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The Impact of Labor, Capital, Energy and Income Growth on Environmental Degradation in Selected Developed Countries

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ABSTRACT

This study observes the persuade of labour force, capital formation, energy use, urbanization and income growth on environmental degradations and confirm the EKC with Consumption of energy in selected developed nations using the panel data during the time period 1995 to 2021. The estimated outcomes of the paper illustrate that when use of energy increases the environmental quality improves. The association between income growth and carbon emission is negative and statistically significant in the long run while, positive in the short run in case of selected developed countries. In long-term labour force and capital formation has positive influence on carbon emanation. Carbon emissions initially rise as consumption of energy rises in the long-term, but after a particular position, it starts reduce. This study suggests that environment can be improved by income growth in the selected developed countries. Controlling urbanization development will allow for a reduction in carbon emissions while enhancing agricultural practices. To reduce carbon emissions, energy usage should be effectively managed and optimized. Furthermore, direction of environmental degradation can be reduced by income growth with optimal use of capital and labor to achievement of better climate conditions.

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1. Introduction

Environmental disturbances includes not only the worldwide warming but unanticipated weather changes, deforestation, pollution along with other factors are also part. The problems connected to climate conditions are now the center of universal attention due to its severe and increasing impacts on human life. From the start of sophistication, people steadily in progress to changing the flora for its personal interest. The environment was greatly impacted by industrialization in order to meet the growing urbanization demand, and now that climate change has become a major issue. But with the spread of pandemic covid-19, almost all countries affected and experienced partial lockdown starting from the January 2020. All Govt. administrations of world have made some restriction on travels to control pandemic spreading.

The several social, cultural, religious, games included world cup of cricket and other occasions negated. Numerous units of productions are discontinuing from working. In the meantime, all efforts are made to restrict spreading of this pandemic. But restricting the movement has a surprising effect on climate. Manufacturing unit becomes non-functional in pandemic days but emissions of waste have cut down clearly. The demands of electricity in manufacturing units are minimized due to non-functioning, use of production inputs like labor and capital had reduced significantly. These entire factors contributed greatly in case of improvement in environments. In especially industrial areas the residents are enjoying a clean sky first time in their lives.

The relationship between energy development and environment has been the subject of extensive literature over the last few decades. Some studies highlight the relation between growth of income and carbon by examining the theory of environmental Kuznets curve. Kuznets curve theory shows that first enlarge in income expansion go together with environmental deterioration while after crossing a specific point additional use of production inputs income growth becomes the source of improving the ecological eminence in case of capital and labor. This paper focuses on environmental degradation by segregating the economic growth into production function inputs the G-7 Countries.

The G-7 forum is recognized as well developed and advanced countries have leading edge to set the infrastructure of economic growth in such tune the process of environmental degradation becomes slowdown. To improve the quality of environment is important target of sustainable development goals agenda 2030. The forums of G-7 countries are recognized as high income industrial countries. It is now normally thinking economic activities improves the standard of life of the people.

To fulfill the requirement of basic needs of fast growing population, these two input are the root cause of economic activities, when there is less capital the labor normally works more to fulfill the demand of the people, more working hours on less quantity of capital increases the wear and tear which further decreases the quality of capital, the capital consumes more energy and produces low outputs, it add considerably and significant in the world environments degradation, mainly by emissions of carbon from the consumption of energy. It is significant that study test the capital and labor are the main inputs of growth and these inputs are the main factor for environmental degradation. The United Nation Reports (2019) stated that the population of G-7 developed countries is 4.6 billion in 2019 (which is 60% of total population of the world. Environmental Degradations are especially tricky in lower income economies, Due to their addiction on traditional energy sources.

The major rationale for choosing G-7 (developed countries) group is their worldwide position about energy use, economic growth and hard work to decrease their emission rank. All of these events are attributable to human being movement, which elevate the stage of carbon dioxide as well as other warm-trapping gases. The production and consumption of energy are the only means of enhancing environmental quality.

This study estimates the role of income growth, labor, capital, and energy on environmental degradation in the case of selected developed countries using panel data. It differs from prior research in that it has used an economic analysis to determine how energy use affects EKC. Furthermore, composition of the study is as follows; in section 2, a review of the literature on the relationship between environmental quality, economic growth, energy consumption, and population is presented. Sections 3 and 4 discuss the data and analysis methodology, and section 5 offers future prospects and policy recommendations.

