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IMPACT OF GAS PRICING AND DEMAND ON OUTPUT IN NIGERIA

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ABSTRACT

This study examines the effect of natural gas pricing and natural gas demand on National output (GDP) in Nigeria. The interactions between gas demand, gas price and GDP was investigated using the structural vector auto-regressive (SVAR) model. Time series monthly data were collected from 1996 -2016 on gas demand, gas supply, gas retail price, petrol retail price and GDP. The result indicated that gas price has a significant impact on gas demand and gas demand also determines gas pricing; and that gas demand has a significant impact on GDP. Furthermore, the impulse response showed the response of GDP to gas demand to be negative, but positive to gas supply petroleum retail price and gas retail price . The variance decomposition showed that petroleum retail contributed more to changes in GDP followed by gas demand, then gas supply, while gas price contributed least. Findings Suggests that the government should invest in gas infrastructure and enact proper monetisation and utilisation policies that will encourage foreign and local investors so as encourage supply and increase revenue earnings for the government .

INTRODUCTION

The Gas sub-sector is recognised as a key asset capable of transforming the Nigerian economy through vital sub-sectors, such as electricity, petro-chemicals, cement, iron and residential. The sub-sector, therefore, has attracted special attention from Government in Nigeria. Among the efforts is the Gas Master Plan, aimed at providing a framework that would ensure the realisation of maximum value from the country's gas resources. It is intended to leverage on the multiplier effect of gas in the domestic economy and optimise the nation's share of the high value export market. Specifically, the Plan was targeted at addressing impediments to the development of the domestic gas sector, stimulate gas monetisation, reduce gas flaring and guarantee long-term gas security for Nigeria (Adeniji & Sipasi, 2016). The gas sub-sector is an area where government effort has produced significant results. Earnings from gas exports stood at US$ 9.6 billion in the last 10 years, while domestic supply increased by about 1,827.0 percent in the same period (CBN, 2015)

Over the years, several policies/regulations have been developed by the Energy Commission of Nigeria via the National Energy Policy to encourage utilization of natural gas in Nigeria. So far, achievements have fallen short as little has changed from the pasts. For instance, gas consumption per head has remained constant, with gas market growth at 3.1% at par with population growth at 2.8% (Cameron, 2016). Some of the policies include the National oil and Gas Policy of 2004 which provides the policy framework for a liberalized and functional gas industry especially domestic gas utilization; Downstream Gas Bill 2005, proposed to implement liberalization of domestic gas markets; the Nigerian Gas Master Plan 2008, which is in line with National Oil and Gas Policy provides framework for developing gas infrastructure blueprint, gas pricing policy and domestic gas supply obligation; National Domestic Gas Supply and Pricing Regulation 2008, provides framework for determining gas pricing across various sectors; Petroleum Industry Bill 2012, proposes a comprehensive legal framework for exploitation of petroleum and gas; and most recently the National Gas Supply and Pricing regulation 2017, which intends to move Nigeria from an oil based to gas based industrial economy. Despite these policies and strategies, the demand for gas in Nigeria is still increasing, while gas supply has remained below the desired level, with good amount of the associated gas still being wasted through gas flaring.

The Nigeria Gas Master Plan (2007), indicated that natural gas domestic demand in Nigeria experienced a boom in 1999, largely attributed to NLNG production and export. But the industry is faced with an exceedingly high demand forecast, from about 5bcf/d in 1999 to over 25 bcf/d by 2020, however domestic demand as at 2016 is estimated at over 12bcf/d. . By December 2017, total amount of gas supplied for local consumption was 2,792.11 bcf out of which 14.1% was commercialized for industrial use, while 44.1% went for the production of LNG for exports; and 41.8% was non-commercialized (NNPC, 2017).

