Sectoral Gas Demand and Sustainable Economic Development in Nigeria

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ABSTRACT

This study investigated the impact of sectoral gas consumption on economic development in Nigeria from 2010 to 2020. Gas demand for power, industries, homes, transportation, and gas costs were used as the independent variables for sectoral gas demand, and the misery index was used as the dependent variable for sustainable economic development, in order to achieve the purpose of the study. The National Bureau of Statistics (NBS), the Nigeria Gas Company, and the Nigerian National Petroleum Corporation (NNPC) were the sources of data on sectoral gas demand and economic development. The Autoregressive and Distributed Lag (ARDL) technique was used to analyse the data after carrying out the unit roots test. The result shows that gas demand for transport, industrial, and power sectors as well as its cost contributed to a rise in the global misery index, which ultimately hampered long run sustainable economic development. On the other side, household demand for gas decreased the misery index and, over time, hence promoted long run economic development in Nigeria. The study also found an insignificant nexus between demand for gas by the various sectors and economic development in the long run. In the short run, gas demand for transport and cost of gas had significant impact on economic development. Based on these results, the study concludes that gas demand had serious implication on economic development in the short run than long run. Consequent upon the findings, the study recommended: an increase in gas demand for household use and for transportation through a stable and competitive price of natural gas in order to enhance sustainable economic development in Nigeria.

Key words: Misery index, sectoral gas demand, power sector, household, transport sector & industrial sector

INTRODUCTION

The huge mineral and natural resources of Nigeria include coal, natural gas, and crude oil, among others. For instance, Nigeria has twice as much natural gas as it has crude oil, and natural gas will be available for far longer than crude oil will. Natural gas deposits in the nation are estimated to be about 2.4 x 1012 cm3 and are anticipated to provide both as a substantial export and domestic fuel for more than a century. Nigeria, which ranks among the top ten countries in the world, has the greatest natural gas deposits in Africa. Although Nigeria had a population of about 200 million people in 2000, the country's use of natural gas and other energies is still very low because of poor infrastructure. This is true even though the country has a large market for natural gas consumption, whether it is for household use, power generation, or other sectoral demand.

The fact that Nigeria flares nearly 40 percent of the fossil fuel it produces—or 20 percent of all flared gas globally—must be kept in mind. In Nigeria, flared gas is burnt off to a 75 percent degree. The answer is to provide the necessary infrastructure to get rid of this waste, which might have been utilized to enhance supply and upsurge earning from suppliers of this energy commodity. Building suitable infrastructure will solve the problem as inadequate infrastructure was the source of this waste. In line with Gbadebo and Okonkwo (2009), it is also possible to liquefy natural gas to create LNG, which is a liquid form.

Given the critical role that energy consumption, especially natural gas consumption, plays in the growth and development of an economy, several scholars have appraised the interaction amid natural gas demand and economic growth. This subject has been studied by Aqeel and Butt (2001), Adegbemi, Olalekan, Adegbemi, and Babatunde (2013), Aminu and Aminu (2015), and other scholars. In congruent with their analyses, the usage of liquefied natural gas in Nigeria has a favourable but modest impact on the nation's economic development.

In spite of Nigeria's wealth of natural gas and the importance of energy consumption on economic growth and development as shown by earlier studies, the nation faces unstable power supply. Power outages are a serious problem for the population because of the low producing capacity compared to installed capacity. For instance, Nigeria has a total installed capacity of around 12000 MW, but only produces about 4000 MW of power, leaving a roughly 8000 MW energy shortfall.

The goal of several Nigerian administrations, both past and current, has been to guarantee a reliable electrical supply statewide. Numerous administrations have made substantial investments in the electricity sector throughout the years, yet little to no improvement in the energy supply has been made (Okorie & Adasi-Manu, 2016). Inadequate energy supply has also hindered the growth and development of the Nigerian economy throughout the years. Due to an expected Gross National Earning per capita of $2,710, the World Bank projected that Nigeria's GDP per capita in 2020 was $2097, a 5.95 percent decrease from 2019. In congruent with the Energy Information Administration from 2007, just 40 percent of Nigerians have access to electricity, with most of it going to metropolitan areas. Given this background, this study seeks to examine the effect of sectoral natural gas consumption on economic development in Nigeria. We shall continue our investigation by reviewing relevant literature, followed by technique employed to achieve the purpose of the study, results and findings and concluding remarks and recommendations.

LITERATURE REVIEW

The examination of the interaction amid energy use and growth within the economy dates back to the 1970s, when Kraft and Kraft (1978) conducted ground-breaking examination that established a unidirectional causality amid increases in Gross National Product (GNP) and energy use in the United States amid 1947 and 1974. Since then, other analyses have been conducted by other academics to support the interaction amid energy use and growth within the economy (Yildrim & Aslan, 2012).Four testable hypotheses have been proposed and presented by appraisals without regard to quality to explain the direction of the link amid energy use and the development of the economy. The development Hypothesis, the Conservation, Feedback, and Neutrality Hypothesis are the four hypotheses concerning the causal link amid energy usage and the development of the economy that are identified in the energy-growth literature. In congruent with Ozturk (2010), Yildirim and Aslan (2012), Ekeocha, Penzin, and Ogbuabor (2020), each of these ideas has substantial policy ramifications.

