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Can Urbanization Influence Carbon Dioxide Emissions? Evidence from BRICS–T Countries

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ABSTRACT

Climate change is one of several issues confronting the planet today. Addressing this problem will create a safer environment for humans and other species. Thus, this study explores how the urban population (UBNP) influences carbon dioxide emissions (CO2e) levels in BRICS–T from 1990–2021 (192 observations) using Pooled OLS and Fixed Effects techniques. In addition, energy intensity (ENIT) and economic growth (GDP) are utilized as control variables. The Pooled OLS result demonstrates that UBNP growth reduces CO2e by 0.19%; a rise in ENIT levels spurs CO2e by 1.10%, and an increase in GDP enhances CO2e by 0.61%. The Fixed Effects outcome shows that an upsurge in UBNP reduces CO2e by 1.19%, while ENIT and GDP rise boosts CO2e by 1.19% and 1.04%, respectively. This study recommends continuous urban planning, rural area development, renewable energy integration, and the use ofenergy–efficient buildings.

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Highlights	Contribution to the field statement
- BRICS–T economies were employed in this research. - The Pooled OLS and Fixed Effects methods were utilized in this study. - Urban population growth reduces carbon dioxide emissions. - A rise in energy intensity levels drives carbon dioxide emissions. - GDP growth spurs carbon dioxide emissions.	This study investigates the impact of urbanization on carbon dioxide emissions in BRICS–T countries. Other studies have focused on BRICS economies alone. This study fills the gap by including Turkey because of its significant position in the Middle–Eastern region, Asia, and Europe. In addition, contrary to other studies, this research found that urban population growth reduces carbon dioxide emissions. In conclusion, this research contributes to the social/economic dimensions of contemporary urbanization by recommending policies that promote sustainable urbanization, such as investing in public transportation and green spaces.

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1. Introduction

Climate change is an essential issue discussed globally. This is because of climate irregularities such as rising temperatures, a decrease in snow cover, rising sea levels, increasing storms, droughts, loss of species, and increased poverty and displacement (United Nations, 2023). In addition, climate change can also affect people's living standards. Greenhouse gases (GHGs) drive climate change, and carbon dioxide emissions (CO_2e) is the most significant contributor. CO_2e is caused mainly by human activities using fossils. Diverse economic variables can spur CO_2e or reduce it. This includes technological progress, governance, foreign direct investment, trade, economic policy uncertainties, and institutional quality. This study focuses on urban population (UBNP), energy intensity (ENIT), and economic growth (GDP) because these channels are essential to achieving a low–carbon economy. The Environmental Transition Theory (ETT) explains the UBNP and CO_2e nexus. The ETT postulates that UBNP initially harms the environment but later contributes to environmental soundness. Also, the association between UBNP and CO_2e has been widely debated, but the outcome remains inconclusive (Dutta & Hazarika, 2023; Liu et al., 2023a; Raihan et al., 2023; Salahuddin et al., 2019; Shen et al., 2017; Suhrab et al., 2023). In addition, reducing ENIT levels is a significant pathway to achieving net–zero by 2050. ENIT refers to the energy needed to produce a given output level. ENIT measures energy efficiency. Higher ENIT levels mean energy inefficiency, while lower ENIT levels depict energy efficiency. In recent times, ENIT improvement levels have declined due to weak ENIT policies and increased energy demand in energy–intensive economies (IEA, 2022). Significant research findings have demonstrated that ENIT contributes to environmental worsening due to the utilization of fossils (Danish et al., 2020; Islam & Rahaman, 2023; Liu et al., 2023b; Shokoohi et al., 2022; Somoye et al., 2023).

The link between GDP and CO_2e has been highly debated. Grossman & Krueger (1991) asserted that an economy grows in three phases: *scale* (first stage), *composite* (second stage), and *technique* (third stage). The *first stage* relates to emerging economies using fossils to power economic activities. At this stage, environmental degradation occurs. On the other hand, the *second* and *third stages* are peculiar to developed economies. As the economy grows, technological innovation and clean energy sources improve environmental quality. In addition, the connection between GDP and CO_2e has remained inconclusive (Cetin et al., 2018; Chandra Voumik & Sultana, 2022; Raihan, 2023; Sikder et al., 2022; Sreenu, 2022).

Why BRICS–T? According to Ullah et al. (2023), BRICS–T collectively contributes to increased CO_2e globally. From 1990–2021, the CO_2e per capita ranking of the BRICS–T economies from the highest to the lowest are as follows: Russia, South Africa, China, Turkey, Brazil, and India. It is also observed that CO_2e in each country is becoming flat. This shows that BRICS–T economies are creating environmental policies that reduce CO_2e. Ullah et al. (2023) further stated that BRICS–T are working towards improving the quality of their environment by reducing CO_2e and expanding clean energy sources in their energy portfolio. In addition, the year 2020 showed a general decline in CO_2e due to theCOVID–19 pandemic (Energy Institute, 2023).

