ASYMMETRIC IMPACT OF SOME SELECTED MACROECONOMIC VARIABLES ON NATURAL GAS CONSUMPTION IN NIGERIA

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ABSTRACT
This study examined the impact of macroeconomic variables on natural gas consumption in Nigeria during the period 1980–2021 using nonlinear autoregressive distributed lag (NARDL) model. Findings indicated that, natural gas consumption falls with exchange rate appreciation, and rises with depreciation in exchange rate in Nigeria. Also, natural gas consumption falls with increase in inflation rate, and increases with the fall in the rate of inflation. Increase in money supply reduces natural gas consumption, so also decrease in money supply. Finally, the results also revealed that, a rise in economic growth increases natural gas consumption, and as well, a fall in economic growth raises natural gas consumption in Nigeria. The study therefore recommends that, effective use of monetary policy tools in checking the growth of money supply, exchange rate and inflation rate could be of help in boosting natural gas consumption and stirring up economic growth in the country. Since natural gas consumption responds negatively to the changes in the exchange rate, implying that, exchange rate depreciation discourages importation, foreign exchange demand, and propel domestic production which in turn results in more natural gas consumption and improved growth and development in the country.

Keywords: Natural gas, Exchange rate, Inflation, Money supply, NARDL, Nigeria, Economic Growth

JEL Classification Code: Q31, Q41, Q43.

1. INTRODUCTION
Natural gas is one of the most important energy sources in the world today, as growth in its consumption has been the fastest of all the fossil fuels in recent years. World energy demand, particularly natural gas has enormously increased since many countries require primary energy sources for sustainable development (Shahbaz et al., 2013). Natural gas is the lowest-carbon fossil fuel, formed deep beneath the earth surface when the decomposed plants and animals are exposed

to extreme heat and pressure for many years (about a million years). It contains high level of methane and few other hydrocarbons like ethane, propane hexane, helium etc. It is easily flammable, making it one of the most used energy source across the world. It is odorless, colorless and non-toxic (Energy Information Administration, 2019). It is a type of fossil fuel which can be used as to provide warmth for cooking and heating, and it fuels power stations that provide electricity to homes and businesses. It also fuels many industrial processes that produce material goods like glass, clothing, fertilizer, petrochemicals and it is an important ingredient in production of paints and plastics. The environmental hazards associated with the combustion of coal and oil have motivated world economies to look for relatively cleaner alternatives turning to natural gas as an alternative to generate the economic outputs (Apergis & Payne, 2010; Hussain & Rehman, 2021; Igbinedion, et al. 2022).

In Nigeria initially over the years, the role of natural gas in energy consumption was very negligible. Until the late 1990s, natural gas was regarded as a by-product of oil exploration and did not get the needed attention compared to crude oil, mainly due to the low level of industrialisation, inadequate regulation of the industry, poor domestic market, government policies on subsidisation of petroleum products and the attitude of the multinational oil companies (MNOCs) whose focus was on crude oil (Aleshinnloye, 2022). Arguably, for many years natural gas was either flared or neglected if encountered in the course of crude oil exploration with obvious consequences on socio-economic and environment.

Although, a considerable number of empirical studies have been conducted on the impact of macroeconomic variables on energy consumption in general and natural gas consumption in particular, very few among them sought to examine the asymmetric impact of macroeconomic variables on natural gas consumption in Nigeria using Nonlinear Autoregressive Distributed Lag (NARDL) model. It is noteworthy that, doing so would provide a better understanding of the impact of both positive and negative changes in macroeconomic variables on natural gas consumption in Nigeria. The superiority of this technique over other classes of autoregressive models is that, it has a better empirical fit and allows for identifying the asymmetric shocks with respect to the variables of the study and also solves for the parametric identification problem present in the system (Galadima & Aminu, 2019). Therefore, the broad objectives of this paper are to examine the impact of macroeconomic variables, namely money supply, inflation, exchange rate, and real GDP on natural gas consumption, and to offer policy recommendations based on the findings of the study. The rest of the paper is structured as follows: literature review, methodology in which the objectives of the paper could be achieved, presentation and analysis of the empirical findings and the final section concludes the paper.