Growth Hypothesis: The Growth Hypothesis emphasises the critical role that energy availability and usage play in output growth by assuming unidirectional causation from energy to the development of the economy. This connection indicates an energy-dependent economy in which poor economic performance might come from either no access to modern energy sources or restricted access to them (Tsani, 2010). In other words, the Growth Hypothesis assumes that, after accounting for capital and labour, energy usage has a direct impact on expansion of the economy. The theory promoted a one-way causal link amid economic expansion and energy use. Energy policies in this case that attempt to cut energy use for prudent reasons would have a detrimental impact on the development of the economy (Emeka, Nenubari, & Godsgrace, 2019).

Conservation Hypothesis: The conservation hypothesis predicts an economy that is less reliant on energy and assumes that expansion of the economy is the dynamic causation of the development of the energy sector. This hypothesis's empirical applicability is supported by the unidirectional causal link amid expansion of the economy and energy usage. As an upshot, energy conservation measures like demand management and outlays in energy efficiency have no adverse effects on production growth in the long term run (Ouedraogo, 2013). The Conservative Hypothesis, as put out by Emeka, Nenubari, and Godsgrace (2019), contends that economic expansion drives up energy usage. The theory promoted a one-way causal link amid economic expansion and energy use. In this case, energy conservation measures on energy use wouldn't be detrimental to the economy.

Feedback Hypothesis: In congruent with the Feedback Hypothesis, energy and the development of the economy are mutually reinforcing and complimentary, and there is empirical evidence to support this link (Ouedraogo, 2013).

Feedback Hypothesis: In congruent with the Feedback Hypothesis, there is a causal interaction amid growth within the economy and energy use. The upshot is a negative feedback loop where changes in one sector have a direct influence on changes in the other. This implies that any attempts to minimise energy usage may negatively affect economic development. Basically, the rules for energy conservation must be properly developed to prevent any possible damage to the economy.

Neutrality Hypothesis: The Neutrality Hypothesis asserts that there exist no connection amid the energy industry and economic expansion. Thus, the absence of a causal link amid energy use and the development of the economy supports the Neutrality Hypothesis. In this case, measures that encourage surged usage and access to energy will not have an impact on the development of the economy (Ouedraogo, 2013). In other words, in congruent with the Neutrality Hypothesis, energy use has no impact on economic expansion. It asserts that there exist no connection amid energy use and expansion of the economy. When there exist no correlation amid energy use and the development of the economy, this theory is validated. Energy conservation measures to lower energy usage in this situation won't have any effect on the development of the economy (Emeka, Nenubari, & Godsgrace, 2019).

Myriad of empirical studies exist on the impact of energy demand on economic growth and development. In a study that covered the period 1980 to 2010, Nwosa and Ajibola (2013) examined the effects of petrol costs on Nigeria's key economic sectors. The study specifically engrossed on the building and construction industries, likewise the agriculture, industrial, transportation, and communication industries. In congruent with the report, the cost of petrol only affects the building and construction industry in the long run, while the agricultural and industrial industries are affected in the short run.

Molly, Richard and Edwin (2022) analyzed influence of gas consumption on economic growth in Kenya. The study period was 2008-2020. Neo Classical growth and Depletion theories were employed. Explanatory research design was employed. Secondary data sourced from the World Bank database. General Method of Moment (GMM) model was adopted. Post estimation tests were conducted before making inferences. Both descriptive and inferential statistics were carried out. Results were presented in form of graphs and tables. The results indicated that coefficient of gas consumption was -2.1673, p=0.024. This implied that 1% increase in gas consumption would result in a reduction of GDP growth rate by 2.1673%. The study observed that gas consumptions influenced economic growth in Kenya. Government should consider the supply of gas and the nature of subsidy available so that the effect of gas consumption coefficient is reversed in order to have positive effect on economic growth rate. Findings of this study could be utilized by government in budget making process in the parliament or ministerial preliminary budgets and in the allocation of funds to various sectors that require substantial energy input. Additionally, findings could assist the government in order to expand current sources and exploit the other sources of energy such as solar energy, wind energy, thermal energy so as to increase the production and consumption of energy in order to increase economic growth rate. Policy makers could use these findings to establish gas policies that are realistic, time bound and those that enhance sustainable economic growth in Kenya. Finally, academicians could use the results in future references and scholarly studies in creating new angle of thinking and doing things.

Galadima & Aminu (2020) carried out a study on the nonlinear unit root and nonlinear causality in the natural gas-economic growth nexus in Nigeria using the Kapetanios-Shin-Shell (KSS) nonlinear unit root test, Kruse nonlinear unit root test, Brock-Dechert-Scheinkman (BDS) nonlinearity test, Nonlinear Ordinary Least Squares (NOLS) model, and, the Hatemi-J asymmetric causality test. They found that natural gas consumption and economic growth series follow nonlinear trend process as indicated by the KSS and Kruse tests, and that the nexus between natural gas consumption and economic growth in Nigeria is nonlinear as confirmed by the BDS and NOLS tests, where an increase in natural gas consumption increases economic growth. The asymmetric causality test revealed evidence of bidirectional causality between the positive impact of natural gas consumption and economic growth, and, unidirectional causality running from economic growth to negative impact of natural gas consumption.

