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THE NEXUS OF NATURAL GAS-BASED INDUSTRIALIZATION AND UNEMPLOYMENT LEVELS IN NIGERIA

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Abstract

This study examines the relationship between natural gas industrialization and the unemployment rate in Nigeria, using bi-annual time series data from 1997 to 2021. The data was tested for stationarity using the Augmented Dickey Fuller method and analyzed using the ARDL approach and Granger causality test. The results of the unit root test indicate that the variables were non-stationary at the level, but became stationary at first level, thus requiring the use of the ARDL Bounds test for cointegration. The bounds test revealed a long-term relationship between the unemployment rate and the explanatory variables. The error correction term (-0.3321) indicated that 33.21% of the short-term disequilibrium is corrected annually. The study found that industrial output has a negative effect on youth unemployment in both the short and long term, suggesting that increasing industrial activities could reduce youth unemployment. The Granger causality test showed a bidirectional causal relationship between natural gas production and unemployment rate in Nigeria, while a unidirectional causal relationship existed *between population growth rate and unemployment rate, as well as between natural gas rent and unemployment rate. Therefore, the paper recommends addressing challenges facing the natural gas sector such as limited infrastructure, low private sector investment, security challenges, limited power (load) capacity, inconsistent gas supply, and high cost of flaring, as well as implementing policies to ensure equitable distribution of its benefits across different sectors of the economy, which would be essential to maximize its potential to boost the economy and create employment opportunities in Nigeria.*

Keywords: Unemployment rate, Industrialization, ARDL, Cointegration, Natural gas

INTRODUCTION

Energy is crucial for human existence and wealth creation. It is a significant driver of economic growth and development. The type and utilization of energy sources affect the economic development of a nation. Natural gas is a vital component of the energy mix and a strategic resource. Energy is essential for the production of goods and services and for building and operating cities that provide jobs, goods, and homes. It is the lifeblood of the global economy (Adelegan, 2018)

KPMG professional Services in its recent report titled 'Global Economic Outlook', said Nigeria's unemployment rate might have reached 40.6% in 2023 based on its estimated figures. The National Bureau of Statistics (NBS) said the country 's unemployment rate stood at 33.3 percent as at 4th quarter, 2020 up from 23.1 percent reported in 2018. KPMG estimated that this rate has increased to 37.7 percent in 2022 and will rise further to 40.6 percent in 2023.

It stated that "Unemployment is expected to continue to be a major challenge in 2023 due to the limited investment by the private sector, low industrialization and slower than required economic growth and consequently the inability of the economy to absorb the 4-5 million new entrants into the Nigerian job market every year,"

In Nigeria, natural gas has been instrumental in fostering economic growth and is a valuable resource. With over 200 trillion cubic feet of natural gas reserves, Nigeria boasts of being the world's ninth-largest natural gas reserve. Nigeria has a long-standing history of dependence on the oil and gas sector, and it is one of the largest natural gas producers in Africa (PwC, 2020). The availability of natural gas in Nigeria has led to the creation of fresh prospects for industrialization and economic development. Furthermore, natural gas is used for a range of applications in Nigeria, including power generation, cooking fuel, Methanol, Fertilizer and Petrochemicals industrial production.

However, despite the abundance of natural gas resources in Nigeria, the gas resources has not been fully utilized domestically and the country continues to struggle with high levels of unemployment. Nigeria's confirmed natural gas reserves are equivalent to over 300 times its yearly domestic consumption, which indicates that the country has around 300 years of gas remaining if entire reserves is dedicated to domestic consumption and it continues at its current rate of less than 2bcfd, and if unproven reserves are disregarded. As per data from Worldometers (2017), Nigeria's annual natural gas consumption per capita stands at 3,192ft^3. The absence of appropriate infrastructure for gas transportation and distribution, coupled with regulatory and policy challenges, contribute to this low consumption rate. Furthermore, Nigeria's natural gas pricing and regulation pose significant challenges, as high subsidies make it challenging for private businesses to invest in the sector. As a result, the competitive gas market that is necessary for the sector's expansion has been hampered.

According to Figure 1, Nigeria's natural gas resources are categorized into reserves, production, utilization, and flaring. However, Nigeria has an ineffective management system for its gas resources, leading to a low gas production level of 226.53 Mm^3/d. The utilization rate for gas is distributed between 82.12 Mm^3/d for NLNG, 65.13 Mm^3/d for reinjection and operational purposes, 31.15 Mm^3/d for gas flaring, and 33.98 Mm^3/d for domestic gas consumption (Boise, 2019). Nigeria is ranked second in terms of size (Onolemhemhen et al., 2017; Yahya and Nkawatoh, 2021).