2. LITERATURE REVIEW

Several studies have investigated the relationship between macro-variables and energy consumption in different regions and countries, and Some researchers argued that macro-variables are the determinants of energy consumption (Saidi & Hammami, 2015; Wildan et al. 2021; Katircioglu et al. 2021; Deka et al. 2021; Purwanto et al. 2021; Iqbal et al. 2021; Wang et al. 2021; Talha et al. 2021; Adejare 2019; Galadima & Aminu, 2019; Burakov et al. 2018; Djulius, 2017; Parker 2017) and therefore these variables could be useful in projecting or influencing energy consumption policies, while others have contrary findings (Khan and Ahmad, 2008; Josheski et al. 2014; Abdullahi, 2014; Malika et al. 2014; Deka et al, 2021; Djulius, 2017). The impact of macro-variables, including gross domestic product (GDP), export, industrial production, current account deficit, etc. have been extensively examined, For instance, exchange rate's dynamics may affect energy consumption through expansion in industrial production and export. Depreciation in exchange rate propels economic activities by increasing industrial production and exports (Amaegberi, Okon & Adie, 2020; Terhemba, 2020), whereas production, especially in the industrial sector, requires the use of energy as an input; hence, industrial expansion leads to increase in energy consumption in the country. Wildan et al. (2021) examined the impact of macroeconomic variables on natural gas export management in Indonesia, using secondary data for the period 1995-2017. ARDL was applied and the results showed that, domestic consumption, exchange rates, natural gas prices and GDP per capita significantly influence the volume of natural gas exports.

Deka and Dube (2021) examine the long-run and short-run relationship between inflation, exchange rate, and renewable energy use in Mexico during the period 1990–2019 by employing ARDL bounds test approach. The results showed that in the long-run renewable energy use impacts both inflation and exchange rate but exchange rate and inflation do not impact renewable energy, while in the short-run, an increase in renewable energy has positive impact on exchange rate appreciation. Katircioglu et al (2021) investigates the role of the financial system in energy demand in the cases of developed and developing countries using annual data from 2000 to 2015. Results indicated that the financial system and financial markets are long-term catalysts for energy consumption in both groups under consideration. Results show that domestic credits by banks, money supply positively impact energy demand in developing countries. Also, Deka et al. (2021) investigated the causal link among the use of renewable energy, rate of currency exchange and the rate of inflation of Brazil with the ARDL model. The findings showed that in the long-run a bidirectional causal association between exchange rate and renewable energy of Brazil exists. Inflation rate also causes renewable energy and exchange rate of Brazil in the long-run.

Purwanto et al. (2021) investigated the factors that characterized the increased use of non-renewable resources that include inflation, poverty and debts using time series data over 28 years (1995-2019). ARDL model was employed, and the results showed that, inflation, poverty, and debts have significantly being the culprits for increased non-renewable energy consumption in both short-run and long-run analysis. Iqbal et al. (2021) examined the determinants of energy inflation in Pakistan by using time-series data for 1991 to 2019 by applying Autoregressive Distributed Lag (ARDL) cointegration for empirical analysis. The findings revealed that, an increase in the demand for energy in economic activities in Pakistan results in energy inflation. Wang et al. (2021) using a two-regime threshold model with smooth transition and Chinese data from 1980 to 2017, they empirically confirmed that oil consumption is more sensitive to the exchange rate volatility. Talha et al. (2021) examined the effect of macroeconomic variables on energy consumption in Malaysia through the use of secondary data from 1986 to 2019 collected on specific macroeconomic indicators such as inflation, oil prices, energy consumption, and gross domestic product. They used multiple linear regression model, correlation model, and descriptive analysis and found that the rate of oil and renewable energy consumption enhances the economic growth and also improves the inflation rate in the country.

Galadima and Aminu (2019) employed Structural VAR (SVAR) model with sign restrictions to examine the transmission of shocks from macroeconomic variables: money supply, inflation, exchange rate and economic growth on natural gas consumption in Nigeria using secondary data from 1981 to 2015. The results revealed that, both in the short run and long run, natural gas consumption responds positively and significantly to the shocks emanating from money supply and economic growth while its response to inflation shock is significant only in the short run but exchange rate shock is not significant. However, money supply has contributed greater proportion of the shocks followed by the economic growth, inflation and exchange rate in the ordering of the variance decomposition. Adejare (2019) empirically examined the effect of interest rate and money supply on petroleum profit tax (PET) in Nigeria. The study employed annual time series data from 1980 to 2013 An Error Correction Mechanism (ECM) Model was adopted and the results showed that, there was unidirectional causality between money supply and PET, money supply has positive effect on PET in the short run but negative effect in the long run.