Mukhtar, Abubakar, Ibrahim, Ibrahim and Hassan (2022) investigated the short-term dynamics as well as the long-term relationship between natural gas consumption and economic growth in Nigeria, taking breaks into account. The techniques employed include Shahbaz-Omay-Roubaud unit root test with sharp and smooth breaks and autoregressive distributed lag (ARDL) model with breaks. The results revealed that natural gas consumption is positively related to growth both in the short-term and long-term but only significant in the latter. However, there is evidence of bidirectional causality in the long-term and unidirectional causality in the short-term, from growth to natural gas consumption. The implication of the findings is that natural gas is a contributing factor to the growth of the Nigerian economy, and any energy policy aimed at increasing the consumption of natural gas could lead to the increase in economic growth and that Nigerian authorities could adopt energy conservation policies in the short-term so as to take the issue of global warming into consideration. Therefore, the paper recommends stepping up efforts to increase natural gas consumption by building more gas storage facilities, pipeline installations, exploring alternative energy sources, raising awareness/enlightenment about the uses of natural gas, suitability in its use, economic and environmental benefits of its use, ensuring its affordable availability, and beeping up security against pipelines vandalization. Moreover, in the short-term, the country could enact energy conservation policies to combat global warming.

Olawuni (2022) empirically analyzes the relationship of fossil energy consumption with economic development in the case of BRICS countries between 1990 and 2019. Fully modified ordinary least squares was used with the quadratic function of coal, oil, and gas consumption to assess the size-based effect across time. This study showed that coal and natural gas consumption follows the inverted U-shaped relationship with HDI, while coal consumption shows a negative relationship with HDI. Hence, coal and gas energy assist in development when its share is small, while over-consumption hampers development. The BRICS countries should optimize coal and gas consumption with respect to economic development. Reducing fossil energy should be substituted with alternative clean energy resources by using advanced technology such as the gasification process.

Ademola, Ditimi and Johnson (2022) adopted time series data of the trio resources between 1980 and 2021, analyzed using Bound test approach of Autoregressive Distributed Lag (ARDL), Vector Autoregressive (VAR) model and Pair wise causality test to determine the nexus between crude oil price, natural gas price and electricity tariff in Nigeria. The study found that the trio of crude oil price, natural gas price and electricity tariff as energy resources are cointegrated with long run relationship but with no significant causal effect amongst them. The study concluded there is existence of relationship but disproportional effects between the trio of Natural Gas Price (NGP), Electricity Tariff (EET) and Crude oil Price (COBP) in Nigeria’s energy market. The study advocates government intervention in the energy market to reduce associated factors that attracts impact of increase energy resources prices on the citizens' welfare outcomes.

Similar to Shahbaz (2013), Arouri and Teulon evaluated the effect of natural gas consumption on economic development. For the sake of conducting empirical examination, the study likewise utilised the ARDL bound testing technique. It found that Natural Gas substantially influences economic development dependent on production model, in congruent with the examination's upshots. The investigation, however, was unable to identify any meaningful links amid the variables in accordance with the demand side paradigm. A bidirectional causal link amid Natural Gas and production growth in Iran was also revealed by the upshots of causal examination.

In Group of seven countries, Kum, Ocal and Aslan (2012) investigated the link between natural gas and output growth. The study used the data from the period of 1970-2008. Applying the Granger causality, the findings of the investigation revealed that NG has uni-directional causal effects on economic development of Italy. On the other hand, the results of causal analysis for United Kingdom suggested that there exist a uni-directional causal association between NG and output growth where the direction of causality run from economic development to NG. As for United States, France & Germany, the study confirmed the presence of feedback association among the variables.

Maji, Chindo, and Rahim (2019) The study estimated the impact of renewable energy on economic growth in West African countries using panel dynamic ordinary least squares (DOLS) and employing a sample of 15 West African countries covering the 1995 to 2014 period. The results of the study indicated that renewable energy consumption slows down economic growth in these countries. This, the study attributed to the nature and source of renewable energy used in West Africa, which is majorly wood biomass. The wood biomasses used in West Africa are usually unclean and highly polluting when burnt. On the other hand, the use of clean energy sources like solar, wind and hydropower which does not have a side effect on human health and the environment is less in West Africa. As such, renewable energy use can slow down economic growth by lowering productivity when unclean and inefficient sources are used.

In a similar study by Awodumi and Adewuyi (2020), on selected African countries, they found that increasing natural gas utilisation is not only effective in enhancing economic growth in Gabon but is also efficient in mitigating environmental pollution but in the case of Nigeria, natural gas utilisation was found to be unfriendly with economic growth and the environment. The study also found that natural gas utilisation exhibited marginal effect on economic growth in Egypt.