2. Literature Review

Literature provides us strong base and evidence to related issues. It is key point for any research and gives important theoretical background which further provides a roadmap against concerned problems. Several studies had found relationship of environments degradation with different variables such as economic growth, energy use, foreign direct investment and trade openness.

Labor practices can have a direct impact on the environment. For example, industries that rely on heavy machinery and manufacturing processes often generate high levels of pollution and waste. This can have a negative impact on local ecosystems and contribute to climate change. Benhabib and Spiegel (1994) perform the Cobb-Douglas aggregate production function-implied growth accounting regressions using cross-country estimates of labour, human capital and environment. Findings of the study show that human capital contributes minimally to the explanation of environment while labour plays beneficial function.

The analysis of England (2000) concludes about relationship between capital formation and income growth. The result of the study explores that increase in capital formation also leads to increase in economic growth, however, labor productivity and income continue to increase

but at decelerating rates. Junginger, de Wit, and Faaij (2006) indicates that the relationship between uses of energy and environmental degradation in developed countries using uses panel data. Positive and significant outcomes have been examined between uses of energy and environmental degradation.

Alam, Fatima, and Butt (2007) finds the role of income growth, energy and population growth on climate change. The estimated outcome indicates that in process of growth is depending on consumption of energy level and it caused to increase carbon emissions with income growth significantly. Raurich, Sala, and Sorolla (2009) concluded that higher levels of capital increases employment level and also reduce wages along the wage equation. Zenebe, Stage, Alemu, and Atlaw (2011) analysis shows that total factor productivity growth matters more than climate change for the overall outcome. If this pattern of growth continued, income levels will also rise very high surprisingly after the 50 years in spite of climate change. The association among energy consumption, carbon dioxide and economic development has been observed by (Baek & Kim, 2011). The result indicates that income growth has a positive effect on environmental quality for the developed countries, but vice versa for the developing countries. Tugcu, Ozturk, and Aslan (2012) investigate that long run relationships of use of energy and income by production functions, and result indicates that energy by fossil fuels was very important and major source for growth. The results confirmed that energy use was matter more for economic growth and production process in the long-term.

Huang, Sadiq, and Chien (2021) examinee the association between carbon production and economic growth and study verifies that there were positive long run link among carbon emissions, Consumption of energy and income growth. Ramos et al. (2012) conclud that the link between labor and income growth in the European Union. There were concluded that the economic condition in European regions is linked with skill of labor. In fact skill of labor more powerfully connected to economic improvement than other inputs.

Lim, Lim, and Yoo (2014) investigates and concluded that long run relationship among consumption of energy, carbon dioxide discharges, and income growth in the Philippines. There were two way relationships between energy use and carbon emission. Bilgili and Ozturk (2015) shows the relationships among capital formation, labor skill and energy uses. The study finds that results of these variables have positive impact on carbon emission and statistically significant in the case of G-7 countries. Energy use improves the labor productivity, capital stock and energy infrastructure enhances economic growth.

Saidi and Hammami (2015) have observed that an increase in capitalization results in a decrease in carbon emissions and an improvement in environmental quality. Ozturk and Bilgili (2015) observed the EKC hypothesis, the once-positive relationship between economic development and environmental deterioration eventually turns into a negative one. The increase in demand for improved environmental quality as a result of income level increases can be used to justify this action. Ahmed, Uddin, and Sohag (2016) observe the relationship between energy and environment. The study uses income growth and technology as controls variables in industrial nations. Finding of the study shows negative association among energy consumption as well as environmental degradation. Jamel and Derbali (2016) validates the long run association among environmental and use of energy, growth process and capital stocks. FMOLS results showed that growth process and energy use have significant but positive impact on climate disturbance. The study verified that bi-directional connections between energy use and income growth and climate disturbance.

