International Journal of Women in Technical Education and Employment
ISSN: 2811-1567. Volume 4 – Issue 1. July 2023
https://fpiwitedjournal.federalpolyilaro.edu.ng

INTERNATIONAL JOURNAL OF WOMEN IN TECHNICAL EDUCATION AND EMPLOYMENT (IJOWITED)

Environmental Degradation and Economic Growth in Nigeria: Investigating the Classical N-shaped EKC Hypothesis

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Abstract
In this study, we go beyond the classical inverted Environmental Kuznets Curve (EKC) proposition to accommodate the N-shaped EKC proposition to explore the relation between environmental degradation and economic growth in Nigeria. Carbon II oxide (CO_2) emission is observed to account for the largest component of Green House Gases (GHGs) which cause environmental degradation with life-threatening consequences. We adopt time series dataset on CO_2 emission and growth rate of per capita GDP (GDPPG) from the World bank-data bank. The N-shaped EKC hypothesis is not ascertained for the country following our findings. We observe that environmental degradation is still rising in the country largely because of increase in CO_2 and other GHGs emissions. We encourage policy makers and stakeholders to promote, make accessible and give incentives for the use of renewable energy sources. We recommend a paradigm shift from GHGs to cleaner and greener energy alternatives, and adoption of policy measures to support action for climate change for attainment of improved environmental quality alongside growth trajectories in the country.

ARTICLE HISTORY

Received: June 10, 2023
Revised: July 16, 2023
Accepted: July 18, 2023

Keywords: Environmental Kuznets Curve, Environmental degradation, Green House Gases, Carbon II oxide, Growth rate of per capita GDP.

Citation
Olaniran-Akinyele, O. & Adewunmi, K. (2023). Environmental Degradation and Economic Growth in Nigeria: Investigating the Classical N-shaped EKC Hypothesis. *International Journal of Women in Technical Education and Employment,* 4(1), 138 – 147.

Introduction
The rising environmental degradation from continuous emission of Green House Gases (GHGs) due to combustion of fossil fuels with carbon dioxide (CO_2) emission being the largest components of the GHGs emissions calls for concern by governments, policymakers, practitioners, and the global community (Olaniran-Akinyele & Adamu, 2023). The emission of GHGs poise an intense warming propensity and lengthy lifespan extending beyond decades to centuries with the antecedent spikes in temperature levels and extreme conditions (Syed *et al*., 2022 & Kurshid *et al*., 2022; Ma et al. 2021). NOOA (2017) and IPCC (2007) highlight the devastating implications of continuous rise in GHGs on climate change and global warming, wellness, value chain of agricultural produce, reduction in water availability, rise in sea levels, decline in precipitation in the arid regions, and extreme conditions with life-threatening consequences. According to the IPCC (2017), by 2100, global temperature is projected to increase to 6.4 degree from 1.1, sea levels to 53.8 cm from 16.5 cm if CO_2 emissions and other GHGs emissions are not controlled and reduced. Unlike other GHGs including Sulphur II oxide (SO_2) and Nitrogen II oxide (NO_2), CO_2 emissions in a country extends to other countries with implications on the health and well-being of all living organisms and threat to survival over

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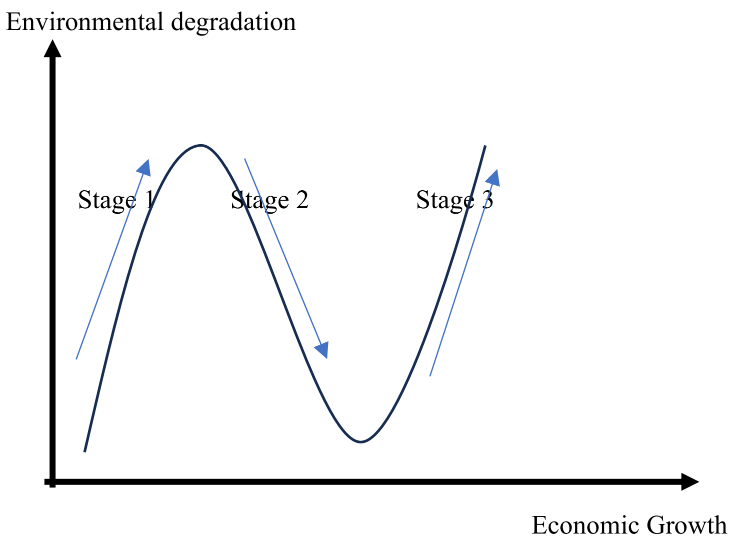
the centuries (Olaniran-Akinyele & Adamu, 2023; Syed et al., 2022; Ma *et al*. 2021).

