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Abstract- The study investigated the impact of technological innovation, institutional quality on the environment in Nigeria. The study spanned from 1990 to 2022. The key variables in the study were technological innovation as proxy by technological index, institutional quality as proxy by six governance indicators, and carbon emission as proxy for environment. While the control variables include energy consumption and Gross domestic product. The study first conducted a pre-estimation test using Descriptive statistics and Correlation matrix, and Augmented Dickey Fuller test for stationarity while Ordinary least was used as major estimation techniques since it does not violates classical linear regression assumption. The findings from the preliminary estimation shows that all data series are stationarity at levels. The result form the best linear unbiased estimates indicate that environmentally related technological innovation destructively affects $C0_2$ emissions while energy consumption and economic growth positively impact $C0_2$ emissions.

Keywords: *technological innovation, institutional quality, environment, gross domestic product.*

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The Impact of Technological Innovation and Institutional Quality on the Environment in Nigeria

Eretan Gbenga [α], Atoyebi Kehinde [σ] & Sodiq Abdullah [ρ]

Abstract- The study investigated the impact of technological innovation, institutional quality on the environment in Nigeria. The study spanned from 1990 to 2022. The key variables in the study were technological innovation as proxy by technological index, institutional quality as proxy by six governance indicators, and carbon emission as proxy for environment. While the control variables include energy consumption and Gross domestic product. The study first conducted a pre-estimation test using Descriptive statistics and Correlation matrix, and Augmented Dickey Fuller test for stationarity while Ordinary least was used as major estimation techniques since it does not violates classical linear regression assumption. The findings from the preliminary estimation shows that all data series are stationarity at levels. The result form the best linear unbiased estimates indicate that environmentally related technological innovation destructively affects $C0_2$ emissions while energy consumption and economic growth positively impact $C0_2$ emissions. Based on these findings, the government should raise investment in environmental technological innovation so as to improve the quality of institutional environment to achieve sustainable development targets.

Keywords: technological innovation, institutional quality, environment, gross domestic product.

I. Introduction

Past decades have witnessed a dramatic surge in the consumption of fossil fuels and other energy sources most especially in developing economies and this becomes imperative in order to achieve economic prosperity (he-man and Islam, 2023; Obodisa et al, 20224, Zhang et al, 2022). The surge in energy consumption has also increases the pace for greenhouse gas emissions (GHG) as a result of catastrophic variations in weather patterns, including tornadoes, volcanic eruptions and earth quakes. The aftermath of these myriads of problems have significantly affected human welfare, wildlife and ecosystems (Obodbisa et al, 2022b).

In addition to other greenhouse emission; $C0_2$ is considered as a major pollution in operation in both developing and developed nations. Therefore, reducing the pace of $C0_2$emission has been a subject to the discourse among world leaders. The $C0_2$ emission was actually tippled since 19A60 due to the continues consumption of solid, liquid and gaseous furls (Ashamed and Saheng, 2021). The regard, innovating in environmental related technology required the development of institutional as an importance factor that can mitigate the adverse effects of $C0_2$ emission on human health and the environment (Khan, 2022, Zhangatal 2022).

Underneath the environmental related technological innovation is the identification of new products and improvements in existing products, process that can reduce energy consumption. Recently, technological innovation has played a vital role in rescuing global all climate charge, Obobisietal, 2002a). Quantum of studies have been conducted on the fundamental role of technological innovation as a driver of industrial transformation, as well as pudding and increasing the quality and efficiency in them modern era (Wang and Li, 2002). It has also been argued that environmental related technology is a powerful teaching that has a more significant positive group etc. on the environmental (Dong et al; 2022). Technology offers benefits to the environmental by using green energy and reducing the use of fossil fuels. These technologies may hope the country in improving the efficiency of their production Oriento. This will help prevent climate change impact and encourage green economic growth, and significantly lower C02 emissions (Dorgatal, 2022). Aside the developments of environmental related technology innovations, institutional framework would also as sit in environmental protein measures by lowering C02 emissions and enhance environmental Quality's (Obobica et al, 2022b).It has also been debated extensively that institutional quality is a sin equal non in government policy implementation and pollution control. Strong institutional frameworks combat corruption, support establishing the rule of law, reducing military participation in poultices and increase, public financial management (Hassan et al, 20220a). The importance of our institutions in determining environmental quality is significant and inestimable intense institutional rules and a strict rule of laid can force businesses to reduce Co2 emissions. Better intuitional quality is essential to decrease pollution and ensure environmental sustainability (Asongu, and Odhuambo, 2019).