Urbanization can be defined as the movement of people from areas that are not developed to areas that are developed within a country. People transit to urban areas because of job opportunities, education and healthcare access, location of industries, infrastructural benefits, and improved quality of life. Although urbanization is frequently viewed as a sign of progress, it also has a variety of drawbacks, including overpopulation, neglect of rural areas, socioeconomic disparity, and ecological challenges. It is observed that the urban population in the BRICS–T economies showed an increasing trend (World Bank, 2023).

This study investigates the impact of UBNP on CO_2e in the BRICS–T countries from 1990 to 2021 using ENIT and GDP as control factors. This research enhances the existing scholarly work by adding Turkey to the BRICS economies. *First*, most studies have focused on BRICS economies alone. Turkey is included because of its significant position in the Middle–Eastern region, Asia and Europe. Turkey is one of the top 20 emitters of global CO_2e. Turkey has a US$1.1 trillion economy and a GDP per capita of US$13,990. In addition, the population of Turkey is 85.3 million, which has tripled since

1960 (World Bank, 2023). A growing population means more energy is needed for economic activities. Most of Turkey's energy consumption comes from oil and gas (Adebayo, 2023). Turkey has pledged to reach net–zero by 2053 (The World Bank, 2022). The economic characteristics of Turkey make it suitable for further investigation. *Second*, this research uses ENIT data to proxy for energy use. Other studies have employed energy use data. *Third*, this research employed Pooled Ordinary Least Square (Pooled OLS) and Fixed Effects methods. The Pooled OLS is simple to implement, while the Fixed Effects controls for unobserved heterogeneity. *Fourth*, unlike other studies, this research found an adverse link between UBNP and CO_2e. *Fifth,* this research contributes to the social/economic dimensions of contemporary urbanization by recommending policies that promote sustainable urbanization, such as investing in public transportation and green spaces. This can help to improve overall public health and make cities more habitable. In addition, revenue generated from carbon pricing can be used for social programs, such as affordable housing and job training. This could eliminate poverty and inequality while fostering a more inclusive economy. The study structure is presented in Figure 1.

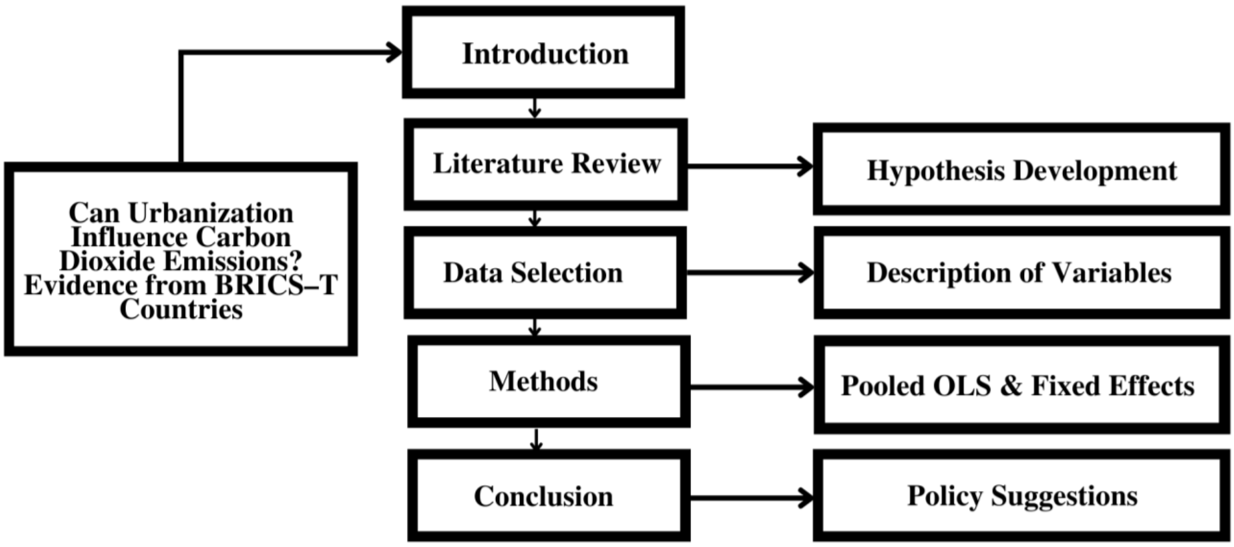

Figure 1. Study Structure.