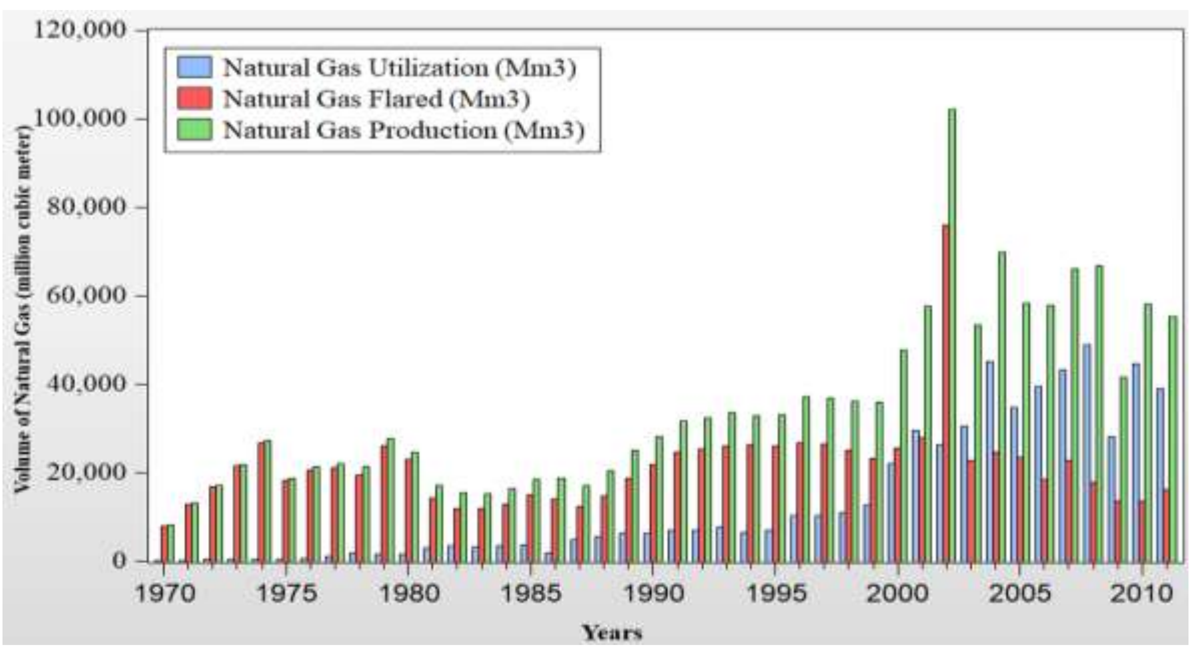


Figure 1: Amount of gas production, utilization and flared in Nigeria from 1970 – 2011 (Source: Ite and Ubok, 2013).

Nigeria has made strides in exploiting its natural gas reserves, with projects such as the Escravos GLT plant, Nigeria LNG Plant, Bonny Non-Associated Gas Plant, Olokola LNG Project, Brass LNG Project, Bonny Island Gas and Power Plant, Brass Fertilizer and Petrochemicals and Seplat Assa North Gas Processing Plant being notable examples. Regrettably, most of these ventures have not been developed, thus impeding the development of Nigeria's petrochemical industry. The industry is crucial to industrial manufacturing and serves to establish linkages between the petroleum sector and the rest of the economy. Therefore, Nigeria's gas usage remains inadequate in comparison to other oil and gas-producing nations (Nwolisa and Ugoji, 2010; Obunukut, Alabi and Bassey, 2016).

The gas sector plays a dual role in contributing to economic growth by generating employment and value through the production, conversion, and distribution of energy products within the economy, as well as supporting other economic sectors. Job opportunities in the gas industry can be classified into three groups: direct, indirect, and induced, and the employment multiplier effect determines the extent to which money spent can create additional jobs in the wider economy. The natural gas-dependent petrochemical industry has had a significant impact on industrial development in Nigeria, particularly in the communication and manufacturing sectors (Adelegan, 2018).

Given the challenges associated with exploiting natural gas in Nigeria, as well as the country's heavy dependence on hydrocarbon resources, it is pertinent to explore the role of natural gas in Nigeria's economic growth. Against the backdrop of a fragile national economy, plagued by high unemployment rates and limited investment opportunities, this study aims to establish a link between natural gas industrialization and unemployment rates (Adelegan, 2018). Examining this relationship is justified because, despite Nigeria's abundant gas reserves, the nation lacks sufficient energy, particularly for industrialization and electricity generation. Flaring of natural gas wastes what could otherwise be a significant source of income. If a long-term connection is formed, money should be invested in gas supply infrastructure to boost the nation's economy (Yahya and Nkawatoh, 2021).

The remainder of this paper is organized as follows. The literature is reviewed in section 2, the technique is introduced in section 3, the results and analyses are presented in section 4, and the conclusion and recommendations are presented in section 5.

LITERATURE REVIEW

The Nigerian government's increasing focus on the natural gas industry has led researchers to closely examine the relationship between natural gas utilization and economic growth, particularly in relation to the country's unemployment rate. While earlier studies indicated a negative or neutral correlation between these two variables, recent policies and measures such as the reduction of flaring, implementation of the Nigerian Gas Master Plan, power sector reforms, and expanding LNG exports have prompted researchers to re-examine the issue and make more effective recommendations. The following empirical studies reveals the connection between the natural gas-based industrialization and effect on the unemployment levels in Nigeria.

Diugwu et al. (2012) conducted a study that investigated the effects of natural gas production, utilization, and flaring on Nigeria's economic growth. The study utilized time-series data spanning from 1970 to 2010 and employed an Error Correction Model (ECM) to establish the long-term association between natural gas production, utilization, and flaring, and economic growth. By examining the impact of natural gas production and utilization on economic growth, the study indirectly sheds light on the relationship between natural gas industrialization and employment levels in Nigeria. The research findings indicated that natural gas production and utilization have a positive impact on Nigeria's economic growth, while flaring has a negative effect. Specifically, the study revealed that an increase in natural gas production and utilization leads to an upsurge in economic growth, while an increase in flaring leads to a decline in economic growth, which could have adverse implications for employment levels.