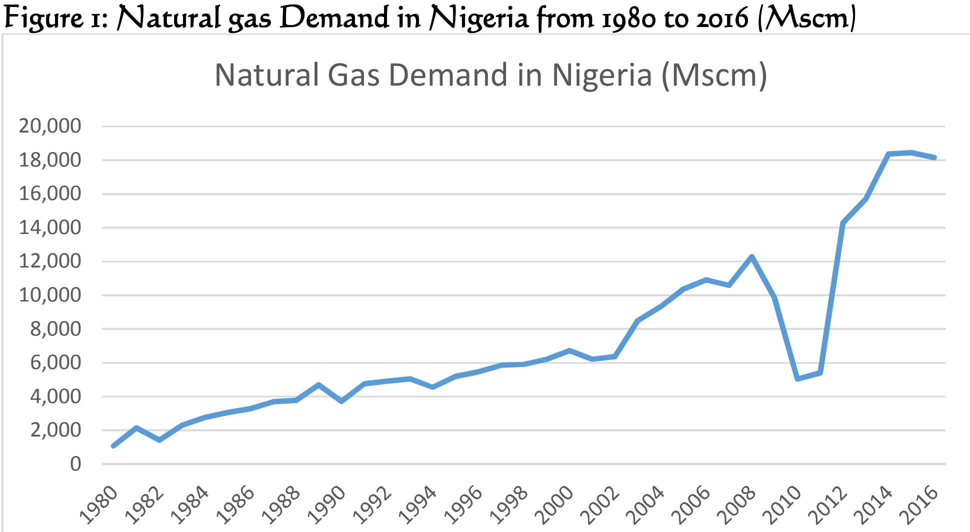
However, low prices charged for gas caused inefficient use of gas, a favour towards gas exporters, but an impediment to private investment (Omisakin, 2011); hence low prices could be a disincentive for private investment in domestic markets but favour gas exporters. In 2015, NERC approved the upward review of Natural gas price, from $1.5 per mcf to $2.5 per mcf.; while the price at the Henry Hub (international benchmark) is $3.10 (U.S. Energy Information Agency, 2017). Furthermore, The Nigerian pipeline system in place has the capacity to deliver 2.5 bcf/d and consist of 1,250 km ranging from 4" to 36" in diameter, with 16 compressor stations (NGC,2014). The pipelines are the main systems of transporting gas to areas of demand, and demand for gas in Nigeria has been growing; in fact, domestic Consumption of gas has grown from 197 mcf/d in 1999 to 573 mcf/d in 2004 (Gulf Of guinea Petroleum COnsulting LTD, 2014) and has reached an annual total of 2792.11 bcf by 2017 (NNPC, 2017). These pipelines exist mainly in the Niger Delta region (south-south region) putting other geopolitical zones at a disadvantage, and forcing the GBIs to seek alternative sources or substitutes further depressing demand forecasts. This creates a constraint on supply and does not satisfy the increasing demand, thus resulting in energy demand-supply mismatch. These are some issues that affect the demand for natural gas and possibly its impact on national output (GDP).

This paper seeks to examine the impact of natural gas price and natural gas domestic demand on national output in Nigeria. In order to achieve this, time series monthly data covering the period 1999 to 2016 will be used to examine the impact of gas price and gas demand on GDP in Nigeria.

Natural Gas Domestic Consumption in Nigeria

Although natural gas is the fastest growing source of primary energy, Nigeria's gas consumption is put at 12% of its Total Primary Energy (TPE) mix, as at 2013(EIA, 2016). But due to low domestic demand, inadequate gas infrastructure and poor incentives for gas development in the country, the gas is not fully utilized (Adamu and Darma, 2016). This has made the country to monetize her gas through exports to Europe, Asia and other parts of the world. Nigeria's natural gas consumption has grown from 123.5 tcf to 186.6 tcf for the period 1996 to 2016 (BP Statistical Review, 2017). The sharp increase in consumption was experienced in 2005 at 183.6 tcf and is attributed to Bonny LNG plant production, mainly for exports. This has been a major revenue earner for the country (Omisakin, 2011). However, Nigerians are inattentive of the potentials of natural gas as an energy source to meet up with growing energy demand. However, insufficient infrastructure (gas pipelines) to move the gas to an area of demand has not helped matters. Thus, investment in gas processing plants, such as (GTP) Gas to Power and (GTL) Gas to Liquid projects will stimulate its demand in the country. With increasing energy demand in Nigeria, mostly due to growing population, emergence of SMEs, low power generation, there is need to meet the demand by providing alternative energy products, increase and diversify source of government revenue, and also enhance electricity supply.

Figure 1: Natural gas Demand in Nigeria from 1980 to 2016 (Mscm)



Source: extracted by author from OPEC ASB, 2017.

Natural Gas demand in Nigeria is continually increasing over the years. Certain factor responsible for this include aggressive power sector reform, efforts by the federal government to attracts investors and instil confidence in the gas sub-sector, relocation of big corporations to resource rich countries such as Nigeria, Angola, Trinidad and Tobago due to abundance of gas resources, low cost of production and rising gas prices in key gas export markets like vibrant LNG business in the country (NGMP, 2007).