2. Literature Evaluation & Hypothesis Development

2.1 UBNP & CO_2e *link*

In 16 emerging economies, Sadorsky (2014) established that the effect of UBNP on CO_2e is negative but statistically insignificant. The study also found that ENIT and GDP drive CO_2e. In Malaysia, Bekhet & Othman (2017) found that UBNP drives CO_2e at the early stages of urbanization. However, this association becomes negative in higher stages. Shen et al. (2017) confirmed mixed results for BRICS. Salahuddin et al. (2019) revealed that UBNP spurs CO_2e in South Africa. In Pakistan, Ali et al. (2019) opined that UBNP drives CO_2e and that it is crucial for the energy stakeholders to promote adopting renewable energy (RNW) technologies. In BRICS, Chen et al. (2022) and Chandra Voumik & Sultana (2022) ascertained that UBNP and GDP boost CO_2e. In 54 African Union countries, Hussain et al. (2022) confirmed that UBNP increases CO_2e. Thus, UBNP should be planned. Sikder et al. (2022) established the same outcome for 23 developing economies. Amin & Song (2023) discovered that GDP drives CO_2e in South and East Asia, while UBNP increases CO_2e in East Asia. Balsalobre-Lorente et al. (2022) revealed that UBNP decreases CO_2e in BRICS. In China, Cheng & Hu (2023) and Lee et al. (2023) found that UBNP increases CO_2e. Based on these assertions, this study suggests that:

Hypothesis 1: UBNP can either have a favourable or unfavourable environmental impact.

2.2 ENIT & CO_2e *link*
The majority of the existing literature has affirmed that ENIT increases CO2e. This is attributed to using fossils and the essentiality of meeting daily energy needs. Abban et al. (2020) revealed that ENIT drives CO2e in BRI economies. Namahoro et al. (2021) opined that in 50 African economies, ENIT serves as a factor that boosts CO2e across regions and income levels. Yang et al. (2022) found a similar outcome for China. Khan et al. (2022) stated that ENIT spurs CO2e in Canada. Koilakou et al. (2023) found a negative ENIT–CO2e nexus in the USA and Germany. Khan & Liu (2023) also discovered an adverse association in Australia. In 26 EU countries, Hodzic et al. (2023) asserted that ENIT is the primary driver of environmental deterioration. This occurs because there is an extensive reliance on fossils during the early phases of development, resulting in a rapid increase in pollution emissions (Harbaugh et al., 2002). Zhang et al. (2023) for Morocco and Chen et al. (2023) for top–ten efficient economies also discovered the enhancing effect of CO2e. Thus, this research hypothesizes the following:

Hypothesis 2: ENIT has an enhancing effect on CO_2e.

2.3 GDP and CO_2e *link*
The connection between GDP and CO_2e has remained inconclusive. A positive GDP–CO_2e nexus is established in the findings of (Adebayo et al., 2021; Ayhan et al., 2023; Karaaslan & Çamkaya, 2022; Naseem et al., 2023; Xue et al., 2023). Conversely, these investigations have identified an inverse association between GDP and CO_2e levels (Khan, 2019; Namahoro et al., 2021; Narayan et al., 2016). Consequently, this study puts forth the hypothesis that:

Hypothesis 3: GDP will spur CO_2e.

The following gaps were identified in these discussions: First, the connection between UBNP and CO_2e has not reached a definitive conclusion, necessitating further examination. Additionally, the correlation between GDP and CO_2e remains uncertain. Likewise, the research on ENIT across the global economy is scanty. Second, this study extends the BRICS economies to include Turkey, which other countries have omitted. Conducting more research on these gaps can lead to improved knowledge about the interconnections of the variables. This understanding can support policy development on how to cut CO_2e and combat climate variation.

3. Data and Method
3.1 Data
The data employed is from 1990–2021. CO_2e measured in metric tons per capita is the dependent variable, while UBNP (total urban population), ENIT (Exajoule/GDP), and GDP (Per capita constant US$2015) are the independent variables. CO_2e and ENIT were extracted from (Energy Institute, 2023), while UBNP and GDP were extracted from (World Bank, 2023). Therefore, an extended model proposed by Ali et al. (2019) is adopted and specified as follows:

$$\mathrm{CO2e_{it}} = \mathrm{f}(\mathrm{UBNP_{it}}, \mathrm{ENIT_{it}}, \mathrm{GDP_{it}}) \ldots\ldots (1)$$

Logs of the variables were carried out to control for outliers and instability in the model (Somoye et al., 2022). Thus, the model is expressed in Equation 2.

$$\mathrm{LCO2e_{it}} = \emptyset_1 + \emptyset_2 \mathrm{LUBNP_{it}} + \emptyset_3 \mathrm{LENIT_{it}} + \emptyset_4 \mathrm{LGDP_{it}} + \mu_{\mathrm{it}} \ldots\ldots (2)$$

$\emptyset_1$: Intercept; $\emptyset_2 - \emptyset_4$: Explanatory Variables Coefficients; μ: Error Term; i: Countries; t: Time.