In a study on petroleum product pricing and complementary policies: experience of 65 Under-developed Countries, Kojima (2013) found that governments have changed their policies often since 2009 to keep up with rising global cost of oils. Rising food costs have made the economic problems worse. Energy and food costs on the global market climbed and decreased in lockstep from January 2004, when global cost of oils started to surge, and January 2013, with a correlation value of 0.89. Public demonstrations over high gasoline and food costs were common in nations with a history of rising cost of oils. Some regimes, like Egypt and the Islamic Republic of Iran, have turned to escalating food and gasoline subsidies.

An empirical study on the effect of the oil sector on Nigeria's economic performance was conducted by Ujunwa (2013). The OLS regression method was utilised via the examination phase. The study, which took into account the influence of time on changes in economic indicators, was conducted by means of the simple regression approach, with time and oil revenue (OREV) acting as repressors and the gross domestic product (GDP), a proxy for growth within the economy, as the dependent variable. The two explanatory factors did not substantially affect the growth performance of the economy of Nigeria during the same time, in congruent with a two-tailed test with 5 percent substantial values. The report so advised that the government create an adequate policy mix that would encourage the oil sector's firms to increase their performance and contribution

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Philip and Akinyemi (2013) examined the long run and short run interactions between the cost of petrol and sectoral production in Nigeria from 1980 to 2010. There were six economic sectors looked at: agriculture, manufacturing, building and construction, wholesale and retail, transportation, and communication. The short run error correction estimate revealed that only output of the manufacturing and agricultural sectors of the economy of Nigeria are affected by a surge in petrol costs in the short run. The long run regression estimate demonstrated that the cost of petrol is a substantial determinant of output in all sectors examined with the exception of the building and construction sector. In order to lessen the overdependence of some economic sectors on petrol as their primary source of power, the report advised, among other things, that the government make sure there is an appropriate supply of electricity.

Hondroyiannis, Lolos, and Papapetrou (2012) employed a trivariate framework to analyse the link amid energy consumption and growth within the economy, with cost development acting as the third variable. The vector error correction model (VECM) estimate was utilised in the examination to take data for Greece from 1960 to 1996 into consideration. The empirical results confirmed the idea that growth within the economy, energy consumption, and cost changes are all correlated over the long term and further showed that aggregate energy consumption is Granger-initiated growth within the economy. However, disaggregated energy consumption revealed that whereas residential energy use has a small Granger effect, industrial energy consumption has a substantial one.

The review done above show that most of the studies examined is concerned about energy demand, consumption and economic growth but were less concerned about how natural gas demand and utilization affect economic development which centred on the wellbeing of the people. For instance, Hondroyiannis, Lolos, and Papapetrou (2012), Ademola, Ditimi and Johnson (2022) and Mukhtar, Abubakar, Ibrahim, Ibrahim and Hassan (2022) all studied the impact of natural gas or energy consumption on economic growth but were not concerned about how natural gas consumed by the different sectors affect economic development. Hence the disaggregation of gas demands into the various sectors and the analysis of their impact on economic development (wellbeing of the people) is the major area of departure of this study from others consulted. These are some of the gaps this study seeks to bridge.

METHODOLOGY

This study presents a hybrid model, this model is a combination of econometric model for sectoral gas demand and Modified Multi-cyclic Hubbert Model for Gas production. The model used state explicitly the functional relationship between sectoral gas demand and sustainable economic development. Misery index (MISD) is use as a proxy to measure the sustainable economic development in the model, therefore MISD represent the dependent variable and the demand function of various sector such as Gas to power demand, Gas to industries demand, Gas to Transport and Gas to Household demand sector became the independent variables. The functional relationship is stated as follows:

MSID = f(Gas to power demand, Gas to industries demand, Gas to household demand, Gas to transport demand and price of gas) .

The above functional relationship is stated thus:

$$MSIN_t = AGSPD_t^{\alpha_1} GSID_t^{\alpha_2} GSTD_t^{\alpha_3} GSHD_t^{\alpha_4} PGDS_t^{\alpha_5} \qquad 1$$

In order to facilitate the estimation of the above relationship in equation 1, it is transformed into a linear model thus: Taking natural log of the data/variables help give the data set uniform scale/unit. It also help to produce a better fits compare to a linear model. Also the coefficients of the variables also serve as their elasticities hence help in their interpretation.

$$\log MSIN_t = \alpha_0 + \log \alpha_1 GSPD_t + \log \alpha_2 GSID_t + \log \alpha_3 GSTD_t + \log \alpha_4 GSHD_t + \log \alpha_5 PGDS_t + u_t$$

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Where: Log = natural logarithm; = intercept or misery index independent of sectoral gas demand; = parameter estimates/coefficients of sectoral gas demand; MSIDt = Misery index (proxy for economic development); GSPDt = Gas to power demand; GSIDt = Gas to industries demand; GSHDt = Gas to household demand; GSTDt = Gas to transport demand. PGDSt = price of per unit of gas in Nigeria

These data are in quarterly basis and cover the period 2001 1st quarter to 2020 4th quarter. The data were sourced from NPC/NGC, the NNPC and the National Bureau of Statistics.