Ubani and Ani (2016) examined the impact of natural gas utilization on economic growth in Nigeria. The study highlighted the potential of natural gas utilization to create employment opportunities and contribute to poverty reduction in Nigeria. However, the authors also note that the benefits of natural gas utilization are dependent on appropriate policies and infrastructure to support the development of the natural gas industry and maximize the benefits of natural gas utilization for Nigeria's economy.

Adelegan (2018) examined the role of natural gas in Nigeria's economic development and its potential impact on unemployment levels. He employed a co-integration technique and error correction mechanism (ECM) based on time series data for the period between 1985 and 2016. A positive relationship between natural gas production and unemployment rates in Nigeria was gotten. It was observed that one percent increase in natural gas production is associated with a 0.31 percent increase in unemployment rates in Nigeria. He suggested that the expansion of the natural gas sector in Nigeria may have led to job losses in other sectors of the economy. The impact of natural gas exports on unemployment rates in Nigeria was also examined and the results showed that natural gas exports have a negative impact on unemployment rates, with a one percent increase in natural gas exports associated with a 0.39 percent decrease in unemployment rates. This result suggested that natural gas exports generate foreign exchange earnings that can be used to create employment opportunities in other sectors of the economy. While the study provided valuable insights into the relationship between natural gas production and unemployment rates in Nigeria, there were several limitations that needed to be considered, such as a more detailed examination of the distributional impacts of natural gas production on employment, and an analysis of the role of policy interventions in shaping the relationship between natural gas production and employment levels in Nigeria.

Emmanuel, Yusuf, and Caleb (2018) focused on the potential benefits of natural gas utilization in Nigeria, with emphasis on reducing poverty and promoting economic development. One of the key issues that the authors address in the paper is the relatively low level of domestic natural gas utilization in Nigeria, despite the country's abundant natural gas reserves. The authors argued that increasing domestic utilization of natural gas can have a positive impact on the country's economy and employment rates. Akpan (2009), as well as, Wang and Economides (2009) in their studies have observed that natural gas utilization can create significant employment opportunities across the entire value chain, from exploration and production to processing and distribution. However, the authors acknowledged that there are a number of challenges that need to be addressed in order to increase domestic natural gas utilization in Nigeria. These challenges include inadequate infrastructure, insufficient regulatory frameworks, and limited access to finance and investment.

Yahya and Nkawatoh (2021) investigated the relationship between natural gas utilization and economic activities, including employment, in Nigeria from 1986 to 2019. The Vector Error Correction Model (VECM) was used to analyze the long-run and short-run dynamics between natural gas utilization and economic activities, including employment. The study found a positive relationship between natural gas utilization and economic activities in Nigeria. Specifically, the authors report that natural gas utilization has a positive and statistically significant impact on economic activities in the long run, suggesting that natural gas utilization is an important driver of economic growth in Nigeria. The study also found evidence of a short-run relationship between natural gas utilization and economic activities. However, in the short run, the impact of natural gas utilization on employment was not statistically significant. This suggests that the positive impact of natural gas utilization on employment may take some time to materialize and calls for further research to better understand the mechanisms through which natural gas utilization affects employment in Nigeria.

Jato and Ayaga (2022) performed a feasibility study on the relationship between natural resource abundance and macroeconomic performance in Nigeria. They highlighted that the country's over-reliance on oil exports has led to the neglect of other sectors of the economy, resulting in a lack of diversification and high unemployment rates. Based on their evaluations, Natural gas, in particular, can play a key role in job creation and economic development in Nigeria, especially if the country can develop a vibrant natural gas market that can meet the domestic demand for energy and support industrialization. They also added that natural gas-based industrialization can create job opportunities in various sectors of the economy, including power generation, manufacturing, and transportation, and can also contribute to poverty reduction and increased household income.

METHODOLOGY

Source of Data and Variables

Time series data used for analysis on the nexus between Natural gas-based industrialization and unemployment rate in Nigeria were gathered from secondary sources. The data set contains a biannual time series for analysis from 1997 to 2021. These statistics were gathered from trusted national and international bodies' bulletins, publications, and data warehouses. They include the Organization of petroleum exporting countries (OPEC), World bank data, National bureau of statistics (NBS) Nigeria, Central bank of Nigeria (CBN), Department of Petroleum Resources (DPR), International Energy Agency (IEA), International Monetary Fund (IMF) and Independent Energy Statistics (IES).

The variables used for this econometric analysis were unemployment rate, natural gas reserves, natural gas production, natural gas consumption, natural gas price, gross domestic product, population growth rate, and the natural gas rent in Nigeria.

Method of Analysis

The Autoregressive Distributed Lag Model (ARDL) was chosen for this analysis as it outperforms other models in terms of capturing independent variables' short- and long-run effects on economic indices. The ARDL model serves as a backup strategy to avoid the spurious regression problem. Hence, the nexus between the natural gas-based industrialization and unemployment rate in Nigeria was perfectly captured by this modelling technique.

Model Specification

The ARDL model uses a combination of endogenous and exogenous variables. The general model of the ARDL (m, n) is as follows:

$$\Delta \mathrm{lnY_t} = \mathrm{a_1} + \sum_{\mathrm{i=1}}^{\mathrm{m}} \mathrm{a_{11}} \Delta \mathrm{LY_{t-i}} + \sum_{\mathrm{i=0}}^{\mathrm{n}} \mathrm{a_{22}} \Delta \mathrm{X_{t-i}} + n_1 ECT_{t-1} + \mu_{1i} \quad 1$$

$$\Delta \mathrm{lnX_t} = \mathrm{a_1} + \sum_{\mathrm{i=1}}^{\mathrm{m}} \mathrm{a_{21}} \Delta \mathrm{LX_{t-i}} + \sum_{\mathrm{i=0}}^{\mathrm{n}} \mathrm{a_{22}} \Delta \mathrm{Y_{t-i}} + n_2 ECT_{t-1} + \mu_{2i} \quad 2$$

Where,

- t represents the time from 1997 to 2021.