3.2 Methods

3.2.1 Pooled OLS & Fixed Effects

The Pooled OLS method is a regression technique used to analyze panel data. Panel data is a blend of cross–sectional and time series dimensions. It is a common technique used to examine the overall relationship between variables while ignoring specific unit or time effects. The Fixed Effects approach, on the other hand, controls for unobserved heterogeneity, improves model fit, addresses time–invariant variables, solves the problem of endogeneity and is well–suited for causal inference.

4. Analysis and Discussions

4.1 Cross–Section Dependence Test

Before conducting the unit root test (second–generation), it is paramount to determine if cross–dependency exists within the model. Table 1 indicates the existence of cross–sectional dependency as evidenced by P–values below the 5% threshold.

Table 1. Cross–Section Dependence Test.

Test	Statistic	Prob.
Breusch–Pagan LM	318.7918	0.0000
Pesaran scaled LM	55.46454	0.0000
Pesaran CD	17.52678	0.0000

4.2 Unit–Root Test

In Table 2, the CIPS test proposed by Pesaran (2007) shows that LCO_2e, LENIT, and LGDP are stationary at level. For the CIDF test, LCO_2e, LUBNP, LENIT, and LGDP are stationary at level. CIPS and CIDF are second–generation unit root tests.

Table 2. Unit–Root Test.

	CIPS		**CIDF**	
	I(O)	(1)	I(O)	I(1)
LCO2e	–2.26415***	–3.59072*	–3.82592**	–5.82854*
LUBNP	–2.29340	–1.83948	–3.88947**	–3.37263**
LENIT	–3.31315*	–3.95465*	–4.84794*	–6.26308*
LGDP	–2. 47856**	–2.76702*	–5.32994*	–5.41996*

Note: * denotes P <0.01, ** denotes P <0.05, *** denotes P< 0.10

4.3 Descriptive Statistics

Table 3 confirms that LUBNP has the highest mean (18.65) and median (18.61). Conversely, LCO_2e has the lowest mean (1.31) and median (1.34). LCO_2e, LUBNP, and LENIT are platykurtic because they are less than 3, while LGDP is leptokurtic because it is more than 3. In addition, all variables are not normally distributed. There are 192 observations, which is sufficient for a panel data analysis.

Table 3. Descriptive Statistics.

	LCO_2e	**LUBNP**	**LENIT**	**LGDP**
Mean	1.315445	18.65758	1.774770	8.405932
Median	1.342851	18.51779	1.748398	8.712844
Maximum	2.717340	20.59872	2.843164	9.498642
Minimum	–0.371064	16.84811	0.955511	6.270796
Std. Dev.	0.837429	1.047222	0.498622	0.831746
Skewness	–0.187868	0.048456	0.193695	–1.160077
Kurtosis	1.788859	1.879063	1.841684	3.151966
Jarque-Bera	12.86431	10.12713	11.93413	43.24966
Probability	0.001609	0.006323	0.002562	0.000000
Sum	252.5654	3582.255	340.7559	1613.939
Sum Sq. Dev.	133.9460	209.4648	47.48721	132.1340

4.4 Pooled OLS Analysis

Table 4 shows the result of the Pooled OLS analysis. The outcome demonstrates that LUBNP growth reduces LCO_2e by 0.19%; a rise in LENIT levels spurs LCO_2e by 1.10%, and an increase in LGDP enhances LCO_2e by 0.61%. The R–R-squared and Adjusted R–R-squared are 99%, respectively, which shows how well the explanatory variables explain the dependent variable. In addition, the model is normally distributed (0.39>0.05).

Table 4. Pooled OLS Analysis.

Variables	Coefficient	Standard Error	T–Stat	Probability
LUBNP	–0.192957	0.004898	–39.39767	0.0000
LENIT	1.106786	0.005937	186.4245	0.0000
LGDP	0.611302	0.003862	158.2999	0.0000
C	–2.187003	0.104346	–20.95913	0.0000

Diagnostic tests	
R–squared	0.99%
Adjusted R–squared	0.99%
F–stat (23503.90)	Prob (0.00000)
Jarque–Bera (1.840765)	Prob (0.398367)

4.5 Fixed Effects Analysis

The Fixed Effects outcome in Table 5 shows that an upsurge in LUBNP reduces LCO_2e by 1.19%, while LENIT and LGDP rise boosts CO_2e by 1.19% and 1.04%, respectively. The R–squared and Adjusted R–squared are 99%, respectively, demonstrating how well the explanatory variables explain the dependent variable. The normality test also shows normal distribution because the probability value exceeds 5% (0.47992). The Redundant Fixed Effect–Likelihood Ratio also shows that the Fixed Effects method is appropriate because it is significant at 1% (0.0000). The Residual Cross–Section Dependence test also showed that there is no cross–dependence because the probability values are more than 5% (Breusch Pagan LM (0.9994) and (Pesaran CD (0.5008).