Estimation Technique

In order to avoid estimating spurious regression, the stochastic properties of the series were tested. Several procedures for the test of order of integration have been developed but the Philip-Perron technique was used in this study. In furtherance, the ARDL model was considered as the best econometric method for this study since the variables have mixed stationarity with I(0) and I(1). Also, the ARDL approach is appropriate for generating short-run and long-run elasticities for a moderate sample size at the same time following the ordinary least square (OLS) approach for cointegration between variables. Specifically, the ARDL equation for the variables under investigation is stated thus:

$$\Delta\ln(Msid_t) = \sum_{i=1}^{n} \alpha_0 \Delta 1n(Msid_{t-1}) + \sum_{i=1}^{n} \alpha_1 \Delta 1n(Gspd_{t-1}) + \sum_{i=1}^{n} \alpha_2 \Delta 1n(Gsid_{t-1}) +$$
$$\sum_{t=1}^{n} \alpha_3 \Delta 1n(Gshd_{t-1}) + \sum_{t=1}^{n} \alpha_4 \Delta 1n(Gstd_{t-1}) + \sum_{t=1}^{n} \alpha_5 \Delta 1n(Pgds_{t-1})\ \beta_0 \Delta\ln(Msid_{t-1}) + \beta_1 \Delta\ln(Gspd_{t-1}) +$$
$$\beta_2 \Delta\ln(Gsid_{t-1}) + \beta_3 \Delta\ln(Gshd_{t-1}) + \beta_4 \Delta\ln(Gstd_{t-1}) + \beta_5 \Delta\ln(Pgds_{t-1}) + U_t \quad (4)$$

Where: $\beta_1 - \beta_5$ = long-run multipliers; α_1 - α_4 = are coefficients of the short-run dynamic of the ARDL model, U_t is serially uncorrelated stochastic term with zero mean and constant variance, and Δ is the first difference operator. Since the long-run relationship amongst the variables has been established, we proceeded to estimate the long-run equation of poverty level thus:

$$InMsid_t = \beta_0 + \beta_1 InGspd_{t-1} + \beta_2 InGsid_{t-1} + \beta_3 InGshd_{t-1} + \beta_4 InGstd_{t-1} + \beta_4 InPgds_{t-1} + \mu_t$$

$$InMsid_t = \beta_0 + \beta_1 InGspd_{t-1} + \beta_2 InGsid_{t-1} + \beta_3 InGshd_{t-1} + \beta_4 InGstd_{t-1} + \beta_4 InPgds_{t-1} + \mu_t$$
(5)

The Akaike Information Criterion (AIC) was used to determine the lag length of the ARDL model by using a lag length of one (1) both for the regressors and regress. This is AIC considers trade-off between model complexity by incorporating the likelihood, number of parameters, and sample size whereas the Bayelsian Information Criterion (BIC) introduces a stronger penalty for model complexity, prioritizing simpler models. In estimating the short-run dynamics, the ARDL error correction equation was formed thus:

$$\Delta\ln(Msid_t) = \sum_{i=1}^{n} \alpha_0 \Delta 1n(Msid_{t-1}) + \sum_{i=1}^{n} \alpha_1 \Delta 1n(Gspd_{t-1}) + \sum_{i=1}^{n} \alpha_2 \Delta 1n(Gsid_{t-1}) +$$
$$\sum_{t=1}^{n} \alpha_3 \Delta 1n(Gshd_{t-1}) + \sum_{t=1}^{n} \alpha_4 \Delta 1n(Gstd_{t-1}) + \sum_{t=1}^{n} \alpha_5 \Delta 1n(Pgds_{t-1}) + \sum_{t=1}^{n} ECM_{t-1} + U_t \quad (6)$$

Where: α_1 - α_4 = short-run parameters. ECM is the lagged error correction term estimated from the long-run dynamics. It shows the adjustment in the coefficient, and it is usually negative and most times statistically significant in order to confirm the existence of cointegration relationship.

Table 1: Descriptive Statistics

Statistic	MSIN	PGDS	GSPD	GSID	GSTD	GSHD
Mean	37.38	2.22	41784.33	6786.38	532.06	108.20
Median	35.53	1.30	41859.26	6861.31	383.41	77.73
Maximum	53.42	3.40	57194.42	13483.54	1215.21	248.10
Minimum	32.37	1.30	22775.12	2134.95	210.64	42.35
Std. Dev.	5.22	1.02	6239.83	2547.56	314.40	64.38
Skewness	1.59	0.19	-0.42	0.46	1.02	1.02
Kurtosis	4.87	1.04	4.11	3.33	2.33	2.33
Jarque-Bera	25.02	7.31	3.50	1.78	8.44	8.45
Probability	0.00	0.03	0.18	0.41	0.02	0.01
Sum	1644.82	97.60	1838511.	298600.9	23410.63	4760.76
Sum Sq. Dev.	1169.76	44.55	1.67E+09	2.79E+08	4250525.	178229.7
Observations	44	44	44	44	44	44

Source: Authors' Computation (E-view 12)

The descriptive statistics result reported in table 1 indicates that misery index (economic development) has mean value of 37.38 percent, this implies that both unemployment and inflation rate had been on a consistent rise (increase above single digit) over the period of this study. A double digits rise in unemployment and inflation rates implies worsening welfare of the people and an indicator of underdevelopment. The price per unit of gas had a mean value of $2.2 USD while gas utilized by the power sector (GSPD), industrial sector (GSID), transport sector (GSTD) and household (GSHD) on an average stood at 41784.33, 6786.38, 532.06 and 108.20 cubic meters respectively over the period.