- m represents the optimal lag order associated with the dependent variable in years.
- n represents the optimal lag order associated with the independent variable in years.

For this analysis, the dependent variable, which is the unemployment rate, is designed as UMR in logarithm form. For the independent variables, they are also in logarithm form designed as Natural gas reserves (NGRS), Natural gas production (NGPN), Natural gas consumption (NGC), Natural gas price (NGP), Natural gas rent (NGR), Gross domestic product (GDP), and population growth rate (PGR).

The dependency equation is given as

$$UMR = f(NGRS, NGPN, NGC, NGP, NGR, GDP, PGR) \quad 3$$

$$UMR_t = a_{ou} + a_{1u}NGRS + a_{2u}NGPN + a_{3u}NGC + a_{4u}NGP + a_{5u}NGR + a_{6u}GDP + a_{7u}PGR + \varepsilon_{tu} \quad 4$$

In terms of natural log, we have the model as

$$\text{In } UMR_t = a_{ou} + a_{1u}\text{In NGRS} + a_{2u}\text{In NGPN} + a_{3u}\text{In NGC} + a_{4u}\text{In NGP} + a_{5u}\text{In NGR} + a_{6u}\text{In GDP} + a_{7u}\text{In PGR} + \varepsilon_{tu} \quad 5$$

Expressing the equation in cointegration form,

$$\Delta\ln UMR_t = a_{ou} + \sum_{i=1}^{n} \alpha_{1u}\Delta\ln UMR_{t-i} + \sum_{i=1}^{n} \alpha_{2u}\Delta\ln NGRS_{t-i} + \sum_{i=1}^{n} \alpha_{3u}\Delta\ln NGPN_{t-i} + \sum_{i=1}^{n} \alpha_{4u}\Delta\ln NGC_{t-i} + \sum_{i=1}^{n} \alpha_{5u}\Delta\ln NGP_{t-i} + \sum_{i=1}^{n} \alpha_{6u}\Delta\ln NGR_{t-i} + \sum_{i=1}^{n} \alpha_{7u}\Delta\ln GDP_{t-i} + \sum_{i=1}^{n} \alpha_{8u}\Delta\ln PGR_{t-i} + \gamma_{1u}\, ln\, UMR_{t-1} + \gamma_{2u}\ln NGRS_{t-1} + \gamma_{3u}\ln NGPN_{t-1} + \gamma_{4u}\ln NGC_{t-1} + \gamma_{5u}\ln NGP_{t-1} + \gamma_{6u}\ln NGR_{t-1} + + \gamma_{7u}\ln GDP_{t-1} + \gamma_{8u}\ln PGR_{t-1} + \varepsilon_{ti} \quad 6$$

Where,

ε_{ti} represents the white noise error term for all the dependency models, Δ displays the first difference, and a_{ou} is the drift component for the dependent variables of different models. The error correction model (ECM) is used for a causality test to identify the short-run dynamics after identifying the long-run association between variables. The ECM equation for this study is presented below.

$$\Delta\ln UMR_t = a_{ou} + \sum_{i=1}^{n} \alpha_{1u}\Delta\ln UMR_{t-i} + \sum_{i=1}^{n} \alpha_{2u}\Delta\ln NGRS_{t-i} + \sum_{i=1}^{n} \alpha_{3u}\Delta\ln NGPN_{t-i} + \sum_{i=1}^{n} \alpha_{4u}\Delta\ln NGC_{t-i} + \sum_{i=1}^{n} \alpha_{5u}\Delta\ln NGP_{t-i} + \sum_{i=1}^{n} \alpha_{6u}\Delta\ln NGR_{t-i} + \sum_{i=1}^{n} \alpha_{7u}\Delta\ln GDP_{t-i} + \sum_{i=1}^{n} \alpha_{8u}\Delta\ln PGR_{t-i} + \emptyset i ECM_{t-1} + \varepsilon_{ti} \quad 7$$

Where,

Δ represents the first difference while ∅ is the coefficients of ECM for short-run dynamics. ECM is the rate of long-run equilibrium adjustment following a shock.

FINDINGS

The following section gives a detailed analysis of the ARDL on its ability to evaluate the relationship between the natural gas-based industrialization and the rate of unemployment in Nigeria.

Descriptive Analysis

The descriptive analysis summarizes numeric data with various statistics to identify trends. The table below shows records for each variable.