Table 5. Fixed Effects Analysis.

Variables	Coefficient	Standard Error	T–Stat	Prob
LUBNP	–0.053523	0.012564	–4.260201	0.0000
LENIT	1.191023	0.014347	83.01504	0.0000
LGDP	1.040176	0.008383	124.0880	0.0000
C	–8.543383	0.200042	–42.70790	0.0000

Diagnostic tests	
R–squared	0.99%
Adjusted R–squared	0.99%
F–stat (61860.65)	Prob (0.00000)
Jarque–Bera (1.468265)	Prob (0.479922)

4.6 Discussion

First, the result that an increase in UBNP reduces CO_2e is supported by the studies of (Balsalobre-Lorente et al., 2022; Khan & Liu, 2023; Koilakou et al., 2023; Sadorsky, 2014; Shen et al., 2017; Somoye et al., 2023). In contrast, these studies found that urbanization increases CO_2e (Chandra Voumik & Sultana, 2022; Cheng & Hu, 2023; Chen et al., 2022; Lee et al., 2023). The negative relationship between UBNP and CO_2e shows that the BRICS–T economies are engaging in sustainable urbanization practices. In addition, Somoye et al. (2023) identified some factors responsible for the negative association between UBNP and CO_2e in Brazil. They include economic and political crisis, demographic changes, government policy effectiveness, effective allocation of resources, and control of pollution. Brazil has encouraged clean energy use through its economic policies, such as hydropower and biofuels. Currently, the decoupling of UBNP–CO_2e is slow in Russia because of its geopolitical challenges and heavy reliance on fossils. As such, Russia has continued to take steps to reduce its CO_2e by investing in renewables, encouraging natural gas use, and driving energy–efficient buildings through its policies. Even though India is going through rapid UBNP, the policymakers in India have developed several projects to promote sustainable urban development. Such projects include the Smart Cities Mission and Jawaharlal Nehru National Solar Mission. Despite China's rapid UBNP growth, established goals have been set by the Chinese government to increase energy efficiency, develop renewable energy generation, and support environmentally friendly transportation options such as electric automobiles and public transportation. In South Africa, coal is the main source of energy supply. The country has implemented some policies to decouple UBNP from CO_2e, such as the creation of the National Development Plan (NDP), support for the Sustainable Cities Network (SCN), and the signing of the Green Economy Accord (GEA). Turkey also depends on fossils for its economic activities, and it has implemented The National Urbanization Strategy (TNUS) to promote sustainable urbanization.

Second, a positive link between ENIT and CO_2e is expected because BRICS–T economies still rely heavily on fossils. This assertion is confirmed in the findings of (Chen et al., 2023; Hodzic et al., 2023; Namahoro et al., 2021; Narayan et al., 2016). Third, this study also anticipated a positive GDP– CO_2e nexus, which is acknowledged by (Amin & Song, 2023; Naseem et al., 2023; Sikder et al., 2022) and opposed by (Khan, 2019; Namahoro et al., 2021; Narayan et al., 2016).

5. Conclusion and Policy Suggestions

Climate change is one of several issues confronting the planet today. Addressing this problem will create a safer environment for humans and other species. Thus, this study explores how the urban population (UBNP) influences carbon dioxide emissions (CO_2e) levels in BRICS–T from 1990–2021 (192 observations) using Pooled OLS and Fixed Effects techniques. In addition, energy intensity (ENIT) and economic growth (GDP) are employed as control factors. The Pooled OLS result demonstrates that UBNP growth reduces CO_2e by 0.19%; a rise in ENIT levels spurs CO_2e by 1.10%, and an increase in GDP enhances CO2e by 0.61%. The Fixed Effects outcome shows that an upsurge in UBNP reduces CO_2e by 1.19%, while ENIT and GDP rise boosts CO_2e by 1.19% and 1.04%, respectively.

Policy suggestions are as follows: (i) To decouple UBNP from CO_2e, urban planning, and rural area development are essential. Urban planning entails designing and managing the physical growth and development of cities and towns. Urban planning also includes expanding and improving public transportation systems. In addition, developing rural areas will decongest the urban areas, put less pressure on urban infrastructure, and reduce CO_2e. (ii) To reduce ENIT levels, renewable energy integration and using energy–efficient buildings are essential. Renewable energy integration entails the installation of solar panels on rooftops and the utilization of geothermal or wind energy where feasible. Incorporating renewable energy into urban development can reduce reliance on fossil fuels and lower CO_2e. Renewable energy use can be enhanced through renewable energy education and awareness. (iii) To decouple GDP from CO_2e, tax policies, and subsidies can be employed. An increase in carbon tax will discourage the use of fossils, while tax incentives and subsidies will encourage renewable energy investments and consumption. In addition, the adoption of new technologies can also reduce CO_2e. Finally, this study has drawbacks by focusing on BRICS–T economies. Other studies can further research other countries for more robust policy formulation.

