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Review Article

Environmental Impact of Agricultural and Industrial Production in Nigeria

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Abstract *- This study explored the environmental impact of agriculture and industrial production with a focus on carbon dioxide emissions in Nigeria between 1981 and 2020. The data for this study were obtained from the Central Bank of Nigeria Statistical Bulletin and World Development Indicators. For the data analysis, the autoregressive distributed lag (ARDL) model, unit root and bounds cointegration, as well as descriptive statistics were employed. The unit root test results that the variables are mixed integrated into orders zero and one. There is also evidence long-run relationship among the variables from the bounds cointegration test result. The ARDL results showed that agriculture output has an insignificant positive effect on carbon dioxide emissions in the long and short run. This suggests that agricultural activities do not significantly contribute to carbon dioxide emissions. In addition, industrial production and transportation activities were found to contribute positively to carbon dioxide emissions, with industrial production having a more significant impact in both the long and short run. This implies that the abatement of environmental pollution can begin with minimizing the negative externalities associated with industrial activities, especially the carbon footprints of firms on the environment*.

Keywords - *Agriculture production, carbon-dioxide, Environment, externalities and industrial production.*

I. INTRODUCTION

The need to increase the yearly output of goods and services has been the concern of successive governments in Nigeria. Though output growth has fluctuated in the past two decades (2001 to 2020), efforts have been made to achieve a prosperous economy and maintain steady growth in output level. This is evidenced by increased government spending as reflected in rising fiscal budget, cut in monetary policy rate (MPR) by the Central Bank of Nigeria (CBN) to revive and foster economic growth, and sector targeted policies like the Anchor Borrowers Programme, Agricultural Credit Guarantee Scheme (ACGS), provision of discounted foreign exchange to manufacturers and industrialists, stimulus loans at reduced interest rate during the Covid-19 period to save ailing small and medium scale enterprises (SMEs) in Nigeria, and policy growth plans such as Transformation Agenda of Goodluck Jonathan and Economic Recovery Growth Plan (ERGP) of President Mohammed Buhari [1][2]. While growth in sectors like agriculture and industrial sector improve the welfare condition of Nigerians as seen in an increase in per capita income from the US $567.93 in 2000 to the US $2097.09 in 2020, ensures food security and expansion in Nigeria's output level, activities in these sectors are triggers of environment degradation, as they are major emitters of greenhouse gases (GHGs).

[3], Observed that activities in the agricultural and manufacturing sectors release a large volume of carbon dioxide into the atmosphere, raising the concentration level. With carbon dioxide (CO2) found to contribute largely to climate change for the period 1750 to 2005, its influence on global warming will exacerbate as activities that increase its atmospheric concentration continues to rise (4).

Activities in the agricultural sector have continued to increase. Data shows that agricultural output jumped from N17.05 billion in nominal terms in 1981 to N1,508.41 billion in 2000. This increase continued as nominal agricultural output rose from N2,015.42 billion in 2001 to N27,371.30 billion in 2017; N31,904.14 billion in 2019, and N37,241.61 billion in 2020 [5]. In the industrial sector, the output level rose from N50.33 billion in nominal terms in 1984 to N2,388.83 billion in 2000. In 2010, industrial output stood at N13,826.43 billion, rising to N19,188.58 billion in 2015. In the last five years, industrial output stood at N18,641.17 billion in 2016; N25,639.17 billion in 2017; N33,218.33 billion in 2018; N39,879.69 billion in 2019 and N43,530.78 billion in 2020 [5].

As noted by [6], growth in the industrial sector, particularly in developing economies, drives urbanization which studies show contribute to environmental damage as energy use intensifies, increasing atmospheric GHG emissions. Agricultural activities have been culpable in causing environmental damage as composition in the sector, especially crop and livestock creation, use up massive landmass, a huge volume of water and are dischargers of significant quantities of methane and nitrous oxide, which threatens environmental sustainability [7].