In the light of this background, the study intends to examine the impact to technological innovations and

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institutional quality on Co2 emissions a proxy for climate change.

II. Selected Existing Literature

Historical validation has provided limited empirical evidence on the role of technological innovation and institutional quality on climate change in selected countries in West Africa. Prominent among these studies are (Youetal; 2022) Quetta. 2020, Ben Amara and Chen, 2002) among others. They argued that environmental related technology innovation has developed a significant instrument for organization to accomplish market reputation, sustainable development and compliance with international environmental laws and standards. Studies by Fernandez et al. 2018: Retro Vic and Tobago eta. 2020; Sabir, 2022 used research and development to measure the level of technological innovation, energy efficiency is also considered as essential indicator for measuring technological innovation. These studies conducted that energy efficiency plays a relatively significant role in product C02 emissions.

In a similar study conducted by Alvarez – Herranz et al, 2017, cheng et al 2019l, Has brain and Alam, 2019, Frdogan et al. 2020). They proposed foreign direct investment as a measure of technological innovation. They concluded that technological innovation positively impact sustainability growth and lowers environmental pollution. Studies conducted by Adebayoetal (2023) on the effect of technological innovation on the environmental in BRCC counties using panel data estimation. They drew an inference that technological advancement reduces C02 emissions for selected countries in BRICS.

Radian & Tuspekora (2002) examine the impact of technological innovation, renewable energy, and economic growth on environmental sustainability in Kazakhstan. The results show that technical innovation and renewable energy sources positively impact the attainment of environmental sustainability by riding $C0_2$emissions, while economic growth and fossil fuel consumption increase $C0_2$ emissions. In another study conducted by Usman and Hammar, 2021) in APEC countries using panel data analysis. They demonstrate that technological advancement harm the environment overtime. This result was also confirmed by Acemogu *et al,* (2012), that while technological innovation encourages economic growth, it can also raise carbon emissions. It is then suggested that government must employ cutting edge technology to encourage infant industry, stressing that technological innovation increases the industrial production levels and destroys the environment. In contrast, Denestor *et al.* 2021) investigated the association between innovation, carbon emissions and trade openings in African countries and found an inverted U – shaped relationship between innovation and carbon emission.

However, the linkage between institutional quality and environment has been found to be under explored in the literature (Jiang *et al,* 2022). A more recent study conducted by Egbetokun *et al.* 2020) proposed that a country's environmental legislation also requires competent institutions to encourage the use of renewable energy and achieve sustainable development. Studies by (Wang *et al.* 2023) investigated the impact of institutional quality, environmental governance and technological innovation on consumption of fossil fuels in the selected European union countries. Their result show that environmental governance and institutional quality reduces the consumption fossil fuels. This result was corroborated by the work of (holder and Seethe, 2021) who concluded that poor institutional quality has a negative impact on C02 emissions in emerging countries. A similar conclusion was also emphasizes by (Wawrzniak and Dri, 2020) that better government effectiveness reduces C02 emissions in emerging and developed countries. Obobiasa *et al* (2022b) also documented that green technical innovation and institutional quality reduce C02 emissions and supports sustainable developments. Similar study conducted by (Salman *et al.,* 2019) investigated the relationship among institutional quality, economic growth and C02 emissions, in Indonesia, South Korea and Thailand. They observed that extensive role of institutional quality goes a long way in decreasing emissions, and increasing economic growth, Kahn and Rae also corroborated the findings of (Salman *et al* ., 2019) by revealing that institutional reduce C02 emissions. Having reviewed that literature so far, it is therefore imperative to unravel the extent to which technological innovation and institutional quality can reduce C02 emissions.