The excessive usage of energy resources, products, and services from combustion of fossil fuel, and electricity had been identified as major factors for continuous CO_2 emission in the country (Olaniran-Akinyele & Adamu, 2023; Ngonadi *et al,* 2020; Bekun et al, 2020; Omisakin, 2009; Okedina, 2019; Yahaya *et al*., 2019).

The classical inverted U-shaped EKC hypothesis is extended to the N-shaped relationship between environmental degradation and income levels (Ngonadi *et al*., 2020; Friedl & Getzner, 2003; Holtz-Eakin & Seden, 1995). According to Ngonadi et al. (2020), the EKC may not only assume the conventional U-shaped or inverted U-shaped relation but could be extended to the N-shaped or inverted N-shaped relation. Sequel to this, our analysis of the N-shaped EKC phenomenon takes lead from the classical inverted U-shaped position.

The classical inverted U-shaped EKC hypothesizes that environmental degradation rises as income per head rises, get to reflection point at which environmental degradation declines with subsequent rise in income per head. The N-shaped EKC on the other hand hypothesizes that environmental degradation rises as income per head rises at the initial stage, declines with subsequent increase in income per head at a later stage and rises gradually with further increase in income per head. In a previous study, the existence of the Classical inverted U-shaped EKC hypothesis was validated with absence of long run cointegration. We seek to extend our previous study by exploring and determining the validity or otherwise of the N-shaped version of the EKC hypothesis for Nigeria in this study.



The N-shaped EKC reflects that environmental degradation rises where the income level is low, reaches a peak and starts declining with subsequent increase in income and gradually starts rising with further increase in income levels in an economy.

Few studies support the existence of the classical U-shaped EKC hypothesis (Dietz & Rosa, 1994; Ozokcu & Ozdemir, 2017; Hatmanu *et al.*, 2022) while a few others Lacheheb *et al*., 2015; Agras & Chapman, 1999; Richmond & Kaufmann, 2006; do not propose sufficient evidence to validate its existence. In the case of Nigeria, the phenomenon is supported by Olaniran-Akinyele and

Adamu, 2023; Bekun *et al*., 2020; Yahaya *et al*., 2019; while Omisakin, 2009; Ajide & Oyinlola, 2010; Okedina et al. 2019 could not propose enough evidence to support the phenomenon in the country.

Methodology

We extract time series dataset on CO_2 emission and growth rate of GDP from the world bank data bank on World Development Indicators over 1990-2019. In line with the EKC assumptions, we specify a nonlinear quadratic equation to validate the classical U-shaped proposition of the EKC hypothesis for our first analysis and a nonlinear cubic equation for the N-shaped EKC hypothesis.

The baseline model adopted for this study is specified as follow.

$$CO_{2t} = f(GDP_t, GDP_t^2, GDP_t^3) \quad (1)$$

We adopt a nested model and specified and estimated the quadratic function in our first analysis and proceeded to the cubic function of our baseline model. The contemporaneous form presentation of model in equation (1) is presented as follow.

$$CO_{2t} = \sigma_0 + \sum_{i=1}^{p} \omega_i CO_{2t-i} + \sum_{j=0}^{q_1} \varpi_j GDP_{t-j} + \sum_{j=0}^{q_2} \tau_j GDP_{t-j}^2 + \sum_{j=0}^{q_3} \vartheta_j GDP_{t-j}^3 + \varepsilon_t \quad (2)$$

The unrestricted ARDL presentation for the model is presented as follow.