Carbon dioxide (CO2) emission has continued to increase unabated in Nigeria. In 2000, carbon emission stood at 70,070 kt and rose to 90,730 kt in 2010. In 2014, carbon discharge into the atmosphere increased to 116,200 kt, only declining to 108,150 kt in 2015 and rising to 112,920 and 130,670 kt in 2017 and 2018, respectively [8]. Since citizen participation in agriculture production is huge, and the sector accounts for a vast share of the gross domestic product and equipment deployed for industrial production are not energy-efficient, this study seeks to test if increasing carbon dioxide emissions in Nigeria is due to agriculture- and industrial-related activities. To achieve this, the paper was structured into five sections. The introduction is captured in Section 1. The literature review and methodology adopted were outlined in Sections 2 and 3, respectively. Section 4 entails results and discussions, and the last section focuses on conclusions and suggestions.

II. LITERATURE REVIEW

A. Theoretical Review

a) Environmental Kuznets' Curve Theory (EKC)

The hypothesis which was propounded by Kuznets in 1995 expresses environmental pollution as a quadratic function dependent on income [3]. It states that an inverse relationship exists between environmental degradation and per capita income in every country. Specifically, the argument of the theory is that, at an initial development level, environmental degradation or pollution increases and later declines after a certain start of income level is reached [9]. First documented by Grossman and Krueger [10], the fact can be observed through three stages: the scale effect stage, composition effect stage and the techniques stage [9][11].

The scale effect stage reflects the growth stage of developing economies where reliance is on the primary sector, which provides the means for sustenance. As opined by [12], the premium is placed on increasing total output, with little attention paid to the quality of the environment. Where little or no changes are made to the economic structure or technology employed, increasing production would suggest pollution will continue to increase. At the second stage,[12] argued that the re-awakeness of the citizenry to a cleaner environment would ensure the quality of the environment takes precedent over output. This will cause a tradeoff between income level and environmental quality. As societies move to this stage, there will be structural changes causing a transition from an agrarian-based economy to industrial and service-sector led. This stage will witness the use of energy-efficient technologies with a less negative impact on the environment as seen in emerging and transition economies.

In the third stage, which has been attained by developed economies, a threshold level of income per capita is reached, which forces proportionate improvement in the quality of the environment. In this stage, the consciousness and push for cleaner and eco-friendly sources of energy are demanded [13].

B. Empirical Review

[14] examined the determinant of two sources of environmental degradation in fifteen [15] Economic Community of West African (ECOWAS) countries employing data from 1990 to 2015. The sources considered were carbon emissions from liquid sources and per-capita carbon dioxide emissions. The countries were divided into low, intermediate and high carbon emitters in order to determine if emissions differ across the three categories. This was analysed using the panel quantile regression method. Agriculture value added negative effect carbon dioxide emissions from liquid sources but increased total carbon emission.

[16] analyzed if greenhouse gas (GHG) emissions in Indonesia is caused by agriculture, manufacturing and urbanization sectors. Annual data from 1970 to 2015 were used and analysed using econometric tools such as autoregressive distributed lag (ARDL) and Granger causality. The work verified the presence of the environmental Kuznets' curve hypothesis in Indonesia and estimated the turning points to be USD 2067.89 per capita. Predominant bidirectional causality was reported as this was confirmed between carbon emissions per capita (CC) and proportion of agriculture value added to GDP, CC and GDP per capita, CC and percentage of manufacturing value-added to GDP.

[16] study report that livestock production is not a contributor to carbon dioxide emissions in Malaysia. The empirical results showed carbon dioxide emissions increase significantly with economic growth and urbanization. Its emissions from the period of 1978 to 2016 are, however, reduced with increases in crop production, fishery production and renewable energy use per capita. These results follow the utilization of the autoregressive distributed lag (ARDL) as an estimator and dynamic OLS and fully modified OLS methods for robustness.