Empirical Review

Some empirical studies and research have been carried out on linkage between natural gas resource and economic growth in gas producing nations. (Fatai, Oxley, & Scrimgeour, 2001) used data from 1960 to1999 and employed ARDL, Johnson's Maximum Likelihood (JML) and Toda and Yamamoto causality test methods. They reported no cointegration between natural gas consumption and economic growth for New Zealand but found cointegration for Australia while neutral effect is validated between both variables. In the same vein, (Solarin & Shahbaz, 2015)reinvestigate the relationship between natural gas consumption and economic growth by including foreign direct investment, capital and trade openness in Malaysia for the period of 1971–2012. The structural break unit root test is employed to investigate the stationary properties of the series. We have applied combined cointegration test to examine the relationship between the variables in the long run. ARDL bounds testing method was also employed to test for a possible long run relationship in the presence of structural breaks. Natural gas consumption, foreign direct investment, capital formation and trade openness have positive influence on economic growth in Malaysia. The results support the presence of feedback hypothesis between natural gas consumption and economic growth, foreign direct investment and economic growth, and natural gas consumption and foreign direct investment. Again, (Masih, 2018) examined the short-run and long-run relationship between economic growth, energy consumption, financial development, capital formation and population by using data set of Malaysia for the period 1971–2014. The auto regressive distributed lag (ARDL) bounds testing approach to test the long run relationship among the variables, while short run dynamics were investigated using the Vector Error Correction Model (VECM). Variance decomposition (VDC) technique was used to provide Granger causal relationship among the variables. The findings suggest that energy consumption is influenced by economic growth and financial development, both in the short and the long run, while the population–energy relationship only holds in the long run. The results have important policy implications for balancing economic growth vis-à-vis energy consumption for Malaysia, and other emerging nations to explore new and alternative sources of energy to meet the rising demand of energy to sustain economic growth.

Also, (Lim & Yoo, 2011) investigated the short run issues between natural gas consumption and economic growth in Korea applying time series technique and employing quarterly data covering 1991-2008. Tests for unit root, cointegration and granger causality based on the multivariate vector error correction models were presented, and results indicated a bidirectional causality between natural gas consumption and economic growth in Korea. This implied that an increase in natural gas consumption directly affects economic growth and that economic growth further stimulates natural gas consumption. Similarly, (He & Gao, 2017))built a theoretic model to estimates the relationship between gas consumption and metropolitan economic performance with annual data from 1978 to 2013 for Guangzhou in China. Based on Granger causality test with vector error correction model, empirical results show that there is Granger causality from gross domestic product to gas consumption for long run in Guangzhou.

In Nigeria (Adamu & Darma, 2016) found cointegration and positive and significant long run relationship between gas consumption and real economic growth between 1981-2013 in Nigeria, using ARDL bound cointegration test. They found that a persistent 1% increase in domestic gas consumption in the long run causes 2.89%mincreases in real economic growth in the country. And if flaring is stopped and more investment in infrastructure in the industry is made, the gas sector will be a dominant one in the economy, hence actualizing the significant link between gas consumption and economic growth. (Onolemhemhen, Adaji, Isehunwa, & Adenikinju, 2017) forecasted the domestic utilization of natural gas in Nigeria, using determinants of domestic utilization of natural gas in Nigeria from 1990-2013. They employed the ARIMA analysis and results indicated that the forecast values show evidence of a slow but gradual increase in the utilization pattern in the near future from 2015-2020. With per capita real GDP as most significant driver of domestic gas utilization in Nigeria, and past volumes of gas utilization positively affected current gas utilization patterns. Electricity generation was positively correlated and highly significant in influencing domestic utilization of gas. But price of gas was not significant in driving domestic gas utilization and FDI has negatively influenced domestic gas utilization and its effect is not statistically significant.
From the literature reviewed, most of the studies on the response of economic growth to Natural gas use have been conducted on developed countries also in Nigeria, and majority of the study used time series analysis in terms of ARDL models, ECM and time series simulation for their empirical analysis, with practically no consideration for VAR models. As such this study employs VAR model in order to examine the role of Gas demand and Gas prices and its effect on some macroeconomic variables and how it impacts on national output.

