeconomy to oil price variations.

2. DATA DESCRIPTION AND METHODOLOGY

Data Description

The study determines the impact of oil price shocks during COVID-19 period on gross domestic product, government revenue, monetary indicators, government consumption and inflation in Nigeria. Following Bohi (2011) fiscal and monetary indicators are used in the analysis. Availability of sufficiently long time series on the aforementioned variables served as an additional criterion for selection. One third of the year data spanning 2020 Q1 to 2024 Q4, a total of 96 observations, were employed [[4]]. All variables, except inflation, are transformed logarithmically and also expressed in their real values by deflating with the base year 2006 consumer price index (CPI). The most challenging feature identifiable from the oil-macroeconomy literature is the measure of oil price shocks to be used for analysis. I thus construct alternative measures of the oil price variable via a number of non-linear transformations which capture key aspects of the departure of the oil price-output interaction from the standard linear view (Hooker 2016a; Hooker 2019; Keane and Prasad 2016). The reason for the statistical transformation of oil prices is to identify explicitly the component of oil price that can be treated as purely exogenous to conditions in both specific countries and the global macroeconomy (Hamilton, 2003). The implication of this is that non-linear variants of the decrease/ fall in oil price filter out many of the endogenous drivers of oil price shocks during the COVID-19 period.

[2] For excellent treatments on the impact of non-linearities on the oil price-macroeconomy linkage, see Mork (2019), Lee *et al.,* (2015), Hamilton (2016), Paik and Leiby (2004), Jimenez-Rodriguez and Sanchez (2005) and the references they contain.

[3] Although, Lorde *et al.,* (2009) embark on a similar exercise, they did not investigate the role of threshold effects in the oil price-macroeconomy relationship for Trinidad and Tobago. Also, the oil shock measure reflecting volatility was adopted. This study, however, employs not only the volatility measure but also other non-linear measures with a view to ascertaining robustness of the results obtained.

[4] All data were obtained from the new CBN quarterly macroeconomic time series database available at the Centre for econometric and allied research (CEAR).

Mis-specification of the functional form is a major, but probably not the only, candidate for explaining the breakdown observed in the relationship between oil price fluctuations and output growth with the inclusion of more recent data (Mork, 2014). Therefore, researchers have directed efforts at exploring various oil price transformations with a view to re-establishing the oil price- output linkage especially in the post 2016 era which was characterized by substantial oil price decreases and higher volatility than earlier episodes as such price movements were unprecedented (Hamilton 2016; Lee *et al*., 2015; Mork 2019).

The traditional, also linear, measure of oil price shocks in the literature as popularised by Hamilton (2013) is the quarterly changes in real oil prices which is constructed as the first log differences of the oil price variable viz;

$$\Delta o_t = \ln o_t - \ln o_{t-1} \quad (3.1)$$

Where o_t is the real oil price in period t and $\ln$ represents the logarithm of the same variable.

Evidence of non-linearity between GDP growth and oil price changes from the literature informed further investigation with the general consensus being that positive oil price changes affect the macroeconomy by lowering real output growth while the effect of oil price decreases on economic activity may at best be minimal. This asymmetry, as a phenomenon, has been well documented in the literature (see Mork 2019, Jimenez-Rodriguez and the references therein). Mork (2019) concludes that oil price decreases are insignificant using a non-linear specification in which only positive changes are considered as follows;

$$\Delta o_t^{+} = \begin{cases} \Delta o_t \, if \, \Delta o_t > 0 \\ 0 \end{cases} \quad (3.2)$$

while intuitively for oil price declines;

$$\Delta o_t^{-} = \begin{cases} \Delta o_t \, if \, \Delta o_t < 0 \\ 0 \end{cases} \quad (3.3)$$

In this instance, oil price rises and declines are given separate treatment. He argued that there was little experience with declining oil prices prior to 2010 with the subsequently observed large oil price decreases eroding both the magnitude and statistical significance of the estimated effect of oil on the macroeconomy.

Hamilton (2016) proposed a Net Oil Price Increase (NOPI) measure on the basis that not all oil price increases impact on the behaviour of rational agents. Hamilton argues, further, that a measure of how an oil increase alters the spending decisions of households and firms would be a comparison of the current oil price to its historical path. Such reluctance to respond to small oil price changes could be as a result of high costs of monitoring energy expenditures and frictions with regard to adjusting consumption (Goldberg, 2018). Hence, the amount by which the log real oil price in quarter t exceeds its maximum over the previous year (i.e last four quarters) is used while oil price increases less than this benchmark are assumed to have no effect. This transformed oil price variable is;

$$\text{NOPI 4} = \max\left[0, \left(\ln o_t\right) - \ln\left(\max\left(o_{t-1,} o_{t-2,} o_{t-3,} o_{t-4,}\right)\right)\right] \quad (3.4)$$

To capture sluggish adjustment mechanisms due to rigidities specific to particular economic settings, Hamilton (2016) proposes a variant of the above measure which covers the amount by which the log of oil prices in quarter t exceeds the maximum over the previous 12 quarters (3 years) as;

$$\text{NOPI 12} = \max\left[0, \left(\ln o_t\right) - \ln\left(\max\left(o_{t-1,\ldots,} o_{t-12,}\right)\right)\right] \quad (3.5)$$

With the above variables, it is possible to examine the causal relationship between “important” oil price increases and macroeconomic indicators.

The macroeconomic environment also matters for an objective assessment of the impact of oil price shocks. Lee *et al*., (2015) show that oil price increases in the aftermath of long periods of price stability have more dramatic implications than those changes which merely correct for large price declines in the immediate, recent past periods. Thus, it is not only the “importance” of an oil price increase, as in Hamilton’s suggestion, that matters but also the volatility of the oil price series. Lee et al’s Scaled Oil Price Increase (SOPI) is calculated based on a Generalized Autoregressive Conditional Heteroscedasticity, GARCH (1, 1), model as follows;

$$o_t = \alpha + \sum_{i=1}^{k} \beta_i o_{t-i} + \varepsilon_t ; \varepsilon_t / I_t \rightarrow N(0, h_t) \quad (3.6)$$

$$h_t = \gamma_0 + \gamma_1 \varepsilon_{t-i}^2 + \gamma_2 h_{t-i} \quad (3.7)$$

$$SOPI = \max(0, \varepsilon_t / \sqrt{h_t}) \quad (3.8)$$

A significant relationship between this conditional variance adjusted oil price shock variable and economic activity implies that an oil price increase will likely lead to a downturn in output growth where volatility is low, with an increase of similar scale resulting in minimal effect under a highly volatile oil price regime (Cunado and Perez de Garcia 2005; Zhang 2008). We adopt two key non-linear transformations, NOPI4 and SOPI, together with the linear measure in what follows.

