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Transport, Energy Consumption, Carbon Emission and Economic Policies Uncertainties in Nigeria

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Abstract

Following the need to find a solution to the threat of climate change globally, this study aimed to investigate the effect of transportation energy consumption and economic uncertainty on transport carbon emission covering the period of 1985 – 2020 in Nigeria. The study employed the Autoregressive Distributed Lag technique to achieve the objective. The results showed that transport energy consumption, population growth and economic uncertainty contribute significantly to transport carbon emission in Nigeria. Therefore, the study recommends that the government implement policies that will nudge people to embrace sustainable means of transportation.

Key Words: *Transport carbon emission, Transport energy consumption, Economic Uncertainty ARDL*

1.0 Introduction

Transport infrastructure, either directly or indirectly through its networks, plays a critical role in economic growth.. This is due to its role in facilitating capital and labour inputs in investment and output generation. It strengthens economic activities through its effect on both human and freight mobility. Hence, it affects all human endeavours in all ramifications. Well-maintained infrastructure promotes economic activity and commerce by facilitating the movement of people, goods, services, and vital inputs in the manufacturing process. The ability of countries to produce and export most items destined for regional and global export markets is dependent on land and maritime transportation. Effective transportation modalities, such as good roads, trains, ports, and air transportation, allow entrepreneurs to bring their goods and services to market safely and on schedule.

However, the transportation industry is a major user of fossil fuel energy, emitting nitrous oxide, methane, and carbon dioxide into the atmosphere. Environmental deterioration has resulted from the manufacturing of these chemicals, culminating in global warming and climate change. The terms "global warming" and "climate change" allude to an increase in the worldwide average temperature.,which are major environmental concerns that endanger human life, ecosystems, and health worldwide. ((Akpan & Akpan, 2015).

Nigeria being a developing country is vulnerable to global warming and climate change. In Nigeria, the problem of climate change is well documented. According to the environmental performance index (2020), Nigeria ranks 100 among 180 countries. This clearly shows that Nigeria is still far in tackling the issue of concern. Millions of people without air conditioning or power are affected by excessive heat, and precipitation fluctuations endanger Nigeria's predominantly rain-fed agricultural sector.

Previous studies in Nigeria have focused on Nigeria's carbon emission determinants by considering economic growth, energy consumption, population urbanisation, and foreign direct investment(Adams et al., 2020; Akpan & Akpan, 2015; Chukwu et al., 2015). To the researchers' best knowledge, little attention has focused explicitly on the concept of discussion. Therefore, the impact of transportation energy use and economic uncertainty on carbon emissions in Nigeria is investigated in this study.

2. Review of Literature

The transport sector still directly accounts for about 24 per cent of carbon emissions from the combustion of fuel globally despite increased use of biofuels, improved energy efficiency and greater electrification. Despite the recent upsurge in carbon emissions from shipping and aviation, about 75 per cent of transport CO_2 emissions come from road transport modes such as buses, cars, trucks, and two-and-three-wheelers(IEA, 2020). CO_2 emissions continued to be on the rise despite significant achievements in the production and the use of electric vehicles. As of December 2019, more than 7 million electric cars are reported on the roads globally, with fleets of electric trucks and buses being deployed majorly in developed countries. According to the recent International Energy Agency report, the increase in transport carbon emissions is largely due to the rising global procurement of heavier and larger vehicles and the growing global economy (IEA, 2020).

For projected freight demand and transport mobility to be met while reducing the growth of CO_2 emissions, coordinated, coherent and integrated policy toolkits is required to set the transport sector on a sustainability track. Many sustainable policy measures and regulations including but are not limited to parking pricing, transit fare subsidies, and shared bicycle systems in the USA, low-emission zone, congestion charging, parking restrictions, and investment in walking and cycling paths in Europe, including the UK, vehicle access restrictions and vehicle registration caps in China (Figure 1.). Compared to other continents, there are no recent policy measures for encouraging low carbon transport alternatives to cars in major African cities despite considerable economic, social, and environmental benefits to the region.

A systematic review of the previous literature has been carried out with the rising body of literature on transportation energy usage and CO2 emissions. Therefore, this section aims to characterise, identify the current state-of-the-art and the gaps in sustainable transport literature. All studies on transport CO_2

emissions and their influencing factors were identified from Scopus and Web of Science. Firstly, we found a total of 95 research papers (i.e., 53 from the web of science and only 42 from the Scopus database) and finally analysed 49 research articles based on inclusion and exclusion criteria.

