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RESEARCH ARTICLE

Investigating the nexus between energy consumption, industrialization, urbanization, economic growth, and Carbon dioxide emission: Panel data analysis from the Belt and Road Initiative countries

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Abstract
An increase in urbanization rises the use of energy in urban areas which leads to high carbon dioxide discharge and worsen environmental quality. Industrialization and economic growth are also linked with environmental quality and thus need to investigate the effect of these factors on environmental quality. This study uses panel data from 1976 to 2019 and investigate the nexus between urbanization, industrialization, economic growth, energy consumption and carbon dioxide emissions in the belt and road initiative countries using static and dynamic panel models. The findings reveals that the effect of urbanization, energy consumption, industrialization and economic growth on carbon dioxide emission is positive and it reduce environmental quality however, international trade significantly reduce carbon dioxide emission. This study further confirms the existence of a U-shape link between urbanization and carbon dioxide while the square term of economic growth doesn't validate the Environmental Kuznets curve hypothesis. The findings of this study have considerable policy suggestions regarding carbon emission mitigation in term of urbanization, energy use, industrialization and economic growth.

Keywords: Urbanization; Carbon dioxide emission; Nonlinear relationship; Environmental Kuznets Curve

Introduction

Same as other factors, urbanization also affects environmental quality where some studies in the prevailing literature indicate that a rise in long term economic growth rises environmental quality while a rise in urban population increases environmental degradation Adem, Solomon et al. (2020). An increase in urbanization rise the use of energy in urban areas which leads to high carbon dioxide discharge and worsen environmental quality Khoshnevis Yazdi and Golestani Dariani (2019). A study confirms the statement that urbanization level raises carbon dioxide emission and worsens the quality of the environment Sadorsky (2014) while opposite findings are also obtained that low density of population makes inefficient public transfer and infrastructure and thus carbon emission reduces Chen, Colombo et al. (2008). Likewise, the lowest carbon footprint in urban areas has been indicated by Muñoz, Zwick et al. (2020) while on the other hand, urbanization in an economy The use of energy and carbon dioxide enhance economic growth while on the other hand, energy consumption has been considered concerning scale effect and the driving factor of development with the use of energy from environmentally friendly Zhang, Wang et al. (2020). Urbanization has been considered that effect carbon emission positively and unreasonably Poumanyvong and Kaneko (2010). Urbanization above the unity level effects the income groups carbon emission differently Martínez-Zarzoso and Maruotti (2011). On the other hand, the nexus between urbanization and carbon emission is found U-shaped Kong, Wang et al. (2021). Urbanization effect national carbon dioxide emission in variables ways in different regions Jorgenson, Auerbach et al. (2014). Uncontrol urbanization level leads to environmental degradation and other related problems such as air pollution, waste disposal and land insecurity Ikumapayi (2020). Newly industrialized countries produce high carbon emission due to high amount of energy use Khoshnevis Yazdi and Golestani Dariani (2019). Countries are increasing production in order to rise economic growth to enhance living standard.
degrade environmental quality Kahouli, Miled et al. (2022). High level or industrialization and a rapid increase in

urbanization have effected the urban building which results a major effect on energy consumption Gierałtowska, Asyngier et al. (2022). Urbanization has different independent effects on energy consumption independently Shao, Chen et al. (2019). Urbanization convert traditional energy consumption to modern types and thus rise intensity of energy which reduce pollution such as pollution purification and urban transportation Martínez-Zarzoso and Maruotti (2011). Several studies indicates that the environmental Kuznets curve in this context is valid. According to this phenomenon, urbanization rise carbon dioxide emission with a rise in urban land and decrease when there is further rise in urban land at the highest level of urbanization Li, Wang et al. (2016); Sadik-Zada and Gatto (2021). Complex mechanism has been debated by which the effect of urbanization on carbon emission has positively or negatively shown Zhou, Wang et al. (2019);Yao, Zhu et al. (2021). Beside urbanization, most of other activities such as industrialization and production in countries are increased in order to rise economic growth while increase in these activities increase energy demand and rise carbon dioxide emission.

The belt and road countries are mostly developing and emerging countries. These countries need to increase industrialization and production to rise economic growth while industrialization and production need high amount of energy. Thus, a rise in energy consumption and economic growth leads to high carbon emission discharge. The rapid industrialization in the countries is also observed as urbanization also linked with economic growth and thus its effect carbon emission. In this study, we believe that the specific characteristics of the belt and road countries, the effect of urbanization, energy consumption, economic growth and industrialization on carbon dioxide can be different as a regional difference. Several previous studies have conducted studies on the effect of urbanization on carbon dioxide emission however industrialization, energy consumption and economic growth has not been considered while this study considered these closely related factors. The nonlinear association between urbanization and carbon dioxide emission has not been considered in such kind of investigation. This study tests both the nonlinear association between carbon emission and urbanization as well testing for the environmental Kuznets curve by introducing the square term of economic growth per capita. Considering the belt and road countries data and its specific characteristics and economic level, this study investigates the effect of urbanization, energy consumption, industrialization and economic growth on carbon dioxide emission from 1976 to 2019 using dynamic panel models. The findings reveals that the effect of urbanization, energy consumption, industrialization and economic growth on carbon dioxide emission is positive and it reduce environmental quality however, international trade significantly reduce carbon dioxide emission. This study further confirms the existence of a U-shape link between urbanization and carbon dioxide while the square term of economic growth doesn't validate the Environmental Kuznets curve hypothesis.

