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Effect of Urbanization and Industrialization on Energy Consumption in Nigeria

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Abstract

Urbanisation and industry necessitate a substantial amount of energy, which increases the urgency of this issue. This study used the Ordinary Least Square (OLS) method to analyse the influence of urbanisation and industrialization on energy use in Nigeria from 1981 to 2021. A positive and statistically significant effect of urbanisation on the usage of renewable and nonrenewable energy sources has been observed in empirical studies. It was also discovered that industrialization positively influenced the utilisation of both renewable and nonrenewable energy sources, though the former just marginally so and the latter far more so statistically. Furthermore, trade openness positively impacted non-renewable energy use while having no effect on renewable energy use. The usage of renewable energy increased substantially during periods of economic expansion, while the use of nonrenewable energy decreased significantly over these same periods. Because of the current trend in urbanisation and industry, power generation should be a top concern.

Background to the Study

The flow of people from the country to the city never stops. Social, economic, and political issues all have a role in producing metropolitan areas with high population densities. Leaving behind rural places plagued by violence or poverty are just two examples (Lucci, Mansour-Ille, Easton-Calabria, & Cummings, 2016). Lifestyle, culture and behaviour, dominant occupations, and the transformation of demographic and social structures are just some of the many aspects of urbanisation that have been studied (Aduku, Eboh, and Egbuchulam, 2021; Hussain and Imitiyaz, 2018). Urban areas are the hub for different categories of industries. One can say that industrialization begins with urbanization.

There is a nexus between industrialization and urbanization. The relevance of industrialization especially for developing nations is increasingly gaining wider recognition among development planners and other managers of the economy. As an example, we might look to China and other emerging economies. Rapid economic growth and development are difficult, if not impossible, to attain without a well-developed industrial sector. The industry not only paves the way for higher output, but it also provides a ready market for intermediate goods and acts as a substitute for imported commodities (Kruse, Mensah, Sen, & Vries, 2021). Energy use is the amount of energy produced and used by human civilization. It comprises every energy used by a nation from every source of energy, useful towards humanity's endeavours, especially in the industrial and technological sectors. Viewed as the power source metric of modernization and development, energy use everywhere in the World has relevant socio-economic implications. Irrespective of whether a developed or a developing country, energy can be said to be the lifeblood of the economy, an important input to almost every form of modern living. A stable and affordable energy supply is basic to guarantee a sustainable standard of living.

No country can boast of sustainable industrialization without avoidable and sustainable energy, or neither derive the benefits of available amenities that facilitate a comfortable living. The well-being and prosperity of any economy could be linked to energy growth. For developing countries such as Nigeria, the availability of reliable and affordable energy accelerates economic activities that could improve the quality of life of individuals. Energy enhances the expansion of industries and promotes agricultural development and trade, which are the basis for employment creation, economic growth and poverty reduction (Imperial, 2019).

Over the years, Nigeria has used a variety of various fiscal tactics to boost the country's industrialization. One such method was the import substitution industrialization programme that ran from 1962 to 1968 (Ishola, 2012). This programme encouraged domestic production of some imported consumer items in an effort to lower overall import levels and boost foreign exchange savings. People in Nigeria have been migrating from the countryside to the cities for a variety of reasons. The increasing economic activities and industries in urban areas enhance rural-urban migration. These have facilitated the process of urbanization over the years. The rate of urban population is increasing fast. Energy is demanded by every sector of the economy including the household sector.

Despite Nigeria's energy potential, the installed energy capacity is 16,384 MW as of 2022. Out of this installed capacity, just about 4,000 MW is dispatched, which is insufficient for the level of demand. Whereas, there is increasing energy usage, reinforced by increasing urbanization and industrialization, estimated to be above the actual production capacity. This gap is made worse by huge commercial and technical losses (*Mbachu*, 2023). The energy dispatched and usage capacity is among the lowest in the world despite increasing urbanization. The shortage of energy to meet the increasing demand has resulted in a power outage frequently experienced in several parts of the country, and a high cost of production operation. This has forced most households and economic operators to use power generators, which, Mbekeani (2013) described as 3 to 5 times more expensive than the cost of electricity from the grid. Research on topics like energy use, industrialization, and urbanisation is abundant. No studies have, as far as we can tell, specifically addressed how industrialization and urbanisation have affected energy use in Nigeria. Thus, this study (i) analyses how Nigeria's growing urban population has affected energy consumption, and (ii) assesses how the country's burgeoning industrial sector has altered this trend.