Zhang, Wang, and Wang (2017) investigates the relationship of enery consumption and EkC and concludes that consumption of energy produced by fossils fuels certainly promoting carbon emission. It is also concluded that carbon emission and energy use both factor affecting each other. Further suggestion made by the study energy produced by fossils fuels must be reduced in case of reducing the emission. York and McGee (2017) assessed how energy connects with income and gases emissions. Income growth was more carefully connected to emissions in countries with a high ratio in their electricity. Onalan and Basegmez (2018) accomplished that many factors shares to economic development, as labor force, technological progress, and energy use and capital formation. The production inputs were main aspects of income growth. The results confirmed that the capital and labor has a significant but positive impact on economic

growth. Shahbaz, Balsalobre, and Shahzad (2019) examined the impact of consumption of energy on carbon release in the case of G-7 countries. The study also included capital formation, and urbanization impact of CO2 emissions. Capital formation is negatively connected with CO2 emissions. Environmental quality disturbed as well as financial growth occurs. Urbanization extended carbon emissions. Liu (2020) investigated the connection between income development and carbon emissions. The results showed that the relationship between carbon dioxide emissions and regional economic growth accompanied the Kuznets curve.

Ditta, Ayub, Raza, and Shah (2021) conducts the study related carbon emissions, economic growth, climatic change. Finding of study explore that carbon emissions is important factor for climate change in case of Pakistan. Furthermore, study explains that there is a negative association between income growth and Co2 in Pakistan. Awan, Abbasi, Rej, Bandyopadhyay, and Lv (2022) explore that the association amongst energy uses, capital formation as well as environment in Malaysia during the time period 1965 t0 2018. Outcomes of the study reveal that uses of energy and capital formation both lead to increase the environment pollution in the case of Malaysia. The study suggests that proper planning is necessary to alleviate environment pollution.

Numerous studies investigate the link between environmental concerns and economic expansion, but energy consumption is the primary driver of growth and is a significant environmental element. The covid-19 pandemic is the strongest proof that labour and capital are more negatively impacted at work than in normal circumstances, but that during pandemic times, environmental quality actually improves significantly. As a result, the study will examine and evaluate the effects of urbanisation, income growth, labour, and capital on environmental deterioration. Furthermore, there hasn't been much study done on this kind of time series analytic research. As a result, this study provides important support for the body of literature already in existence. The way in which this study differs from earlier studies is that it includes an econometric examination of the EKC's basic model, as well as data on energy use, labour costs, working capital, and overall income growth.

Data has been collected from global energy statistical book, world development atlas as well as world development indicators for selected countries such as Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and United State during the time 1995 to 2021.

3. Theoretical Framework

In this study carbon emission in metric ton is used as an exogenous variable. Theoretically, growth factors are more dependable on carbon dioxide emissions. (Danish et al.); Shahbaz, Balsalobre, et al. (2019) utilize the link between carbon emisssion and energy consumption. The association between income growth by using the annual rate of log of total GDP and carbon emission is used by many research scholar such as Park and Lee (2011) supports the N-shaped EKC between environmental deterioration and economic growth. Shahbaz, Balsalobre-Lorente, and Sinha (2019) use the GDP and his study conclusions favor the income growth has clear and significant impact on carbon emission. Borhan, Ahmed, and Hitam (2012) observes the relationship between CO2 and that after a specific point income growth and carbon emission have negative relationship. In and Doucouliagos (1997) verifies the causility relationship of labor force and economic growth.

Capital formation is used to explore the impact on cardon emission according to England (2000) in case of developed countries. Husain and Islam (2016) discover that capital formation has positive path with total factor productivity. Pata (2018) utilize that carbon dioxide emissions based on energy consumption and it causes to economic growth. Huang et al. (2021) investigates the long-term correlation between carbon pollution and energy use. Urbanization is employed to learn the urbanization growth in carbon emission and this variable is used by many other studies such as (Dietz & Rosa, 1997).

4. Data and Model Description

Discovering the EKC turning point and the empirical impact of energy use on the environment is the major issue. How much FDI and population in selected developed countries impact the environment, as well as how much energy use does. The covid-19 pandemic severely impacted the global labour force, capital, energy consumption, income growth, and urbanization, however during this time, the environment's condition actually somewhat improved. This climate

improvement investigates significant environmental factors. The data lying on CO2 emissions million tons, Energy Consumption (kWh), income growth in constant $ in GDP, gross capital formation (in constant $), labor as head count ratio in working, and Urbanization acquired from global energy statistical book, world development atlas as well as world development indicators. All factors have been included in the study as a whole during the time period 1995 to 2021. Furthermore, panel data has been used for estimation purposes.