The rest of the paper is structure as follows; literature review is presented in part 2, section 3 is composed of variables and method used, part 4 present results and discussions while the part 5 conclude the study findings and give policy implications.

Literature review

Large number of studies have been examined the nexus between different factors with environmental quality proxy by carbon dioxide emission such as economic growth, energy consumption and urbanization. However, these studies have not yet achieved enough conclusions and thus this topic still need investigation. For instance, Kong, Wang et al. (2021) studied the link between urbanization and carbon emissions in China. The results show a U-shaped association between urbanization and environmental degradation. (Bao & Lin, 2021) Based on provincial data, the spatial vector autoregression model was used to explore the relationship between economic growth, carbon emissions and technological innovation from 2003 to 2017. The results of this study indicate that the study variables were positively correlated. Pece, Simona et al. (2015) examine the relationship on economic growth and technology innovations in Central and Eastern European countries. Using patents, trademarks, and R&D spending as innovation indicators, we found a positive relationship between innovation and economic growth. (Pala, 2019) examined the impact of technology on economic growth in 25 developing countries Using a random coefficient model and using R&D and researchers, they reveals that R&D spending had a significant negative impact on economic growth in some countries in the study sample. Mukhtarov, Humbatova et al. (2020) examine the association between energy and economic growth. The authors used the ARDL model and collected the data from 1993 to 2015. The results show that economic growth increases renewable energy consumption. Financial development was also found that rises renewable energy. Another study by Godil, Sharif et al. (2020) studied the nexus between institutions, ICT and carbon emission using QARDL and data from 1995 to 2018. The study shows that economic growth along institutions raises carbon dioxide while ICT reduce emission. (Chien et al., 2021) also conducted such a study using ARDL for the period 1980 to 2018. The study country was Pakistan and the authors found that economic growth significantly increases carbon emissions, and the EKC hypothesis is validated. They further show that renewable energy and technological innovation can negatively impact carbon emissions. Globalization is a significant source of increased carbon dioxide emissions in Pakistan. Suki, Suki et al. (2022) examine the relationship between renewable energy consumption, technological innovation, and carbon emissions in Malaysia. Using a bootstrapped ARDL model, the findings suggest that using renewable energy can help reduce environmental degradation, and technological innovation can reduce ecological footprint and carbon emissions. Their study also confirmed the EKC hypothesis. Khoshnevis Yazdi and Golestani Dariani (2019) used Indonesia data from 1971 to 2019 and examine the nexus

between urbanization, economic growth and carbon dioxide. Using vector error correction model and found the existence of pollution haven hypothesis while there was found a unidirectional causal relationship from economic growth, FDI and economic growth to carbon dioxide emission. Other studies have also conduct such investigation such as the study of Ponce de Leon Barido and Marshall (2014) validate the findings of above study. These authors conducted a study to examine the nexus between carbon dioxide and urbanization in 80 countries from 1983 to 2005. The authors used fixed and random effects models and reveals that urbanization rise carbon dioxide.

Chen, Liu et al.) studied the nexus between urbanization and carbon dioxide emission by considering the transformative role of government effectives from 1996 to 2018 in OECD countries using FGLS and correlated errors models. The authors found the existence of U shape association between urbanization and carbon dioxide. They further evidence the government effectiveness transformative role in this association. Some authors also believes that quality institutions also effect the nexus between urbanization, industrialization and carbon dioxide such as Wu and Madni (2021) studied the nexus between institutional quality, transportation and industrialization with carbon dioxide emission in the belt and road countries from 1996 to 2018. The study implemented panel threshold regression and found the threshold level of institutional quality in the sample countries. Institutional quality above the level, carbon dioxide doesn't destroy the environment while below is related to environmental degradation. Most of the studies indicates that urbanization increase carbon dioxide emission. A study is conducted by Zhang, Song et al. (2021) used China data from 2000 to 2012 to examine the nexus between urbanization, population and carbon dioxide emission. GMM, two stage least square models were employed to the data for analysis and the results illustrate that temporary residence has a marginal influence on urbanization and carbon dioxide emission nexus. Likewise, Kahouli, Miled et al. (2022) explore the association of trade, urbanization, economic growth and carbon dioxide emission. The time period of the study is from 1971 to 2019 and data sample country is Saudi Arabia. The authors used ARDL and VECM models and found that the use of energy and carbon dioxide enhance economic growth while on the other hand, energy consumption degrade environmental quality. Martínez-Zarzoso and Maruotti (2011) used data for different countries groups from 1975 to 2015 and explore the effect of urbanization on carbon dioxide emission. The authors found that urbanization above unity differently affects the income groups. Kong, Wang et al. (2021) studied urbanization and carbon emissions in China. The results show a U-shaped association between urbanization and environmental degradation. Energy consumption and economic growth is also widely debated and most of the previous studies shows that energy consumption drive economic growth as well both energy use for production and economic growth increase carbon dioxide and leads to environmental degradation. A study by Gierałtowska, Asyngier et al. (2022) investigate the nexus between urbanization, renewable energy and carbon dioxide from 2000 to 2016 in a sample of 163 countries. The authors analyzed the data with GMM model and found U-shape association between urbanization and carbon dioxide. The author further expresses that the effect of renewable energy on carbon dioxide is negative. They also found the existence of EKC hypothesis in the sample countries. (Bao & Lin, 2021) used provincial data and applied the spatial vector autoregression model to explore the relationship between economic growth, carbon emissions and technological innovation from 2003 to 2017. The findings show that technological innovation, economic growth and carbon dioxide are positively correlated over time. (Pece, Simona et al. (2015) examine the relationship between innovation and economic growth in Central and Eastern European countries. Using patents, trademarks, and R&D spending as innovation indicators, we found a positive relationship between innovation and economic growth. (Pala, 2019) examined the impact of technology on economic growth in 25 developing countries Using a random coefficient model and using R&D and researchers, they found that R&D spending had a significant negative impact on economic growth in some countries in the study sample. Mukhtarov, Humbatova et al. (2020) examine the association between energy and economic growth. The authors used the ARDL model and collected the data from 1993 to 2015. The results show that economic growth increases renewable energy consumption. Financial development was also found that rises renewable energy. Another study by Godil, Sharif et al. (2020) studied the nexus between institutions, ICT and carbon emission using QARDL and data from 1995 to 2018. The study shows that economic growth along institutions raises carbon dioxide while ICT reduce emission. 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Methodology