Theoretical Literature

Putty–Clay Model

The Putty-Clay Model serves as the foundation of this research. Leif Johansen (1959) proposes this view. His model was built using a deterministic growth strategy. According to this concept, different combinations of capital and energy have different fixed proportions. Since preexisting capital consumes energy at a constant rate, this results in a poor short-run elasticity of energy use. Energy price fluctuations and production are found to have an asymmetrical relationship (Lee, Mizen, and Mahony (2022); Mork (1987); Tatom (1988). Atkeson and Kehoe (1999) found a negative correlation between rising energy costs and production, but only a weak association between falling costs and increased output.

Empirical Literature

Karasoy (2023), analysed Turkey's energy insecurity in relation to industrialization, deindustrialization, and financialization while adjusting for the effects of urbanisation and alternative energy sources. The analysis included data from 1980 to 2018. To examine the information, the authors employed an augmented nonlinear autoregressive distributed lag method. Compared to deindustrialization, which had no effect on Turkey's energy security, industrialization was found to enhance the country's long-term energy insecurity. The results also demonstrated how urbanisation contributed to the decline of Turkey's energy reliability. Financialization was found to increase Turkey's energy insecurity, while the use of alternative energy sources was found to boost the country's energy safety.

The authors Akinsola, Ologundudu, and Akinsola (2022) studied the continent of Africa from 1990 to 2019 and found a correlation between industrialization, urbanisation, and pollution. To examine the information, we employed the ARDL method (autoregressive distributed lag). According to the results, environmental damage increases as urbanisation and industry spread. Studying how industrialisation and urbanisation affect energy consumption in Nigeria, Ifeyinwa, Binitie, and Adeyeye-Ahmed (2022) found some interesting results. Time spans from 1981 to 2016 were used for the analysis. To examine the information, we used the autoregressive distributed lag (ARDL) model. Overall energy consumption was found to be positively influenced by industrial output in both the long and short term, whereas the industrial portion of aggregate output had a negative effect in the long term. Additionally, both the long-term and short-term effects of urbanisation were shown to be favourable and substantial. Electricity use was similarly unaffected by measures of industrialization such as the share of total output derived from the industrial sector. Carbon intensity and urbanisation were also found to have a long-term and short-term favourable impact on people's need for power. Urbanisation, energy use, and environmental deterioration in Nigeria were all studied by Jó'zwik, Gavryshkiv, and Galewska (2022), but they restricted their attention to countries in the European Union. The research spanned the years 2000-2018. FMOLS, MG, CCEMG, and AMG were utilised to examine the data. Carbon dioxide emissions per person were shown to increase significantly as urbanisation increased.

In order to better understand how urbanisation, energy consumption, and globalisation affect environmental quality, Khalid, Hanif, and Rasul (2022), looked at the G7. From 1988 to 2018, 30 years of data were analysed for this study. Panel autoregressive distributed lag (ARDL) was used for the data analysis. These results demonstrated the negative effects of urbanisation, economic expansion, and the use of nonrenewable energy sources on environmental quality, whereas the positive effects of renewable energy use and globalisation were revealed. Globalisation was found to have a negligible negative impact on environmental quality in the long run, although urbanisation and the use of renewable and nonrenewable energy sources were found to have a considerable positive impact in the short term.

From 1990 to 2020, Raihan & Tuspekova (2022), looked studied how several factors in Turkey's economy and society, such as renewable energy consumption, urbanisation, industrialization, tourism, agricultural productivity, and forest area, influenced the country's carbon output. The information was examined with the help of the DOLCE method. Researchers discovered that as urbanisation, industry, and tourism blossomed, so did emissions of carbon dioxide. Carbon dioxide emission reductions were also observed in tandem with increases in the use of renewable energy sources, agricultural output, and forest cover.