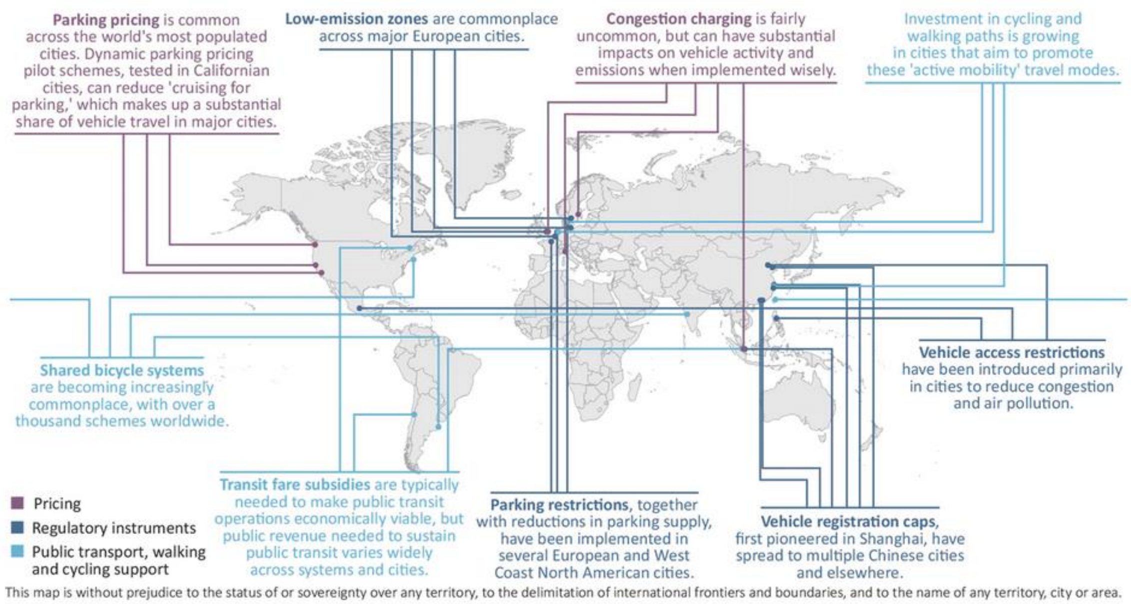

Figure 1: Recent policy instruments promoting sustainable alternatives to car travel in major cities (IEA, 2020)

There are different angles researchers have studied transport carbon emissions. The first strand is related to the factors influencing the transport CO_2 emissions. Transport energy consumption remains the dominant factor influencing the sector carbon emissions (Danish et al., 2018; C. Feng et al., 2020; Li & Zhao, 2015). Simultaneously the framework of the environmental Kuznets curve (EKC) hypothesis was sometimesutilised to establish the impact of the expanding economy on transport CO_2 emissions (Alshehry & Belloumi, 2017; Zhang et al., 2020). It was discovered that the causal relationship between transportation infrastructure and sectoral carbon emissions was bidirectional by Meng & Han (2018) and Tiwari et al. (2020), while Anwar et al. (2021)Lin & Omoju (2017) focused on investment (public-private partnership) as a sustainable way for mitigating emissions in CO_2 in transport. Many studies also identified the rate of urbanisation and population growth as key determinants of transport CO_2 emissions (Lin & Omoju, 2017; Liu et al., 2020; Lv et al., 2019).

With the current pandemic, researchers' attention has been drawn to economic policy uncertainty. For example, Altig et al. (2020) examined economic uncertainty before and during COVID-19 and found that all uncertainty indicators increased during the pandemic. Adams et al. (2020) and Pirgaip and Dinçergök (2020) looked into the relationship between energy consumption and CO2 emissions, using economic policy uncertainty as a moderator. The studies discovered a significant link between economic policy uncertainty and CO2 emissions for both rich and developing countries. To our knowledge, no study has attempted to investigate the impact of economic policy uncertainty on the nexus between transportation energy consumption and transport CO_2 emissions, most especially in Nigeria, with only Maduekwe et al. (2020) without consideration of uncertainty. Our research will be the first empirical work to examine the impact of transport energy consumption and economic uncertainties on transport carbon emissions in Nigeria.