III. Theoretical Framework and Methodology

The underlying theoretical model underlining the relationship between environment, technological innovations and institutional takes its root from Environmental Kuznets curve as proposed by Simon-Kuznets. (EKC) conjecture seeks to establish an inverted U-shaped nexus between income per capita and environmental degradation. It emphasizes that at early stages of economic growth and development, environmental degradation increase at an increasing rate. Nonetheless, after some threshold of economic developments, the movements tend to reverse at higher levels of economic progress.

Kuznets curve when used to analyses environments income and pollution it is called (EKC).

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This means that for a society to attain higher level of development, natural resources must be employed because it will have some residual effects on the environment there by achieving prolonged and sustained development with better institutional quality in the process.

As economy develops, pollution grows at a faster rate since priority and attention are devoted to rising and increasing material production output. This leads to insensitivity of the people which makes them more interested in financial gains other than the environment in which they live in. The rapid growth therefore leads to higher use and utilization of natural resources and subsequently higher levels of pollutants which degrades and reduces environmental quality.

a) Data

Since the study intends to unravel the extent to which innovation related technology and institutional quality impact on the environment. It is therefore imperative to identifying some key variables needed for estimation namely dependent and independent variables. The study use carbon emission C02 as proxy for environmental (Umar *et al.,* 2020) while technological innovation and institutional quality are used as independent variables. The study went further to incorporate some control variables such as economic growth, energy consumption and trade openness. The data were sourced from World Bank Development indicator, 2021, institution quality was used as governance indicator.

b) Model Specification

Following the work of (Shabir *et al.,* 2021) and (Wang *et al,.* 2023) the model as specifies as follows.

$$C0_2 - fF\ (TI, IQ, TOP, ECO, GDP).$$

Where TI represents Technological innovations, Technological index was used to represent technology innovation, IQ – represents institutional Quality which according to Wang *et al*. (2023) include six governance indicators namely control of corruption (CC), government effectiveness (GE), Political stability (PS), and regulatory quality (RQ). Rule of law (RL) and voice and Accountability (VA). The data were obtained from world development indicators and in the range of –2.5 to 2.5.

TOP – represents trade openness which could be obtained by the addition of export plus import as a ratio of GDP.EO represents energy consumption – Aggregate energy consumption as a ratio of GDP.GDP – represents Gross domestic product as a proxy for economic growth.

IV. Result Presentation, Analysis and Interpretation

This section entails the presentation of results from the data analysis also well as the interpretation of the obtained results on the effects of technological innovation, institutional quality on environment.

The remaining aspects comprise the descriptive statistics unit root result, correlation and ordinary least square regression result.

Table 4.1: Description Statistics.

Variable	C02	TI	IQ	ECO	GDP
Mean	0.057243	0.030695	0.026638	0.001248	0.045129
Median	0.058150	0.039250	0.026450	0.009000	0.038800
Maximum	0.230500	0.153300	0.031100	0.43220	0.097900
Minimum	l-0.055800	-0.131300	0.024400	-0.435700	0.035,000
Std. Dev.	0.60750	0.053224	0.001419	0.145360	0.017653
Skewness	0.628366	-0.842927	1.160923	l-0.434319	2.116536
Kurtosis	3.430486	4.740159	4.700781	6.70l86971	5.l894809
Jarqu-Bera	3.088214	10.27295	14.49634	25.39069	46.02294
Probability	0.213502	0.00587842	0.000711	0.000003	0.000000
Observation	42	42	42	42	42

Source: Author's Computation (2023) Using E-views (10)

The statistical measure of central tendency, dispersion, skewness, kurtosis and normality test describe the characteristics of the above data. The jarque–Bera (JB) statistics rejected the null hypothesis of normal distribution for all the variables namely Carbon dioxide emission, technological innovation institutional qualities, energy consumption and Gross domestic product are statistically significant at 5% as their JB probability is lesser than 5%, this indicate that cross. sectional variables are normal. According to the probability of the used variable (CO_2, TI, IQ, ECO, GDP) except for $C0_2$ with the probability value of0.1213502 which is greater than 5% level.