Radoine, Bajja, Chenal, and Ahmed (2022), studied how the expansion of the economy, the value added by manufacturing, urbanisation, financial development, foreign direct investment, and the use of renewable energy affected the quality of the environment in

West African countries. The sample periods range from 1991 to 2018, and the data was obtained from a number of different countries. Driscoll-Kraay (DK) panel regression analysis was used to look at the data. Results demonstrated that industrial value-added, urbanisation, financial progress, and FDI all contributed to environmental degradation. It was also determined that both economic development and the use of renewable energy sources make important contributions to environmental well-being.

The impacts of industrialization, renewable energy, and urbanisation on the global ecological footprint were studied by Quito, Ro-Rama, Alvarez-Garca, and Durán-Sánchez (2022). Research covered the years 1995-2017. Westerlund cointegration and quantile regression were utilised to examine the data. The results demonstrated that urbanisation and renewable energy mitigate environmental degradation across all quantiles, with the greatest impact seen at the top quintiles. The results also showed that industrialisation has a negative and significant impact on the lower quantiles but a favourable impact on the higher quantiles.

Industrialization, renewable energy (RE) output, RE consumption, inflation, and energy import were all factors that Sriyakul, Chienwattanasook, and Chankoson (2022) investigated in relation to the EG of ASEAN countries. Timeframes between 2006 and 2020 were studied. To do this, we employed a method called Methods of Moments Quantile-Regression (MMQR). A positive correlation was found between the ASEAN EG and industrialization, RE output, RE consumption, energy import, and inflation. Industrialization, urbanisation, and the use of renewable energy were studied by Voumik & Sultana (2022) to determine their impact on the environment in the BRICS nations of Brazil, Russia, India, China, and South Africa. Data from the years 1972-2021 were analysed for this study. The analysis of the data was performed using the cross-sectionally augmented autoregressive distributive lag (CS-ARDL) method. Conclusions increased environmental degradation is associated with increased industrialization, urbanisation, income, and electricity. It was also shown that the use of renewable energy in developed countries greatly slows the rate of environmental degradation in the BRICS countries. Energy use in Chinese homes was studied by Wu and Lin (2022). The years 2000 through 2020 were analysed in this study. A STIRPAT analysis was performed on the data. Consumption of direct energy, or energy that occurred naturally and was not changed, was found to have a positive U-shaped relationship with the rate of urbanisation. In addition, negative effects on direct energy consumption and positive effects on indirect consumption were discovered as a result of population concentration.

China's rapid industrialization and urbanisation have had a significant effect on the country's carbon emission intensity, which Xu, Dong, and Zhang (2022) studied. Analysis was performed using the STIRPAT model. It was shown that urbanisation and employment rates among urban populations are the primary determinants of carbon emissions per person. Rather than reducing carbon emissions per person, industrialization was found to increase energy usage. Chinese researchers Han, Zeeshan, Ullah, Rehman, and Afridi (2021) analysed the impact of urbanisation and freer trade on renewable and nonrenewable energy use from 1990 to 2018. Analysis of the data was performed using Quantile Regression in this study. Conclusions from the research. In three quintiles, urbanisation has a considerable impact on non-renewable energy consumption, but in the other quintiles, it has a negligible impact. Also, practically all quantiles' coefficients were statistically insignificant, suggesting that urbanisation had no discernible impact on the share of renewable energy used.

Newly industrialised countries have had their environmental quality studied by Sahoo and Sethi (2021), who looked at how urbanisation, population density, economic structure, and inventions affected the situation. Timespan between 1990 and 2017 were analysed. We analysed the information using both the Mean Group and Pooled Mean Group methods. Studies have shown that environmental quality declines as cities expand, people consume more energy, and economies get wealthier. The effects of urbanisation on several forms of energy efficiency were studied by Lvn, Chen, and Jianquan (2020). The research included panel data from 30 different Canadian provinces from 1997 to 2016. Overall energy efficiency, as well as its short- and long-term implications, were found to be negatively affected by urbanisation. There has been a significant uptick in research documenting urbanization's negative impact on long-term efficiency.