$$\Delta CO_{2t} = \sigma_0 + \sum_{i=1}^{p} \sigma_i \Delta CO_{2t-i} + \sum_{j=0}^{q_1} \varphi_j \Delta GDP_{t-j} + \sum_{j=0}^{q_2} \upsilon_j \Delta GDP_{t-j}^2 + \sum_{j=0}^{q_3} \chi_j GDP_{t-j}^3 + \gamma_1 CO_{2t-1} + \gamma_2 GDP_{t-1} + \gamma_3 GDP_{t-1}^2 + \gamma_4 GDP_{t-1}^3 + \varepsilon_t \quad (3)$$

The Error correction form of this model is specified as follow.

$$\Delta CO_{2t} = \sigma_0 + \sum_{i=1}^{p} \sigma_i \Delta CO_{2t-i} + \sum_{j=0}^{q_1} \varphi_j \Delta GDP_{t-j} + \sum_{j=0}^{q_2} \upsilon_j \Delta GDP_{t-j}^2 + \sum_{j=0}^{q_3} \chi_j \Delta GDP_{t-j}^3 + \delta ECT_{t-1} + \varepsilon_t \quad (4)$$

Empirical Analysis and Results Discussion

Pre-diagnostic reports

The Augmented Dickey Fuller (ADF) test statistic, DF-GLS statistic and the Phillips Perron statistics were conducted for our series. The series following the stationarity test were combination of level and difference stationary processes.