Adam et al. (2018) examined the causal relationship between crude oil price, exchange rate, and rice price in Indonesia using monthly data from January 2000 to September 2017. The result of data analysis using vector autoregressive model showed that the relationship between crude oil price and rice price is positive, while the relationship between exchange rate and rice price is positive before the 3rd month. However, this relationship turns into negative after the 3rdmonth. Burakov et al. (2018) investigated the casual relationship between energy consumption, trade openness, exchange rate and foreign direct investment Russia and Belarus for the period from 1997 to 2017. The error correction approach was employed and the results showed that in the short run trade openness and exchange rate affect foreign direct investment in positive and significant manner. In the long run, energy consumption, trade openness and exchange rate positively affect foreign direct investment.

3. METHODOLOGY

3.1 Types and sources of Data

The type of data used for this study are secondary time series data relating to natural gas consumption, exchange rate, money supply, inflation rate and economic growth for a period 1981 and 2020 sourced from the World Development Indicators while data on NGC from US Energy Information Administration(EIA).

Table 1. Description of the Variables

Variables	Code	Description	Source
Natural Gas Consumption	NGC	Annual volumes of natural gas consumed for different purposes (industrial, residential/service, and production of electricity) within the Nigerian economy, measured in Billion cubic feet (Bcf),	US EIA
Inflation rate	INF	the rate at which the prices rises persistently and continuously in the general level of prices of goods and services in an economy.	WDI, WB

Exchange rate	EXCR	the rate at which a country's currency is exchanged for other countries currencies.	WDI, WB
Money supply	MS	Money supply (MS) is the broad money which measures total sum of money in the economy, defined as narrow money plus savings and time and savings deposits with banks including foreign currency deposits as a percentage of GDP.	WDI, WB
Real Gross Domestic Products (RGDP) (constant 2015 US$)	RGDP	RGDP is real gross domestic products GDP is the sum of gross value added by all resident producers in the economy plus any product taxes, minus subsidies not included in the value of the products. Data are in constant 2015 U.S. dollars	WDI, WB

3.2 Model Specification

The study adapted the model used by Deka and Dube (2021). While Deka and Dube (2021) used the variables of exchange rate, renewable energy, inflation and Real GDP; this study differed by using exchange rate, inflation rate, broad money supply, Real GDP and natural gas consumption instead of renewable energy consumption to better explain how macro-variables affect natural gas consumption. The functional and baseline models are presented below:

NGC=F(EXCR, MS, INF, RGDP)..(1)

$$NGC_t = \beta_0 + \beta_1 EXCR_t + \beta_2 MS_t + \beta_3 INF_t + \beta_4 RGDP_t + \mu_t \text{..............................(2)}$$

Here, β_0 is the constant intercept, *β1- β4*are the coefficients of explanatory variables to be estimated, *t* is the time dimension and μ_t denotes the error term in the model. The log linear specification of equation (3) is as follows:

$$LNGC_t = \beta_0 + \beta_1 LEXCR_t + \beta_2 LMS_t + \beta_3 INF_t + \beta_4 LRGDP_t + \mu_t \text{.......................(3)}$$

where LNGC is the logarithm of natural gas consumption, LEXCR is the logarithm of exchange rate, LMS is the logarithm of broad money supply, INF is the inflation rate, LRGDP is the logarithm of Real Gross Domestic Products proxied for economic growth,$\beta_0$is the constant intercept, *β1- β4* are the coefficients of explanatory variables to be estimated, *t* is the time dimension and μ is the error term which is assumed to be normally distributed.

3.3 Estimation Procedure

3.3.1 Unit root test

The study applied the traditional unit root tests of augmented Dickey- Fuller (ADF), and Phillips Perron to test the stationarity of the variables of the study.

3.3.2 NARDL Approach to Co-integration

This study adopted non-linear Autoregressive Distribution Lag (NARDL) Model developed by Shin, Yu and Greenwood-Nimmo (2014). The technique provides for the incorporation of the possibility of nonlinear effects of positive and negative shocks in the explanatory variables on the dependent variable, unlike the Linear ARDL in which the possible effects of the explanatory variables remain the same. It also provides cumulative dynamic multiplier graphs, used in identifying the patterns of movement from positive and negative changes in the explanatory variables (Sohail et al. 2021; Pedro & Adesina-Uthman, 2022).