2.1 ECONOMETRIC METHODOLOGY

The analysis begins with ascertaining the order of integration of the variables. The procedure adopted in this study involves the use of the Phillips-Perron (2018) (PP) and Kwatkowski *et al.*, (2012) KPSS test. The null hypothesis of the PP test is non-stationarity, thus failure with respect to rejection implies unit root in the series. On the contrary, stationarity is assumed under the null in the KPSS test. Following these unit root tests, the Johansen (2018) maximum likelihood approach to cointegration is employed to examine the presence of any long-run association among the variables. To account for the sensitivity of results using this approach to cointegration to the choice of lag length, the schwarz information criterion (SIC) is used. Also, in order to understand the dynamics of responses, both the impulse response functions (IRFs) and variance decomposition (VD) are used in a vector autoregressive (VAR) framework. While the impulse response functions track the responsiveness of the regressands in the VAR to shocks to each of the other variables, the variance decompositions provide information on the proportion of the movements in the dependent variables accounted for by their own shocks vis-à-vis the shocks to other factors.

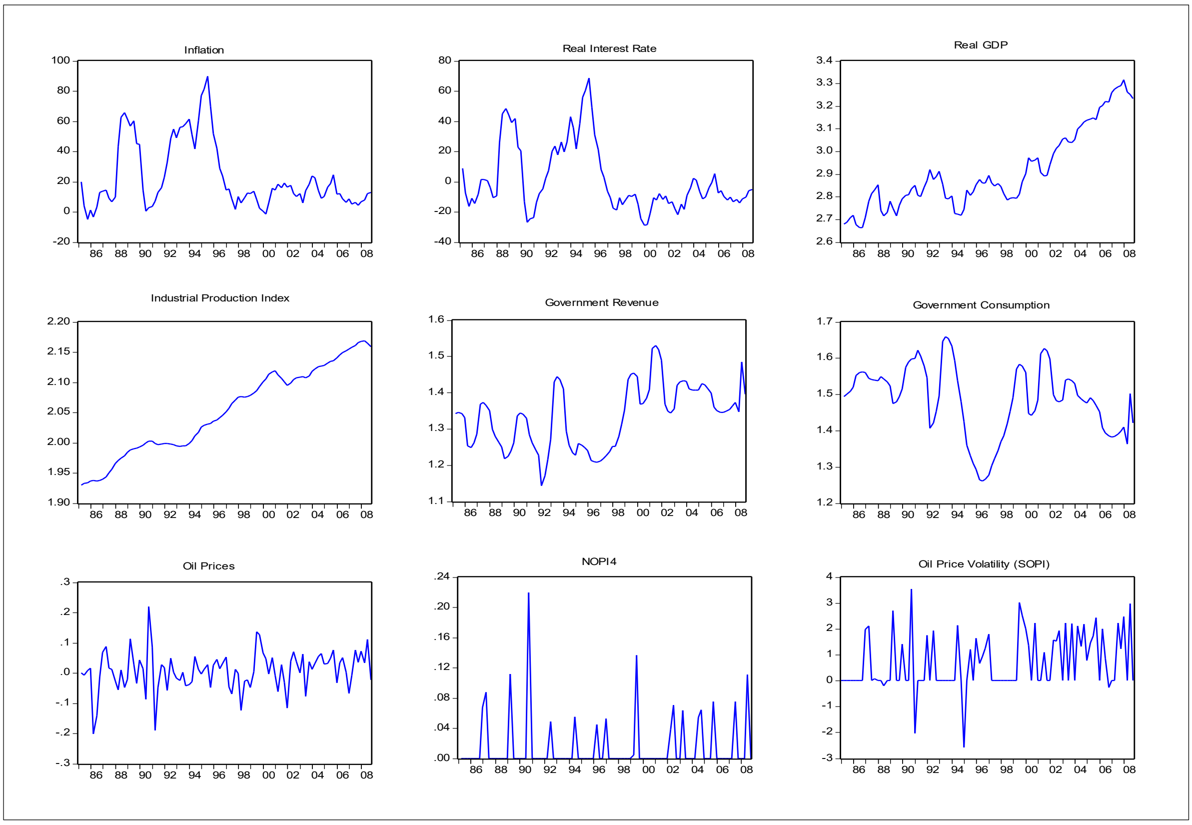

Figure 1: Variable Plots 2020-2024

The magnitude of the impact of oil price fluctuations or its volatility on an economy depends in part on the degree of reliance on oil imports and/or exports (Huang *et al*., 2005). Hence, oil price shocks may have moderate effects on economic activities until some critical threshold is reached. To capture this notion, a formal multivariate threshold autoregressive (MVTAR) model a la Huang (2008) is adopted viz;

$$y_t = (\sum_{j=1}^{4}\alpha_{1j}d_{ij} + \sum_{i=1}^{p}\phi_{i,1}y_{t-i})(1 - I[q_{t-d} > c]) + (\sum_{j=1}^{4}\alpha_{2j}d_{ij} + \sum_{i=1}^{p}\phi_{i,2}y_{t-i})I[q_{t-d} > c] + \varepsilon_t \quad (3.9)$$

where y_t is (Rgdp, Rev, Inf, oilP) [5]. $d_{tj} = 1$ if observation t is characterized by quarter j and restricted to zero otherwise. z_{t-1} represents the I (1) variables cointegrating vector or an error correction term while q_{t-d} denotes the threshold variable with delay period (d) and threshold level (c). ε_t is a stochastic term assumed to be distributed as N(0,1) and I[.] is an index function which equals 1 if the expression in bracket holds and zero otherwise.

3. EMPIRICAL RESULTS AND DISCUSSION OF FINDINGS

3.1 Time Series Properties

Stationarity tests performed on all the variables are presented in Table 1. Both the PP and KPSS tests indicate that INF, RIR, RGDP, INDP, REV and GCONS are all integrated of order one, that is, I (1) while the oil shock measures (OILP, NOPI4 and SOPI) are I (0). Interestingly, however, both the linear (OILP) and volatility adjusted (SOPI) measures of oil price shocks appear to be integrated of order one as shown by the KPSS testing procedure. Since the inclusion of a trend term in the auxiliary regression completely reverses this outcome, the conclusion is that both series are levels stationary and differencing them would be inappropriate (Hamilton, 2014; Iwayemi and Fowowe, 2009).

The need for the conventional cointegration tests is obviated since the variables are integrated of different orders. Hence, the impact analysis is done within a VAR framework with all non- stationary variables entering the unrestricted model in their differenced form (Rafiq *et al*., 2009; Farzanegan and Markwardt, 2009).