Over the period under review, gas utilized by the power sector (GSPD), industrial sector (GSID), transport sector (GSTD) and household (GSHD) had a peak values of 57194.42, 13483.54, 1215.21 and 248.10 cubic meters respectively while misery index and price of gas per cubic unit had maximum values of 53.42 percent and $3.4 USD respectively. The high standard deviation in misery index, price of gas and the various demand for gas by the various sectors revealed that economic development and demand for gas have been unstable over the period under investigation. The Jarque Bera statistic which measures the extent to which the sample data are normally distributed shows that misery index (MSIN), price of natural gas (PGDS), gas demand by the transport sector (GSTD) and Gas demand by households are not normally distributed. However, Gas demand by the power and industrial sectors are normally distributed given their probability values.

Table 2. Unit roots Test Result using Philip-Perron Procedure

Variable	PP Statistic	1%	5%	10%	Decision
Log(GSPD)	-3.47	-3.592	-2.931	-2.604	Stationary@i(0)
Log(MSIN)	-6.18	-3.597	-2.933	-2.605	Stationary@ i(1)
Log(GSID)	-7.16	-3.597	-2.933	-2.605	Stationary@ i(1)

Log(GSTD)	-6.58	-3.597	-2.933	-2.605	Stationary@ i(1)
Log(GSHD)	-6.58	-3.597	-2.933	-2.605	Stationary@ i(1)
Log(PGDS)	-6.49	-3.597	-2.933	-2.605	Stationary@ i(1)

Source: Authors' Computation (E-view 12)

The unit root test result reported in table 2 indicates that misery index (economic development), industrial gas demand, gas demand for transport, gas demand for household and price of natural gas were stationary at first difference i(1) while demand for gas for power generation was stationary at order zero i(0). This mix order of stationarity informed the used of the ARDL method for our analyses.

Table 3. ARDL Bound Test – F-Bounds Test – Selected Model: ARDL (1, 3, 0, 3, 0, 3) Null Hypothesis: No levels relationship

Test Statistic	**Value**	**Critical level**	**I(0)**	**I(1)**
			Asymptotic: n=1000	
F-statistic	5.41	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Authors' Computation (E-view 12)

The bound test result presented in table 3 shows that the F- statistic of 5.41 is greater than the critical levels statistic at 10%, 5%, 2.5% and 1% respectively. By this result, we rejected the null hypothesis of no levels relationship which implies that a long run relationship exist among the variables in the economic development model. The confirmation of long run nexus is the requirement for carrying out the long run estimates and error correction model for the variables in the economic development model.

Table 4. ARDL Long run Result Selected Model: ARDL (1, 3, 0, 3, 0, 3)

Variable	Coefficient	t-Statistic	Prob.
LOG(GSPD)	0.643632	1.239720	0.2266
LOG(GSID)	0.016789	0.213957	0.8323
LOG(GSTD)	10.53395	0.342896	0.7345
LOG(GSHD)	-10.39198	-0.341091	0.7359
LOG(PGDS)	0.094944	0.694611	0.4937
C	-20.88748	-0.435205	0.6671

Source: Authors' Computation (E-view 12)

The long run result reported in table 4 shows that gas demanded and consumed by the power sector has a positive but insignificant relationship with misery index. This implies that gas to power (power generated via gas) increased misery index hence worsen economic development. This result deviated from the apriori theoretical expectation but agrees with the finding by Awodumi and Adewuyi (2020) who found natural gas

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consumption to be unfriendly with economic growth in environmental sustainability. An increase in gas consumed by the power sector increases electricity supply hence increase investment, reduces unemployment and stabilises price level. The low power generated, transmitted and distributed in Nigeria may have accounted for this result.

Gas utilised or demanded by the industrial sector also has a positive and insignificant relationship with misery index. This indicates that increase in gas demand by the industrial sector spurred misery index hence increase unemployment and price level in Nigeria over the period under study. This result is not also in tandem with the theoretical expectation but agrees with but agrees with the finding by Awodumi and Adewuyi (2020). The low utilisation of gas by the industrial sector in Nigeria may have contributed to its low contribution to economic development in the country.

Gas demand by the transport sector also has positive and insignificant nexus with misery index. This indicates that increase in gas demand and utilised by transport sector stimulated unemployment and price level (misery index) hence caused underdevelopment. This result is also contrary to apriori theoretical expectation but agrees with but agrees with the finding by Awodumi and Adewuyi (2020). This result could be traced to the poor utilisation of gas in the transport sector.

Gas demanded by household has negative and insignificant relationship with misery index. This implies that household consumption of gas retarded unemployment and price level (misery index) hence enhances economic development. This result is in tandem with apriori theoretical expectation and theory and earlier studies by Kum et al (2012); Umeh et al (2019); Maji et al (2019) and Galadima and Aminu (2020.). Increase in gas demand by households help conserve the environment by reducing deforestation and pollution hence spur the living conditions of the family members in particular and the society at large.