Theoretical framework

The demand supply model was analysed via the framework below:

Q^d = F (GRP, PRP, GS, GD, GDP, ε_1)

Q^s = F (GRP, PRP, GS, GD, GDP, ε_2)

Where:

Q^d is Quantity of natural gas demanded

Q^s is Quantity of natural gas supplied

GRP is Gas Retail Price

PRP is Petroleum Retail Price

GS is Gas Supply

GD is Gas Demand

GDP is Gross Domestic Product

ε_1, ε_2 are error terms.

And GRP, PRP, GS, GD and GDP pre-determined variables.

The forces of demand and supply determine the price and quantity of a commodity sold. In an oligopolistic market, like the Nigerian gas market, the price is rigid due to fear of possibility of price wars and competition is a constant struggle amongst rivals. Thus, interactions between suppliers and demanders establishes a unique price for the commodity (Mankiw, 2011). And so, an increase in supply of gas through investments in pipelines for transport, encouraging domestic utilisation through electricity generation, industrialisation etc. etc. will lead to an increase in demand for gas as the price is rigid, causing a shock in productivity and eventually national output. These are exogenous variables that are assumed to grow exponentially, according to the Solow growth model (Zhou, 2015)

The Solow-Swan model is an exogenous growth model of long run economic growth under neoclassical economics. It explains how to attain long run economic growth from population growth or labour, capital accumulation and increase in productivity technological progress. The model depicts that continuous rise in capital investment temporarily increases growth rate (Riley, 2018).

In this case, the demand for natural gas will prompt the supply of natural gas especially in Nigeria. This will require huge investments in the sector, as the gas is being utilised through electricity generation, industrialisation and even exports generation, productivity will increase and national output will also increase.

METHODOLOGY

This research will use the Structural Vector Autoregressive (S-VAR) model to estimate the interaction between Gas price, Gas Demand and GDP in Nigeria. Structural Vector Autoregressive is chosen because it is not atheoretic like the unstructured (traditional) VAR. It is an extension of the traditional (unstructured) VAR analysis that attempts to identify the atheoretic restriction used in traditional VAR (Hsiao, 1981). An important merit of using the VAR is its ability to allow modellers to capture dynamics between explanatory variables. And also, Its applicability when estimating relationships between supply and demand deviations and also volatility in a time series model (Misund & Alte, 2015). The VAR model which assumes that the variables are non-stationary in level and stationary in first differences and the variables not cointegrated, is written as a moving average as follows:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \cdots A_i\varepsilon_{t-i} = \sum_{i-0}^{\infty} A_i\varepsilon_{t-i}$$
$$= A(L)\varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(3.1)$$

$$A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{31}(L) & A_{41}(L) & A_{51}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) & A_{25}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) & A_{35}(L) \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & A_{45}(L) \\ A_{51}(L) & A_{52}(L) & A_{53}(L) & AA_{54}(L) & A_{55}(L) \end{bmatrix} \begin{bmatrix} \Delta p_t^* \\ \Delta y_t^* \\ \Delta y_t \\ \Delta e_t \\ \Delta p_t \end{bmatrix} = A(L) \begin{bmatrix} \varepsilon_t^{s*} \\ \varepsilon_t^{s*} \\ \varepsilon_t^{s} \\ \varepsilon_t^{d} \\ \varepsilon_t^{m} \end{bmatrix} \ldots\ldots$$

(3.2)

Where $X_t = [\Delta GRP_t^*, \Delta PRP_t^*, \Delta GS_t, \Delta GD_t, \Delta GDP_t]'$, is a vector with all the variables expressed in log difference form. A_i is a 4x4 matrix, representing the impulse responses of endogenous variables to structural shocks $\varepsilon_t = [\varepsilon_t^{s*}, \varepsilon_t^{s*}, \varepsilon_t^{s}, \varepsilon_t^{d}, \varepsilon_t^{m}]'$, and L is a lag operator. It is assumed that the shocks are serially uncorrelated and orthonormal, with a variance-covariance matrix normalized to form an identity matrix.