Table 1: Unit Root Tests

Variable	PP				KPSS				
	Level		First Difference		Level		First Difference		Decision
	Drif	Drift +trend	Drift	Drift +trend	Drift	Drift +trend	Drift	Drift +trend	
INF	-2.462	-2.610	-6.817***	-6.796***	0.452*	0.185**	0.044	0.037	I(1)
RIR	-2.585	-2.741	-7.091***	-7.053***	0.527**	0.137*	0.035	0.036	I(1)
RGDP	-0.566	-2.171	-7.946***	-7.914***	2.005***	0.429***	0.074	0.040	I(1)
INDP	-0.873	-2.126	-4.109***	-4.119***	2.427***	0.113*	0.078	0.055	I(1)
REV	-2.905	-3.482*	-7.383***	-7.339***	0.919***	0.151**	0.032	0.026	I(1)
GCONS	-2.659	-2.847	-7.327***	-7.288***	0.355*	0.122*	0.036	0.035	I(1)
OILP	-7.899***	-8.161***	NA	NA	0.376*	0.031	0.024	0.022	I(0)
NOPI4	-10.372***	-10.316***	NA	NA	0.061	0.053	0.027	0.021	I(0)
SOPI	-9.682***	-10.571***	NA	NA	0.813***	0.051	0.030	0.023	I(0)

Notes: PP-Phillips and Perron (2018) unit root test with the Ho: Variables are I (1); KPSS-Kwiatkowski, Phillips, Schmidt and Shin (2012) unit root test with Ho: variables are I(0); ***, ** and* indicate significance at the 1%, 5% and 10% levels, respectively while, NA implies not applicable.

3.2 ONE-REGIME VAR ANALYSIS

This begins with the unit root testing approaches presented in Table 1 above. It also involves the use of impulse response functions and forecast error variance decomposition to assess the response of macroeconomic variables to a unit shock to oil prices and the proportion of the variations in the variables attributable to oil price shocks respectively. The analysis that follows is hence preoccupied with these issues together with the standard sensitivity checks typical in most VAR based enquiries.

3.2.1 Impulse Response Functions

The responses of the key macroeconomic variables to different oil price shocks are displayed in figures 2 to 5. These impulse responses, displayed in the last column of each figure, trace the effect of a one-time shock to a measure of oil price shocks on the

[5] This oil price variable includes the linear benchmark (OILP) as well as the two other non-linear transformations (NOPI4 and SOPI) which are used in turn for the VAR analysis.

contemporaneous and future values of each of the other endogenous variables.

In Figure 2, the response of macroeconomic variables to shocks to the benchmark linear oil price indicator is shown. Output responds positively throughout the 10 quarters following the change in oil prices. However, the significance of the response dies out after about 4 periods. Inflation initially drops in a seemingly precipitous manner during the first 3 quarters but this decline becomes completely muted 10 quarters later.

The response of government revenue to a shock to oil prices is insignificant in all periods after the one-time shock. Thus, output, inflation and government receipts respond differentially to shocks to the linear oil price variable [6].

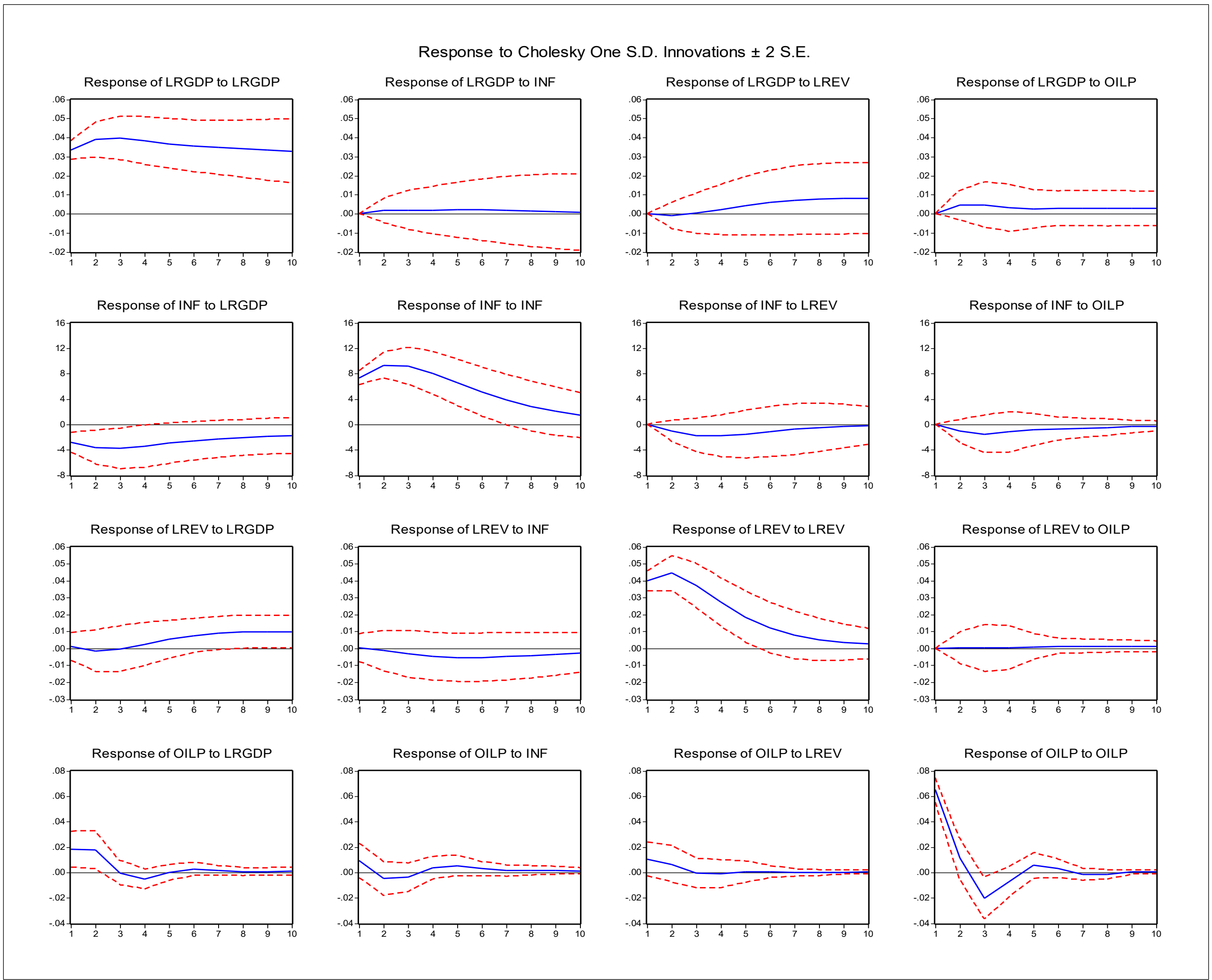

Figure 2: Impulse Response Functions of shocks to benchmark measure (oilP)

The observed breakdown in the oil price-macroeconomy relationship especially after the oil price collapse of the mid-2010s led to efforts at exploring plausible explanations for this phenomenon. Hamilton (2016), along this line, posits that novel [7], oil price changes are likely to have more impact on economic activities than those which are simply corrections of past oil price changes. He therefore suggested a net oil price shock measure (NOPI4) which only accounts for all prices that are greater than the prices recorded for the preceeding four quarters.