Table 4.1 reveal that the average growth rate within the period was 0.030695 with the maximum of 0.153300 reported in 2012, while the minimum is 0.039250 observed in 2017. Similarly the P-value of all estimates and result which represented the probability of observing a simple value as extreme as the value actually observed given that the null hypothesis is true served as a guide for accepting or rejecting null hypothesis at various stage in the analysis, by comparing it to significance level.

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Table 4.2: Correlation Matrix of the Variables.

Variable	$C0_2$	TZ	I	ECO	GDP
$C0_2$	1.0000	0.3700	0.0415	+0.2046	-0.1313
TI	0.3700	1.0000	0.257	-0.0606	-0.4l848
IQ	0.0415	0.2537	1.0000	l-0.0571	-0.5188
ECO	-0.2046	- 0.06066	-0.0606	-0.0571	1.0000
GDP	-0.1318	-90.4848	-0.5188	0.0360	1.000

Source: Author's Computation, 2023 Using E-view 10.

Table 4.2 Shows the correlation matrix of variables for detection of possible strong correlation between technology innovation, institutional quality on the environment. From the result, it shows there's a strong and positive relationship between technological innovation and institutional quality on the environment.

It can be inferred that positive association exist between technological innovation and institution quality with technological innovation value of 0.3700 and 0.045 for institutional quality which means that $C0_2$ emission is positively associated with technological innovation and institutional quality in Nigeria. Also, the result shows that there is a positive relationship between $C0_2$ emission and energy consumption and negative relationship with Gross domestic product. This result validates the energy led $C0_2$assumption. This shows that a 1% rise in energy usage will probably enhance carbon emissions by 0.2046 and a decrease of 0.4313 percent in the Gross domestic product in the long run. This outcome is consistent with the previous studies of (Lawson, 2002, Islam *et al,* 2021 and Musha *et al,* 2021).

a) Stationarity Test

The study examined the unit root test on the selected variables using the Augmented Dickey Fuller (ADF) and the result of the unit root is presented below:

Table 4.3

Variable	Test Order	Critical Value	P Value	Order of Integrate
$C0_2$	Level	-4.145238	0.0033	I(O)
TI	Level	-6-529573	0.0000	I(O)
IQ	Level	-2.630404	0.0122	I(O)
ECO	Level	l-5.128463	0.0001	I(O)
GDP	Level	l-3.750442	0.0320	I(O)

Table 4.3 displays the stationary of the variables used in the study. It can be inferred from the table that all the variables are integrated at levels. This means that there is no long run relationship among the variables, a short run relationship may exist and there is no need for co-integration estimation.

Table 4.4: Ordinary Least Square Result

Dependent Variable: $C0_2$.

Methods: least square.

Variables	Coefficient	Std Error	t-statute	Pro
TI	0.0311679	0.151565	2.056406	0.0468
IQ	-0.073356	0.054395	l-1.348270	0.1857
ECO	-0.1070l57	5.641250	L0.108977	0.9850
GDP	-0.083095	0.ll876187	-0l.0948370	-9,250
C	0.019752	0.198422	0.09905470	.9212

R-Squared	0.178194	Mean dependent view	0.031190
Adjusted R-Square	0.089350	S.D deponent View	0.053475
S.C. Regression	0.051030	Akaike Info Criterion	-3.001477
Slum Square resultt	0.096349	Schwarz criterion	-2.794611
Log (Likelihood	68.0101	Hannah – Qulin Crater	-2.92565
F – Statistic	2.005700	Durbin – Watson stat	1.219277
Prob (F-statiscs)	0.113856		