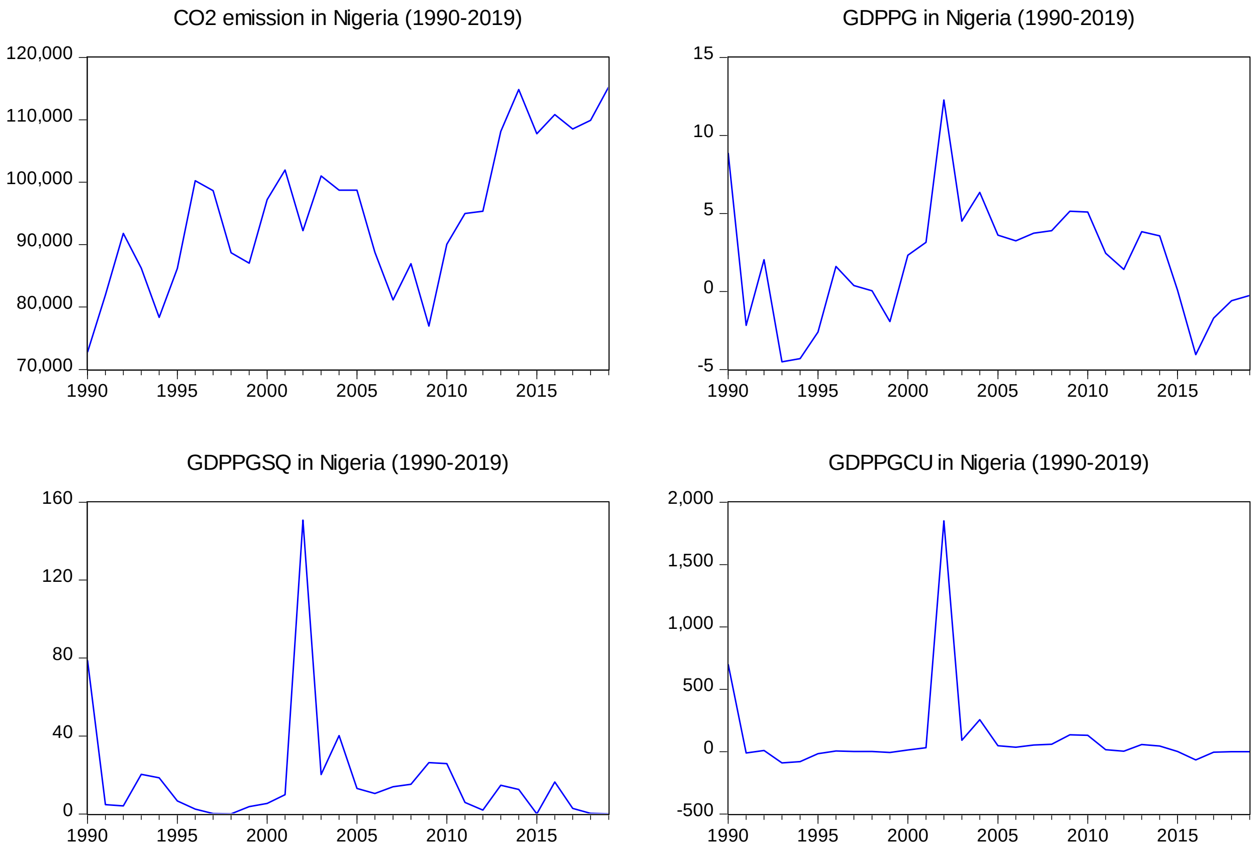


Figure 1: CO2, GDPPG, GDPPGSQ, GDPPGCU detail carbondioxide emission, growth rate of per capita GDP, the squared value of the growth rate of per capita GDP, and the cubic value of the growth rate of per capita GDP. Where CO2 is taken as measure of environmental degradation and GDPPG, measure of income per person in the country.

Table 1: Summary Statistics

	CO2	GDPPG	GDPPGSQ	GDPPGCU
Mean	95036.67	1.844482	17.53457	108.3514
Median	95170.00	2.170702	10.19343	10.36909
Maximum	115280.0	12.27614	150.7036	1850.058
Minimum	72770.00	-4.507149	0.001055	-91.56001
Std. Dev.	11473.45	3.823582	29.63922	357.4215
Skewness	0.027406	0.449385	3.441665	4.188844
Kurtosis	2.157118	3.406951	15.23661	20.39509
Jarque-Bera	0.891817	1.216745	246.3935	465.9685
Probability	0.640242	0.544236	0.000000	0.000000
Sum	2851100.	55.33447	526.0370	3250.542

Sum Sq. Dev.	3.82E+09	423.9736	25476.02	3704753.
Observations	30	30	30	30

Table 2: Unit Root Test Results

Test Method	CO_2		*GDPPG*		*GDPPGSQ*		*GDPPGCU*	
	Level	*First Differenced*	*Level*	*First Differenced*	*Level*	*First Differenced*	*Level*	*First Differenced*
ADF test statistic	-2.0660	-5.4883***	-3.5289***	-8.8436***	-5.4253***	-9.1849***	-5.4418***	-9.2634***
P-P test statistic	-2.0660	-6.1579***	-3.6714***	-16.4861***	6.1254	-0.7855	-5.4418***	-24.66598***
DF-GLS test statistic	-1.4347	-4.9418***	-2.7902***	-1.4540	-3.9282***	-6.1108 ***	-4.3555***	-7.0519***
REMARK	NON STATIONARY	STATIONARY	STATIONARY	Mixed but STATIONARY	MIXED but STATIONARY	MIXED but STATIONARY	STATIONARY	STATIONARY

***, **, * represent statistical significance at 1%, 5% and 10% levels respectively

Determination of lag length

Table 3: The Vector Auto Regression Analysis

Lag	LogLTC	LRTC	FPETC	AITC	STC	HQTC
0	-265.1210	NA	1.32e+08	21.52968	21.72470	21.58377
1	-255.4828	15.42103*	66069222*	20.83863*	21.08240*	20.90624*
2	-255.3856	0.147832	71307783	20.91084	21.20338	20.99198
3	-255.3042	0.117211	77193068	20.98433	21.32562	21.07899
4	-255.2356	0.093202	83827178	21.05885	21.44889	21.16703
5	-255.2228	0.016372	91671504	21.13783	21.57662	21.25953

*indicates lag order selected by the criterion

Cointegration test
Table 4: Cointegration report

Statistic	Output	Sig.(%)	I-(0)	I-(1)
F-stat	2.1273	1	4.29	5.61
k	3	5	3.23	4.35
		10	2.72	3.77
t-stat	-2.0291	1	-3.43	-4.37
		5	-2.86	-3.78
		10	-2.57	-3.46