The NARDL model represents the asymmetric error correction term as follows:

$$\Delta LNGC_t = \alpha_0 + \alpha_1 LNGC_{t-1} + \alpha_2^+ LEXCR_{t-1}^+ + \alpha_3^- LEXCR_{t-1}^- + \alpha_4^+ LMS_{t-1}^+ + \alpha_5^- LMS_{t-1}^- + \alpha_6^+ LINF_{t-1}^+$$
$$+ \alpha_7^- LINF_{t-1}^- + \alpha_8^+ LRGDP_{t-1}^+ + \alpha_9^- LRGDP_{t-1}^- + \sum_{I=1}^{q} \beta_1 \Delta LNGC_{t-1} + \sum_{I=0}^{K_2} \beta_2^+ \Delta LEXCR_{t-1}^+$$
$$+ \sum_{I=0}^{K_2} \beta_3^- \Delta LEXCR_{t-1}^- + \sum_{I=0}^{K_3} \beta_4^+ \Delta LMS_{t-1}^+ + \sum_{I=0}^{K_3} \beta_5^- \Delta LMS_{t-1}^- + \sum_{I=0}^{K_4} \beta_6^+ \Delta LINF_{t-1}^+ + \sum_{I=0}^{K_4} \beta_7^- \Delta LINF_{t-1}^-$$
$$+ \sum_{I=0}^{K_4} \beta_8^+ \Delta LRGDP_{t-1}^+ + \sum_{I=0}^{K_4} \beta_9^- \Delta LRGDP_{t-1}^- + \mu_t \text{...........(7)}$$

From the model above, $LEXCR^+_t$, $LEXCR^-_t$, LMS^+_t, LMS^-_t, $LINF^+$t and $LINF^-_t$ and $LRGDP^+$t and $LRGDP^-_t$ are the positive and negative shock components of the explanatory variables. The parameter β_i, indicates short-term coefficients, while long-term coefficients are denoted by α_i with i= 1….n. $LNGC_t$ is the dependent variable, with optimal lag q; while $LEXCR_t$, LMS_t, $LINF_t$ and LRGDPt are the independent variables, with k_i optimal lags.

4. RESULTS AND DISCUSSION OF FINDINGS

4.1 Descriptive Statistics

Before going to the econometric estimation, it is worth to have a look at descriptive statistics of the variables. In the descriptive statistics, the data are suppose to be in their raw form without any transformation. The result is presented in Table 4.1. This is essential due to these statistics summarize the statistical properties of the series of the model.

Table 2. **Descriptive Analysis**

Variables	NGC	EXCR	INFR	MOS	RGDP
Mean	295.2439	98.31591	18.7788	16.6652	3.6813
Median	208.0000	101.6973	12.5510	13.5270	2.5413
Maximum	667.0000	358.8108	72.8355	28.6252	7.2113
Minimum	38.00000	0.546781	5.38801	9.06333	1.6213
Std. Dev.	202.4004	100.6851	16.7158	6.10943	1.9813
Observations	41	41	41	41	41

Source: Author's computation using Eviews 10

Table 2 presents the descriptive statistics results. The standard deviations analysis revealed higher volatility in NGC emissions, followed by EXCR andINF while, MOS and RGDP recorded lowest volatility.

4.2 Unit Root Test Result

A summary of unit root test results regarding order of integration based on different unit root criteria is given in Table 2

Table 2 **Augmented Dickey Fuller (ADF) Unit Root Test Result**

Variables	T-Statistics	Critical Values			Remarks
		1%	5%	10%	
LNGC	-3.634133	-4.211868	-3.529758	-3.194611	I(0)
LEXCR	-5.672682	-4.205004	3.526609	-3.194611	I(1)
INF	-3.772278	-4.211868	-3.529758	-3.196411	I(0)
LMS	-7.872961	-4.205004	-3.526609	-3.194611	I(1)
LRGDP	-3.095241	-3.615588	-2.941145	-2.609066	I(1)

Source**:** Author's computation using Eviews 10

From the ADF unit root test results in table 2, LNGC and INF are stationary at level I(0), while LEXCR, LMS and LRGDP are stationary at first difference I(1). Therefore all the variables are combination of both I(0) and I(1) and none of them is of I(2). Thus, the variables are qualified to run for NARDL approaches to co-integration.