Source: authors Computation (2023) using E-view 10

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Table 4.4 Show the ordinary least square result coefficients, standard error, t-statistics and probability value for all the selected variables. The result of the coefficient show the influence of specified independent variable of technological innovation, institutional quality and gross domestic product on environment in Nigeria. The study observed that a unit change in variable such as technological innovation charge in variable such as technological innovation (0.04468, P < 0.05), Renewable energy consumption (0.9850, P >0.05), and institutional quality (1Q), (0.1857, P > 0.5) and Gross domestic product (0.9212, P > 0.05) will result into an increase in the growth rate in carbon emission in the long run. This implies that all the indicators of Technological innovation and gross domestic product contributed positively toward the carbon dioxide emission but does not statically significant at 5% level of significance.

Similarly, the coefficient of determination (R- Square) value of 0.3608.38 Indicate that 36.08% of the variation in technological innovation and Gross domestic product attributed to changes in variables such as carbon emission while standard error of the regression value of 0.46029supports the overall fitness.

V. Conclusion

This study investigated the effect of technological innovation, institutional quality, gross domestic product on carbon emission in Nigeria with the application of ordinary least square (OLS) and various diagnostic test techniques. The results of unit root test suggest that all the variables in the model are stationary at level and that of correlation indicate that there exist positive relationship between technological innovation, institutional quality on the environment which implies the existence of short – run relationship between carbon emission, technological innovation and gross domestic product.

The result also revealed that technological innovation and gross domestic product are positively related with carbon emission, which means technological innovation and gross domestic product does not hinder carbon emission based on the P – value as expressed in the analysis above.

References Références Referencias

1. Abbasi, F., and Riaz, K. (2016). CO2 emissions and financial development in an emerging economy: An augmented VAR approach. *Energy Policy* 90, 102–114. doi: 10. 1016/j.enpol.2015.12.017
2. Acemoglu, D., Aghion, P., Bursztyn, L., and Hemous, D. (2012). The environment and directed technical change. *Am. Econ. Rev.* 102 (1), 131–166. doi: 10.1257/aer.102. 1.131
3. Acheampong, A. O., Opoku, E. E. O., and Dzator, J. (2022). Does democracy really improve environmental quality? Empirical contribution to the environmental politics debate. *Energy Econ.* 109, 105942. doi: 10.1016/j.eneco.2022.105942
4. Adebayo, T. S., Ullah, S., Kartal, M. T., Ali, K., Pata, U. K., and Ağa, M. (2023). Endorsing sustainable development in BRICS: The role of technological innovation, renewable energy consumption, and natural resources in limiting carbon emission. *Sci. Total Environ.* 859, 160181. doi: 10.1016/j.scitotenv. 2022.160181
5. Ahmad, M., Ahmed, Z., Yang, X., Hussain, N., and Sinha, A. (2022). Financial development and environmental degradation: Do human capital and institutional quality make a difference? *Gondwana Res.* 105, 299–310. doi: 10.1016/J.GR.2021.09.012
6. Ahmad, M., and Zheng, J. (2021). Do innovation in environmental-related technologies cyclically and asymmetrically affect environmental sustainability in BRICS nations? *Technol. Soc.* 67, 101746. doi: 10. 1016/J.TECHSOC.2021.101746
7. Ahmad, N., Youjin, L., Žiković, S., and Belyaeva, Z. (2023). The effects of technological innovation on sustainable development and environmental degradation: Evidence from China. *Technol. Soc.* 72, 102184. doi: 10.1016/J. TECHSOC.2022.102184
8. Ahmad, S., Khan, D., and Magda, R. (2022). Assessing the influence of financial inclusion on environmental degradation in the ASEAN region through the panel PMGARDL approach. *Sustainability* 2022, 7058. doi: 10.3390/SU14127058
9. Álvarez-Herránz, A., Balsalobre, D., Cantos, J. M., and Shahbaz, M. (2017). Energy innovations-GHG emissions nexus: Fresh empirical evidence from OECD countries. *Energy Policy* 101, 90–100. doi: 10. 1016/J.ENPOL.2016.11.030
10. Amin, N., Shabbir, M. S., Song, H., Farrukh, M. U., Iqbal, S., and Abbass, K. (2023). A step towards environmental mitigation: Do green technological innovation and institutional quality make a difference? Technol. *Forecast. Soc. Change* 190, 122413. doi: 10.1016/J.TECHFORE.2023.122413
11. Asongu, S. A., and Odhiambo, N. M. (2019). Inclusive development in environmental sustainability in sub-Saharan Africa: Insights from governance mechanisms. *Sustain. Dev.* 27 (4), 713–724. doi: 10.1002/SD.1936
12. Azam, M., Liu, L., and Ahmad, N. (2021). Impact of institutional quality on environment and energy consumption: Evidence from developing world. *Environ. Dev. Sustain.* 23 (2), 1646–1667. doi: 10.10 07/s10668-020-00644-x
13. Ben Amara, D., and Chen, H. (2020). A mediation-moderation model of environmental and eco-innovation orientation for sustainable business growth. *Environ. Sci. Pollut. Res.* 27 (14), 16916–16928. doi: 10.1007/s11356- 020-08206-4

