Oil Price Volatility and Economic Growth in Nigeria: a Vector Auto-Regression (VAR) Approach

Edesiri Godsday Okoro[1]

Abstract: The study examined oil price volatility and economic growth in Nigeria linking oil price volatility, crude oil prices, oil revenue and Gross Domestic Product. Using quarterly data sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin and World Bank Indicators (various issues) spanning 1980-2010, a non-linear model of oil price volatility and economic growth was estimated using the VAR technique. The study revealed that oil price volatility has significantly influenced the level of economic growth in Nigeria although; the result additionally indicated a negative relationship between the oil price volatility and the level of economic growth. Furthermore, the result also showed that the Nigerian economy survived on crude oil, to such extent that the country's budget is tied to particular price of crude oil. This is not a good sign for a developing economy, more so that the country relies almost entirely on revenue of the oil sector as a source of foreign exchange earnings. This therefore portends some dangers for the economic survival of Nigeria. It was recommended amongst others that there should be a strong need for policy makers to focus on policy that will strengthen/stabilize the economy with specific focus on alternative sources of government revenue. Finally, there should be reduction in monetization of crude oil receipts (fiscal discipline), aggressive saving of proceeds from oil booms in future in order to withstand vicissitudes of oil price volatility in future.

Keywords: crude oil prices; oil revenue; gross domestic product; white heteroskedasticity test

JEL Classification: O47; C25

1. Introduction

The Nigerian economy has been undergoing fundamental structural changes over the years. The economy which was largely at a rudimentary stage of development has been experiencing structural transformation after the country's independence (Dappa and Daminabo, 2011). When Nigeria became politically independent in October 1960, agriculture was the dominant sector of the economy; contributing about 70 percent of the Gross Domestic Product (GDP), employing about the same

[1]Master Student, Department of Accountancy, Nnamdi Azikiwe University, Awka, Nigeria, Address: Anambra, Nigeria, Tel.:+2348060492273, Corresponding author: edesirioracle@yahoo.com.

percentage of the working population and accounting for about 90 percent of foreign earnings and federal government revenue (National Centre for Economic Management and Administration (NECEMA), 2012). During this period, manufacturing and mining activities were at a very low level of development while the country's participation in external trade was based on the level of economic activities in agriculture where it had a comparative advantage. Thus, agriculture dominated the country's export trade while manufactured items dominated imports (Central Bank of Nigeria (CBN), 1993). Oil was discovered in commercial quantity in Nigeria in 1956 and since then, oil has been the mainstay of the country's economy up-till this present dispensation. In Nigeria, oil accounts for more than 90 percent of its exports, 25 percent of its Gross Domestic Product (GDP) and 80 percent of government total revenues (Adebiyi, et.al 2012).

The term oil price volatility refers to instability, changes, a rise or fall, in the supply or demand side of oil prices in the international oil market. The rise or flux in the prices of oil can be termed positive (i.e. a rise) or negative (i.e. a fall). Akpan (2012) opined that the instability in the prices of oil have been traditionally traced to supply side disruptions such as OPEC supply quotas, political upheavals in the oil-rich Middle East and militancy in the Niger Delta region. Nnanna and Masha (2003) observed that, changes in global oil market prices bring about a tremendous effect on economic growth, especially in the real sector. The real sector is where goods and services are produced through the combined utilization of raw materials and other production factors such as labour, land and capital. The real sector therefore forms the main driving force of any economy in the world and the engine of economic growth. The real sector comprised of agriculture, industry, building and construction, and services.

In Nigeria, much of the revenues are generated from the real sector (especially the oil and gas industry). This forms the pivot for government budgets and subsidization of domestic petroleum product prices (especially gasoline which is the most demanded for transportation and other uses in the country). Volatility in oil prices bring about a favourable investment climate, increased national income within the period with a slight decline in the growth rate of Gross Domestic Product (GDP); despite the perceived benefits of volatility in oil prices, the economy of Nigeria during the boom were yet undesirable (Adeniyi, Abimbola and Akin, 2011). Hence it appears that oil price volatility thus affect economic growth. If this premise is true, then there is therefore the fundamental issue of ascertaining whether oil price volatility could positively or negatively affect economic growth in Nigeria.