Table: 1 Variables and Data Source Description

Variables	Proxies	Descriptions	Units
Environmental degradation	CO_2	Carbon Dioxide	CO_2 emissions in metric-tons is used as an exogenous variable
Economic Growth	GDP	Gross Domestic Product	constant $ in GDP
Labor Force	LF	Labor Force	head count ratio in working
Capital formation	K	Gross capital formation	(in constant $)
Energy consumption	E	Electricity consumption	Annually electricity consumption (kWh)
Urbanization	UB	Urbanization	Uses proxy for population in cities

4.1. Model Specification

In the current work, the environmental Kuznets curve assumption, which is based on Kuznets's assertions, is examined and put to the test in order to investigate the effect of labour force, capital, and energy consumption on carbon emission in the case of selected developed countries. Kuznets's accomplished link of N shaped association among economic growth (total productivity) as well as Co2.

The goal of the study is to evaluate EKC by separating economic growth into increases in capital and labour productivity. According to the hypothesis, labor and capital are the main drivers of economic development, given that other factors of production remain constant (ceteris paribus). When a study demonstrates the EKC with money, it signifies that technology advancement leads to more effective utilization, which in turn improves the quality of the environment. The absence of capital goods in less developed nations typically has a negative impact on productivity. Additionally, the low quality of the capital and the several shifts that the labour force must work to meet demand have an adverse impact on the environment.

The study uses Panel ARDL technique for measuring the impact of labour force, capital formation, energy use, urbanization and income growth on environmental degradations in the long-term and confirms the EKC with Consumption of energy in selected developed nations using the panel data during the time period 1995 to 2021. Panel ARDL is a useful approach for analyzing the relationships between variables in a panel data context. It accounts for the potential presence of cross-sectional dependence and heterogeneity, and can provide insights into the short- and long-run dynamics of the variables of interest. Common panel unit root tests have been used in this research. Therefore, the methods developed by Im, Pesaran, and Shin (2003); Levin, Lin, and Chu (2002) have been used to determine whether data are stationary. For estimation purposes following model is presented here.

$$CO2_{it} = F(E_{it}, GDP_{it}, K_{it}, LF_{it}, UB_{it}) \quad (1)$$

CO_2 = Carbon Dioxide
E = Electricity consumption
GDP = Gross Domestic Product
K= Gross capital formation
LF = Labour force
UB = Urbanization
i = for country
t =for time period

$$\ln CO2_{it} = \beta_1 + \beta_2 \ln E_{it} + \beta_3 \ln GDP_{it} + \beta_4 \ln K_{it} + \beta_5 \ln LF_{it} + \beta_6 \ln UB_{it}) + \mu_{it} \quad (2)$$

5. Results

The results unit root tests, reveals mixed integration order as well as Pesaran cross dependence which demonstrates no cross sectional dependence in the presented model. For estimation purpose, this study uses panel ARDL technique. The ARDL is an effective technique for assessing and separating long-term relationships from short-term outcomes.

Table: 2 Levin - lin chu unit root test

At level			At Difference	
Variable	**Statistic**	**P. value**	**Statistic**	**P. value**
LCO2	2.17	0.98	-3.86	0.00
LE	-2.11	0.98	-4.61	0.00
LGDP	-1.68	0.04	-7.06	0.00
LK	-3.25	0.00	-5.90	0.00
LLF	-2.43	0.00	-2.43	0.00
LUB	-4.40	0.00	-2.28	0.01

Table: 3 IPS W- stat unit root test

At level			At Difference	
Variable	**Statistic**	**P. value**	**Statistic**	**P. value**
LCO2	1.97	0.97	-5.40	0.00
LE	2.54	0.99	-3.58	0.00
LGDP	1.37	0.91	-6.04	0.00
LK	-1.57	0.05	-5.90	0.00
LLF	0.74	0.77	-3.73	0.00
LUB	-0.10	0.45	-2.00	0.02

Calculated values of Levin-Lin-Chu and IPS unit-root test show that all variables are not significant in level but significant at 1st difference.