[3] assessed the macroeconomic factors that affect carbon dioxide (CO2) emission in Nigeria. The research focused on macroeconomic factors such as real gross domestic product (GDP) per capita, energy consumption, trade openness, financial development, the share of manufacturing in GDP, population and oil price. The effect

of these variables on carbon dioxide emission was analyzed from 1980 to 2016 using the linear and non-linear autoregressive distributed lag methods. The validity of the environmental Kuznets curve in Nigeria was refuted as the study found that an increase in GDP per capita had asymmetric and asymmetric positive effects on carbon dioxide emission. Similarly, energy consumption and manufacturing output linearly and non-linearly cause carbon dioxide emissions.

[9] research probed if environmental degradation is induced by agrarian activities. The empirical study conducted in Nigeria using annual data from 1981 to 2014 validated the inverted U environmental Kuznets curve in Nigeria. The result follows estimation conducted using the autoregressive distributed lag (ARDL) method, the Bayer and Hanck cointegration method and Granger causality test. Though the study showed an agricultural-induced environmental degradation as agricultural activities have a detrimental effect on the environment, increased foreign direct investment inflows will help mitigate this environmental pollution induced by activities in the agricultural sector.

[12] empirically tested the environmental Kuznets curve hypothesis in the BRICS countries of Brazil, South Africa, India, China and Russia. The study investigated if carbon emissions or environmental degradation is driven by agricultural activities as control was made for trade openness, energy use and mobile use. The dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) methods utilized produced results suggesting agriculture impacts negatively on the environment of the BRICS countries from 1990 to 2014.

The focus of the paper by [7] was analysing if agricultural production is the reason for carbon emission in four emerging countries of Brazil, South Africa, India and China from 1971 to 2013. To accomplish this objective, the dynamic ordinary least square (DOLS) and fully modified ordinary least squares (FMOLS) method were used. In finding individual contributions to carbon emission, the study disaggregated agricultural production into crop and livestock production. The panel results attributed increased carbon dioxide emissions in the four emerging countries to crop production, livestock production and economic growth. The environment of the emerging economies improves with increased energy consumption and population size.

[17] confirmed that the agriculture-induced environmental Kuznets' curve exists in Pakistan. This finding by [15] followed the application of the fully modified ordinary least squares (FMOLS) method to annual data of Pakistan covering the period from 1971 to 2014. The result showed Gross domestic product (GDP) had an elastic and positive effect on carbon dioxide (CO2) emission, as agricultural value-added and energy use had an inelastic positive effect on carbon dioxide emission. The direction of causality found using the Toda-Yamamoto causality method was bidirectional as a result revealed that air pollution in Pakistan is caused by changes in agriculture, income growth and energy use following bidirectional causality among energy use, GDP, agriculture and carbon dioxide emission.

[18] obtained evidence of the existence of bidirectional causality between millet rice production and carbon emission in Ghana. There was evidence supporting bidirectional causality between sorghum production and carbon dioxide emissions, millet production and carbon emissions, milled rice production and carbon emissions. A unidirectional causality from corn production to carbon emissions was also found. The presence of these directions of causality was evidenced using the Granger method on annual data from 1960 to 2015. The autoregressive distributed lag (ARDL) results showed neither palm kernel production, copra production, millet production, milled rice production, sorghum production, and green coffee production significantly raise carbon dioxide emissions in the long run, but jointly they affect carbon emissions. The results show green coffee and copra production amplified carbon emissions in the short run, while sorghum and millet production reduces its emission in the short term.

The result of the research by [19] on the environmental Kuznets' curve (EKC) using agriculture output was consistent with the EKC hypothesis. The autoregressive distributed lag (ARDL) results showed real GDP contributed significantly to increased carbon emission in Turkey from 1968 to 2010. This followed the proof that carbon dioxide emission and its determinant have a long-run relationship. Carbon dioxide emission in Turkey was not traced to agricultural production as agriculture had a significant negative impact on its emission in the short and long run. The study also revealed energy consumption as contributing positively to carbon emission.