Table 1: Statistical Summary of the Variables

	GDP	NGC	NGP	NGPN	NGR	NGRS	PGR	UMR
Mean	293.166	0.409	4.161	1.970	0.748	167.501	2.600	5.061
Median	339.480	0.386	3.683	1.858	0.756	181.162	2.688	3.935
Maximum	577.566	0.677	9.239	3.210	1.588	206.931	2.713	9.908
Minimum	53.916	0.115	1.864	1.070	0.063	102.060	2.388	3.598
Std. Dev.	170.081	0.173	1.937	0.643	0.390	31.762	0.115	2.103
Skewness	-0.156	0.013	1.119	0.389	0.334	-0.729	-0.496	1.350
Kurtosis	1.579	1.588	3.392	1.949	2.869	2.032	1.658	3.059
Jarque-Bera	4.407	4.153	10.757	3.562	0.965	6.388	5.801	15.192
Probability	0.110	0.125	0.005	0.168	0.617	0.041	0.055	0.001
Sum	14658.300	20.450	208.060	98.524	37.400	8375.070	130.0	253.054
Sum Sq. Dev.	1417442.0	1.468	183.878	20.290	7.455	49433.370	0.644	216.676
Observations	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000

Source: Authors Computation, 2023 (Eviews-10)

The results of the descriptive analysis presented in Table 1 indicated that the skewness test revealed positive and negative values for the series, indicating the presence of both high and low tails. Additionally, the Jarque-Bera statistics probability indicated that the variables follow a normal distribution.

Optimal Lag Length Determination

The optimal lag length for annual data is often one or two lags, whereas one to eight delays are good for quarterly data (Jeffrey, 2012). According to the Akaike information criterion (AIC), Schwarz criterion (SC), and Hannan-Quinn criterion, Table 2 displays the results of establishing the ideal lag length from lag one (1) to lag eight (8). The lag length with the minimum AIC value is considered the one with the optimal lag length as an optimal lag order 4 with an Akaike information criterion (AIC).

Table 2: Optimal Lag Length Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	26.06853	NA	6.30E-11	-0.785588	-0.467564	-0.666454
1	426.648	644.4105	2.89E-17	-15.41948	-12.55726	-14.34727
2	533.2608	134.4248	5.84E-18	-17.27221	-11.86579	-15.24693
3	728.8046	178.54	4.08E-20	-22.9915	-15.04089	-20.01316
4	956.4271	128.6562*	2.24e-22*	-30.10553*	-19.61072*	-26.17411*

Source: Authors Computation, 2023 (Eviews-10)

Unit Root Test

Since empirical studies have shown that most economic variables are not stationary at the level, the augmented Dickey and Fuller (1979) (ADF) unit root test is required to determine the stationary property of the series used in the model. The estimation of the results showed that all the variables were not stationary (NS) at level; and yet became stationary (S) at first differencing at 5% critical value, which was supported by the ADF statistic values, critical values and p-values of the respective variables estimated in the test.

Table 3: Augmented Dickey and Fuller (ADF) test at level and first difference

At Level					At First Difference				
Variables	**ADF Statistics**	**Critical value (5%)**	**Prob.**	**Remark**	**Variables**	**ADF Statistics**	**Critical value (5%)**	**Prob.**	**Remark**
UMR	-0.06897	-2.92662	0.9466	NS	**UMR**	-3.58851	0.49170	0.279	S
GDP	-1.27039	-2.92814	0.6352	NS	**GDP**	-3.21997	-2.92814	0.0253	S
NGC	-1.56622	-2.92517	0.4917	NS	**NGC**	-6.83297	-2.92517	0	S
NGP	-1.96097	-2.92662	0.3025	NS	**NGP**	-4.99528	-2.92814	0.0002	S
NGPN	-2.00265	-2.92662	0.2848	NS	**NGPN**	-4.55335	-2.92814	0.0006	S
NGR	-2.45712	-2.92517	0.1323	NS	**NGR**	-6.43576	-2.92814	0	S
NGRS	-1.42613	-2.92662	0.5614	NS	**NGRS**	-3.32907	-2.92814	0.0193	S
PGR	-0.81240	-2.92517	0.8063	NS	**PGR**	-3.74797	-2.92517	0.0063	S

Source: Authors Computation, 2023 (Eviews-10)

Bound Test of Cointegration

From the ARDL bounds test result, it is clear that there is a long run relationship amongst the variables. This is because the computed F-statistic of about 10.63013 is higher than the upper critical bounds at 1%, 2.5%, 5% and 10% critical values. This provided evidence to reject the null hypothesis of no cointegration at 5% significance level for the growth model, which shows that there is a long-run relationship among the variables. Therefore, this study shows that there is a long run relationship between natural gas-based industrialization and the unemployment levels in Nigeria.

Table 4: Co-integration Bounds Test

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	10.63013	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.50%	2.43	3.51
		1%	2.73	3.9

Source: Authors Computation, 2023 (Eviews-10)

Long Run Analysis

Based on the long-run analysis in table 5, we observed that both GDP and NGC all have a positive and significant impact on the UMR with coefficients and probabilities of (21.68097, 0.0056) and (8.866803, 0.0149) respectively. A negative and significant relationship was experienced for NGPN, NGRS and NGR on the UMR with coefficients and probabilities of (-32.22714, 0.0031), (-16.00053, 0.0185), and (-18.53325, 0.0247) respectively; while a negative and insignificant relationship was experienced for NGP on the UMR with coefficients and probabilities of (-0.614944, 0.64). PGR had a positive and insignificant impact on the UMR with readings of (23.26937, 0.0975).