The new decomposed model with restrictions can be represented in the matrix form:

$$\begin{bmatrix} \Delta GRP_t^* \\ \Delta PRP_t^* \\ \Delta GS_t \\ \Delta GD_t \\ \Delta GDP_t \end{bmatrix}$$
$$= \begin{bmatrix} A_{11}(L) & 0 & 0 & 0 & 0 \\ A_{21}(L) & A_{22}(L) & 0 & 0 & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & 0 & 0 \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & 0 \\ A_{51}(L) & A_{52}(L) & A_{53}(L) & A_{54}(L) & A_{55}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_t^{s*} \\ \varepsilon_t^{s*} \\ \varepsilon_t^{s} \\ \varepsilon_t^{d} \\ \varepsilon_t^{m} \end{bmatrix} \ldots\ldots\ldots.(3.3)$$

The exogenous variables in the structural VAR are model follows an autoregressive process, while the endogenous variables are expressed as functions of their own lags plus the lags of exogenous variable:

$$\Delta y_t^* = \rho + \sum_{i=1}^{n} \rho_i \Delta y_{t-i}^*$$
$$+ \mu_t' \ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.11)$$

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$$X_t = \rho + \sum_{i=1}^{n} \rho_i X_{t-i} + \sum_{i=1}^{n} \theta_i \Delta y_t^* + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.12)$$

where $X_t = [\Delta DGDP_t, \Delta REER_t, \Delta INF_t]'$, ρ_i and θ_i are coefficient matrixes, while $\mu_t'$and $\mu_t = [\mu_t^1, \mu_t^2, \mu_t^3]$ are a mixture of structural innovations of reduced residuals. Since the first difference transformation makes the variables stationary, it is easier to be represented in an MA form as:

$$X_t = \theta + \sum_{i=1}^{n} G_i\, \mu_{t-i}, and\ \theta = (1 - \sum_{i=1}^{n} \rho_i)^{-1}(\rho + \sum_{1=1}^{n} \theta_i \Delta y_{t-i}^*) \dots\dots\dots\dots\dots (3.13)$$

From the above expression, an impulse response equation G_i is derived:

$$\sum_{j=0}^{\infty} G^j\, L^j = (1 - \sum_{i=1}^{n} \rho_i\, L^i)^{-1} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.14)$$

From the above equations and restrictions, the structural shocks can be recovered as linear combinations of reduced-form innovations which can be used to compute the correlation of the shocks between the variables and assess the degree of asymmetry between them.

Variance Decomposition

Variance decomposition will be used to identify the contribution of each shock in explaining variations of the other variables in the Structural Vector Auto-Regression models. It shows the proportion of fluctuation in the dependent variables due to variables' own shocks to other variables. Optimal lag length criteria will be used to ensure that the estimates from the structural VAR are robust. The criteria consist of Akaike, Shwach and Hannan-Quinn Information Criterion.

Testing the Properties of Time Series Data

It is important that the time series properties of a set of data are checked prior to any econometric analysis. In so doing, we tend to avoid any spurious results that may occur in case the series is non-stationary otherwise has unit root. A stationary time series is one whose statistical properties such as mean, variance, autocorrelation, etc. are all constant over time. A non-stationary series, y_t is said to be integrated of order *d* and is made stationary by differencing it *d* times, i.e., a non-stationry series $y_t \rightsquigarrow I(d)$ to become stationary. If a series is stationary in level, then $d = 0$ or $y \rightsquigarrow I(0)$. If a series is differenced once to become stationary then $y_t \rightsquigarrow I(1)$. All the series were tested for stationarity by using the Augmented Dickey Fuller (ADF) and Phillip-Perron tests. Following Greene's (2003) approach, the unit root test based on Augmented Dickey Fuller (ADF) follows equation:

$$Y_t = \alpha + \beta Y_{t-1} + \sum_{i=1}^{n} \beta_j\, \Delta Y_{t-1} + \varepsilon \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.1)$$

$$Y_t = \alpha + \gamma t + \beta Y_{t-1} + \sum_{i=1}^{n} \beta_j \, \Delta Y_{t-1} + \varepsilon \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (3.2)$$

Equations (3.1) and (3.2), indicate ADF tests without trend and with trend respectively.

The unit root test based on Phillip-Perron follows equation:

$$\Delta X_t = a + bX_{t-1} + c(t + \frac{T}{2}) + \mu_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (3.3)$$

a, b, and *c* are the coefficients and *T* is the total number of observations. The *ADF* and *PP* unit root tests posit a null hypothesis $\beta = 0$ versus an alternative hypothesis $\beta < 0$, where the *ADF* and *PP* statistics is compared with the observed Mackinnon critical value 5% level of significance. If ADF and PP statistics is greater than the Mackinon criterion, we reject the null hypothesis and conclude that the time series is stationary.