Conflict of Interests

The Authors declare that there is no conflict of interest.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article, and data is available upon request.

CRedit author statement

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References

Abban, O. J., Wu, J., & Mensah, I. A. (2020). Analysis on the nexus amid CO2 emissions, energy intensity, economic growth, and foreign direct investment in Belt and Road economies: does the level of income matter? *Environmental Science and Pollution Research*, *27*(10). https://doi.org/10.1007/s11356-020-07685-9

Adebayo, T. S. (2023). Assessing the environmental sustainability corridor: linking oil consumption, hydro energy consumption, and ecological footprint in Turkey. *Environmental Science and Pollution Research*, *30*(7). https://doi.org/10.1007/s11356-022-23455-1

Adebayo, T. S., Udemba, E. N., Ahmed, Z., & Kirikkaleli, D. (2021). Determinants of consumption-based carbon emissions in Chile: an application of non-linear ARDL. *Environmental Science and Pollution Research*, *28*(32). https://doi.org/10.1007/s11356-021-13830-9

Ali, R., Bakhsh, K., & Yasin, M. A. (2019). Impact of urbanization on CO2 emissions in emerging economy: Evidence from Pakistan. *Sustainable Cities and Society*, *48*. https://doi.org/10.1016/j.scs.2019.101553

Amin, N., & Song, H. (2023). The role of renewable, non-renewable energy consumption, trade, economic growth, and urbanization in achieving carbon neutrality: A comparative study for South and East Asian countries. *Environmental Science and Pollution Research*, *30*(5). https://doi.org/10.1007/s11356-022-22973-2

Ayhan, F., Kartal, M. T., Kılıç Depren, S., & Depren, Ö. (2023). Asymmetric effect of economic policy uncertainty, political stability, energy consumption, and economic growth on CO2 emissions: evidence from G-7 countries. *Environmental Science and Pollution Research*, *30*(16). https://doi.org/10.1007/s11356-023-25665-7

Balsalobre-Lorente, D., Driha, O. M., Halkos, G., & Mishra, S. (2022). Influence of growth and urbanization on CO2 emissions: The moderating effect of foreign direct investment on energy use in BRICS. *Sustainable Development*, *30*(1). https://doi.org/10.1002/sd.2240

Bekhet, H. A., & Othman, N. S. (2017). Impact of urbanization growth on Malaysia CO2 emissions: Evidence from the dynamic relationship. *Journal of Cleaner Production*, *154*. https://doi.org/10.1016/j.jclepro.2017.03.174

Cetin, M., Ecevit, E., & Yucel, A. G. (2018). The impact of economic growth, energy consumption, trade openness, and financial development on carbon emissions: empirical evidence from Turkey. *Environmental Science and Pollution Research*, *25*(36). https://doi.org/10.1007/s11356-018-3526-5

Chandra Voumik, L., & Sultana, T. (2022). Impact of urbanization, industrialization, electrification and renewable energy on the environment in BRICS: fresh evidence from novel CS-ARDL model. *Heliyon*, *8*(11). https://doi.org/10.1016/j.heliyon.2022.e11457

Cheng, Z., & Hu, X. (2023). The effects of urbanization and urban sprawl on CO2 emissions in China. *Environment, Development and Sustainability*, *25*(2). https://doi.org/10.1007/s10668-022-02123-x

Chen, H., Tackie, E. A., Ahakwa, I., Musah, M., Salakpi, A., Alfred, M., & Atingabili, S. (2022). Does energy consumption, economic growth, urbanization, and population growth influence carbon emissions in the BRICS? Evidence from panel models robust to cross-sectional dependence and slope heterogeneity. *Environmental Science and Pollution Research*, *29*(25). https://doi.org/10.1007/s11356-021-17671-4

Chen, W., Alharthi, M., Zhang, J., & Khan, I. (2023). The need for energy efficiency and economic prosperity in a sustainable environment. *Gondwana Research*. https://doi.org/10.1016/j.gr.2023.03.025

Danish, Ulucak, R., & Khan, S. U. D. (2020). Determinants of the ecological footprint: Role of renewable energy, natural resources, and urbanization. *Sustainable Cities and Society*, *54*. https://doi.org/10.1016/j.scs.2019.101996

Dutta, U. P., & Hazarika, N. (2023). Urbanization and carbon emissions: Panel evidence from 68 low-income and lower-middle-income countries. *Journal of Urban Affairs*, 1–20. https://doi.org/10.1080/07352166.2023.2174871

Energy Institute. (2023). *Energy Charting Tool*. https://www.energyinst.org/statistical-review/energy-charting-tool/energy-charting-tool

Grossman, G., & Krueger, A. (1991). *Environmental Impacts of a North American Free Trade Agreement*. https://doi.org/10.3386/w3914