Table 5: ARDL Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGDP	21.68097	5.935515	3.652753	0.0065
LOGNGC	8.866803	2.871304	3.088076	0.0149
LOGNGP	-0.614944	1.265408	-0.485965	0.64
LOGNGPN	-32.22714	7.706096	-4.182032	0.0031
LOGNGRS	-16.00053	5.425675	-2.94904	0.0185
PGR	23.26937	12.40482	1.875833	0.0975
NGR	-18.53325	6.718661	-2.758474	0.0247
C	-45.49469	33.07951	-1.375313	0.2063

Source: Authors Computation, 2023 (Eviews-10)

Short Run Analysis and Error Correction Mechanism

Based on the short run analysis in table 6, we observe that NGP, NGPN, NGRS and NGR all had a negative but significant impact on the UMR with coefficients and probabilities of (-

0.886945, 0.0095), (-1.877963, 0.0009), (-3.113857, 0.0184), and (-3.11799, 0.016) respectively. A positive and significant impact observed on the UMR by both the NGC and the PGR with coefficients and probabilities of (2.092173, 0) and (9.80101, 0.0054); while GDP had a positive and insignificant relationship with UMR with coefficients and probability of (2.691069, 0.1571).

The coefficient of the error correction term in the model has the right sign (i.e., negative) and statistically significant at the 1% level. This indicates adjustment to long-term equilibrium in the dynamic model. This implies that deviations from the short-term growth rate in economic growth adjust quickly to long run equilibrium at 33.2% annually.

Table 6: ARDL Short Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D(UMR(-1))	-1.231054	0.319605	-3.851801	0.0049
D(LGDP)	2.691069	1.723567	1.561337	0.1571
D(LNGC)	2.092173	0.194099	10.7789	0
D(LNGP)	-0.886945	0.261782	-3.3881	0.0095
D(LNGPN)	-1.877963	0.363747	-5.162833	0.0009
D(LNGRS)	-3.113857	1.054926	-2.951731	0.0184
D(PGR)	9.80101	2.596591	3.774568	0.0054
D(NGR)	-3.11799	1.025298	-3.041057	0.016
CointEq(-1)*	-0.332051	0.024005	-13.83266	0.0000
R-squared	0.999901	Mean dependent var.		5.152739
Adjusted R-squared	0.999444	S.D. dependent var.		2.169716
S.E. of regression	0.051143	Akaike info criterion		-3.20542
Sum squared resid.	0.020925	Schwarz criterion		-1.6948
Log likelihood	111.7247	Hannan-Quinn criteria		-2.63953
F-statistic	2188.802	Durbin-Watson stat		2.873403
Prob (F-statistic)		0		

Source: Authors Computation, 2023 (Eviews-10)

Post-Diagnostic Test

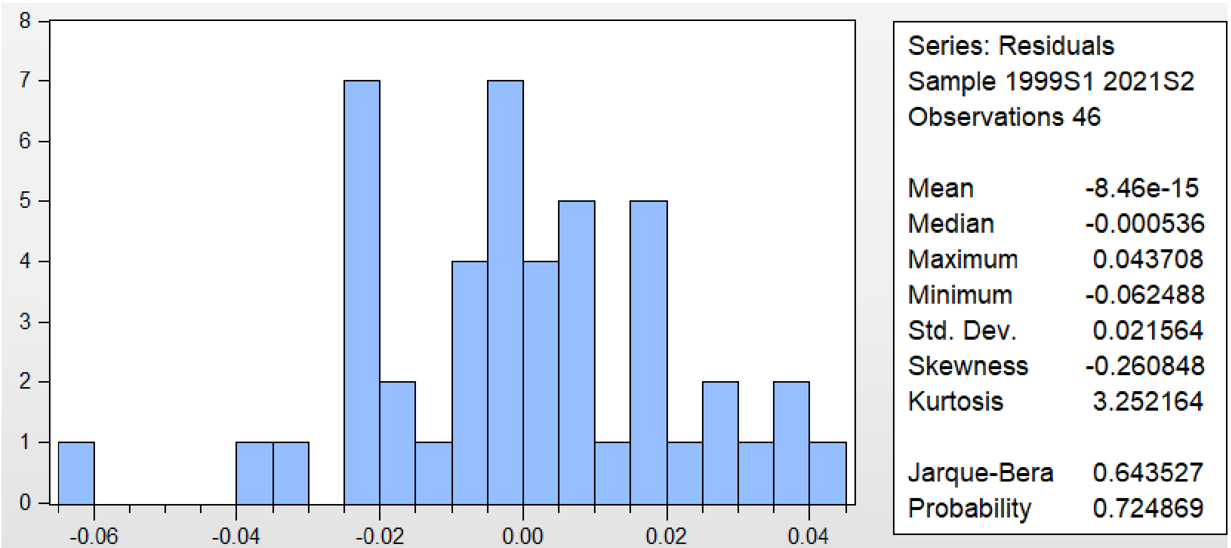
The various diagnostic tests here include normality test, heteroscedasticity test, serial correlation test, and stability test. These tests are presented in Table 7, Table 8 and in Figure 2 to Figure 4.

Residual Diagnostic Test

Probabilities above 0.05 accept the null hypothesis, while probabilities below 0.05 reject the null hypothesis. From the result in figure 2, the probability is 0.643527 which is greater than 0.05 at

5% significant level and therefore, the null hypothesis is accepted. This means that the residuals are normally distributed.

Figure 2: Jarque-Bera Normality test



Source: Authors Computation, 2023 (Eviews-10)

Table 7: Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	2.118787	**Prob. F(37,8)**	0.1321
Obs*R-squared	41.7405	**Prob. Chi-Square(37)**	0.2723
Scaled explained SS	1.421647	**Prob. Chi-Square(37)**	1

Source: Authors Computation, 2023 (Eviews-10)

From table 7, the Prob. F-value gave 0.1321 which is greater than 0.05; thus we accept the null hypothesis that there is no heteroscedasticity among the variables used in the model.