2. Prior Literature

Traditionally, oil prices have been more volatile than many other commodity or asset prices since World War II. The trend of demand and supply in the global economy coupled with activities of OPEC consistently affects the price of oil. Changes in oil prices in the global economy are so rapid and unprecedented. This is partly due to increased demand of oil by China and India (Hamilton, 1983). However, the global economic meltdown counteracted the skyrocketing oil price in Nigeria. During the inception of the crisis, oil price crashed below $40/b in the world market which had serious consequences on Nigeria fiscal budget leading to the downward review of the budget oil bench mark price. Today oil price is oscillating between $75/b and $80/b. This rapid change has become a great concern to everybody including researchers and policy makers.

Oil prices have been very volatile since 1999. Spikes from March 1999 are because of the following factors: (i) OPEC restricted crude oil production and there is greater cooperation among its members; (ii) Asian growing oil demand signifying recovery from crisis; and (iii) Shrinking non-OPEC production. The world market responded accordingly with sharp increase in prices, with crude oil prices increasing and exceeding US$30/b towards the end of 2000. OPEC then tried to maintain prices at a range between US$22/b and US$28/b by increasing or reducing production, and with increases in output by non-OPEC producers, particularly Russia (Adeniyi, 2012).

Gunu and Kilishi (2010) asserted that the September 11 2001 was another incident that sent crude oil prices plummeting, despite earlier production increases by non-OPEC producers and reduction of quotas by OPEC member countries but soon afterwards, prices moved to the US$25/b range. In 2004, prices moved above this range, with the crude oil hovering above US$40/b per barrel during the year. The monthly average world gasoline prices increased from US$0.26 a litre in January 2004 to US$0.37 in January 2007 and to US$0.73 by August 2008. Diesel prices were US$0.25 a litre in January 2004, US$0.42 in January 2007, and US$0.84 in August 2008. Bassam (2010) observed that during this period, some developing countries including Nigeria experienced a large currency appreciation which partially helped offset oil price increases. Other countries experienced currency depreciation, exacerbating the impact of steep oil price rises. Retail fuel prices of gasoline and diesel in August 2008 were, on average, about 50 percent higher in industrialised countries than in developing countries. Gasoline, diesel, and household kerosene prices in oil-importing developing countries were twice as high as those in oil-exporting countries.

By region, Sub-Saharan Africa had the highest gasoline and diesel prices in the developing world, a consequence of the landlocked nature of some of its countries, inadequate economies of scale in small markets, inadequate infrastructure for

transporting fuels, rising demand for diesel to offset power shortages, and relatively high rates of taxation. Retail prices of liquefied petroleum gas, used in household cooking, were low in relation to world prices, reflecting the tendency of governments to subsidize fuel. However, a number of countries - including Bangladesh, China, Egypt, Ethiopia, India, Indonesia, the Islamic Republic of Iran, Malaysia, Nepal, Nigeria, Sri Lanka, the Syrian Arab Republic, Venezuela, and the Republic of Yemen - set fuel prices in an ad hoc manner, and most have seen growing price subsidies in recent years (Akpan, 2012). In Nigeria the domestic retail prices are regulated and subsidized by government, however, the prices are adjusted (upward or downward) from time to time.

According to Nouriel and Brad (2004), volatility in oil prices has a stagflationary effect on the economy of an oil importing country: they slow down the rate of growth (and may even reduce the level of output – i.e. cause a recession) and they lead to an increase in the price level and potentially an increase in the inflation rate. Volatility in oil prices act like a tax on consumption. The factors contributing to volatility in oil prices can be isolated as follows: the continued fall in Naira and political tension in the South-South region; high demand for crude oil by other countries and uncertainty about the future of oil producers. The depreciation of the Naira against other major currencies contributed to increasing fuel prices. The banking crisis that erupted in 2006, following more than a year of less acute financial turmoil, has substantially reinforced the cyclical downturn of oil prices. Also, the consequent global economic meltdown contributed to the volatile nature of oil prices.