3. Methodology

The study adopted the(Sulaiman& Abdul-Rahim, 2018) model, which was used to measure the relationship between carbon emission, income, energy consumption, and population growth. However, the model was modified using transport carbon emissions measured in metric tonnestoreplace the general carbon emission. In addition,economic uncertainty added to the independent variables due to the objective of the present study. Hence, the empirical model for this study is presented in equation 1:

3.1.Model Specification

the study used the following models, to empirically investigate the effect of transport energy consumption and economic uncertainties on transport carbon emission,:

$$TCO_2t = \beta0 + \beta_1 ECt + \beta_2 TECt + \beta_3 POPG + \beta_4 EPUt + \varepsilon t \ldots\ldots\ldots\ldots..1$$

Where :

TCO_2= transport carbon emissions (in millions metric tons)

EG = Economic Growth

TEC = Transport Energy Consumption

POPG = Population Growth

EPU = Economic Policies Uncertainty

εt is the regression error term.

Factors 1, 2, 3, and 4 indicate the effects of economic growth, transportation energy consumption, and economic policy uncertainty on CO2 emissions from transportation, respectively.

All the variables were transformed into logarithm as:

$$lnTCO_2t = \beta0 + \beta_1 \, lnEGt + \beta_2 \, lnTECt + \beta_3 POPG + \beta_4 EPUt + \varepsilon t \ldots\ldots\ldots\ldots..2$$

3.2 Sources of Data:

Secondary data were used for this study spanning 1985 and 2020. Energy transport carbon emission and transport energy consumptionproxied by energy consumption, real gross domestic product per capita and population were obtained from world development bank indicators, and economic policy uncertainty was sourced from the world uncertainty index.

3.3 Estimation Technique

This study employs the Autoregressive distributed lag technique to investigate the effect of transport energy consumption and economic uncertainty on transport carbon emission in Nigeria. The ARDL technique is suitable for a model in which the unit root test is integrated of values not greater than one, i.e. the variables are stationary at levels and first difference.

The ARDL have different procedures. The first stage is to conduct the unit root test to determine the stationary properties of each variable. The second procedure is to determine a long-run relationship between the regressand and regressors within a univariate framework. The final procedure is to estimate an error correction model if the variables are cointegrated.

Table 1: Unit Root Test

Variable	Augmented Dickey-Fuller Test	Level of Integration		
	Level	First difference	Critical value (5%)	
LnTCO	-0.99873	-5.94466**	-2.93113	I(1)
LnTEC	-1.20479	-5.88159**	-2.94102	I(1)
LnEG	-0.0291	-3.394459**	-2.94584	I(1)
LnPOPG	-3.737193**		-2.95402	I(0)
LnEPU	-0.0872	-5.776998**	-2.94115	I(1)

Notes: ** denotes significance at 5%

Authors' Computations, 2021

4. Empirical Results

This section presents the empirical results on the effect of transportation energy consumption and economic policy uncertainty on transportation carbon emissions are presented in this section.

4.1. Unit Root Test

Table 1 shows the results of the unit root test. The Augmented Dickey-Fuller Test was used to conduct the unit root test (ADF). The result reveals a zero and one mixed integrating order. Only population growth is integrated at order zero, i.e. I(0), whereas all other variables are integrated at order one, as shown. As a result, the adoption of the ARDL approach was justified.

4.2. ARDL Result

The ARDL result is presented in Table 2 based on Akaike Information Criteria (AIC). The result reveals that the lag value of transport carbon emission is positive but not significant. The instantaneous effect is insignificantly negative, while the lag value has a significant negative effect on carbon emission. The coefficient of transport energy consumption, population growth, and economic uncertainty significantly affect transport carbon emissions in Nigeria. This means that a 1% increase in transportation energy consumption in Nigeria will result in a 0.58 percent rise in transportation energy consumption.

In addition, a one per cent increase in economic uncertainty will also aggravate an increase in transport carbon emission. The coefficient of determination (R^{2}) shows that variations in all the explanatory variables explain 92 per cent of the variation in transport energy consumption. The F-Statistic Value of the model is also significant. In addition, the Durbin Watson statistic shows that the model is free from serial correlation.