4.3 Lag Length for F- Bound Cointegration Test

It is necessary to determine the optimal lag length before conducting the NARDL cointegration test. The result is presented in the table below.

Table 3 **Lag Length for F- Bound Cointegration Test**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-220.6418	NA	0.098920	11.87589	12.09136	11.95255
1	-36.98550	309.3159*	2.37e-05*	3.525553*	4.818384*	3.985532*
2	-14.08429	32.54382	2.84e-05	3.636015	6.006206	4.479311
3	11.59921	29.73879	3.33e-05	3.600042	7.047592	4.826654

Source**:** Author's computation using Eviews 10

Table 3 above presents the lag order selection by five different criteria. All the lag selection criteria suggest that a lag length of one (1) is optimal for the F-bound cointegration test. Therefore, this study used a lag length of one for the cointegration test.

4. Bound Test for Cointegration

Bounds Test for cointegration was performed to check the presence of longrun relationship among the variables. The null hypothesis is that there is no long-run relationship

Table 4 **Bound Test for Cointegration**

H_0: *No cointegration*

F-Statistic	Significance Level	Bound Critical Values		K
		I(0) Bound	I(1) Bound	
41.91294	1%	2.79	4.1	8
	2.5%	2.48	3.7	
	5%	2.22	3.39	
	10%	1.95	3.06	

Source: Author's computation using Eviews 10

The result of the F-bound test of cointegration is reported in table 4. The result shows that the value of F-statistics is 41.91294and is higher than both the lower and the upper bound critical values at 5% level of significance. Hence, the null hypothesis of no cointegration is rejected and the alternative hypothesis of the presence of cointegration among the variables of the study is accepted. Therefore, the variables have longrun equilibrium relationship.

4.5 Non-Linear ARDL Longrun Response

The estimated non-linear long-run dynamics of the ARDL model are presented in table 5.

Table 5 **Non-Linear ARDL Longrun Response**

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	3.189240	1.190128	2.679746	0.0126
LEXCR_POS	-0.076171	0.150481	-0.506183	0.6170
LEXCR_NEG	8.643237	4.374915	1.975635	0.0589
INFR_POS	-0.000708	0.004244	-0.166767	0.8688
INFR_NEG	-0.000530	0.004243	-0.124797	0.9016
LMOS_POS	-0.136258	0.544707	-0.250148	0.8044
LMOS_NEG	0.158308	0.514496	0.307696	0.7608
LRGDP_POS	2.344720	0.665727	3.522044	0.0016
LRGDP_NEG	-4.187684	2.740189	-1.528246	0.1385

Source: Author's computation using Eviews 10

Table 5 shows the result of the nonlinear response of natural gas consumption (NGC) to macroeconomic variables of exchange rate (EXCR), inflation rate (INFR), money supply (MOS) and Real Gross Domestic Products (RGDP) in Nigeria with positive and negative responses. From the table 5, the longrun result shows that the response of NGC to positive changes in exchange rate (EXCR) is -0.076, while the response of NGC to negative changes in EXCR is 8.64. This implies that when EXCR appreciates by 1 per cent, NGC decreases by about 0.08 per cent, but when EXCR depreciates by 1 per cent, NGC decreases by 8.6 per cent, confirming the result of Deka et al. (2021) and Galadima and Aminu, (2019). This suggests that the response of NGC to positive changes in NGC is different from its response to negative changes in NGC. Therefore, The relationship between NGC and EXCR in Nigeria is asymmetric.

Furthermore, the response of NGC to both positive and negative changes in inflation rate (INFR) is negative (-0.000708 and -0.000530 respectively) . This implies that NGC decreases by 0.00071 per cent when inflation rate increases by at least 1 per cent, while decrease in inflation rate by 1 per cent results in 0.0005 per cent rise in NGC in the longrun as revealed by Purwanto et al. (2021). For money supply, the response of NGC to positive changes is negative, whereas the negative changes is positive but statistically insignificant, implying that 1 per cent increase in money supply decreases NGC by 0.14 per cent , whereas a per cent decrease in money supply increases NGC by 0.16 per cent, contradicting the findings of Galadima and Aminu (2019). This suggests that, increase in money supply is not put into good use in Nigeria within the study period. Also, For RGDP, the response of NGC to positive changes is positive and statistically significant, whereas the negative changes is negative but statistically insignificant. The result shows that 1 per cent increase in RGDP increases NGC by 2.3 per cent, whereas a unit decrease in RGDP increases NGC by 4.2 per cent. This is consistent with the findings of Talha et al. (2021).