[6] For the sake of robustness we change the ordering of the variables in the unrestricted VAR. The results using three alternative orderings, available upon request, show that the responses of the variables to a shock to the linear oil price measure are similar to the obtained here.

[7] Novelty in this instance is defined in terms of oil price realisations that substantially exceed historically observed to the values. The history will however depend on how much of past price information the analyst decides to take on board.

We construct and employ this oil shock measure and display the impulse responses in Figure 3. Here, the response of output to a one unit shock to NOPI4 is minimal. Specifically, there is a marginal rise in output up to about quarter 4 before tapering off occurs in latter periods. Inflation shows no significant response to important oil shocks over the previous four quarters. Nevertheless, the response of government revenue to oil price shocks (NOPI4) appears to be significant for most of the periods following a one-off shock to oil prices. This sharply contrasts with the results obtained with the linear measure. Since unimportant oil prices are assigned a value of zero in constructing the NOPI4, it is plausible that only substantial price changes which are more likely to affect oil revenue receipts are included. Hence, the marked difference in the results returned by both models in our VAR framework.

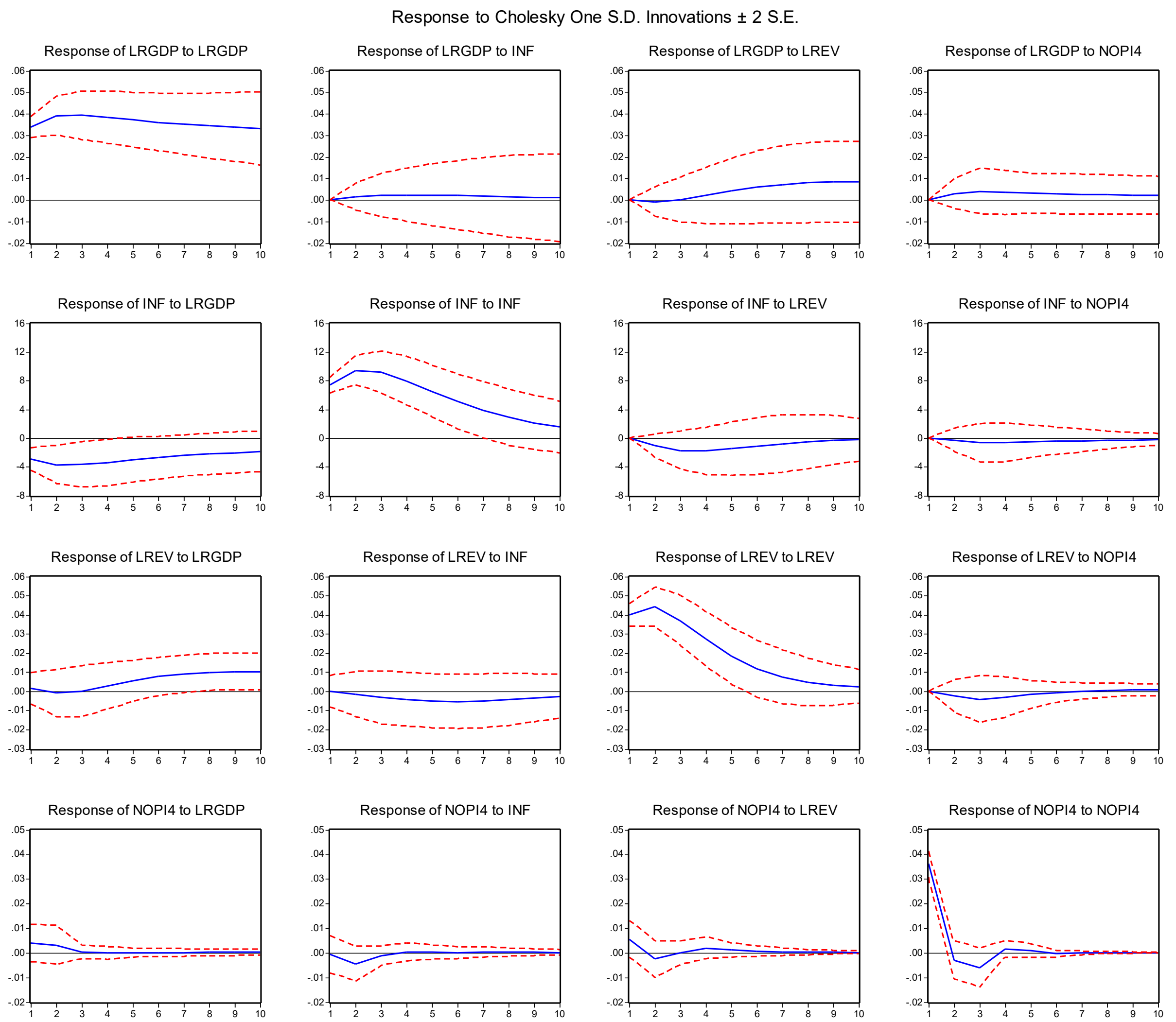

Figure 3: Impulse Response Functions of shocks to NOPI4

Following Lee *et al.*, (2015) we also construct a volatility adjusted measure of oil price shocks. This SOPI is obtained from a GARCH (1,1) model of oil price change. The intuition behind this is simply that oil price movements are likely to be more important in an environment characterised by historically stable prices whereas the impact of oil shocks may be muted where prices are known to be volatile. Figure 4 displays the impulse responses of the macroeconomic variables to shocks to the SOPI measure. In this case, output shows no response to shocks to SOPI. This implies that the volatility of oil prices is not an important factor influencing real output variations in Nigeria. Also, inflation did not respond to shocks to oil prices in all the 10 periods after the occurrence of such a shock. However, government revenue first increases around the 2 quarter before the effect dies out.