Granger causality
Table 5: Causality test result

Ho	lags	F-statistics	P-value
No causality from GDPPG to CO_2	1	0.0031	0.9560
No causality from CO_2 to GDPPG	1	0.0945	0.7610
No causality from $GDPPG^2$ to CO_2	1	0.6228	0.4372
No causality from CO_2 to $GDPPG^2$	1	0.1165	0.7354
No causality from $GDPPGSQ^3$ to CO_2	1	1.0171	0.3225
No causality from CO_2 to $GDPPGSQ^3$	1	0.3776	0.5442
No causality from $GDPPG^2$ to GDPPG	1	2.3163	0.1401
No causality from GDPPG to $GDPPG^2$	1	1.3856	0.2498
No causality from $GDPPG^3$ to GDPPG	1	2.00391	0.1688
No causality from GDPPG to $GDPPG^3$	1	1.29500	0.2655
No causality from $GDPPG^3$ to $GDPPG^2$	1	0.00975	0.9221
No causality from $GDPPG^2$ to $GDPPG^3$	1	0.03203	0.8593

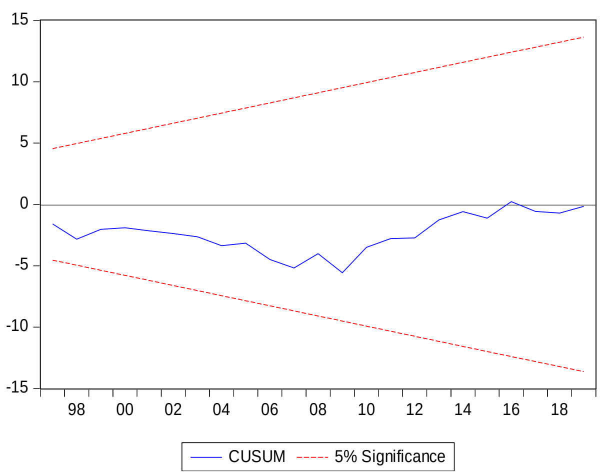
The granger causality test reports the non-existence of causal relationship amongst the series employed in our analysis.

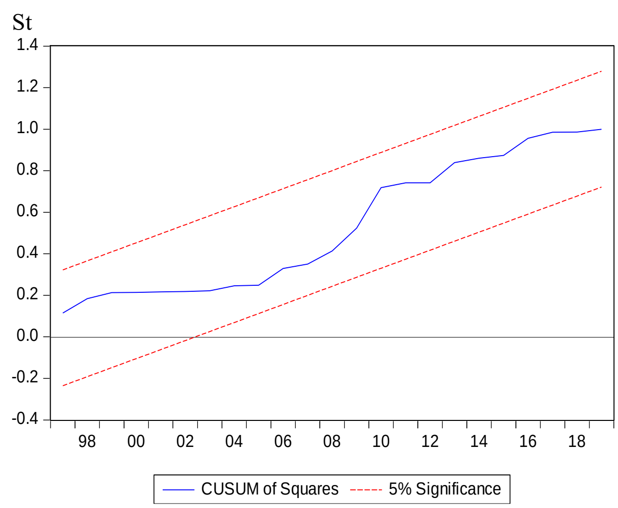
Table 6: First differenced ARDL model estimation results.

Variable	Coefficient
$\Delta CO_2(-1)$	0.0491
	(0.1748)
ΔGDPPG	1696.816**
	(626.2728)
ΔGDPPGSQ	81.7606
	(153.7370)
ΔGDPPGCU	-20.0523
	(13.7743)
C	1030.870
	(1319.886)

R^2 = 0.3251
$\bar{R}^2$ = 0.2078
DW= 2.2028
F-statistic= 2.7701
BG(LM)Test=0.8763(0.3594)
BPG(Hetero.)=0.4996(0.7363)
Prob(F-stat)= 0.051495
JB=0.8114(0.6665)

Note: The asterisks; ***, **,* denote significance at the 1%, 5% & 10% levels respectively. Standard errors are presented in parentheses





Discussion of results

The unit root test results indicate CO_2 emission to be a difference stationary process and GDPPG, GDPPGSQ and GDPPGCU as level stationary processes. We estimate the first differences ARDL model as the bound test revealed the non-existence of steady state relationship amongst the series employed in our analysis and proceed to conduct the granger causality test to infer about the short run causal relationships amongst the series. We discover no evidence of causal relationships amongst the variables. Our post diagnostic tests statistics; the BPG heteroscedasticity test, the serial correlation LM test and JB normality tests indicate neither serial correlation nor heteroscedasticity, and report normal distribution for our series.