4.6 Nonlinear ARDL shortrun Response

The estimated linear short-run coefficients of the ARDL model are presented in table 6 below.

Table 6 **Nonlinear ARDL shortrun Response**

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	6.351068	0.204769	31.01577	0.0000
D(LEXCR_POS)	0.205925	0.025242	8.158132	0.0004
D(LEXCR_POS(-1))	0.692446	0.033615	20.59933	0.0000
D(LEXCR_NEG)	-18.35491	1.064488	-17.24295	0.0000
D(LEXCR_NEG(-1))	2.892295	1.256584	2.301711	0.0696
D(INFR_POS)	0.006067	0.000825	7.354240	0.0007
D(INFR_POS(-1))	-0.003097	0.000856	-3.615916	0.0153
D(INFR_NEG)	-0.000855	0.000888	-0.963016	0.3798
D(LMOS_POS)	0.665936	0.075198	8.855707	0.0003
D(LMOS_NEG)	0.408577	0.096691	4.225610	0.0083
D(LRGDP_POS)	1.554025	0.320369	4.850736	0.0047
D(LRGDP_POS(-1))	1.656348	0.292373	5.665192	0.0024
D(LRGDP_NEG)	15.69951	1.474343	10.64847	0.0001
D(LRGDP_NEG(-1))	-1.107023	0.376738	-2.938445	0.0323
ECM(-1)	-0.983158	0.031394	-31.31713	0.0000

Source: Author's computation using Eviews 10

Table 6 shows the result of the shortrun asymmetric coefficients of the independent variables with positive and negative responses. ceteris paribus, a 1 per cent appreciation in exchange rate increases natural gas consumption (NGC) by 0.21 per cent in the shortrun. Also, an appreciation in the previous value of exchange rate by 1per cent, increases natural gas consumption by 0.70 per cent. Again, a depreciation in exchange rate by 1 per cent, increases NGC 18.3 per cent, but a depreciation in the previous year exchange rate by 1 per cent, reduces NGC by about 2.8 per cent. In the same vein, an increase in inflation rate by 1 per cent increases natural gas consumption by 0.006 per cent. The result also shows that an increase in the previous year inflation rate by 1 per cent, reduces natural gas consumption by 0.0031 per cent. A unit decrease in the current INFR increases NGC by 0.00085 per cent. An increase in money supply by 1 per cent raises NGC by 0.67 per cent. 1 per cent decrease in money supply reduces natural gas consumption (NGC) by 0.41 per cent in the shortrun. Also, an increase in RGDP by 1 per cent, increases natural gas consumption by 1.5 per cent, as well, an increase the previous year RGDP by 1per cent, increases natural gas consumption by 1.65 per cent. Again, a decrease in RGDP by 1 per cent, reduces NGC by 15.7 per cent, but a decrease in the previous year RGDP by 1 per cent, increases NGC by about 1.11 per cent. The Error Correction Mechanism *ECMt(-1)* is negative and statistically significant, which implies that for every disequilibrium or divergence in the longrun, there will be convergence or correction toward equilibrium by 98 per cent.

4.7 Longrun Asymmetry: Wald Test

Table 7below shows the result of longrun asymmetric relationship of the Wald test between the dependent variable (LNGC) and the independent variables (LEXCR, INFR, LMOS and LRGDP). The null hypothesis states that H_0: there is no longrun asymmetric relationship. From the table, if the F-statistics value is statistically significant, then reject the null hypothesis and conclude that there is longrun asymmetric relationship.