Table 8: Breusch-Godfrey Serial Correlation LM Test

F-statistic	8.133879	Prob. F(2,6)	0.1906
Obs*R-squared	33.6054	Prob. Chi-Square(2)	0.1352

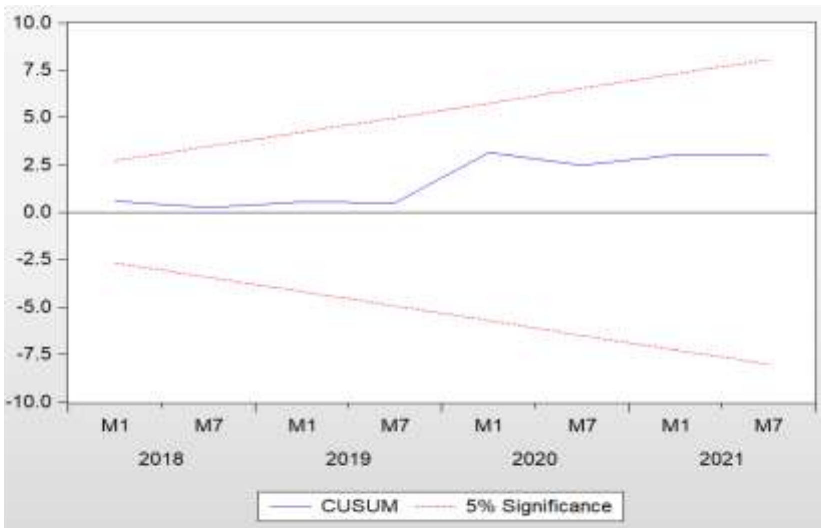
Source: Authors Computation, 2023 (Eviews-10)

Table 8 shows that the Breuch-Godfrey Serial Correlation LM test F-statistic is significant at 5%. This implies that the null hypothesis of serial correlation is rejected at the 5% level.

Stability Diagnostic Test

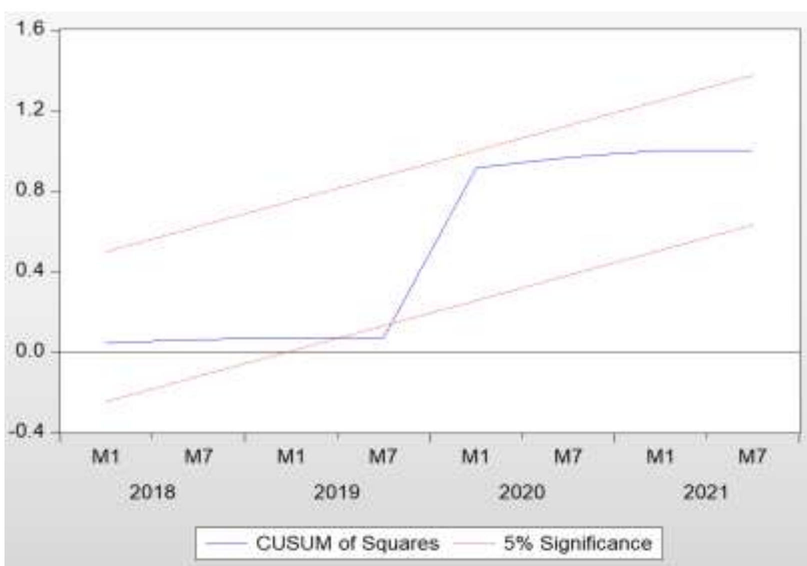
The CUSUM test and CUSUM squares test are used to detect changes in parameters. If the cumulative sum goes beyond the area between the two critical lines, it suggests instability. Figures 3 and 4 show the results of both tests, and they indicate that the parameters were stable, as the 5% significance line remained within the critical lines. However, there was some instability observed in the CUSUM square plot in 2019.

Figure 3: CUSUM test



Source: Authors Computation, 2023 (Eviews-10)

Figure 4: CUSUM SQUARE test



Source: Authors Computation, 2023 (Eviews-10)

Granger Causality Test

This test was conducted to depict the nature of the relationship between unemployment level in Nigeria and the explanatory variables in the model. The causality results in table 9 indicated a bidirectional relationship between NGPN and UMR. These effects are statistically significant at the 1% level of significance. Hence, both natural gas production and unemployment rate causes changes on each other. A unidirectional relationship exists between PGR and UMR, since PGR causes a change in UMR and UMR does not cause change in PGR, as well as, between NGR and UMR, since NGR causes a change in UMR and UMR does not cause change in NGR.

Table 9: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
LGDP does not Granger Cause UMR	46	2.56515	0.0542
UMR does not Granger Cause LGDP		0.29602	0.8787
LNGC does not Granger Cause UMR	46	1.54035	0.2107
UMR does not Granger Cause LNGC		0.05067	0.995
LNGP does not Granger Cause UMR	46	1.1902	0.3312
UMR does not Granger Cause LNGP		0.13973	0.9664
LNGPN does not Granger Cause UMR	46	2.76129	0.0418
UMR does not Granger Cause LNGPN		4.45197	0.0049
LNGRS does not Granger Cause UMR	46	0.2424	0.9124
UMR does not Granger Cause LNGRS		0.34759	0.844
PGR does not Granger Cause UMR	46	3.186	0.024
UMR does not Granger Cause PGR		2.07068	0.1044
NGR does not Granger Cause UMR	46	6.9558	0.0003
UMR does not Granger Cause NGR		1.17659	0.337

Source: Authors Computation, 2023 (Eviews-10)

CONCLUSIONS

This study was an empirical investigation into the nexus of natural gas industrialization on unemployment levels in Nigeria for the period 1997 to 2021. The study employed the ARDL approach, the error correction mechanism and the Granger causality test. The result of the empirical analysis indicates that natural gas-based industrialization exerts a negative and significant effect on unemployment rate in Nigeria. This implies that increased use of natural gas in Nigeria's industrialization will drastically reduce the rate of unemployment in the country. Thus, natural gas-based industrialization is truly a catalyst for structural transformation and job creation in Nigeria.