Table 2: ARDL Result

Dependent Variable: LOG(TCO)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(TCO(-1))	0.087845	0.172259	0.509961	0.6142
LOG(EG)	-0.06599	0.084105	-0.78465	0.4395
LOG(EG(-1))	-0.14785	0.062874	-2.35156	0.0262
LOG(TEC)	0.579211	0.142163	4.074287	0.0004
LOG(POPG)	0.356605	0.096952	3.678166	0.001
LOG(EPU)	0.046113	0.020884	2.207999	0.0359
LOG(EPU(-1))	0.020627	0.018611	1.108296	0.2775
C	-2.8994	0.983023	-2.94948	0.0065
R-squared	0.917788			
Adjusted R-squared	0.896474			
F-statistic	43.0598			
Prob(F-statistic)	0			
Durbin-Watson stat	2.148115			

Source: Authors' Computation, 2021

4.3. Bound Test

Table 3 displays the results of the bound test. At a 5% significance level, the estimated F-statistic (4.51) is greater than Pesaran's critical lower bound value of 2.86 and upper bound value of 4.01. As a result, the null hypothesis of no cointegration is ruled out. As a result, it is argued that the dependent and independent variables in the model have a long-run cointegration relationship.

Table 3: ARDL Bounds Test

Test Statistic	Value	K
F-statistic	4.51178	4

Source: Authors' Computation, 2021

4.4. Long and Short-run Results

Table 3 shows the short-run coefficients of the effect of energy consumption on transportation carbon emissions. Apart from economic growth, all other explanatory variables, such as transportation energy consumption, population expansion, and economic policy uncertainty, had a significant positive effect on transport carbon emissions in both short and long-run models during the time under consideration. According to the findings, a 1% increase in transportation energy consumption results in a 0.57 percent rise in transportation carbon emissions. The long-run result backs up this conclusion.As shown in Table 4, a 1% increase in transportation energy consumption will result in a 0.63 percent rise in transportation carbon emissions over time.

Furthermore, the results demonstrate that a 1% rise in population growth corresponds to 0.35 and 0.39 percent increases in the short and long-run models, respectively. The economic uncertainty coefficient shows that a 1% rise in economic uncertainty increases transportation carbon emissions by 0.05 and 0.07 percent in the short and long run.

The ECM coefficient is also negative as expected and statistically significant as dictated by the p-value (0.000) and the t-statistic (-5,295255). The result shows that about 91 per cent of disequilibrium in the transport carbon emission in the previous year are corrected for in the current year. The significance of the ECM is a confirmation of the existence of along run equilibrium between transport carbon emission and transport energy consumption, and economic uncertainty.

Table 4: Short and Long Run Result

Dependent Variable: LOG(TCO)				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(EG)	-0.06599	0.084105	-0.78465	0.4395
DLOG(TEC)	0.579211	0.142163	4.074287	0.0004
DLOG(POPG)	0.356605	0.096952	3.678166	0.001
DLOG(EPU)	0.046113	0.020884	2.207999	0.0359
CointEq(-1)	-0.91216	0.172259	-5.29526	0

Cointeq = LOG (CO) - (-0.2344*LOG (RGDP) + 0.6350*LOG (TEC) + 0.3909*LOG (POPG) +0.0732*LOG (EPU) -3.1786).

Table 5 Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EG)	-0.23444	0.062613	-3.74424	0.0009
LOG(TEC)	0.634992	0.146562	4.332591	0.0002
LOG(POPG)	0.390948	0.105714	3.698172	0.001
LOG(EPU)	0.073167	0.008564	8.543226	0
C	-3.17863	1.16659	-2.72472	0.0112

Source: Authors' Computation, 2021

4.5. Diagnostic Tests

The model's adequacy was tested using the serial correlation test and the normalcy test, with the findings shown in Table 6 and Figure 1, respectively.

4.5.1 Serial Correlation Test

To see if the variables were serially correlated, the Breusch-Godfrey Serial Correlation LM Test was employed. Table 6 reveals that the R-squared value and F-statistics probability are more than 0.05; thus, we accept the null hypothesis and reject the alternative hypothesis, concluding that error terms are not serially connected. It shows that the subsequent values of the error term are unconnected to their earlier values, indicating that the residual is desirable.