Table 7 **Longrun Asymmetry: Wald Test**

Variables	Equation	T-stats	Chi- Square	F-stats	Prob.
LEXCR	NARDL	2.118498	4.488032	4.488032	0.0451
INFR	NARDL	4.489182	20.15276	20.15276	0.0002
LMOS	NARDL	0.888646	0.789693	0.789693	0.0383
LRGDP	NARDL	-2.396515	5.743285	5. 743285	0.0244

Source*:* Author's computation using Eviews 10

Therefore, from the table7 above, there is evidence of longrun asymmetry between the dependent variable (LNGC) and the independent variables (LEXCR, INFR, LMOS and LRGDP). Therefore, the study reject the null hypothesis and conclude that there is evidence of longrun asymmetric relationship.

4.8 Shortrun Asymmetry Wald Test

Table 8below shows the result of the shortrun asymmetric relationship of the Wald test between the dependent variable (LNGC) and the independent variables (LEXCR, INFR, LMOS and LRGDP).

Table 8**Shortrun Asymmetry Wald Test**

Variables	Equation	T-stats	Chi- Square	F-stats	Prob.
LEXCR	NARDL	4.570240	20.88709	20.88709	0.0001
INFR	NARDL	1.840924	3.389003	3.389003	0.0786
LMOS	NARDL	2.570240	12.86709	12.86709	0.0001
LRGDP	NARDL	1.804533	3.245340	3.245340	0.0332

Source*:* Author's computation using Eviews 10

The null hypothesis is H_0: there is no shortrun asymmetric relationship. From the table, if the F-statistics value is statistically significant at 5% level, then reject the null hypothesis and conclude that there is shortrun asymmetric relationship. Therefore, from the table 8, there is evidence of shortrun asymmetry between the dependent variable (LNGC) and the independent variables (LEXCR, LMOS and LRGDP), except INFR. Therefore, the study reject the null hypothesis and conclude that there is evidence of shortrun asymmetric relationship.

Table 9 **Diagnostic Test**s

Tests	F- statistics	Obs*R-squared	Prob.
Jaque Bera	---	---	0.841302
Serial Correlation	0.151316	0.525634	0.8605
Heteroskedasticity	0.852184	12.02817	0.6076
RAMSEY RESET	3.684605	---	0.0680

Source: Author's computation using Eviews 10

Table 9 reveals the diagnostic tests of the results to confirm whether the model is stable, robust and efficient, and can give a good forecast. The first test is the Jaque Bera (normality test) developed by Jaque and Bera (1980) to test for the normality distribution of the residuals. The null hypothesis(H_0) is that the residuals are normally distributed.

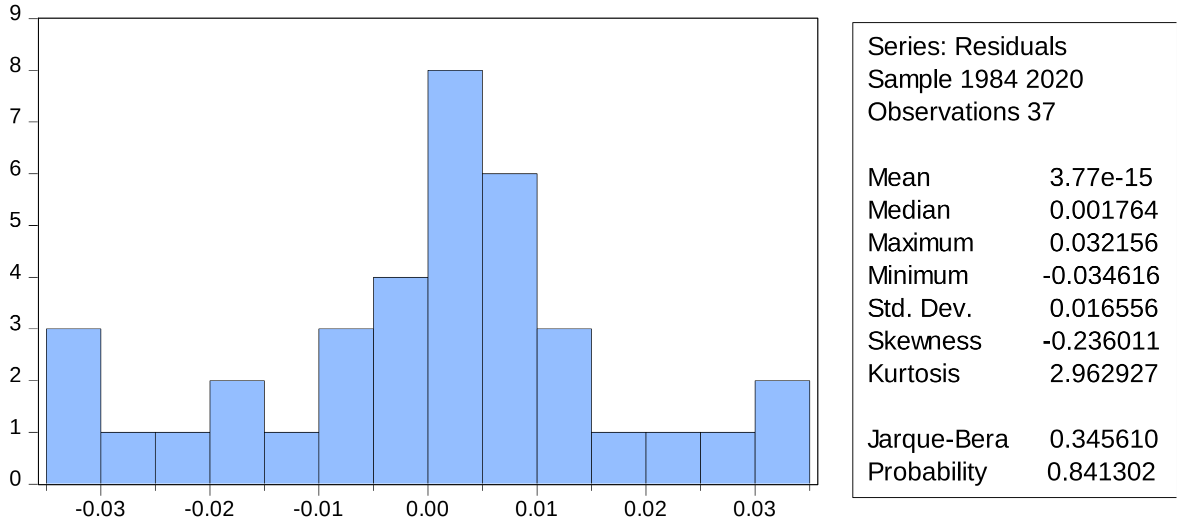
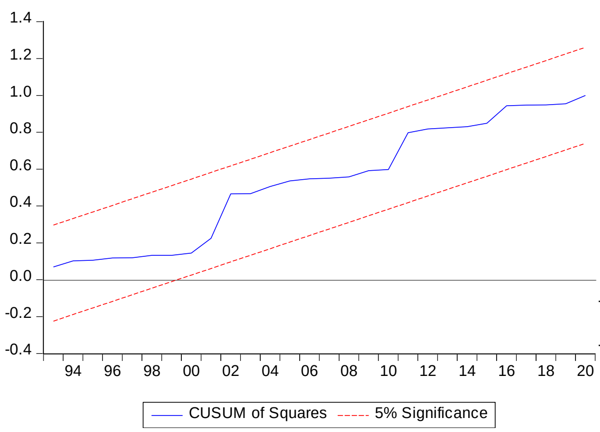