In examining the environmental Kuznets' curve, Rafiq, Salim and Apergis [2016] employed linear and non-linear panel methods to determine the factors that drive carbon dioxide emissions in low-income, medium-income and high-income countries from 1980 to 2010. Amongst other findings, the study revealed that in the linear model, energy intensity, affluence, and nonrenewable energy consumption drive carbon emission. In the non-linear model, the population was found to increase emissions of the pollutant. In reducing the emissions of this pollutant, the result shows agriculture and service sector value added significantly makes this possible.

The study by [20] centred around the effect of industrialization-led economic growth on carbon emissions in Nigeria. The work which examined this relationship from 1980 to 2011 made use of econometric techniques such as cointegration and vector error correction method (VECM) in the dynamic study of influencing factors of industrial value-added, population, energy intensity, GDP per capita and other control variables on carbon dioxide emission. The cointegration result indicates long-run relationship exists between the variables. Further analysis carried out revealed that carbon emissions in Nigeria are not due to industrial activities carried out as the effect of industrial value-added on carbon dioxide emission (CO_2) is inverse and significant. Rather, the work showed that carbon emissions increase as population and per capita income increase.

III. MATERIALS AND METHODS

A. Research Design

In this study, an ex post facto research design was adopted given the data collection, and sources are secondary, which are devoid of manipulation.

B. Model Specification

The model for this study followed closely the work of [9] with modifications following the introduction of industrial and transportation activities based on the theoretical and empirical evidence on their link to carbon dioxide emissions and, by extension, environmental degradation. The functional form of the model is provided as follows:

$$CBE = f(AGR, INDR, TRP) \quad (1)$$

Where: CBE = Carbon dioxide emissions

AGR = agriculture production

INDR = industrial production

TRP = transportation services

The log representation of the model is provided below:

$$Log(CBE) = \beta_0 + \beta_1 Log(AGR) + \beta_2 Log(INDR) + \beta_3 Log(TRP) + U_t \quad (2)$$

Where: β_0 = Intercept

β_1- β_3 = slope parameters

Log = natural log notation

U_t = random error

The autoregressive distributed lag (ARDL) model specification of the model is as follows:

$$Log(CBE_t) = M_0 + \sum_{i=1}^{k} M_1 \Delta Log(CBE)_{t-1} + \sum_{i=1}^{k} M_2 \Delta Log(AGR)_{t-1} + \sum_{i=1}^{k} M_3 \Delta Log(INDR)_{t-1} + \sum_{i=1}^{k} M_4 \Delta Log(TRP)_{t-1} + \alpha_1 Log(CBE)_{t-1} + \alpha_2 Log(AGR)_{t-1} + \alpha_3 Log(INDR)_{t-1} + \alpha_4 Log(TRP)_{t-1} + U_t \quad (3)$$

Where: M_0 = Constant Parameter

M_1- M_2 = Short run coefficients

α_1 - α_4 = Long run multipliers

K = notation for the maximum lag

C. Method of Data Analysis

This study used the ARDL model to estimate the dynamic relationship between carbon dioxide emissions and the exogenous variables. As proposed by [21], ARDL is appropriate in handling time-series data that are fractionally integrated which are not up to order two. It is equally considered very flexible given that it incorporates the long and short-run coefficients in a single equation set-up. Aside from the ARDL, this study employed augmented Dickey and Fuller's (1981) unit root test alongside bounds cointegration test to examine the stationary properties of each of the variables and evidence of long-run relationship among the variables. Additionally, descriptive statistics such as mean, standard deviation and Jarque-Bera statistic were employed for analyzing the distribution of the variables over the study period. Post-estimation tests such as serial correlation, heteroscedasticity and stability tests were employed to evaluate the reliability of the estimated model.