This study by Li, Li, and Strielkowski (2019) used a fixed effect model to investigate the effects of urbanisation and industrialization on energy efficiency and the security of the energy supply. Research was conducted using data collected from 2006 to 2015. It was discovered that industrialization and urbanisation can greatly enhance energy efficiency. Researchers in China looked at how urbanisation affected carbon emissions from both land use and people. Specifically, the years 2005-2014 were studied. Spatial econometric and the STIRPAT procedures were utilised to examine the information. The effects of urbanisation on carbon emissions were determined to be negligible. Carbon dioxide emissions also grew considerably in terms of land area as cities expanded.

Model Specification

For purposes of achieving goals 1 and 2, the following is the functional form of the estimating model:

$$ENERGY = g(URBAN, INDUST, TOPEN, ECOG) \quad . \quad . \quad . \quad (1)$$

where:

ENERGY =	Energy use, measured by (disaggregated to) renewable energy use (REC) and nonrenewable energy use (NREC)
URBAN =	Urbanization, measured by the urban population growth rate
INDUST =	Industrialization, measured by manufacturing value- added as a percentage of GDP
TOPEN =	Trade openness, measured by total trade divided by GDP
ECOG =	Economic growth, measured by percentage changes in real GDP

We present equation (1) in econometric form as follows:

$$ENERGY = \beta_0 + \beta_1 URBAN + \beta_2 INDUST + \beta_3 TOPEN + \beta_4 ECOG + u_{1t} \ldots (2)$$

Where all the variables remained as defined earlier. u_{1t} is the error term. β_1, β_2, β_3, and β_4 are parameters estimated. The a priori expectation of all the parameters is positive. That is, β_1, β_2, β_3, and $\beta_4 > 0$. Note that equation (2) is specified to capture objectives one and two.

The dependent variable (ENERGY) is disaggregated into renewable and nonrenewable energy use. For this reason, equation (2) will be estimated twice. First, the equation will be estimated taking renewable energy as the dependent variable. Thereafter, the equation will be estimated again. But, this time, nonrenewable energy use will be used as the dependent variable. On this basis, it will provide empirical results on the impact of the independent variables in inequation (2) on renewable energy use and nonrenewable energy use respectively.

Descriptive Statistics of the Variables

Mean, standard deviation, maximum values, minimum values, skewness, and kurtosis were calculated for the variables and the results are shown in Table 1.

Table 1: Calculating the Variables' Mean, Standard Deviation, Minimum Values, Maximum Values, Skewness, and Kurtosis

Variables	Obs.	Mean	Standard Deviation	Minimum value	Maximum value	Probability (Skewness)	Probability (Kurtosis)
REC	41	85.6259	2.2173	80.3421	88.8319	0.0087	0.4981
NREC	41	19.5041	1.5411	15.8541	22.8447	0.4030	0.9912
UBAN	41	4.8889	0.5873	4.1419	6.0351	0.2153	0.0499
MVAPGDP	41	7.6199	2.4871	4.4569	14.0772	0.0091	0.3669
TOPEN	41	254.1639	199.0242	1.19	566.87	0.5181	0.0000
ECOG	41	3.2068	5.3667	-13.1278	15.3291	0.0164	0.0290

Source: Author's Computation

Mean values are close to their corresponding standard deviation values for nonrenewable energy usage, urbanisation, manufacturing value-added as a proportion of GDP, trade openness, and real GDP growth. This suggests that the values observed for each variable tend towards their respective means. The substantial disparity between the mean and the standard deviation values for renewable energy use suggests that the data values are not centred on the mean. Each variable has a minimum value that is smaller than its mean value and a maximum value that is larger than its mean value. This demonstrates that the values of the variables are dispersed around their respective means.