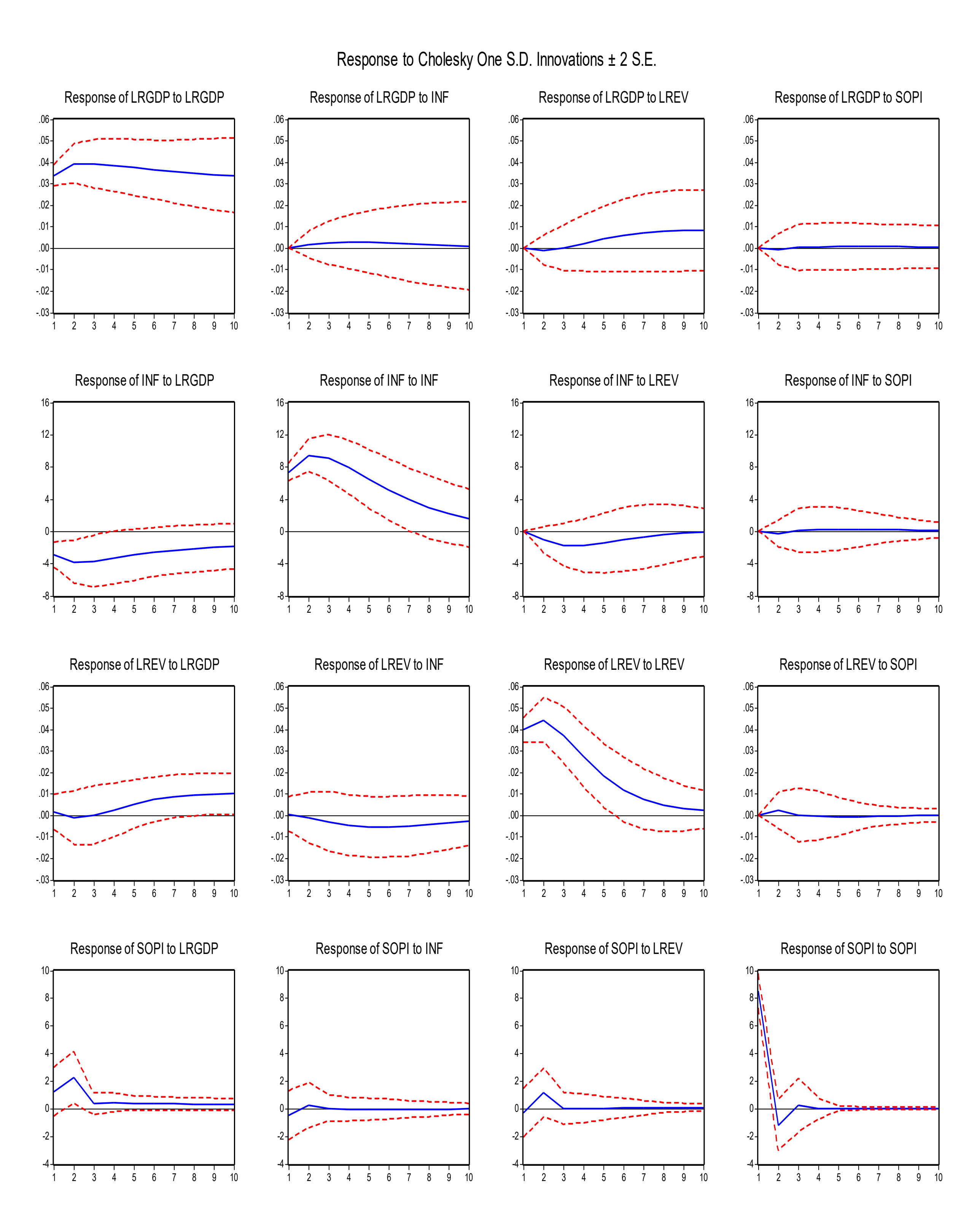

Figure 4: Impulse Response Functions of shocks to SOPI

To ascertain the robustness of our results, we use an alternative measure of output- the industrial production index- to test the sensitivity of responses to the measure of output adopted. The summary of this exercise is displayed in Figure 5 below.

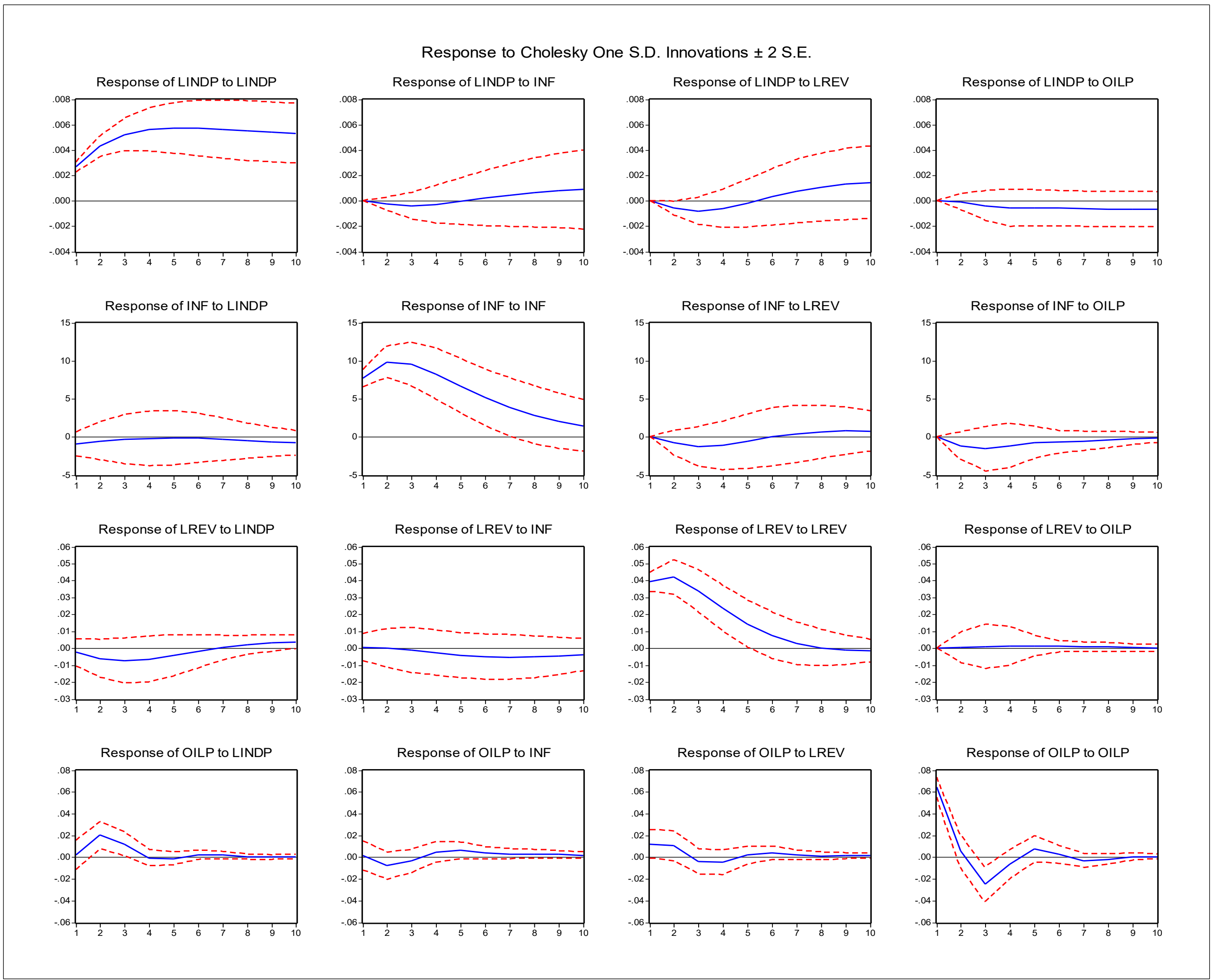

Figure 5: Impulse Response Functions of shocks to Oilp (Using Industrial Production Index).