Source of Data

The Study employed time series data on Nigeria's selected macroeconomic variables (Gas Demand, Gas Supply, Gas Price, Petroleum Retail Price and GDP) covering the period of 1996 – 2016 on a monthly basis which represents sample period of 252 months. In specific terms, the data employed represent series from January 1996 to December 2016. The series for Gas Demand and Gas supply was sourced from the statistical review of word energy. Gas Retail Price and was sourced from the CBN Annual Report (various editions). GDP was sourced from the CBN statistical bulletin 2016. It should be noted that the series were obtained in Quarterly form but were sliced to monthly form using eviews-9.

Data Analysis and interpretation of result

The data were analyzed Econometric views (E-views) 9.0 using various econometric techniques to determine the direction of interaction amongst the variables under consideration. Graphical analysis was carried out in order to observe trend flows in the variables under consideration. Diagnostic tests were conducted on the data to be sure the data were valid enough for relevant inferences to be made. The model was then estimated and interpretations of major findings were made.

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Unit Root Tests

Table 4.1: Unit root test

	ADF Test Statistic			PP Test Statistic		
Variables	levels	1st difference	2nd difference	Levels	1st difference	Order of Integratio
GDP	-1.2211 {**cor**	-3.665	-4.767	0.948	-8.629	I(1)
GD	-1.4708	-5.471		-0.5505	-22.994	I(1)
GS	1.5849	-5.144		-0.9691	-9.8491	I(1)
GRP	0.1944	-7.205		0.6448	-12.296	I(1)
PRP	-1.8614	-5.306		-1.7259	-9.374	I(1)

Note: -4.5325= 1% level of significance; -3.6736 = 5% level of significance; -3.2773 = 10% level of Significance

Source: *author's computation using eviews 9.*

The results of the unit root tests are shown in Table 4.1

As seen in table 4.1, the results indicate that all the variables: GD, GS, GRP, PRP are stationary at 1st difference, meaning they all have unit roots at levels. Both ADF and PP test Provide conflicting results for GDP, as ADF indicates that GDP is stationary at 2nd difference, while PP was stationary at 1st difference. However, specteral analysis of the correlogram indicates that GDP is stationary at 1st difference because the spikes of its autocorrelation function fall within the band limits

Co-integration Test

With the observation that some of the variables have unit root problem, that is, not stationary at their levels, a co-integration test becomes a necessity. This test is carried out using the Johansen approach. *Table 4.2* is an extract from the co-integration result.

Table 4.2: Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.075128	48.92202	69.81889	0.6839
At most 1	0.054689	30.25618	47.85613	0.7058
At most 2	0.044503	16.81441	29.79707	0.6537
At most 3	0.020582	5.934158	15.49471	0.7033
At most 4	0.004024	0.963704	3.841466	0.3263

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level
** MacKinnon-Haug-Michelis (1999) p-values

The Trace statistics and Engel value indicate that there is no cointegration at 0.05 level of significance. This means that there is no cointegration among the variables. Since the variables are stationary at first difference, the study proceeded with the SVAR.

VAR Lag Order Selection Criteria
Table 4.3: Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	952.8006	NA	2.31e-10	-7.998317	-7.925151	-7.968827
1	3353.756	4680.343	4.53e-19	-28.04857	-27.60958*	-27.87163*
2	3395.398	79.41953	3.94e-19	-28.18901	-27.38419	-27.86462
3	3422.522	50.58589*	3.87e-19*	-28.20694*	-27.03629	-27.73509
4	3435.959	24.49141	4.27e-19	-28.10936	-26.57287	-27.49006

* 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
HQ: Hannan-Quinn information criterion

Lags	LM-Stat	Prob
1	56.34310	0.0003
2	43.77239	0.0115
3	23.44229	0.5518**
4	40.29876	0.0272
5	17.76396	0.8522

Probs from chi-square with 25 df.
Source: *Computed using E-Views 9 Software Package*

In order to properly estimate VAR model which is an input in estimating SVAR model, it is necessary to get the optimal lag length using Lag length selection criteria. The optimal lag length was chosen in order to ensure that the SVAR is consistent/robust. Table 4.3 shows the optimal lag length of the VAR model. The results reveal that the optimal lag length chosen for this study is 3, based on the different selection criteria. Again, 3 as the optimal lag length was chosen because at that lag, the model is free from serial correlation as shown on the table.

Stability Test

The conditions to declare a model stable using AR roots are: all roots must lie within the polynomial bound and the roots must be less than one. Below is the graphical representation of the AR Roots test.