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14. Chaudhry, I. S., Ali, S., Bhatti, S. H., Anser, M. K., Khan, A. I., and Nazar, R. (2021). Dynamic common correlated effects of technological innovations and institutional performance on environmental quality: Evidence from East-Asia and Pacific countries. *Environ. Sci. Policy* 124, 313–323. doi: 10.1016/J.ENVSCI.2021.07.007
15. Cheng, C., Ren, X., Wang, Z., and Yan, C. (2019). Heterogeneous impacts of renewable energy and environmental patents on CO 2 emission - evidence from the BRIICS. *Sci.TotalEnviron*. 668, 1328–1338. doi: 10.1016/j.scitotenv.2019.02.063.
16. Dumitrescu, E. I., and Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Econ. Model.* 29 (4), 1450–1460. doi: 10.1016/J.ECONMOD. 2012.02.014
17. Egbetokun, S., Osabuohien, E., Akinbobola, T., Onanuga, O. T., Gershon, O., and Okafor, V. (2020). Environmental pollution, economic growth and institutional quality: Exploring the nexus in Nigeria. *Manag. Environ. Qual. Int. J.* 31 (1), 18–31. doi: 10.1108/ meq-02-2019-0050
18. Erdoğan, S., Yıldırım, S., Yıldırım, D. Ç., and Gedikli, A. (2020). The effects of innovation on sectoral carbon emissions: Evidence from G20 countries. *J. Environ. Manag.* 267, 110637. doi: 10.1016/j.jenvman.2020.110637
19. Fernández Fernández, Y., Fernández López, M. A., and Olmedillas Blanco, B. (2018). Innovation for sustainability: The impact of R&D spending on CO2 emissions. *J. Clean. Prod.* 172, 3459–3467. doi: 10.1016/j.jclepro.2017.11.001
20. Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrical* 37 (3), 424–438. doi: 10.2307/1912791
21. Haldar, A., and Sethi, N. (2021). Effect of institutional quality and renewable energy consumption on CO2 emissions an empirical investigation for developing countries. *Environ. Sci. Pollut. Res.* 28 (12), 15485–15503. doi: 10.1007/s11356-020-11532-2
22. Hasan, M. M., and Du, F. (2023). Nexus between green financial development, green technological innovation and environmental regulation in China. *Renew. Energy* 204, 218–228. doi: 10.1016/J.RENENE.2022.12.095
23. Hashmi, R., and Alam, K. (2019). Dynamic relationship among environmental regulation, innovation, CO2 emissions, population, and economic growth in oecd countries: A panel investigation. *J. Clean. Prod.* 231, 1100–1109. doi: 10.1016/J.JCLEPRO.2019.05.325
24. Hassan, S. T., Khan, S. U. D., Xia, E., and Fatima, H. (2020a). Role of institutions in correcting environmental pollution: An empirical investigation. *Sustain. Cities Soc.* 53,101901. doi: 10.1016/j.scs.2019.101901