Based on the findings in the short run test, we observe that natural gas price, natural gas production, natural gas reserves and natural gas rent all had a negative but significant impact on the unemployment rate. A positive and significant impact observed on the unemployment rate by both the natural gas consumption and the population growth rate, while gross domestic product had a positive and insignificant relationship with the unemployment rate in Nigeria. On the long-run analysis, we observed that both gross domestic product and natural gas consumption have positive and significant impact on the unemployment rate. A negative and significant relationship was experienced for natural gas production, natural gas reserves and natural gas rent on the unemployment rate; while a negative and insignificant relationship was experienced for natural gas price on the unemployment rate. Population growth rate had a positive and insignificant impact on the unemployment rate in Nigeria.

RECOMMENDATIONS

Addressing the challenges facing the natural gas sector such as limited infrastructure, low level of private sector investment, security challenges, limited power capacity, inconsistent gas supply, high cost of flaring, and implementing policies that ensure equitable distribution of its benefits across different sectors of the economy would be crucial to maximizing its potential to boost Nigerian economy, which in turn, would generate employment opportunities in Nigeria. There is also a need for further research to deepen our understanding of the factors that influence the relationship between natural gas industrialization and employment levels. Future researchers may consider usage of quarterly or monthly time series data to obtain better nexus results.

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APPENDICES

Table 10: Ramsey RESET Test

	Value	**df**	**Probability**
t-statistic	0.724985	13	0.4813
F-statistic	0.525604	(1, 13)	0.4813

F-test summary:			
	Sum of Sq.	**df**	**Mean Squares**
Test SSR	0.002697	1	0.002697
Restricted SSR	0.069403	14	0.004957
Unrestricted SSR	0.066706	13	0.005131

Source: Authors Computation, 2023 (Eviews-10)

Table 11: Pearson Correlation

	UMR	LGDP	LNGP	LNGC	LNGPN	LNGRS	NGR	PGR
UMR	1	0.4222	0.4081	0.4906	0.0902	0.4917	0.2437	0.7891
LGDP	0.4222	1	0.0475	0.7320	0.8135	0.9370	0.7849	0.0993
LNGP	0.4081	0.0475	1	0.0526	0.3423	0.1602	0.0739	0.6899
LNGC	0.4906	0.7320	0.0526	1	0.5743	0.6441	0.6246	0.3145
LNGPN	0.0902	0.8135	0.3423	0.5743	1	0.7197	0.7599	0.3138
LNGRS	0.4917	0.9370	0.1602	0.6441	0.7197	1	0.7050	0.1141
NGR	0.2437	0.7849	0.0739	0.6246	0.7599	0.7050	1	0.1141
PGR	0.7891	0.0993	0.6899	0.3145	0.3138	0.1141	0.1141	1

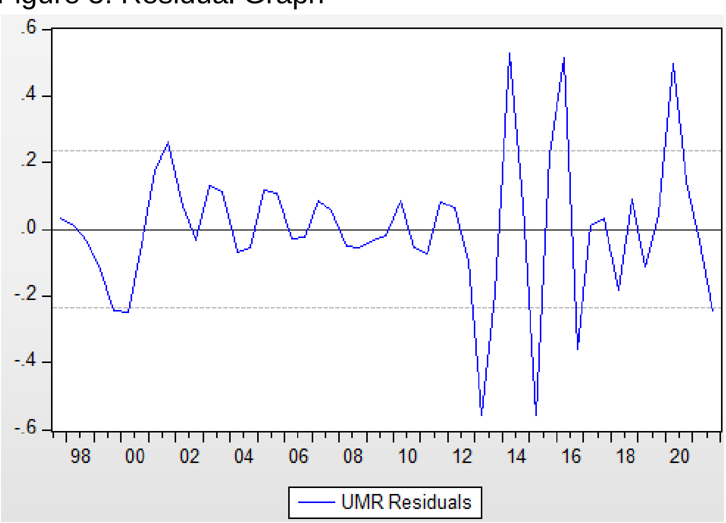
Source: Authors Computation, 2023 (Eviews-10)

Table 12: Variance Inflation Factors

Variable	Coefficient Variance	Centered VIF
UMR(-1)	0.002793	6.701211
LGDP	0.048334	5.96124
LNGP	0.029645	4.669736
LNGC	0.043804	8.623562
LNGC(-1)	0.033664	6.708193
LNGPN	0.123454	7.22762
LNGRS	0.483996	6.42156
NGR	0.045076	5.641428
PGR	3.019614	8.10609
PGR(-1)	3.06507	8.94838
C	14.19429	NA

Source: Authors Computation, 2023 (Eviews-10)

Figure 5: Residual Graph



Source: Authors Computation, 2023 (Eviews-10)