Table 6 Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.319027	Prob. F(2,25)	0.7298
Obs*R-squared	0.871043	Prob. Chi-Square(2)	0.6469

Source: Authors' Computation, 2021

4.5.2. The Normality test

Figure 2 shows the result of the normalcy test. The Jarque-Bera statistic (2.469561) demonstrates that the residual is normally distributed, with a probability (0.280899) value greater than 0.05. (Five per cent). This shows that the normal distribution null hypothesis should be accepted.

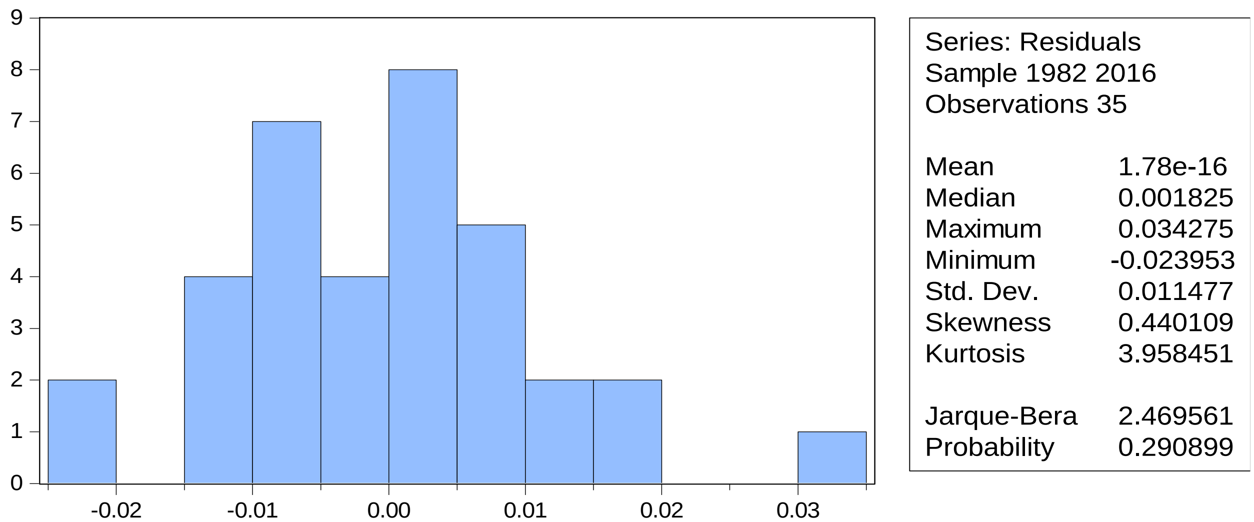

Figure 2: Normality test

4.6. Discussion of Findings

Based on the global concern on the increase in global warming and the threat to climate change due to the increase in carbon emission in general and transport carbon emission in particular. Therefore, this research was conducted to join other researchers in identifying the major determinants of transport carbon emission in Nigeria.

The study results showed that transport energy consumption, population growth, and economic uncertainty significantly positively impact transport carbon emission in Nigeria. This means that the higher the level of transport energy consumption, population growth and economic uncertainty, the higher the increase in transport carbon emission in Nigeria. This result is in tandem with the study of Sulaiman & Abdul-Rahim, (2018), Adams et al. (2020) and Amin &Dogan (2021).

5. Conclusion and Recommendation

This study analysed the effect of transport energy consumption and economic uncertainty on transport carbon emissions in Nigeria between 1985 and 2020. The findings of the result based on the Autoregressive Model technique suggests transport energy consumption, population growth and economic uncertainty contribute positively to transport carbon emission in Nigeria.

The first implication of the result is that the higher the level of transport energy consumption, the greater the transport carbon emission and, consequently, the worse the climate condition in Nigeria. In addition, the greater the increase in population growth and economic uncertainty, the higher the level of transport carbon emission in Nigeria.

Therefore, this study recommends the use of economic policies that will nudge people to embrace sustainable transportation. The government can achieve this by subsidising people who patronise public transport instead of their private car. In order words, the government should promote a sustainable transportation system by encouraging people to embrace energy-efficient means of transportation.In addition, the government should optimise the positive effect of economic uncertainty on transport carbon emission.

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