Price of gas is positively related to misery index. This shows that a rise in the price of gas causes a simultaneous increase in unemployment and price level (misery index). This result is in tandem with apriori theoretical expectation and the work of Heidari et al (2013) which found that a reduction in the price of natural gas as means of increasing gas demand and promoting economic growth and development. An increase in end user price of gas will increase cost of living hence fuels misery index or underdevelopment.

The insignificance of all the variables under investigation implies that sectoral gas demand contributed less to economic development in Nigeria over the period of this study.

Table 5. ARDL Error Correction Model Result – Selected Model: ARDL (1, 3, 0, 3, 0, 3)

Variable	Coefficient	t-Statistic	Prob.
DLOG(GSPD)	0.115168	1.335696	0.1937
DLOG (GSPD (-1))	-0.058393	-0.716354	0.4804
DLOG (GSPD (-2))	-0.255271	-3.413775	0.0022
DLOG(GSTD)	5.379491	6.786422	0.0000
DLOG (GSTD (-1))	-0.132256	-2.346488	0.0272
DLOG (GSTD (-2))	-0.158255	-2.580631	0.0161
DLOG(PGDS)	0.269667	3.465155	0.0019
DLOG (PGDS (-1))	0.164249	1.694388	0.1026
DLOG (PGDS (-2))	0.267444	2.694209	0.0124
CointEq(-1)*	-0.521583	-6.851270	0.0000
R^2 = 0.68, $R^2_{adjusted}$ = 0.58, F-Statistic = 7.5, Prob (F-stat) = 0.00, Durbin Watson statistic = 2.24			

Source: Authors' Computation (E-view 12)

The autoregressive and distributed lag error correction result reported in table 5 shows that gas utilized by the power sector has positive relationship with misery index at level but has negative nexus with misery index at lags 1 and 2. This implies that gas consumed by the power sector increased misery index at level but retarded misery index and promotes economic development at the lags level. The negative relationship of gas demand by the power sector and misery index conforms with apriori theoretical expectation and it is in agreement with earlier studies by Kum et al (2012); Umeh et al (2019); Maji et al (2019) and Galadima and Aminu (2020) which found natural gas consumption and utilisation to be economic growth and development friendly.

The result also revealed that gas demanded and utilized by the transport sector has positive relationship with misery index at level but had negative nexus with misery index at lags 1 and 2. This implies that gas consumed by the transport sector increased misery index at level but retarded misery index and promotes economic development at the lags level. The negative relationship of gas demand by the transport sector and misery index conforms with apriori theoretical expectation and it is in agreement with earlier studies by Kum et al (2012); Awodumi and Adewuyi (2020); and Galadima and Aminu (2020) which found natural gas consumption and utilisation to be friendly with economic growth and development. The significance of gas demanded by the transport sector at level and the lags levels implies that gas utilized by the transport sector has serious implication on economic growth and development in Nigeria.

The positive link between price of gas and misery index at level and lags 1 and 2 shows that price of gas consumed fuels misery index hence retarded economic development. Price is crucial to consumption and well being of an individual. The higher the price of a commodity the lower the demand for such commodity hence price reduce consumption and hamper economic development. This result is in consonance with earlier study by Heidari et al (2013) which opined a reduction in the price of natural gas as means of increasing gas demand and promoting economic growth and development.

The negative coefficient of the speed of adjustment (ECM) and its significance at 5 percent level shows that sectoral gas demand adjusts speedily to changes in both short and long run dynamics in economic development. From the result in table 5, the speed of adjustment is about 0.52 or 52% which implies that sectoral gas demand speed of adjustments to both short and long run changes in misery index (economic development) is about 52%. Also the goodness of fit of 0.68 indicates that 68 percent of the total variation in economic development is explained by sectoral gas demand in Nigeria over the period of this study.

Table 6: Model Diagnostic test

Diagnostic test	F-statistic	Probability
Jarque-Bera test for normality	1.39	0.50
Breusch-Godfrey serial correlation LM test	1.03	0.37
ARCH Heteroskedasticity test	3.68	0.06
Ramsey RESET test for specification error	10.59	0.003

Source: Authors' Computation (E-view 12)

The results of the model diagnostics tests on the residual as reported in table 6 reveal that the error term is normally distributed around the mean as the null hypothesis is accepted. It also show no evidence of autocorrelation given the serial correlation LM test probability. Also, the test for heteroscedasticity revealed that it is absent in the model as we accept the null hypothesis of homoscedasticity. However, the Ramsey

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RESET test indicates specification error as null hypothesis is rejected. The adherence of the model to the basic assumptions of ordinary least squares estimation affirm that the model is good for prediction and forecast hence the best linear estimator (the BLUE)