Table: 4 Result test of Cross Section Dependence

Test	Statistics Value	Prob. value
Pesaran CD	0.13	0.8967

It is usually predictable that fluctuation in panel data is cross-sectionally unbiased. The Pesaran-CD test is used to check whether the cross sectional data are dependent or not. In the given model this test is applied. The results of the Pesaran cross sectional test show that probability value is insignificant at 10% level. In this scenario the study accepts the null hypothesis. So the model shows that study has no cross section dependency. To examine the long run relationship among carbon emissions, energy use, income growth, capitalization, labor force and urbanization, following Pedroni residual cointegration test is applied to verify the cointegration. The results are as under:

Table: 5 Pedroni residual cointegration tests

Tests	Statistic	Prob.
Panel v – statistic value	0.86	0.1941
Panel Rho – statistic value	0.53	0.7049
Panel pp – statistic value	-3.59	0.0001
Panel ADF - statistic value	-3.62	0.0001
Group Rho - statistic value	1.15	0.9392
Group pp – statistic value	-3.77	0.0001
Group ADF – statistic value	-3.83	0.0001

The results of most statistics including panel ADF-statistics, Panel PP-Statistic, Group PP-Statistic and Group ADF-Statistic are significant, so the study verifying that there is cointegration among the variables.

Table: 6 Test for each cross-section

Cross-section	Jarque Bera.	Prob.	Cross-section	Jarque Bera.	Prob.
1	1.39	0.50	5	3.27	0.20
2	0.38	0.83	6	0.55	0.76
3	0.13	0.94	7	0.88	0.64
4	0.58	0.75			

The Jarque-Bera test's probability is insignificant, as shown by the histogram's normality test, which demonstrates that the data is normally distributed. The Pedroni residual cointegration test confirms the cointegration in the tested model. These figures confirm the correlation among carbon dioxide emissions, energy consumption, income growth, labour force, capital formation, and urbanization.

Table: 7 Descriptive Statistics Test

Variables	Mean	Std. Dev.	Minimum	Maximum	Skewness	Obs.	Prob.
CO2	1.31E+09	1.68E+09	3.00E+08	5.79E+09	1.956	189	0.70
GDP	4.40E+12	4.31E+12	1.02E+12	1.83E+13	1.858	189	0.62
E	6.19E+11	8.78E+11	2.22E+10	2.97E+12	1.860	189	0.52
LF	4.8774770	4.4127913	1.3601139	1.60E+08	1.615	189	0.68
K	9.79E+11	9.10E+11	2.00E+11	3.88E+12	1.693	189	0.78
UB	8.2653688	6.9616199	2.2760570	2.71E+08	1.629	189	0.56

Outcomes of the table 6 indicates that mean values of estimated variables of carbon dioxide emission (CO2), GDP, LF, E, LF, K and UB are 1.31E+09, 4.40E+12, 6.19E+11, 4.8774770, 9.79E+11, 8.2653688. Probability values of the table reveals that data is normal distributed in this study.

Table: 8 Long run results

Variable	Coefficients	Std. errors	T-values	Prob. Values
LE	1.08	0.11	9.22	0.00
LE2	-0.04	0.01	-3.98	0.00
LGDP	-0.66	0.15	-4.40	0.00
LK	0.20	0.14	1.41	0.16
LF	2.29	0.30	0.96	0.33
LUB	0.64	0.25	2.57	0.11

Table: 9 Results of short run

Variables	Coefficients	Std. Errors	T-values	Prob. values
ECM-1	-0.15	0.08	-1.97	0.05
ΔLE	-7.05	56.22	-1.26	0.21
ΔLE2	2.98	2.38	2.25	0.01
ΔLGDP	0.26	0.35	0.73	0.46
ΔLK	0.05	0.05	2.03	0.00
ΔLF	-0.60	0.32	-1.88	0.06
ΔLUB	0.94	1.23	0.77	0.44

Results of table 8 and 9 indicate that carbon emissions increase by 1.08 % if energy uses rise by one percent which indicates that Carbon emissions are strongly impacted by energy use. These results are supported by (Huang, 2013 and Kais et al. 2016). CO2 decrease by 0.04% if LEC2 rises by 1% in the long-run. Energy use (LEC2) is a negative yet considerable effect on CO2. The need for access to energy sources like electricity rises along with the population, and as a result, there is a rise in EC and CO2. The results of earlier investigations support this association according to (Dogan & Turkekul, 2016) and (Saboori & Sulaiman, 2013) reducing energy use is a good way to reduce CO2 emissions, but doing this will also slow down economic growth. In the short-term 1% increases in energy demand, carbon emissions will decrease by 7.05%. The relationship between CO2 and EC is negative as well as statistically insignificant. Carbon emissions increases 2.98% with a 1% increase in LEC2 in short period. Carbon emissions are considerably but favorably impacted by energy consumption. In long run the relationship between income growth and carbon emission is statistically negative and statistically significant. The results of the study indicate that if income growth increases 1% then carbon emissions decrease 0.66%, while in the short run if income growth increases 1%, then carbon emissions increase by 0.26%. This relationship is statistically insignificantly and positive between carbon emissions and economic growth in the short run time period. These results are supported by (Alam et al., 2007). The study finds positive relationship between capital formation and carbon emissions both in long run and short run in. The study's findings show that a 1% rise in capital formation causes a 0.20% long-term increase in carbon emissions and a 0.05% short-term increase. These outcomes are validated by (Lynch, 2016; Onalan & Basegmez, 2018). The study describes that 1% increases labor force leads to increase carbon emissions 0.29% in the long