IV. RESULTS AND DISCUSSION

A. Descriptive Statistics

The descriptive statistics are provided in Table 1

Table 1. Descriptive analysis of the variables

	CBE	AGR	INDR	TRP
Mean	86619.30	8216.517	12149.94	430.6883
Median	85630.00	4932.755	11652.20	261.1000
Maximum	130670.0	18348.18	16742.15	1059.270
Minimum	42441.86	2303.510	8255.760	170.2800
Std. Dev.	19017.90	5530.399	2497.893	274.3866
Jarque-Bera	0.500628	4.571858	2.432128	4.778880
Probability	0.778556	0.101680	0.296394	0.091681
Observations	40	40	40	40

Source: Author's computation with E-views 10

A cursory look at Table 1 shows that carbon dioxide emissions averaged 86619.30, which outputs of the agriculture and industrial sectors, as well as transportation, have mean values of 8216.517, 12149.94 and 430.6883 respective during the study period. The standard deviations showed that all the variables are clustered around their respective mean values, with the exception of industrial output. In addition, the probability values of Jarque-Bera statistics for all the variables are greater than 0.05, which implies that they are normally distributed at a 5 per cent level. The evidence of normal distribution among the variables is good for their use in the estimation of the model.

B. Unit Root Test

The unit root test was conducted using the ADF method. The results are presented in Table 2.

Table 2. ADF unit root test results

Variable	ADF statistic at levels	ADF statistic at 1st difference	5 per cent critical value	Order of integration
LOG(CBE)	-4.898	NA	-3.53	I(0)
LOG(AGR)	-1.92	-5.872	-3.53	I(1)
LOG(INDR)	-4.499	NA	-3.53	I(0)
LOG(TRP)	-3.578	NA	-3.53	I(0)

Source: Author's computation with E-views 10

Note: A implies not computed because stationarity was achieved at levels

The ADF unit root test results presented in Table 2 showed that all the variables, with the exception of agriculture output, were stationary at levels. Consequently, the null hypothesis of the unit root was rejected for the three variables, which implies that they are all integrated of order zero. With evidence of a non-stationary process in agriculture output, the variable was subjected to the first difference test, and it was found to be stationary at the first difference. This implies that it is integrated into order one. The results of the unit root test showed that the variables are mixed integrated, which makes it appropriate for the application of the bounds cointegration test.

C. Bounds Cointegration Test

The bounds cointegration test was carried out at 5 per cent using F-statistic, and the results are presented in Table 3.

Table 3. Result of bounds cointegration test

LOG(CBE)		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	6.754	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
1%	4.29	5.61

Source: Author's computation with E-views 10

Note: K denotes the number of explanatory variables

As observed from the result, the computed F-statistic (6.754) is greater than the upper critical value (3.77) at a 5 per cent level. This implies that the variables are cointegrated. In other words, the null hypothesis that no long-run exists is rejected at 5 per cent. This indicates that carbon dioxide emission has a long-run relationship with the underlying explanatory variables. This finding is in accordance with the results of (9) and (15), which provided empirical evidence for estimating the ARDL model.

D. Estimation of the Model

The estimated ARDL model, which reveals the dynamic relationship between the dependent and independent variables, are presented in Table 4.

Table 4. ARDL estimates

Dependent Variable: LOG(CBE)				
Selected Model: ARDL(1, 3, 3, 2)				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(AGR)	0.348897	0.294236	1.185772	0.2473
DLOG(AGR(-1))	0.645333	0.380432	1.696316	0.1028
DLOG(INDR)	1.504823	0.479088	3.141016	0.0044
DLOG(INDR(-1))	1.086096	0.360438	3.013265	0.0060
DLOG(TRP)	0.587601	0.335634	1.750719	0.0928
DLOG(TRP(-1))	0.517913	0.256881	2.016161	0.0551
CointEq(-1)	-0.658268	0.174614	-3.769840	0.0009
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(AGR)	-0.669714	0.545911	-1.226782	0.2318
LOG(INDR)	2.930779	1.020428	2.872108	0.0084
LOG(TRP)	0.112029	0.394411	0.284041	0.7788
C	-10.967187	6.801879	-1.612376	0.1200