The N-shaped EKC hypothesis is supported where the measure of income, its squared and cubic values are positive, negative, and positive accordingly implying that $\beta1 > 0$, $\beta2 < 0$ and $\beta3 > 0$ (Alvarez-Herranz & Balsalobre-Lorente, 2016). Our estimation results do not validate the existence of the N-shaped EKC hypothesis in Nigeria as only GDPPG is signed appropriately with its squared and cubic values not signed appropriately relative to the N-shaped EKC assumptions.

Conclusion

The N-shaped EKC hypothesis was not validated in our study, although the classical inverted U-shaped relationship was found to exist in the country; Olaniran-Akinyele & Adamu, 2023; Bekun et al., 2020; Yahaya et al., 2019) in contrast to some other studies; Omisakin, 2009; Ajide & Oyinlola, 2010; Okedina et al. 2019 which fail to validate the inverted U-shaped relationship. From our findings, an increase in GDP leads to an increase in environmental degradation at the initial stage of development, with the increase sustained in subsequent period and gradually declines at a later period. We discover and conclude from our analysis that initial increase in the growth rate of GDP increases environmental degradation in the first and second stages of the country's growth trajectory, with the increase later resulting into improvement in environmental quality in the final stage.

We attribute the non-existence of the EKC hypothesis in our analysis to the fact that the country is yet to attain significant increase in its income per head complemented with reductions in the incidences of poverty, unemployment, inequality, and insecurity relative to the developed economies of the world.

We conclude on non-existence of the inverted N-shaped hypothesis in the case of Nigeria as the coefficients of GDPPG and its squared value are positive with the cubic value of GDPPG negative.

Recommendation

The N-shaped proposition of the EKC hypothesis cannot be validated in the country as we found that our measure of income-GDPPG and its squared value are positively signed, and the cubic value negatively signed with significance established for only GDPPG at the 5 percent level. We propose that policies to increase awareness about the adverse effects of environmental degradation from GHGs, especially CO_2 emission from fossil fuel combustion be supported and recommend a paradigm shift from GHGs to cleaner and greener energy alternatives and adoption of policy measures to support action for climate change and renewable energy sources to attain growth trajectories with improved environmental quality in the country. With the low values of R^2 and adjusted R^2 in our report. Consideration of a vector of relevant variables accounting for growth in subsequent studies is suggested.

References

Agras, J., & Chapman, D. (1999). A dynamic approach to the environmental Kuznets curve hypothesis. *Journal of Ecological Economics 28*, 267–277.

Ajide, K.B., & Oyinlola, M.A. (2010) Does the level of economic growth influence environmental quality in Nigeria: A test of Environmental Kuznets curve (EKC) hypothesis? *Pakistan Journal of social sciences. 7*(4), 325-329

Alvarez-Herranz, A. & Balsalobre-Lorente, D. (2016). Economic growth and energy regulation in the Environmental Kuznets curve. *Environmental Science and Pollution Research Journal*. *2*(3), 16478-16494

Bekun, F.V., Agboola, M.O., & Joshua, U. (2020) *Economics of green energy handbook*. Springer

Dietz, T, & Rosa, E.A. (1994). Rethinking the environmental impacts of population, affluence, and technology. *Human Ecology Review, 1* 277-300

Friedl B, & Getzner M (2003) Determinants of CO2 emissions in a small open economy. *Journal of Ecological Economics 45*,133–148.