It is interesting to note the difference observed with the use of the industrial production index. While output response was positive in the case of the linear benchmark (Figure 2), the converse is true when the industrial production index is the output measure adopted. It is plausible that oil price changes result in the transfer of income from oil importers to oil exporters. For instance, an oil price increase implies that an input into production has become relatively scarce in oil importing economies hence the negative output response displayed in Figure 5. This result agrees to a large extent with the arguments extensively developed in Abesinghe (2001).

3.2.2 Variance Decomposition

The variance decomposition typically shows the proportion of the forecast error variance of a variable which can be attributed to its own shocks and the innovations of the other variables. The general picture that emerges from a deeper look at Tables 1 to 4 below appears to be that oil price shocks only accounts for a small proportion of the forecast error variance of output, government revenue and inflation.

Table 1: Variance Decomposition Using Linear Oil Shock Measure (oilP)

Dependent Variable	Period	Standard Error	Output (Real GDP)	Inflation	Government Revenue	Oil
Output (Real GDP)	1	0.0335	100	0.0000	0.0000	0.0000
	5	0.0842	98.7283	0.1787	0.3182	0.7748
	10	0.1157	96.9228	0.178	2.1926	0.7066
Inflation	1	7.8579	12.8816	87.1194	0.0000	0.0000
	5	20.0953	13.95	82.1574	2.4535	1.4394
	10	22.0548	16.3977	79.6157	2.5164	1.4702
Government Revenue	1	0.0399	0.0926	0.0022	99.9052	0.0000
	5	0.0782	0.6139	1.0589	98.3089	0.0182

	10	0.0829	6.6924	2.2438	90.9395	0.1242
Oil	1	0.0689	7.0196	1.8054	2.3477	88.8273
	5	0.0764	11.5558	2.8615	2.6233	82.9594
	10	0.0767	11.6436	3.1032	2.6123	82.6409

Table 2: Variance Decomposition Using NOPI4

Dependent Variable	Period	Standard Error	Output (Real GDP)	Inflation	Government Revenue	NOPI4
Output (Real GDP)	1	0.0336	100.0000	0.0000	0.0000	0.0000
	5	0.0843	98.8473	0.2239	0.3044	0.6244
	10	0.1157	96.9402	0.2119	2.2933	0.5546
Inflation	1	7.9091	13.4424	86.5576	0.0000	0.0000
	5	20.0009	14.2899	82.9567	2.4499	0.3034
	10	22.0352	17.2140	79.8894	2.5248	0.3719
Government Revenue	1	0.0398	0.1433	0.0005	99.8562	0.0000
	5	0.0781	0.6219	0.9857	97.7763	0.6159
	10	0.0829	7.0481	2.2535	90.1240	0.5745
NOPI4	1	0.0367	1.1088	0.0352	2.2669	96.5891
	5	0.0379	1.6056	1.6067	2.9115	93.8762
	10	0.0379	1.6105	1.6099	2.9317	93.8478

Table 3: Variance Decomposition Using SOPI

Dependent Variable	Period	Standard Error	Output (Real GDP)	Inflation	Government Revenue	SOPI
Output (Real GDP)	1	0.0337	100.0000	0.0000	0.0000	0.0000
	5	0.0844	99.3751	0.2999	0.3080	0.0168
	10	0.1161	97.5594	0.2722	2.1488	0.0196
Inflation	1	7.9018	13.9402	86.0598	0.0000	0.0000
	5	19.9342	14.4613	83.0260	2.4632	0.0494
	10	21.9635	17.1583	80.3162	2.4539	0.0716
Government Revenue	1	0.0397	0.1221	0.0169	99.8609	0.0000
	5	0.0781	0.5575	1.0370	98.3122	0.0932
	10	0.0827	6.5543	2.2677	91.0817	0.0964
SOPI	1	8.6261	1.9493	0.3345	0.1191	97.5970
	5	9.0921	8.2279	0.3752	1.7119	89.6850
	10	9.1228	8.8039	0.3974	1.7167	89.0819

Table 4: Variance Decomposition using Linear Measure (oilP) and Industrial Production Index

Dependent Variable	Period	Standard Error	Output (Industrial Production)	Inflation	Government Revenue	Oil
Output (Industrial Production)	1	0.0027	100.0000	0.0000	0.0000	0.0000
	5	0.0109	97.8019	0.2617	1.2348	0.7016
	10	0.0168	95.6276	0.8375	2.4955	1.0396
Inflation	1	7.7763	1.4209	98.5791	0.0000	0.0000
	5	19.2799	0.3659	96.9808	1.0690	1.5843
	10	20.7777	0.6717	96.4182	1.3201	1.5899
Government Revenue	1	0.0393	0.3839	0.0203	99.5957	0.0000
	5	0.0736	2.9352	0.4712	96.4999	0.0937
	10	0.0750	3.3560	2.5062	93.9942	0.1436
Oil	1	0.0655	0.0853	0.0505	3.4244	96.4399
	5	0.0766	9.3733	2.3542	5.0498	83.2227
	10	0.0773	9.3568	2.9706	5.3630	82.3095

Table 1 presents the forecast error variance decomposition when the linear measure of oil shocks is used. It is easily seen that oil price shocks had 0% initial impact on output while there was a slight increase to about 0.77% in the 5th period before an eventual marginal decline to 0.71% at the end of the 10th period. Another striking finding from this table is that oil price shocks contributes less than 1% to the variations in the other macroeconomic variables except for the 5th and 10th period inflation of 1.44% and 1.47% in that order. It is also interesting to note that the results from the use of alternative oil shock measures, that is NOPI4 and SOPI, are quantitatively indistinguishable from the results in Table 1 [8]. Also,

[8] Although the output effects in Tables 2 and 3 are less than 1%, the magnitude is higher when the NOPI4 measure is used. In the fifth period for instance, oil shocks accounted for 0.624 and 0.017 in the model with NOPI4 and SOPI respectively.

irrespective of the oil shock measure adopted the proportion of the variances in the forecast errors of inflation and government revenue explained by oil shocks remains at best infinitesimal. There is however, as seen from Table 4, a relatively more pronounced impact on macroeconomic variables. For example, oil price shocks account for more than 1% of the variance of output and about 1.6% of the variance of inflation after about 10 periods.