Post-estimation tests		
Test	Test statistic	Probability value
Breusch-Godfrey serial correlation LM test	3.239	0.1979
White heteroskedasticity test	14.988	0.2421
Ramsey RESET test	3.9445	0.0591

Source: Author's computation with E-views 10

The results showed that agriculture output has an insignificant positive effect on carbon dioxide emissions in the long and short run. This finding is contrary to earlier findings by (7) and (15). It, however, suggests that agricultural activities do not significantly contribute to carbon dioxide emissions. It was also observed that industrial out has a significant positive impact on carbon dioxide emissions in the long and short run. From the short-run results, a percentage increase in the contemporaneous and first lag of industrial output triggers a 1.505 and 1.09 per cent increase in carbon dioxide emissions, respectively. In addition, the long-run result showed that a 1 per cent increase in industrial output leads to 2.930 per cent in carbon dioxide emissions. This finding indicates that the environmental pollution impact of industrial activities is greater in the long run than in the short run. The significant positive contribution of industrial output to carbon dioxide emissions corroborates with the findings of (22), which showed that industrialization escalated global pollution levels due to the impact of carbonized and energy-intensive economic structure in many developing and developed economies. The results further showed evidence of the significant positive contributions of transportation to carbon dioxide emissions in the long run. This finding explained the growing environmental degradation impact of various transportation activities. The error correction coefficient (-0.658) is negative and significant at a 5 per cent level. This implies that the model can adjust to a long-run equilibrium position at a

speed of 65.8 per cent. The post-estimation tests results showed that there is no serial correlation and heteroscedasticity in the model. It also found that the coefficients are stable over the study period. Thus, the model can be relied upon for prediction and policy prescription.

V. CONCLUSION

The environmental effects of agriculture and industrial activities have continued to generate concerns considering the growing emphasis on sustainable development, which prioritizes social, economic and environmental sustainability. Thus, this study examined the environmental impact of agriculture and industrial production with a focus on carbon dioxide emissions. The findings showed that agriculture activities do not pose a threat to sustainability, considering their insignificant effects on carbon dioxide emissions. However, industrial production and transportation activities were found as the sources of carbon dioxide emissions, with industrial production having a more significant impact in both the long and short run. This implies that the abatement of environmental pollution begins with minimizing the negative externalities associated with industrial activities, especially the carbon footprints of businesses on the environment. Given the findings, this study concludes that growth in industrial and transportation services is associated with the growing level of carbon dioxide emissions with negative external effects on the environment. The recommendations proffered based on the findings are as follows:

1. Government and other stakeholders in the agriculture sector should promote sustainable indigenous agriculture practices in Nigeria, which have little or no carbon footprints on the environment.
2. Policymakers should mitigate the growing carbon footprints of industrialists through appropriate regulation and imposition of taxes. This will help to reduce the negative spill-over effects of industrial production on the environment.

REFERENCES

[1] Kyarem, R. N. and Ogwuche, D. D. Nigeria's Economic Recovery & Growth Plan (ERGP): Tackling the Macroeconomic Downside Risks. International Journal of Advanced Studies in Economics and Private Sector Management. 5(3) (2017) 1-10.

[2] Uche, E. Development Plans and Policies in Nigeria: Observed Impediments and Practical Best Alternatives. International Journal of Research and Scientific Innovation. 6 (7) (2019) 27-36.

[3] Cosmas, N. C., Chitedze, I. and Mourad, K. A. An econometric analysis of the macroeconomic determinants of carbon dioxide emissions in Nigeria. Science of the Total Environment. 675 (2019) 313-324.

[4] [Online]. Available: www. Ucsusa.com Union of concerned scientists.global_warming/science_and_impacts/science/co2-andglobal-warming-faq.html#. WTEX42jyhPY. (2017).

[5] Central Bank of Nigeria. Statistical Bulletin. Abuja. (2020)

[6] Nguyen, H. M. and Nguyen, L. D. The relationship between urbanization and economic growth: An empirical study on ASEAN countries. International Journal of Social Economics. 45(2) (2018) 316-339.