25. Hassan, S. T., Khan, S. U. D., Xia, E., and Fatima, H. (2020b). Role of institutions in correcting environmental pollution: An empirical investigation. *Sustain. Cities Soc.* 53, 101901. doi: 10.1016/J.SCS.2019.101901
26. Ibrahiem, D. M. (2020). Do technological innovations and financial development improve environmental quality in Egypt? *Environ. Sci. Pollut. Res.* 27 (10), 10869–10881. doi: 10.1007/s11356-019-07585-7
27. Islam, M. M., Khan, M. K., Tareque, M., Jehan, N., and Dagar, V. (2021). Impact of globalization, foreign direct investment, and energy consumption on CO2 emissions in Bangladesh: Does institutional quality matter? *Environ. Sci. Pollut.Res.* 28, 48851–48871. doi:10.1007/s11356-021-13441-4
28. Jiang, Q., Rahman, Z. U., Zhang, X., Guo, Z., and Xie, Q. (2022). An assessment of the impact of natural resources, energy, institutional quality, and financial development on CO2 emissions: Evidence from the B&R nations. *Resource. Policy* 76, 102716. doi: 10.1016/j.resourpol.2022.102716 Frontiers in Environmental Science 11 frontiersin.org
29. Khan, A. A., Khan, S. U., Ali, M. A. S., Safi, A., Gao, Y., Ali, M., et al. (2022). Role of institutional quality and renewable energy consumption in achieving carbon neutrality: Case study of G-7 economies. *Sci. Total Ennviro.* 814, 152797. doi: 10.1016/J.SCITOTENV.2021.152797
30. Lawson, L. A. (2020). GHG emissions and fossil energy use as consequences of efforts of improving human well-being in Africa. *J. Environ. Manag.* 273, 111136. doi:10.1016/ J.JENVMAN.2020.111136
31. Liu, H., Anwar, A., Razzaq, A., and Yang, L. (2022). The key role of renewable energy consumption, technological innovation and institutional quality in formulating the SDG policies for emerging economies: Evidence from quantile regression. *Energy Rep.* 8, 11810–11824. doi: 10.1016/J. EGYR.2022.08.231
32. Musah, M., Owusu-Akomeah, M., Boateng, F., Iddris, F., Mensah, I. A., Antwi, S. K., et al. (2021). Long-run equilibrium relationship between energy consumption and CO2 emissions: A dynamic heterogeneous analysis on north africa. *Environ. Sci. Pollut.Res.,* 29(7), 10416–10433. doi: 10.1007/S11356-021-16360-6
33. Obobisa, E. S., Chen, H., and Mensah, I. A. (2022b). The impact of green technological innovation and institutional quality on CO2 emissions in African countries. *Technol. Forecast. Soc. Change* 180, 121670. doi: 10.1016/j.techfore.2022. 121670
34. Obobisa, E. S., Chen, H., and Mensah, I. A. (2022c). The impact of green technological innovation and