Significant Skewness probability values can be found for the utilisation of renewable energy, the manufacturing value-added share of GDP, and real GDP growth. The data do not follow a normal distribution, hence the null hypothesis is rejected at the 5% significance level. This suggests the variables do not follow a normal distribution. However, the Skewness probability values of non-renewable energy consumption, urbanisation, and trade openness are negligible. This means that at the 5% significance level, we can accept the null hypothesis that the data values follow a normal distribution. That is, there was no rightward or leftward bias in the data. Urbanisation and commercial openness make no discernible difference to the Kurtosis. Because of this, we accept the 5% level of significance for the null hypothesis of no kurtosis in a normal distribution. Kurtosis values are statistically significant for renewable energy consumption, non-renewable energy use, and manufacturing value-added as a share of GDP. Thus, at the 5% significance level, the null hypothesis is rejected. Therefore, the variables' tails are not normally distributed (renewable energy use, nonrenewable energy use, and industrial value-added as a proportion of GDP).

Unit Root Test

The stationarity of the variables was tested using the Augmented Dickey-Fuller and Phillips-Perron procedures. Table 2 shows the final result.

Table 2: Augumented findings from the Dickey-Fuller and Philips-Perron unit root tests

Variable	Augmented Dickey-Fuller Result		Philips–Perron Result		Lag order	~I(d)
	Level	1st Difference	Level	1st Difference		
REC	-2.657	-4.295*	-2.571	-6.537*	1	I(1)
NREC	-3.299	-4.246*	-3.378	-6.561*	1	I(1)
UBAN	-1.901	-3.758*	-1.915	-6.109*	1	I(1)
MVAPGDP	-2.371	-3.605*	-2.589	-5.592*	1	I(1)
TOPEN	-2.561	-4.165*	-2.374	-6.563*	1	I(1)
ECOG	-3.467	-3.786*	-3.159	-10.377*	1	I(1)

Where * indicates rejection of the null hypothesis of the presence of a unit root and a 5% level of significance. Akaike's Final Prediction Error (FPE) and Akaike's information criteria were used to determine the best lag times to use. At level and 1st difference, the 5% critical values for the ADF are -3.548 and -3.552, while for the Philips -Perron method, these numbers are -3.540 and -3.544. Both the estimated Augmented Dickey -Fuller and Philips-Perron unit root tests account for trend.

Source: Author's Computation using STATA 17

The test statistics of the variables are smaller than the level form critical values for both the Augmented Dickey-Fuller and the Philips-Perron tests at the level. This suggests that the presence of a unit root can be assumed at the 95% confidence level in both tests. What this says is that none of the variables are level, non-stationary processes. As a result, we utilise the results of the test performed at the varying levels of first difference. All variables became significant at the t-test stage (test statistic >= criterion value). The presence of a unit root cannot be assumed, hence H0 is rejected. Specifically, this indicates that the variables are integrated of order 1, I(1).

The Impacts of Urbanization and Industrialization on Energy Use

The first objective is to look at how urbanisation affects energy use, while the second objective another is to analyse how industrialization affects it. The findings are therefore shown and discussed below. The cointegration result is provided and discussed, however, before the results for objectives 1 and 2 are presented and addressed. Table 3 displays the results of a Johansen test for cointegration, which was conducted.

Table 3: Result of Johansen test for cointegration

Maximum Rank	Eigenvalue	Trace Statistics	5% critical value
0	-	70.6690	59.46
1	0.4824	44.9842	39.89
2	0.4338	22.7994*	24.31
3	0.2675	10.6543	12.53
4	0.2382	0.0389	3.84
5	0.0010		

Source: Author's computation

In all cases up to and including rank 1, the trace statistics exceeds the corresponding 5% critical threshold. The result is the existence of two cointegrating equations. The null hypothesis should be rejected at the 5% level due to the presence of cointegrating equations. The variables in the first and second objectives' equation are thus cointegrated. Objective 1 and 2 were estimated by use of the OLS method, which involved estimating an equation. Tabulated 4 is the outcome. Renewable energy consumption (REC) and nonrenewable energy consumption (NREC) are used to quantify the dependent variable, energy consumption, in this analysis. Energy consumption from renewable sources (REC) is provided in column (1), whereas energy consumption from nonrenewable sources (NREC) is reported in column (2) as a result of urbanisation and industrialization.