Granger, C.W.J. (1969). Investigating causal relationships by econometric models and cross-spectral methods. *Econometrica, 37*(3), 424-438

Grossman & Krueger (1995). Economic growth and environment. *Quarterly Journal of Economics. 110(*2), 353-377

Grossman and Krueger (1995). Economic Growth and the Environment. *Quarterly Journal of Economics, 110*, 353-377.

Hatmanu M., Caustisanu, C. & Andreea, O.L. (2022) On the relationships between CO2 emissions and their determinants in Romania and Bulgaria. An ARDL approach. *Journal of Applied Economics. 54*(22). 2582-2595.

Holtz-Eakin, D. & Seden, T.M. (1995). CO2 emission and economic growth. *Journal of Public economics. 57*, 85-101.

Intergovernmental Panel on Climate Change (IPCC). 2007a. Climate change 2007. *The physical science basis*. The IPCC. Cambridge UK, Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). 2007b. *Climate change 2007. Impacts, adaptation, and vulnerability.* The IPCC. Cambridge UK, Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). 2007c. *Climate change 2007. Mitigation*. The IPCC. Cambridge UK, Cambridge University Press.

Kurshid, N. Fiaz, A., Kurshid, J. & Ali, K. (2022). Impact of climate change shocks on economic growth: A new insight from non-linear analysis. *Journal of Frontiers in Environmental Science.*

Kuznets, P. & Simon, P. Economic growth and income inequality. *American Economic Review*. *45*(1). 1-28.

Lacheheb, M., Abdul Rahim, A.S., & Sirag, A. (2015) Economic growth and carbon dioxide emissions: Investigating the Environmental Kuznets Hypothesis in Algeria. *International Journal of Energy Economics and Policy 5(*4), 1125-1132.

Ma, Q., Murshed, M., & Khan, Z. (2021). The nexus between energy investments, technological innovations, emission taxes and carbon emissions in China. *Energy Policy, 155*,

Mishra, M.K. (2020). *The Kuznets curve for the sustainable environment and economic growth*. ZBW.-Leibniz Information centre for economics, Kleil, Hamburg.

National Oceanic & Atmospheric Administration (NOAA). (2017). CarbonTracker CT2015. https://www.esrl.noaa.gov/gmd/ccgg/carbontracker/CT2015/.

Ngonadi, J.C., Okere, J. & Ngonadi, J. (2020). Non-linear nexus between CO2 Emission, Economic growth in Nigeria. *European Journal of Business and Management Research 5*(6). https://doi.org/10.24018/ejbmr.2020.5.6.612

Okedina, I., Lawal, E.O., Ifayemi, O., & Akinsola, V.S. (2019) Carbon emissions and economic growth in Nigeria*. Hezekiah University Journal of Management and Social Sciences 7(*1).

Olaniran-Akinyele, O.F. & Adamu, A.M. (2023). CO2 emission and economic growth in Nigeria: investigating the environmental Kuznets curve. *Journal of Management and Technology*

Omisakin, A.O. (2009) Economic growth and environmental quality in Nigeria: Does Environmental Kuznets curve hypothesis hold? *Environmental Research Journal, 3*(1), 14-18

Ozokcu, S. & Ozdemir, O. (2017). Economic growth, energy, and environmental Kuznets curve. *Renewable and Sustainable Energy Review. 72*, 639–647

Richmond, A.K. & Kaufmann, R.K. (2006). Is there a turning point in the relationship between income and energy use and/or carbon emissions? *Journal of Ecological Economics, 56*, 176-189.

Shahbaz, M. & Balsalobre-Lorente D. (eds.), Econometrics of Green Energy Handbook, https://doi.org/10.1007/978-3-030-46847-7

Syed, A., Raza, T., Bhatti, T. T. & Eash, N. N. (2022). Climate impacts on the agricultural sector of Pakistan: Risks and solutions. *Journal of Environmental challenges 6*.

World bank (2023). World development report 2021/2022: data bank, World Bank.

Yahaya, N. S., Mohd Jali, M. R, & Olajide, R. J. (2019) Investigating the Environmental Kuznets Curve (EKC) hypothesis in Nigeria. *European Academic Research vi*(12)