© 2023 Global Journals

institutional quality on CO2 emissions in African countries. *Technol. Forecast. Soc. Change* 180, 121670. doi: 10.1016/J.TECHFORE.2022.121670
35. Obobisa, E. S., Chen, H., and Mensah, I. A. (2022a). Transitions to sustainable development: The role of green innovation and institutional quality. *Environ. Dev. Sustain.,* 1–30. doi: 10.1007/S10668-022-02328-0/FIGURES/7
36. Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *J. Appl. Econ.* 22 (2), 265–312. doi:10.1002/JAE.951
37. Petrović, P., and Lobanov, M. M. (2020). The impact of R&D expenditures on CO2 emissions: Evidence from sixteen OECD countries. *J. Clean. Prod.* 248, 119187. doi: 10.1016/j.jclepro.2019.119187
38. Raihan, A., and Tuspekova, A. (2022). Role of economic growth, renewable energy, and technological innovation to achieve environmental sustainability in Kazakhstan. *Curr.Res. Environ. Sustain.* 4, 100165. doi: 10.1016/j.crsust.2022.100165
39. Rehman, F., and Islam, M. M. (2023). Does energy infrastructure spur total factor productivity (TFP) in middle-income economies? An application of a novel energy infrastructure index. *Appl. Energy* 336, 120836. doi: 10.1016/J.APENERGY.2023.120836
40. Shabir, M., Ali, M., Hashmi, S. H., and Bakhsh, S. (2022). Heterogeneous effects of economic policy uncertainty and foreign direct investment on environmental quality: Cross-country evidence. E*nviron. Sci. Pollut.Res.* 29 (2), 2737–2752. doi: 10.1007/s11356-021-15715-3
41. Umar, M., Ji, X., Kirikkaleli, D., and Xu, Q. (2020). COP21 Roadmap: Do innovation, financial development, and transportation infrastructure matter for environmental sustainability in China? *J. Environ. Manag.* 271, 111026. doi: 10.1016/J.JENVMAN.2020.111026
42. Usman, M., and Hammar, N. (2021). Dynamic relationship between technological innovations, financial development, renewable energy, and ecological footprint: Fresh insights based on the STIRPAT model for Asia pacific economic cooperation countries. *Environ. Sci. Pollut. Res.* 28 (12), 15519–15536. doi: 10.1007/s11356-020-11640-z
43. Wang, C., and Li, J. (2020). The evaluation and promotion path of green innovation performance in Chinese pollution-intensive industry. *Sustain.* Switz. 12 (10), 4198. doi: 10.3390/su12104198
44. Wang, E. Z., and Yang, M. (2022). Green complexity and CO2 emission: Does institutional quality matter? *Energy Econ.* 110, 106022. doi: 10.1016/J.ENECO.2022. 106022 Frontiers in Environmental Science 12 frontiersin.orgShabir et al. 10.3389/fenvs.2023.1174827
45. Wang, J., and Dong, K. (2019). What drives environmental degradation? Evidence from 14 sub-Saharan African countries. Sci. *Total Environ.* 656, 165–173. doi: 10.1016/J. SCITOTENV.2018.11.354
46. Wang, S., Li, J., and Razzaq, A. (2023). Do environmental governance, technology innovation and institutions lead to lower resource footprints: An imperative trajectory for sustainability. *Resource Policy* 80, 103142. doi: 10.1016/J.RESOURPOL.2022.103142
47. Wang, S., Zeng, J., and Liu, X. (2019). Examining the multiple impacts of technological progress on CO2 emissions in China: A panel quantile regression approach. Renew. Sustain. *Energy* Rev. 103, 140–150. doi: 10.1016/J.RSER.2018.12.046
48. Wang, X., Wang, Y., and Wei, C. (2023). The impact of natural resource abundance on green economic growth in the belt and road countries: The role of institutional quality. Environ. *Impact Assess.* Rev. 98, 106977. doi: 10.1016/J.EIAR.2022.106977
49. Zhang, D., Ozturk, I., and Ullah, S. (2022). Institutional factors-environmental quality nexus in BRICS: A strategic pillar of governmental performance. , 35(1), 5777–5789. doi: 10.1080/1331677X.2022.2037446
50. Zhang, N., Wang, B., and Liu, Z. (2016). Carbon emissions dynamics, efficiency gains, and technological innovation in China's industrial sectors. *Energy.* 99, 10–19. doi: 10.1016/j.energy.2016.01.012

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