Table 4: Estimates of the energy effects of urbanisation and industrialization

Energy use	(1) Renewable energy use	(2) Nonrenewable energy use
UBAN	1.9539 (t = 4.14) (p = 0.000)	0.1113 (t = 3.30) (p = 0.000)
MVAPGDP	0.2061 (t = 1.81) (p = 0.079)	0.2504 (t = 2.76) (p = 0.009)
TOPEN	0.0023 (t = 1.41) (p = 0.166)	0.0059 (t = 4.64) (p = 0.000)
ECOG	0.1346 (t = 2.62) (p = 0.013)	-0.0092 (t = -0.23) (p = 0.822)
Constant	95.7400 (t = 40.30) (p = 0.000)	19.6754 (t = 10.42) (p = 0.000)
R-Squared	0.5935	0.6681
Adj. R-Squared	0.5484	0.6090
F(4, 36)	13.14 (p = 0.0000)	7.92 (p = 0.0001)
Durbin-Watson d-statistic	1.8970	1.5441
Breusch-Godfrey LM chi	0.104 (p = 0.8403)	2.357 (p = 0.1247)

Source: Author's computation

The utilisation of renewable energy sources in row (1) increases as cities grow. The utilisation of renewable energy rises by 1.95 percentage points for every percentage point of urbanisation. In absolute terms, the t-value of 4.14 is higher than 2. Applying the 2-tailed test, we conclude that urbanisation has a statistically significant effect on the use of renewable energy. The lack of an association between urbanisation and the usage of renewable energy is rejected at the 5% level in column (1), therefore contradicting the null hypothesis. Because 0.000 is less than 0.05, we can confidently reject the null hypothesis without making a serious mistake. There is a statistically significant and positive relationship between urbanisation and the utilisation of renewable energy in row 1. Similarly, urbanisation boosts the use of conventional energy sources in row 2. An increase in urbanisation is directly correlated with a 0.11 percent rise in the consumption of fossil fuels. Urbanisation has a statistically significant effect on the consumption of non-renewable energy sources (t = 3.30). Column (2) also rejects the null hypothesis, at the 5% significance level, that urbanisation has no effect on the consumption of non-renewable energy. Because 0.000 is less than 0.05, we can confidently reject the null hypothesis without making a serious mistake.

If you look at column (1), you'll see that for every 1 percentage point increase in manufacturing value-added as a share of GDP, renewable energy consumption rises by 0.21 percentage points. 1.81 is the t-value. As the t-value is not significant at the 5% level, we reject the null hypothesis that the manufacturing value-added as a proportion of GDP has any statistically significant effect on the percentage of total energy consumption that is generated by renewable sources. A p-value of 0.079 is not statistically significant below the 5% level. Therefore, column (1)'s null hypothesis is supported at the 5% level as well. Column (1) shows a positive and statistically insignificant effect of the manufacturing value-added share of GDP on the utilisation of renewable energy sources. However, as seen in column (2), the percentage of GDP devoted to manufacturing has a positive and statistically significant effect on the consumption of nonrenewable energy. In column (2), the usage of nonrenewable energy increases by 0.25% for every 1% increase in industrial value-added as a proportion of GDP.

The t-value for the trade openness coefficient is 1.41, and the corresponding coefficient is 0.0023 in column (1). The null hypothesis that trade openness has no statistically significant effect on the usage of renewable energy is accepted at the 5% level in row (1), as the t-value is less than 2 in absolute terms. With a p-value of 0.166 > 0.05, it is reasonable to reject the alternative hypothesis. The utilisation of renewable energy, measured in row (1), rises marginally as trade openness rises. A positive and statistically significant trade openness coefficient is seen in column. Since there is no statistically significant relationship between trade openness and the adoption of renewable energy sources, the null hypothesis is rejected in column (2). Column (2) shows a dramatic uptick in the use of renewable energy as trade liberalisation rises.