3. Empirical Evidence

Oil price volatility on economic growth has occupied the attention of researchers for almost four decades (Adeniyi, 2012; Lutz and Cheolbeom, 2007). In a study of the impact of oil price volatility on economic growth in Nigeria using four key macroeconomic variables, Gunu and Kilishi (2010) found that oil prices have significant impact on real GDP, money supply and unemployment and that the impact on the fourth variable, consumer price index is not significant. The findings implied that three key macroeconomic variables (real GDP, money supply and unemployment) were significantly explained by exogenous and the highly volatile variable, hence the economy of Nigeria is vulnerable to external shocks. Similarly, Lutz (2006), and Olivier and Jordi (2007) empirically examined the impact of oil price volatility on economic growth. In his study, Lutz (2006) established that volatility in oil prices is crucial in assessing the effect it has on US real GDP and CPI inflation, suggesting that policies aimed at dealing with volatility in oil prices must take careful account of the origins of changes in oil prices. In the same way, Olivier and Jordi (2007) investigated the macroeconomic effects of oil price

volatility using a set of industrialized economies in the aftermath of oil price changes of the 1970s and of 2000s, focusing on the differences across episodes. They found that lack of concurrent adverse changes, smaller share of oil in production, flexibility of labour markets and improved monetary policy played an important role in the economy.

In a study on the effect of oil price shocks on output, inflation, real exchange rate and money supply in Nigeria using quarterly data from 1970 to 2003, Olomola and Adejumo (2006) established that oil price shocks do not affect output and inflation in Nigeria. They argued that oil price shocks do significantly influence real exchange rates.

Rebeca and Marcelo (2004) assessed the effect of oil price shocks on real economic activity of some industrialized OECD countries using a multivariate VAR analysis. Their study found evidence of a non-linear impact of oil prices on real GDP. Also that among oil importing countries, oil price increases are found to have a negative impact on economic activity in all cases but Japan with oil price increases affecting the UK negatively and Norway positively. Empirical evidence suggests that there are relatively few cases of research on oil price volatility in Nigeria; thus, the present study focused on oil price volatility and economic growth in Nigeria using the VAR model.

4. Methodology

This study was carried out in Nigeria to see the influence of oil price volatility on the level of economic growth. The study covered the period 1980-2010.

4.1. Method of Analysis

In order to ascertain the volatility in oil prices and the influence on the level of economic growth, an unrestricted Vector Auto-Regression (VAR) Model was adopted. The VAR model provides a multivariate framework where changes in a particular variable (oil price) are related to changes in its own lags and to changes in other variables as well their lags. The VAR treats all variables as endogenous and does not impose *a-priori* restriction on structural relationships (Gujarrati, 2003). The VAR estimates the relative importance of a variable in generating variations in its own value and in the value of other variables which can be accessed via Forecast Error Variance Decomposition (VDC). There was also a co-integration test as well as a normality test, which helped to determine if the error term of the variables under consideration were normally distributed.

4.2. Data Definition and Source

The data for this study were generated from the Central Bank of Nigeria (CBN) Statistical Bulletin and World Bank Indicators for Nigeria (various issues) during

1980-2010. The data for Crude Oil Price (COP), Oil Revenue (OREV) and Gross Domestic Product (GDP) were sourced from the Central Bank of Nigeria Statistical Bulletin and Oil Price Volatility (OPS) from the World Bank Indicators for Nigeria.

4.3. Model Specification

The econometric model considered in this study takes Crude Oil Prices, Oil Revenue and Oil Price Volatility as the independent variables and Gross Domestic Product as dependent variable. These variables are used at constant prices. This is used to obtain a reliable parameter estimates in the time series VAR model. Generally, a VAR model is specified as:

$$\mathbf{Y_t = m + A_1Y_{t-1} + A_2Y_{t-2} + \ldots + A_pY_{1-p} + \epsilon_t} \qquad \mathbf{(1)}$$

Equation (1) specifies VAR (P) process, where A_i($_i$=1,2,…p) are K x K matrices of coefficients, m is a K x 1 vector of constants and ϵ_t is a vector of white noise process. Therefore, a model for the analysis can be stated explicitly as follows:

GDP = F(OPV, OREV, COP) (2)

Where:

GDP = Gross Domestic Product

OPV = Oil Price Volatility

OREV = Oil Revenue

COP = Crude Oil Price

In order to estimate equation (1 and 2), we can translate this into equation 3 as stated below:

$$\mathbf{GDP = m_0 + A_1OPV_{t-1} + A_2OREV_{t-2} + A_3COP_{t-3} + \epsilon_t} \qquad \mathbf{(3)}$$

5. Results and Discussion

The tests were conducted in order of priority. The ADF Unit Root Test came first which was closely followed by the Co-integration Test, Over-parameterized and Parsimonious Error Correction Test and Diagnostic Test came next which was concluded by the Variance Decomposition Test.