Harbaugh, W. T., Levinson, A., & Wilson, D. M. (2002). Reexamining the empirical evidence for an environmental Kuznets curve. In *Review of Economics and Statistics* (Vol. 84, Issue 3). https://doi.org/10.1162/003465302320259538

Hodžić, S., Šikić, T. F., & Dogan, E. (2023). Green environment in the EU countries: The role of financial inclusion, natural resources and energy intensity. *Resources Policy*, *82*. https://doi.org/10.1016/j.resourpol.2023.103476

Hussain, M. N., Li, Z., & Sattar, A. (2022). Effects of urbanization and nonrenewable energy on carbon emission in Africa. *Environmental Science and Pollution Research*, *29*(17). https://doi.org/10.1007/s11356-021-17738-2

IEA. (2022). *SDG7: Data and Projections*. https://www.iea.org/reports/sdg7-data-and-projections/energy-intensity

Islam, S., & Rahaman, S. H. (2023). The asymmetric effect of ICT on CO2 emissions in the context of an EKC framework in GCC countries: the role of energy consumption, energy intensity, trade, and financial development. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-023-27590-1

Karaaslan, A., & Çamkaya, S. (2022). The relationship between CO2 emissions, economic growth, health expenditure, and renewable and non-renewable energy consumption: Empirical evidence from Turkey. *Renewable Energy*, *190*. https://doi.org/10.1016/j.renene.2022.03.139

Khan, M. (2019). Does macroeconomic instability cause environmental pollution? The case of Pakistan economy. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-019-04804-z

Khan, M. K., Babar, S. F., Oryani, B., Dagar, V., Rehman, A., Zakari, A., & Khan, M. O. (2022). Role of financial development, environmental-related technologies, research and development, energy intensity, natural resource depletion, and temperature in sustainable environment in Canada. *Environmental Science and Pollution Research*, *29*(1). https://doi.org/10.1007/s11356-021-15421-0

Khan, Y., & Liu, F. (2023). Consumption of energy from conventional sources a challenge to the green environment: evaluating the role of energy imports, and energy intensity in Australia. *Environmental Science and Pollution Research*, *30*(9). https://doi.org/10.1007/s11356-022-23750-x

Koilakou, E., Hatzigeorgiou, E., & Bithas, K. (2023). Carbon and energy intensity of the USA and Germany. A LMDI decomposition approach and decoupling analysis. *Environmental Science and Pollution Research*, *30*(5). https://doi.org/10.1007/s11356-022-22978-x

Lee, C. C., Zhou, B., Yang, T. Y., Yu, C. H., & Zhao, J. (2023). The Impact of Urbanization on CO2 Emissions in China: The Key Role of Foreign Direct Investment. *Emerging Markets Finance and Trade*, *59*(2). https://doi.org/10.1080/1540496X.2022.2106843

Liu, H., Wong, W. K., The Cong, P., Nassani, A. A., Haffar, M., & Abu-Rumman, A. (2023a). Linkage among Urbanization, energy Consumption, economic growth and carbon Emissions. Panel data analysis for China using ARDL model. *Fuel*, *332*. https://doi.org/10.1016/j.fuel.2022.126122

Liu, F., Khan, Y., & Marie, M. (2023b). Carbon neutrality challenges in Belt and Road countries: what factors can contribute to CO2 emissions mitigation? *Environmental Science and Pollution Research*, *30*(6). https://doi.org/10.1007/s11356-022-22983-0

Namahoro, J. P., Wu, Q., Zhou, N., & Xue, S. (2021). Impact of energy intensity, renewable energy, and economic growth on CO2 emissions: Evidence from Africa across regions and income levels. *Renewable and Sustainable Energy Reviews*, *147*. https://doi.org/10.1016/j.rser.2021.111233

Narayan, P. K., Saboori, B., & Soleymani, A. (2016). Economic growth and carbon emissions. *Economic Modelling*, *53*, 388–397. https://doi.org/10.1016/J.ECONMOD.2015.10.027

Naseem, S., Hu, X., Shi, J., Mohsin, M., & Jamil, K. (2023). Exploring the optical impact of information communication technology and economic growth on CO2 emission in BRICS countries. *Optik*, *273*. https://doi.org/10.1016/j.ijleo.2022.170339

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2). https://doi.org/10.1002/jae.951

Raihan, A. (2023). The dynamic nexus between economic growth, renewable energy use, urbanization, industrialization, tourism, agricultural productivity, forest area, and carbon dioxide emissions in the Philippines. *Energy Nexus*, *9*. https://doi.org/10.1016/j.nexus.2023.100180

Raihan, A., Muhtasim, D. A., Farhana, S., Rahman, M., Hasan, M. A. U., Paul, A., & Faruk, O. (2023). Dynamic Linkages between Environmental Factors and Carbon Emissions in Thailand. *Environmental Processes*, *10*(1). https://doi.org/10.1007/s40710-023-00618-x