Fig. 3 ***Normality Test***
Source: Author's computation using Eviews 10

Lastly, the results of diagnostics tests have been presented in table 9 and figure 3which showed that the error terms are normally distributed. Similarly, the model is well specified based on the Ramsey rest test, and free from serial correlation heteroscedasticity problem. Stability of both the short and long run parameters were checked using CUSUM and CUSUMsq and the result is presented in Figs. 4 and 5. They revealed that the plots are within the 5% critical bounds and justify the stability of the models during the study period.



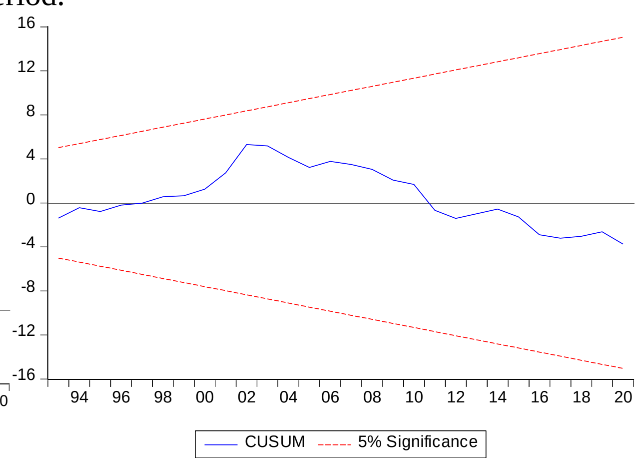


Fig.4 Cusum Test
Source: Author's computation using Eviews 10

Fig.5 Cusum of Squared Test
Source: Author's computation using Eviews 10

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study empirically examined the asymmetric impact of macroeconomic variables on natural gas consumption in Nigeria from 1980 to 2021. To achieve the objectives of the study, nonlinear ARDL and the shortrun and longrun asymmetry Wald test were employed. The finding from NARDL revealed that, appreciation in exchange rate reduces natural gas consumption, and depreciation in exchange rate also decreases natural gas consumption in Nigeria, though the impact is statistically insignificant. Also, natural gas consumption falls with rise in inflation rate, whereas, increases with the fall in the rate of inflation in Nigeria, hence concluded that high rate of inflation are unfavorable to natural gas consumption in Nigeria. An increase in money supply reduces natural gas consumption, whereas a decrease in money supply also decreases NGC. Finally, the results also revealed that, the response of natural gas consumption to positive changes in RGDP is positive and statistically insignificant that, a rise in RGDP increases natural gas consumption, and as well, a fall in RGDP raises natural gas consumption in Nigeria, justifying the early stage of environmental kuznet hypothesis.

The implication of the results is that forecasting the macroeconomic variables and natural gas consumption in Nigeria would be more statistically appropriate using nonlinear approach. Another policy implication of the findings is that, natural gas consumption could be affected by the possible changes in exchange rate, money supply, inflation rate and hence affect growth in Nigeria. Therefore, the study recommends that, effective use of monetary policy tools in checking the growth of money supply exchange rate and inflation rate could be of help in boosting natural gas consumption and stirring up economic growth in the country. Since natural gas consumption and exchange rate are inversely related, though insignificant, it implies that exchange rate depreciation discourages importation, foreign exchange demand, and propel domestic production which in turn results in more natural gas consumption and improved growth and development in the country.

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