5.1. ADF Unit Root Test

Table 1. Summary of ADF Unit Root Test

Variables	Level date	1st diff	1% CV	5% CV	10% CV	Order of Integration
OREV	-2.07	-5.46*	-3.69	-2.97	-2.62	I(1)
OPV	-4.20*	-6.38	-3.69	-2.97	-2.62	I(0)
COP	0.66	-2.86***	-3.69	-2.97	-2.62	I(1)
GDP	1.37	-5.08*	-3.69	-2.97	-2.62	I(1)

* Statistically significant at 1% level

*** Statistically significant at 10% level

The Augmented Dickey Fuller (ADF) unit root test was used to test whether the variables are stationery or not and their order of integration. The result of the ADF unit root test is shown in table I above. The result of the ADF unit root test followed expectations. All the variables except Oil Price Volatility (OPV) were non-stationery. They however became stationary after taking the first order difference. The oil price volatility was stationary at the level probably because it is computed in ratio. This set the pace for the next stage of the analysis which is a test of co-integration.

5.2. Co-integration Test

The Johansen co-integration test was used to test for the long run relationship among the variables. The results of the Johansen co-integration test are shown in tables IIa and table IIb below.

Table 2a. Summary of Johansen Co-integration Test Result

Hypothesize No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.640692	77.78483	68.52	76.07
At most 1*	0.602173	48.10118	47.21	54.46
At most 2	0.431028	21.37075	29.68	35.65
At most 3	0.143147	5.016967	15.41	20.04
At most 4	0.018340	0.536789	3.76	6.65

Table 2b. Summary of Johansen Co-integration Test Result

Hypothesize No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.640692	29.68365	33.46	38.77
At most 1	0.602173	26.73042	27.07	32.24
At most 2	0.431028	16.35379	20.97	25.52
At most 3	0.143147	4.480178	14.07	18.63
At most 4	0.018340	0.536789	3.76	6.65

The results of the Johansen co-integration test in tables IIa and IIb above showed that a long run relationship exists among oil price volatility, oil revenue, crude oil prices and economic growth. The trace test indicated two co-integrating equation while the max-eigen statistic indicated one co-integrating equation. Once there is co-integrating vector, a long run relationship is concluded (Gujarati, 2003). The existence of at least one co-integrating equation permits us to estimate over-parameterized and parsimonious error correction mechanism (ECM).

5.3. Over-parameterized and Parsimonious Error Correction Mechanism

The Over-parameterized and Parsimonious Error Correction Mechanism (ECM) test are shown in tables IIIa and IIIb below.

Table 3a. Summary of Over-parameterized ECM result Dependent Variable: DLGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLCOP	0.483866	0.105695	4.577960	0.0001
DLCOP(-1)	0.300630	0.293394	1.024661	0.3184
DLCOP(-2)	0.023727	0.281602	0.084259	0.9337
DLOREV	0.291112	0.116558	2.497571	0.0219
DLOREV(-1)	0.492357	0.116026	4.243516	0.0004
DLOREV(-2)	0.029815	0.163759	0.182066	0.8575
OPV	-0.889766	0.181262	-4.908717	0.0000
ECM(-1)	-0.454316	0.167069	-2.719327	0.0105
C	0.068255	0.169144	0.403534	0.6911

$R^2 = 0.73$, $R^2 = 0.61$, AIC = 1.96, SC = 2.38, Dw = 2.07

The over-parameterized error correction mechanism (ECM) model includes various lags of the variables. The parsimonious ECM model (or preferred model is gotten by deleting the insignificant variables from the over-parameterize ECM model. The Schwarz criterion and the Akaike information criteria were used to select the appropriate lag length. The parsimonious ECM result was gotten by deleting insignificant variables from the over-parameterize ECM model. The parsimonious ECM result was used to test whether oil price volatility have influenced the level of economic growth using the desirable variables based on applicable decision rule.