run. The relationship between labor force and carbon emission is positive and statistically insignificantly in the long, while in short run, this relationship is negative. The outcomes of the study indicate that 1% labor force increases leads to decrease carbon emissions 0.60%. These results are supported by (Benhabib & Spiegel, 1994). The association between urbanization and cabon emissions is positicve and signifcant. The outcomes of the study study explores that 1% increases urbanization leads to increase carbon emissions 0.64%. These outcomes supported by (Shahbaz, Balsalobre, et al., 2019).

$$= \boldsymbol{Antilog\ of}\left(-\left(\mathbf{0.5} \times \frac{\boldsymbol{coefficient\ Attach\ with\ GPD}}{\boldsymbol{coefficient\ attached\ with\ the\ quadratic\ term\ of\ GDP}}\right)\right)$$

$$= \boldsymbol{Antilog\ of} - \left(\mathbf{0.5} \times \frac{\mathbf{1.06}}{\mathbf{-0.04}}\right)$$

$$= \boldsymbol{Antilog}(\mathbf{13.25})$$

$$\boldsymbol{Turning\ Point} = \mathbf{1.853E+13}$$

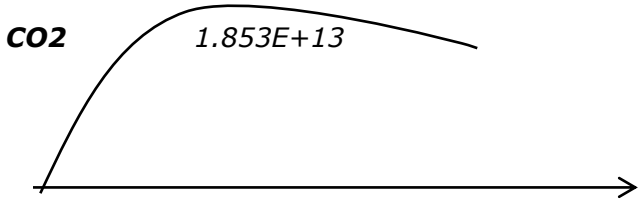

Figure: 1 Turning Point of EKC

The EKC's turning point lies in the range of energy data at 1.853E+13, and the graphical explanation demonstrates that as energy reaches this point, CO2 emissions start to grow.

6. Conclusion

The objective of study is to examining the impact of income growth, labors, capital and electricity use on environmental degradations. The study uses panel data to verify an environmental Kuznets curve with energy consumption during the time period 1995 to 2021. The study uses ARDL technique to estimate the results. This study also supported the EKC theory with regard to energy usage. Energy use greatly reduces carbon emissions, which is a good thing. Ahmed et al. (2016); Alam et al. (2007); Huang et al. (2021); Saboori and Sulaiman (2013) investigate the same positive association among CO2 and EC in the long-term. Carbon emissions are significantly but adversely affected by energy consumption (LEC2). Energy use has a small but detrimental effect on carbon emissions in the short term. Carbons emissions are significantly and negatively impacted by income growth in long period while, insignificant in the short-term. These outcomes supported by (Alam et al., 2007). Influence of capital formation on environmental degradation is insignificant as well as positive in long-term but in short-term result of capital formation is statistically significant and positive. These results are supported by (Lynch, 2016; Onalan & Basegmez, 2018). There is positive and statistically significant association between labor force and carbon emission in long-term while negative in short-period. These results are supported by (Benhabib & Spiegel, 1994). The association between urbanization and cabon emissions is positicve in long run and short run but signifcant in the long run while, insignificant in the short run. Massive urbanization has increased the need for infrastructure, health care, and schooling. The demand for fossil fuels has grown due to urbanization, which has a negative impact on the environment. These outcomes are supported by (Shahbaz, Balsalobre, et al., 2019). The study recommends that income growth in the selected developed nations can improve the environment. The pattern set by industrialized nations like advanced countries are followed by the other nations. Controlling urbanization development will allow for a reduction in carbon emissions while enhancing agricultural practices. To reduce carbon emissions, energy usage should be effectively managed and optimized.

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