Figure 4.1

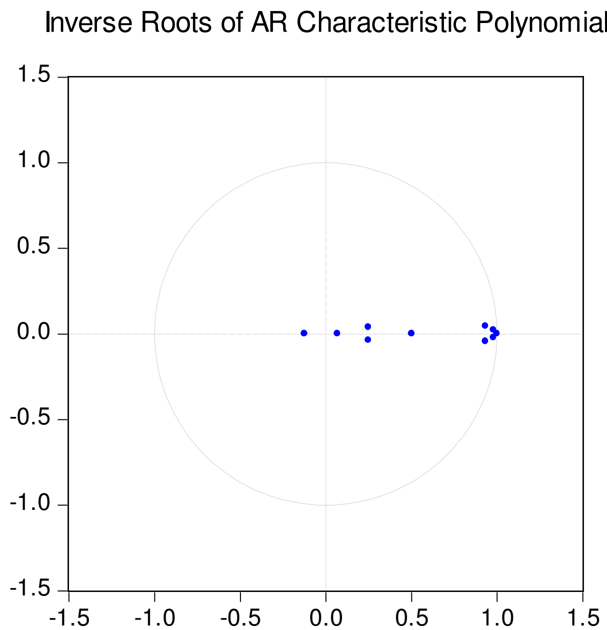

Figure 4.5 presents the VAR stability. The graph shows that all the roots of the VAR model lies inside the unit circle. Thus the estimated VAR model fulfils the stability condition. All the preliminary VAR diagnostics have been fulfilled which permits the study to proceed with further analysis.

Impulse Response Function

Impulse is an unexpected shock on an economic variable, the reaction of another economic variable to the impulse is referred to as response. It is derived from the estimated SVAR. Shock1 represent GDP, Shock2 represent GD shock3 represent GRP shock4 represents GS and Shock5 represent PRP. Impulse Response Function (IRF) graphical representation for five periods is given as:

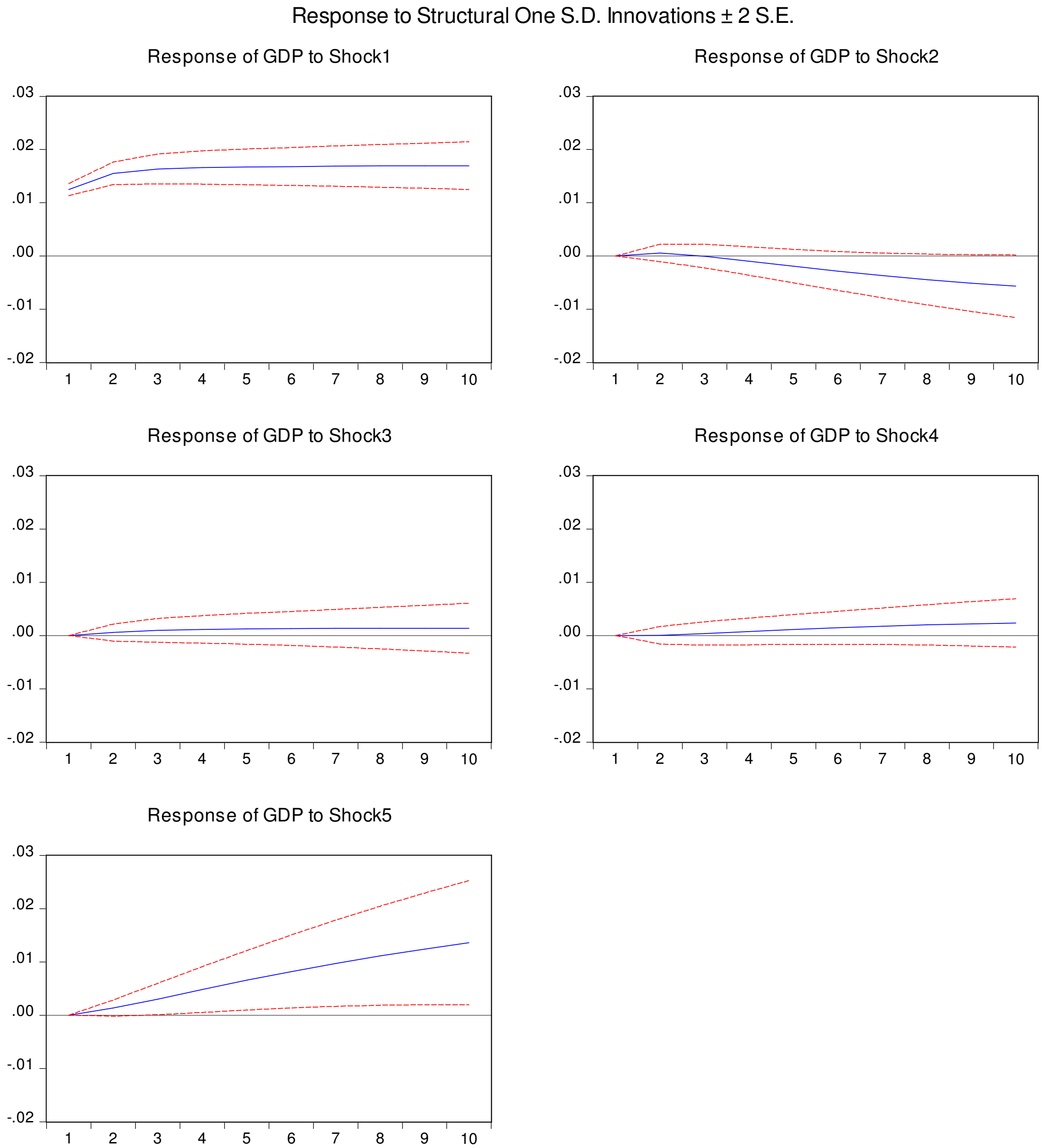

Figure 4.2, shows the response of GDP to sudden changes in the dependent variables. Panel 2, shows that the response of GDP to a shock in GD within the first 3 quarters is insignificant. But from the fourth to the tenth quarters, the response of GDP to a shock in GD is negative. This could be due to the upward review of price by the Nigerian Federal Government in order to encourage producers and also attract investment into the sector. Panel 3 shows that response of GDP to a shock in GS is positive but not significant. This could be due to availability of substitute products like petroleum products e.g. PMS,

diesel, kerosene etc. that can serve as alternative to natural gas in cases of shortage of supply. And panel 4 and 5 showed that both GRP and PRP responded positively to GDP. This implies that an increase in price of both gas and petroleum would yield more revenue to the government, since energy products are complimentary in nature.

SVAR Forecast Error variance decomposition

Table 4.7 Variance Decomposition

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.012462	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.019978	99.42018	0.073424	0.073882	0.000475	0.432036
3	0.026004	98.16734	0.043559	0.175610	0.019571	1.593922
4	0.031266	96.09872	0.123619	0.254763	0.071656	3.451239
5	0.036148	93.31249	0.376893	0.309726	0.150581	5.850309
6	0.040843	90.02927	0.781852	0.345472	0.245249	8.598158
7	0.045450	86.48031	1.290450	0.366807	0.345366	11.51707
8	0.050012	82.85647	1.854964	0.377418	0.443181	14.46797
9	0.054547	79.29541	2.437254	0.380083	0.533597	17.35366
10	0.059058	75.88654	3.010164	0.376909	0.613709	20.11268

Factorization: Structural

Source: *Computed using E-Views 9 Software Package*

Variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregressive. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. It identifies the predominant shocks that contribute more to the changes in the dependent variables in the SVAR, in the short run one year forecast error, medium term 5 year forecast error and in the long run 10 year forecast error. Table 4.6 provides the variability of GDP to changes in GD, GS, GPR and PRP. PRP contributes more to changes in GDP both in the short run, medium and long run; followed by GD and then GS. GRP contributes the least to GDP.

CONCLUSION AND RECOMMENDATIONS

This study examines the effect of natural gas demand, natural gas price and national output using SVAR model; with GDP as a proxy for national output and petroleum retail price as additional explanatory variable. The impulse response function show that GDP responded negatively to GD, while GS, GRP and PRP responded positively to the GDP. While the variance decomposition results showed that PRP contributes more to changes in GDP both in the short, medium and long run; this is followed by GD, then GS while GRP contributes the least.

The negative effect of GD on GDP could be due to the little contribution to Nigeria's TPE mix (12%). Although the demand is increasing, perhaps the supply is not matching the demand due the problems of infrastructural inadequacies and other insecurity challenges faced in areas of production. While the positive response of GDP to GRP could mean that the new pricing policy of the Federal Government has improved investors' confidence and by extension gas supply (GS). The positive response of PRP to GDP could be due to the dominance of petroleum products in the Nigerian energy mix and the high substitutability of petroleum products. This study therefore recommends that the government invest in gas supply infrastructure and improve investor confidence by improving the security situation especially in the natural gas production areas, which is in line with the Nigerian Gas Master Plan.

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