Coefficient of economic growth is 0.1346 (positive) and t-value is 2.62 (significant). In column (1), the t-value is statistically significant, therefore we can rule out the null hypothesis that GDP growth has no effect on RE consumption at the 5% significance level. Rejecting the null hypothesis at the 5% significance level is further supported by the substantial p-value. Rising GDP leads to a 0.13 percentage point spike in column (1)'s renewable energy use. Column (2) shows a negative and statistically insignificant coefficient. As can be seen in column (2), greater economic freedom leads to a little drop in the consumption of nonrenewable energy sources.

For each change in the independent variables, we may calculate the proportional change in the dependent variable using the coefficient of determination (R2). There is a 0.5935 R2 value. Therefore, the factors in column (1) might explain around 59.35% of the total variation in the use of renewable energy. The R2 value is 0.6681 in cell (2). Consequently, the variables in column (2) account for approximately 55.81 percent of the variance in the usage of nonrenewable energy. Columns 1 and 2 in the table both have probability values of less than 0.05, making the F-statistics significant. Since the model's independent variables affect both renewable and non-renewable energy use, the model is robust. Both columns of the Durbin-Watson test statistics, (1) and (2), are close to 2. This confirms that there is no autocorrelation between the two sets of data. As a result, autocorrelation cannot be found. Breusch-Godfrey LM chi2 values are not statistically significant, thus we also accept the null hypothesis that there is no serial correlation between the two columns.

Multicollinearity Test

The multicollinearity of the variables can be tested for with the Variance Inflation Factor (VIF) test. Table 5 displays the results.

Table 5: Tests for multicollinearity using the Variance Inflation Factor (VIF) are estimated.

Variable	VIF	1/VIF
TOPEN	1.85	0.541973
MVAPGDP	1.45	0.690784
UBAN	1.38	0.723900
ECOG	1.37	0.728813
Mean VIF	1.51	

The VIF values are quite low (under 10). Multicollinearity is not present if the VIF is less than 10, and it is present if it is larger than 10. We reject the alternative hypothesis of multicollinearity and instead assume that the variables all have small VIF values. In other words, multicollinearity is not an issue due to the independence of the variables.

Heteroskedasticity Test

The variables' heteroskedasticity is examined using the Breusch-Pagan / Cook-Weisberg test. Below, Table 6 displays the results of the tests conducted on the estimation columns (1) and (2) of Table 4.

Table 6: Estimates of Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance
chi2(1) = 0.00 Prob > chi2 = 0.9879

Source: Computed by the author using STATA 17

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance
chi2(1) = 0.56 Prob > chi2 = 0.4563

Source: Computed by the author using STATA 17

A result in either column (1) or (2) with a p-value larger than 0.05 indicates that the null hypothesis that the independent variables have constant variance is accepted at the 5% level of significance. That's a good sign that there's no heteroskedasticity in the data. That is, their differences are always the same.

Conclusion and Recommendations

Results from an analysis of how urbanisation and industry have affected energy use in Nigeria are presented. Increasing urbanisation is inferred to lead to a corresponding increase in energy consumption. Greater energy use is another consequence of industrialization. More non-renewable energy than renewable energy is used to power the industrialization of the world. Increases in the usage of renewable energy and decreases in the use of nonrenewable energy are both signs of a thriving economy. There is a small positive effect of trade liberalisation on renewable energy, and a large positive effect on nonrenewable energy. It is suggested in the paper that:

i. Since the current trend of urbanisation and industrialization is driving up energy demand, power generation should be a top priority. With oversight from a national board, local and state governments should be given the freedom and the obligation to create power on their own. To make this happen, lawmakers at all levels of government will need to agree on a specific goal and pass it into law.
ii. As has been the trend worldwide in recent years, non-renewable energy sources should be actively promoted.

The country's economic growth process could be improved by taking the following steps.

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