Table3b. Summary of Parsimonious ECM result Dependent Variable DL GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLCOP	-0.685214	0.077328	-8.861098	0.0000
DLCOP	0.642603	0.149431	4.300324	0.0001
DLOREV	0.250244	0.111010	2.254250	0.0340
DLOREV(-1)	0.495617	0.108928	4.549924	0.0001
ECM(-1)	-0.721014	0.304142	-2.370651	0.0242
C	-0.052484	0.121754	-0.431063	0.6704

$R^2 = 0.78$, $R^2 = 0.77$, AIC = 1.86, SC = 2.15, Dw = 2.07

The t-value result (t-cal 8.86 > t-crit 2.052) indicates that oil price volatility have negatively affect economic growth. The result showed an additional factor. The negative sign attached to the coefficient of oil price volatility signifies that in Nigeria, volatility in oil prices have negatively affected the level of economic growth. The result showed that an increase in oil price volatility by 1 unit actually reduced the level of economic growth by 0.69 units. Also, the t-test in this regard has a value of 2.25 at the levels and 4.55 at the first difference which are less than the t-critical of 2.052. This is an indication that oil revenue has significant impact on the level of economic growth in Nigeria. This result has special significance because both the previous level of oil revenue and the current level of oil revenue were statistically significant. This is an indication of the Nigerian government over-reliance on revenue from the oil sector. Furthermore, the t-test in this regards has the value of 4.30 which is greater than the t-critical (2.052) suggesting that crude oil price has significantly influenced the level of economic growth in Nigeria. This is not surprising however since the Nigerian economy relies almost entirely on crude oil revenue. The Nigerian case is so severe that the budget of the country is tied to particular price of crude oil. This was why a sudden drop in the oil price in 2008 as a result of the global financial crisis led to a downward readjustment of the budget.

5.4. Vector Error Correction (VEC)

The portion of the VEC result that is of most significance is shown in table IV below:

Table 4. Summary of Vector Error Correction Results

Co-integrating Eq:	**Co-integrating Eq 2**			
LGDP(-1)	1.000000			
LCOP(-1)	47.35423			
	(14.2973)			
	[3.31212]			
LOREV(-1)	248.5813			
	(30.0155)			
	[8.28177]			
OPV(-1)	-848.8212			
	(91.2922)			
	[-9.29785]			
OREV(-1)	-0.003367			
	(0.00043)			
	[-7.91601]			
C	-2128.183			
Error Correction:	**D(LGDP)**	**D(LCOP)**	**D(LOREV)**	**D(OPV)**
CointEq1	-0.000966	-0.407183	-0.000314	-0.173256
	(0.00086)	(0.05926)	(0.00111)	(0.05639)
	[-1.12841]	[-6.87080]	[-0.28369]	[-3.07275]

The result of the VEC showed that COP equation and the OPV equation represents the co-integrating equation. The others are statistically flawed. They have the right sign but were not significant.

5.5. Diagnostic Test

The diagnostic test is used to test whether the errors are normally distributed, whether the variance is constant or not and whether the errors are serially correlated. The test of stability also forms part of the diagnostic test. Table V presents the first part of the diagnostic test.

Table 5. Diagnostic Test Result: Jarque-Bera

Jarque-bear	0.59	Probability	0.75
White Heteroskedasticity test			
f-statistic	1.01	Probability	0.30
Breusch Godfrey Serial Correlation LM test			
f-statistic	0.14	Probability	0.87

The result of the Jarque-Bera normality test shows that the errors are normally distributed. The white heteroscedasticity test shows that the errors are homeskedastic and the result of the Breusch Godfrey Serial Correlation LM test indicated no evidence of serial correlation in the residuals. The result of the stability test is shown in figures 1 and 2 below:

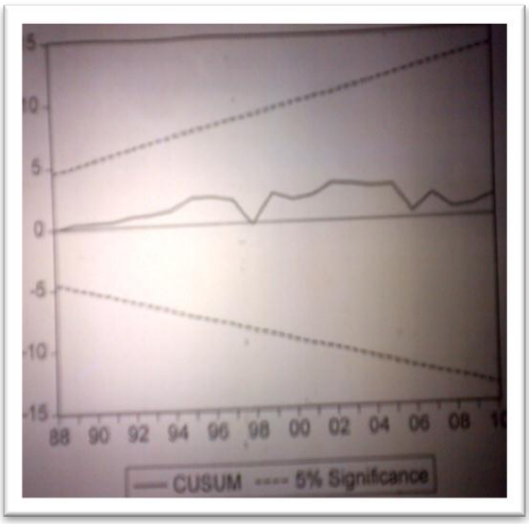

Figure 1: CUSUM Stability Test

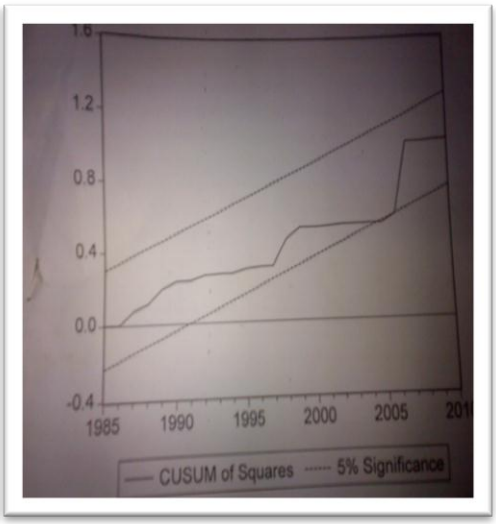

Fig. 2: CUSUM Q Stability Test

The result of the Cumulative Sum of Recursive Residuals (CUSUM) test in the figure above indicated that the model is stable since the 5 percent line falls in-between the two 5 percent lines. Also, the Cumulative Sum of Squares of Recursive Residuals (CUSUM Q) indicated stability in the model.

5.6. Variance Decomposition

The variance decomposition tests the proportion of changes in the dependent variable that has been explained by the changes in the independent variables. The result of the variance decomposition is shown in table VI below:

Table 6. Summary of Variance Decomposition Result

Period	S.E.	Variance GDP	COP	OPV	OREV
1	1780142.	100.0000	0.000000	0.000000	0.000000
2	3285982.	34.58371	40.52078	7.103264	17.79225
3	3832300.	45.29962	33.98349	5.222418	15.49447
4	4242651.	50.02630	31.11930	6.006581	12.84782
5	4504541.	46.23058	35.98962	5.371077	12.41773
6	4817001.	48.99059	34.53738	5.031366	11.44066
7	6063125.	67.07404	22.47035	3.186895	7.268716
8	6932526.	64.99905	20.03120	3.634832	11.33491
9	8244110.	59.17076	21.23684	3.578833	16.01357
10	9332918.	61.39760	20.41590	3.188355	14.99814

The result indicated that oil price volatility did not explain significant percentages

of the changes in the level of economic growth during the first period. Oil price volatility was explained by 7 percent of the changes in level of economic growth in the second period and this reduced to 6 percent in the fourth period and 3 percent in the tenth period, reflecting the problem caused by oil price volatility to economic growth. The volatility to crude oil price however explained a significant percentage of changes in economic growth. Volatility to crude oil price explained 41 percent of changes in crude oil in the second period and this reduced to 35 percent in the fifth period and declined further to 20 percent in the tenth period. This indicated the over-reliance of the country on the price of crude oil in the world market. Volatility to oil revenue was explained by 17 percent of changes in economic growth and this was 16 percent in the ninth period and fell to 14 percent in the tenth period.

6. Conclusion and Recommendations

There is a vast literature establishing robust results across many countries on the connection between oil price volatility and economic growth. This implies that connections should also exist between oil price volatility and economic growth in Nigeria. This study examined oil price volatility on economic growth in Nigeria during 1980-2010, using a VAR analysis. The study concluded from the findings that oil price volatility have significant influence on economic growth although a negative impact. This constitutes serious implication for the management of the country economy because crude oil price is a major determinant of the budget formulation in Nigeria while GDP is a key macroeconomic policy targets. If these variables are influenced by a change, almost unpredictable exogenous variable like crude oil prices, then the economy becomes highly vulnerable to unpredictable external shocks.

Based on the above, it was recommended that there should be a strong need for policy makers to focus on policy that will strengthen/stabilize the structure of the economy with specific focus on alternative sources of government revenue. The way to minimize this volatility in oil prices is to diversify the economy so as to make it less oil dependent; there should be reduction in monetization of crude oil receipts (fiscal discipline), aggressive saving of proceeds from oil booms in future in order to withstand vicissitudes of oil price volatility in future; Policy makers should design the optimal policy mix that would help the nation cope efficiently with the economic and social costs of the external shocks accompanying higher oil prices and the country need to establish and enforce prudent fiscal rules to smooth surplus export receipts over time, invest them for future growth and minimize wasteful spending.

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