Figure 1. Model stability Test – Recursive Residuals

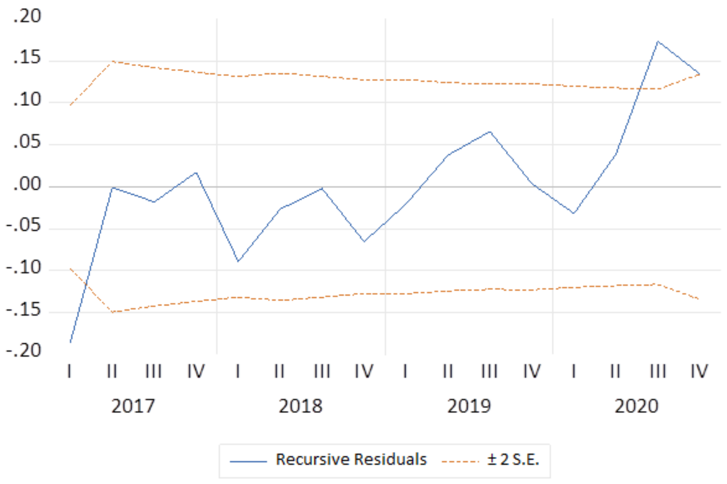


Figure 2. Model stability Test – CUSUM

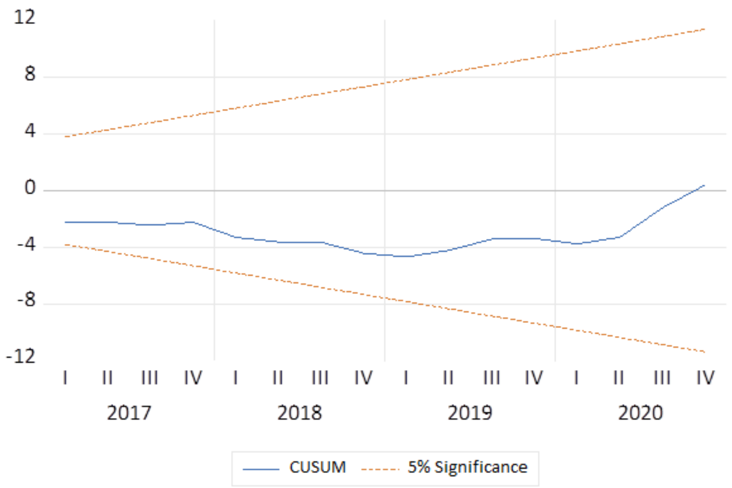
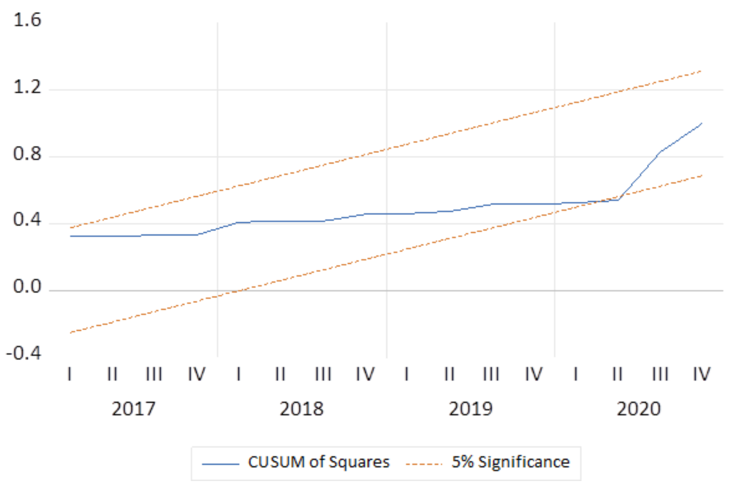


Figure 2. Model stability Test – CUSUM of squares



Source: Authors' Computation (E-view 12)

The trended nature of most time series data shows that it is prone to instability hence testing for the stability of the variables is necessary. In carrying the stability test, It is necessary to include short-run dynamics in testing for the stability of the long-run parameters of the economic development model. To this end, this study adopted the Bahmani-Oskooee and Shin (2002) method, as well as applying the cumulative sum of recursive residual (CUSUM) to the residuals of the ARDL error correction model. For stability of the short-run dynamics and the long-run parameters of the economic development model, it is a necessary condition that the recursive residuals, CUSUM and CUSUM of squares values stay within the 5% critical bound represented by two straight lines whose equation are detailed in Brown et al. (1975). As shown in Figures 1, 2 & 3 neither the recursive residuals nor the CUSUM, and CUSUM of the square plots crossed the 5% critical lines, therefore, the study concluded that the estimated parameters for the short-run dynamics and the long-run of the economic development model were relatively stable. That is, a stable economic development model existed over the period of this study.

CONCLUDING REMARKS AND RECOMMENDATIONS

This study investigated the impact of sectoral gas consumption on economic development in Nigeria from 2010 to 2020. The Autoregressive and Distributed Lag (ARDL) technique was used to analyse the data after carrying out the unit roots test. The result shows that gas demand for transport, industrial, and power sectors as well as its cost contributed to a rise in the global misery index, which ultimately hampered long run sustainable economic development. On the other side, household demand for gas decreased the misery index and, over time, hence promoted long run economic development in Nigeria. The study also found an insignificant nexus between demand for gas by the various sectors and economic development in the long run. In the short run, gas demand for transport and cost of gas had significant impact on economic development. Based on these results, the study concludes that gas demand had serious implication on economic development in the short run than long run. Consequent upon the findings, the study recommends, an increase in gas demand for household use and for transportation through a stable and competitive price of natural gas in order to enhance sustainable economic development in Nigeria.

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