3.3 TWO-REGIME VARIABLE ANALYSIS

Oil price shocks affect macroeconomic performance with this effect depending to some extent on economy's degree of oil dependence. There have been significant changes in the responses of both oil importing and exporting countries since the major energy crisis of the early 1970s. These coping strategies range from fuel substitution in the former countries to efforts at diversification in the latter. To capture the impact of such an effect we use the oil price variable as the threshold variable and then split the sample into two regimes. Regime 1 contains all observations less than or equal to a critical threshold value while those greater than this value are the components of Regime 2.[9] We now turn to the impulse responses of macroeconomic variables to a unit shock to oil prices in our constructed Regimes 1 and 2 in what follows.

3.3.1 Impulse Response Functions (Regimes 1 and 2)

Figures 6 and 7 display the impulse response functions of macroeconomic variables to oil shocks during the COVID-19. The output effects appear to be insignificant as seen from figure 6. There is, however, a period of marginal increase in output in response to oil shocks which is also not significant over the range from the 3^{rd} to the 6^{th} periods. Inflation, in similar fashion, declined between periods 2 and 7 although this reduction was found to be insignificant as well. Therefore, the output and price effects of oil shocks in Regime 1 seem to be inconsequential. Government revenue, in contrast, shows a significant fall around the 3^{rd} period. However, the statistical importance of this decline is not clear.

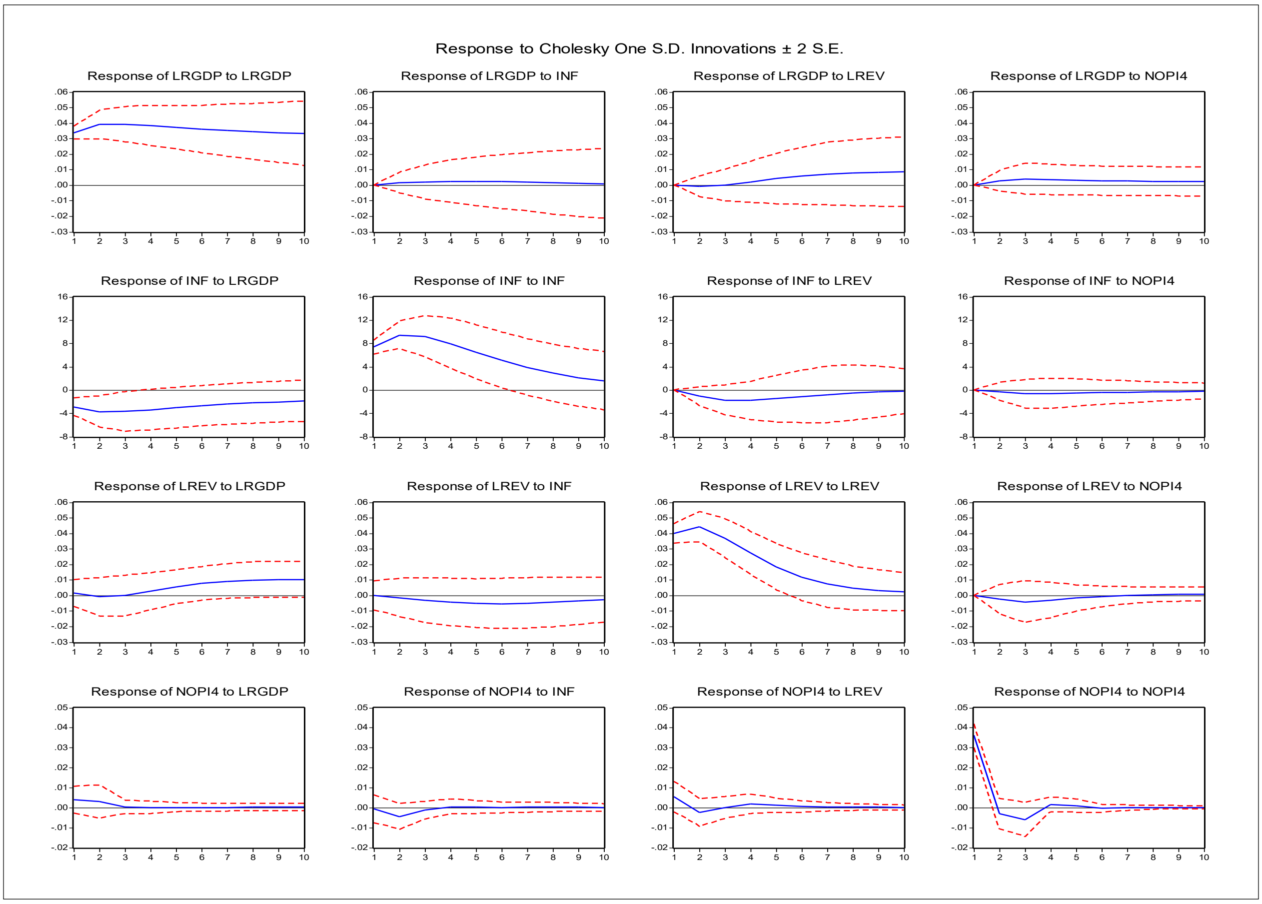

Figure 6: Impulse Response Functions of shocks to NOPI4 in Regime 1

[9] It is noteworthy that a threshold value of 0.0034 is chosen as the critical point beyond which oil shocks become important. Sample splitting using this benchmark left us with 42 observations in Regime 1 and 54 observations in Regime 2. Also, the number of observation in each regime was similar when real output and other oil price measures were chosen as threshold variable. For the interested reader, these additional results are available upon request.