Sadorsky, P. (2014). The effect of urbanization on CO2 emissions in emerging economies. *Energy Economics*, *41*. https://doi.org/10.1016/j.eneco.2013.11.007

Salahuddin, M., Gow, J., Ali, M. I., Hossain, M. R., Al-Azami, K. S., Akbar, D., & Gedikli, A. (2019). Urbanization-globalization-CO2 emissions nexus revisited: empirical evidence from South Africa. *Heliyon*, *5*(6). https://doi.org/10.1016/j.heliyon.2019.e01974

Shen, L., Shuai, C., Jiao, L., Tan, Y., & Song, X. (2017). Dynamic sustainability performance during urbanization process between BRICS countries. *Habitat International*, *60*. https://doi.org/10.1016/j.habitatint.2016.12.004

Shokoohi, Z., Dehbidi, N. K., & Tarazkar, M. H. (2022). Energy intensity, economic growth and environmental quality in populous Middle East countries. *Energy*, *239*. https://doi.org/10.1016/j.energy.2021.122164

Sikder, M., Wang, C., Yao, X., Huai, X., Wu, L., KwameYeboah, F., Wood, J., Zhao, Y., & Dou, X. (2022). The integrated impact of GDP growth, industrialization, energy use, and urbanization on CO2 emissions in developing countries: Evidence from the panel ARDL approach. *Science of the Total Environment*, *837*. https://doi.org/10.1016/j.scitotenv.2022.155795

Somoye, O. A., Ozdeser, H., & Seraj, M. (2022). Modeling the determinants of renewable energy consumption in Nigeria: Evidence from Autoregressive Distributed Lagged in error correction approach. *Renewable Energy*, *190*. https://doi.org/10.1016/j.renene.2022.03.143

Somoye, O. A., Ozdeser, H., Seraj, M., & Turuc, F. (2023). The determinants of CO2 emissions in Brazil: The application of the STIRPAT model. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, *45*(4), 10843–10854. https://doi.org/10.1080/15567036.2023.2251921

Sreenu, N. (2022). Impact of FDI, crude oil price and economic growth on CO2 emission in India: -symmetric and asymmetric analysis through ARDL and non -linear ARDL approach. In *Environmental Science and Pollution Research* (Vol. 29, Issue 28). https://doi.org/10.1007/s11356-022-19597-x

Suhrab, M., Soomro, J. A., Ullah, S., & Chavara, J. (2023). The effect of gross domestic product, urbanization, trade openness, financial development, and renewable energy on CO2 emission. *Environmental Science and Pollution Research*, *30*(9). https://doi.org/10.1007/s11356-022-23761-8

The World Bank. (2022). *Key Highlights: Country Climate and Development Report for Turkey*. https://www.worldbank.org/en/country/turkey/brief/key-highlights-country-climate-and-development-report-for-turkiye

Ullah, S., Luo, R., Adebayo, T. S., & Kartal, M. T. (2023). Paving the ways toward sustainable development: the asymmetric effect of economic complexity, renewable electricity, and foreign direct investment on the environmental sustainability in BRICS-T. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-023-03085-4

United Nations. (2023). *Causes and Effects of Climate Change*. https://www.un.org/en/climatechange/science/causes-effects-climate-change

World Bank. (2023). *World Bank Open Data*. https://data.worldbank.org/

Xue, P., Liu, J., Liu, B., & Zhu, C. (2023). Impact of Urbanisation on the Spatial and Temporal Evolution of Carbon Emissions and the Potential for Emission Reduction in a Dual-Carbon Reduction Context. *Sustainability*, *15*(6). https://doi.org/10.3390/su15064715

Yang, Z., Cai, J., Lu, Y., & Zhang, B. (2022). The Impact of Economic Growth, Industrial Transition, and Energy Intensity on Carbon Dioxide Emissions in China. *Sustainability (Switzerland)*, *14*(9). https://doi.org/10.3390/su14094884

Zhang, X., Shi, X., Khan, Y., Khan, M., Naz, S., Hassan, T., Wu, C., & Rahman, T. (2023). The Impact of Energy Intensity, Energy Productivity and Natural Resource Rents on Carbon Emissions in Morocco. *Sustainability (Switzerland)*, *15*(8). https://doi.org/10.3390/su15086720

Abbreviations

BRI	:Belt and Road Initiative
BRICS–T	:Brazil, Russia, India, China, South Africa, and Turkey
CO2e	:Carbon Dioxide Emissions
ENIT	:Energy Intensity
EU	:European Union
GDP	:Gross Domestic Product
IEA	:International Energy Agency
Pooled OLS	:Pooled Ordinary Least Square
RNW	:Renewable Energy
UBNP	:Urban Population

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