[7] Appiah, K., Du, J. and Poku, J. Causal relationship between agricultural production and carbon dioxide emissions in selected emerging economies. Environmental Science and Pollution Research. 25(25) (2018) 24764-24777.

[8] World Bank. World Development Indicator. Geneva. (2020)

[9] Agboola, M. O. and Bekun, F. V. Does agricultural value-added induce environmental degradation? Empirical evidence from an agrarian country. Environmental Science and Pollution Research. 26(27) (2019) 27660-27676.

[10] Grossman, G. M. and Krueger, A. B. Economic growth and the environment. The Quarterly Journal of Economics. 110(2) (1995) 353-377.

[11] Alvarez-Herranz, A., Balsalobre-Lorente, D., Shahbaz, M. and Cantos, J. M. Energy innovation and renewable energy consumption in the correction of air pollution levels. Energy Policy. 105 (2017) 386-397.

[12] Balsalobre-Lorente, D., Driha, O. M., Bekun, F. V. and Osundina, O. A. Do agricultural activities induce carbon emissions? The BRICS experience. Environmental Science and Pollution Research. 26(24) (2019) 25218-25234.

[13] Shahbaz, M. and Sinha, A. Environmental Kuznets curve for CO2 emissions: a literature survey. Journal of Economic Studies. 46(1) (2019) 106-168.

[14] Nwaka, I. D., Nwogu, M. U., Uma, K. E. and Ike, G. N. Agricultural production and CO2 emissions from two sources in the ECOWAS region: New insights from quantile regression and decomposition analysis. Science of the Total Environment. 748 (2020) 141329.

[15] Prastiyo, S. E. and Hardyastuti, S. How agriculture, manufacture, and urbanization induced carbon emission? The case of Indonesia. Environmental Science and Pollution Research. 27(33) (2020) 42092-42103.

[16] Ridzuan, N. H. A. M., Marwan, N. F., Khalid, N., Ali, M. H. and Tseng, M. L. Effects of agriculture, renewable energy, and economic growth on carbon dioxide emissions: Evidence of the environmental Kuznets curve. Resources, Conservation and Recycling. 160 (2020) 104879.

[17] Gokmenoglu, K. K. and Taspinar N, Testing the agriculture-induced EKC hypothesis: the case of Pakistan. Environmental Science and Pollution Research. 25(23) (2018) 22829-22841.

[18] Owusu, P. A. and Asumadu-Sarkodie, S. Is there a causal effect between agricultural production and carbon dioxide emissions in Ghana?. Environmental Engineering Research, 22(1) (2017) 40-54.

[19] Dogan, N. Agriculture and Environmental Kuznets Curves in the case of Turkey: evidence from the ARDL and bounds test. Agricultural Economics. 62(12) (2016) 566-574.

[20] Lin, B., Omoju, O. E. and Okonkwo, J. U. Impact of industrialisation on CO2 emissions in Nigeria. Renewable and Sustainable Energy Reviews. 52 (2015) 1228-1239.

[21] Pesaran, M. H. and Shin, Y. An autoregressive distributed lag modelling approach to cointegration analysis. Chapter 11 in S. Strom (ed.), Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium. Cambridge University Press, Cambridge. 6 (1999)

[22] Sarkodie, S. A., Owusu, P. A. and Leirvik, T. Global effect of urban sprawl, industrialization, trade and economic development on carbon dioxide emissions. Environmental Research Letters. 15(3) (2020) 034049.

[23] Rafiq, S., Salim, R. and Apergis, N. Agriculture, trade openness and emissions: an empirical analysis and policy options. Australian Journal of Agricultural and Resource Economics. 60(3) (2016) 348-365.

[24] Dickey, D. A. and Fuller, W. A. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica: Journal of the Econometric Society. 49(4) (1981) 1057-1072.