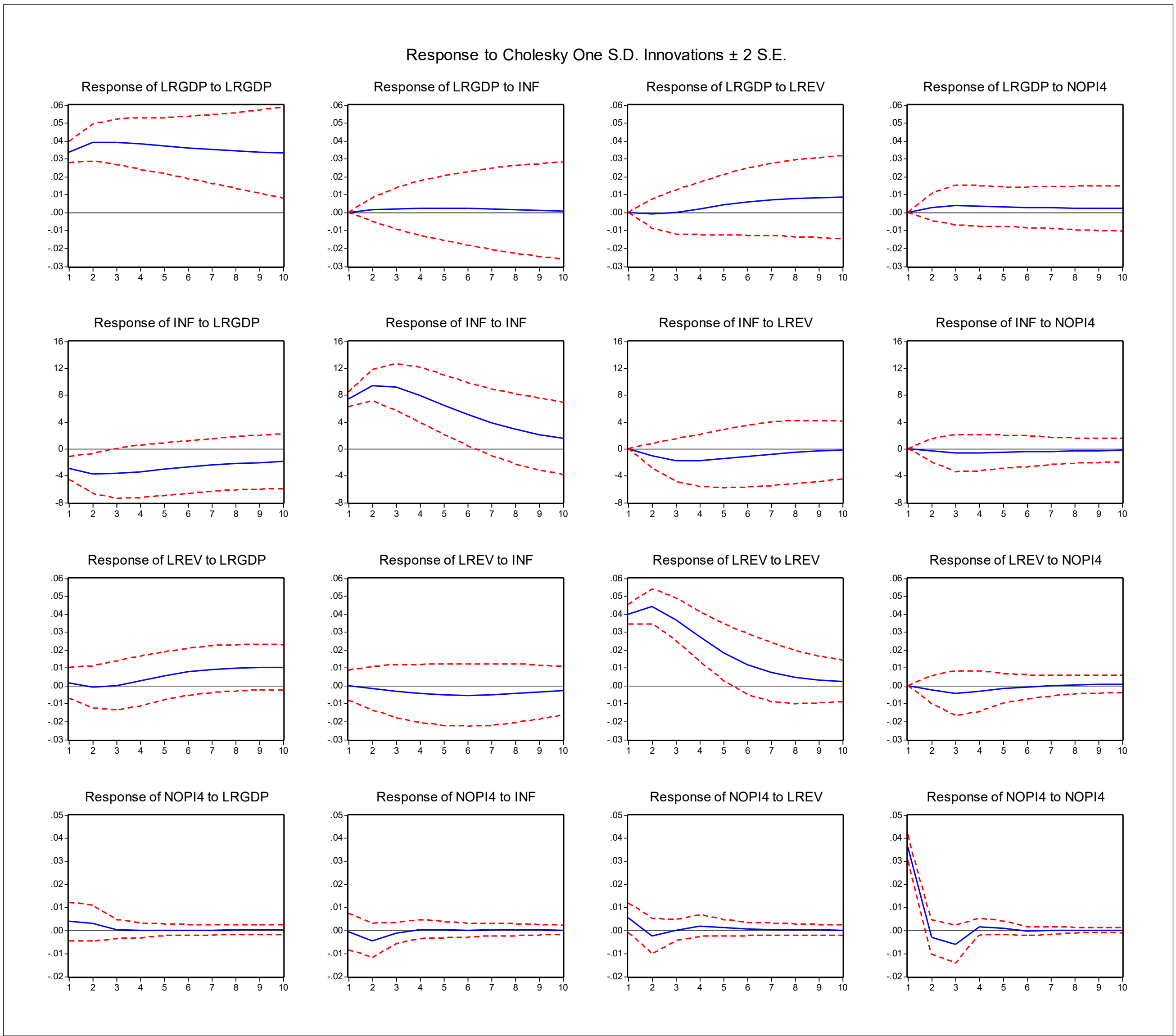

Figure 7: Impulse Response Functions of shocks to NOPI4 in Regime 2

A deeper look at Figure 7, which shows the impulse response functions for Regime 2, reveals that responses of output, inflation and government revenue to a one-time shock to oil prices are similar to those obtained in Regime 1. Hence, it appears as though the response of the Nigerian macro-economy to shocks to oil prices is independent of the critical threshold level as there seems to be no obvious distinction between the impulse responses across regimes. This, arguably [10], makes a case for the unimportance of thresholds in the oil price-macroeconomy relationship in Nigeria. This conclusion is not different from those of earlier studies [11], like Ayadi *et al.*, (2000), Ayadi (2005) and Olomola and Adejumo (2006) who found oil price shocks during the advent of COVID-19 to have minimal impacts on the Nigerian economy.

3.3.2 Variance Decomposition for Regime 1

The last column of Table 5 below shows the respective proportions of the forecast error variance of macroeconomic variables attributable to oil price shocks. The overall picture that emerges is one in which oil price fluctuations explain far less than 1% of the variations in output and the other variables.

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[10] Arguable in the sense that the choice of both threshold variable and the critical threshold value, in this study, are somewhat arbitrary. The NOPI4 measure of oil price shocks was used as threshold variable while a critical value of 0.0034 was adopted. Hence, Regime 1 comprised values less than or equal to 0.0034 and Regime 2 those observations greater than 0.0034.

[11] The point of departure, however, of the present study is that thresholds were not explicitly considered in these studies.

Table 5: Variance Decomposition using NOPI4 in Regime 1

Dependent Variable	Period	Standard Error	Output	Inflation	Government Revenue	NOPI4
Output	1	0.0336	100.0000	0.0000	0.0000	0.0000
	5	0.0843	98.8473	0.2239	0.3044	0.6244
	10	0.1157	96.9402	0.2119	2.2933	0.55546
Inflation	1	7.9091	13.4424	86.5576	0.0000	0.0000
	5	20.0009	14.2899	82.9567	2.4498	0.3034
	10	22.0352	17.2140	79.8894	2.5248	0.3719
Government Revenue	1	0.0398	0.1433	0.0005	99.8562	0.0000
	5	0.0781	0.6219	0.9856	97.7763	0.6159
	10	0.0829	7.0481	2.2535	90.1240	0.5745
NOPI4	1	0.0367	1.1088	0.0352	2.2669	96.5891
	5	0.0379	1.6056	1.6067	2.9114	93.8762
	10	0.0379	1.6105	1.6099	2.9317	93.8479

The results for Regime 2, not presented here for the sake of brevity, seem to suggest a similar conclusion since in no case was the effect of oil shocks greater than 0.7123 (the response of output after about 10 periods). In sum, the variance decomposition results reinforce the conclusion from the previous impulse response functions that oil price shocks appear not to have appreciable effect on the macroeconomy in Nigeria.

4. CONCLUSIONS AND POLICY IMPLICATIONS

This paper empirically investigated the effects of oil price shocks during COVID-19 on macroeconomic variables, with particular emphasis on real output, in Nigeria. The preponderance of evidences in the literature deal with this issue as it concerns net oil importing economies. Although a number of studies focus on oil exporters, this study follows a different course by explicitly taking account of not only potential non-linearities but also the plausible role of thresholds in influencing the oil price-macroeconomy linkage. Broadly speaking, our findings show that the impact of oil price shocks during COVID-19 on most of the macroeconomic variables in Nigeria is at best minimal. Specifically, the results of the impulse response functions and variance decomposition analysis to a large extent confirmed that oil price shocks are only able to explain a small proportion of the forecast error variance of these macroeconomic aggregates during COVID-19. Oil price shocks, as revealed by variance decomposition, accounted for less than 1% of the variations in output, inflation and Government revenue. The most striking finding, however, was that this pattern persists even when critical thresholds are included in the estimation procedure. Hence, we find evidence of a muted effect of oil price shocks on the Nigerian economy. Although a policy of diversification is usually recommended for economies which depend solely on oil revenue, the applicability of such an option appears unclear from what we have found in the case of Nigeria.

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