This study uses panel data from 1976 to 2019 for the belt and road initiative countries and investigate the nexus between urbanization, economic growth, industrialization, energy consumption and carbon dioxide emission. The study uses both static and dynamic panel models to examine this association. The models include ordinary least square, fixed effect model, two step difference GMM and two step system GMM. However, before the formal analysis, this

study first implemented a panel unit root test to test the stationarity of the data. After performing these preliminary tests, we further conduct formal analysis using static and dynamic panel models. These estimators include OLS, fixed-effects models, two-step differencing, and two-step systematic generalized method of moments (GMM). The GMM model was proposed by (Arellano & Bond, 1991) and is considered a recent application of the topic, and most studies have focused on this estimator when dealing with panel data. First, the study uses static models, OLS, and fixed effects to deal with heterogeneity. These static estimators were used to compare the results of the current study with previous studies and to compare the results with dynamic model results. By using a GMM model, it will deal with endogeneity issues related to study variables Kinyondo, Pelizzo et al. (2021). The system GMM model handles grouping equation differences s at the horizontal level. The instrument specified in the model is the variable delay value of the level in the difference equation. The variables also studied are the horizontal equation and the first difference mean. Monte Carlo simulations by (Blundell and Bond, 1998) show that the SGMM model is most effective at estimating this dilemma. The over descriptive constraint test was replaced by the Sargan test with the Hansen test, and Arellano and Bond's serial correlation test was also used. Most of the results of these tests confirmed our study expectations. Hansen test values give recognition and show the effectiveness of the instrument. The baseline empirical models are presented below in form of generalized method of moments. The first equation shows the direct effect of urbanization and economic growth along other explanatory variables while empirical model in equation 2 presented the nonlinear association between the study variables.

$$CO2_{it} = \beta_0 + \beta_1 CO2_{it-1} + \beta_2 URB_{it} + \beta_3 ECG_{it} + \beta_4 IND_{it} + \beta_5 ENR_{it} + \beta_6 TR_{it} + \varepsilon_{it} \quad (1)$$

$$CO2_{it} = \beta_0 + \beta_1 CO2_{it-1} + \beta_2 URB_{it} + \beta_3 (URB)^2_{it} + \beta_4 ECG_{it} + \beta_5 (ECG)^2_{it} + \beta_6 IND_{it} + \beta_7 ENR_{it} + \beta_8 TR_{it} + \varepsilon_{it} \quad (2)$$

In equations 1 and 2, CO2 is carbon dioxide emission taken as metric tons per capita, URB is urban population, ECG is economic growth taken as GDP per capita, IND is industrialization, ENR is energy consumption while TR is international trade. Likewise, the square of urbanization is taken to examine the nonlinear association and also the square of economic growth is taken to test for the Environmental Kuznets Curve. The data for all selected variables were downloaded from the world bank database world development indicator. Table 1 present the variables explanation and table 2 shows the variables statistics. Likewise, the correlation is given in table 3. It is believed by large number of researchers that an increase in urban population is also related to an increase in carbon dioxide emission Li, Fang et al. (2019); Khan, Han et al. (2021). Urbanization transfers a rural to urban transition and moves an agricultural economy to an industrial economy (Muhammad, Long et al. (2020). When there is an increase in urbanization, the emission level will increase as inhabitant production and improvement in living standards as well as industrialization. However, it's also been argued that agglomeration in population due to the rise in urbanization enhances the energy use effectiveness and contributes to achieving economy of scale Solarin and Lean (2016). Several studies in preceding literature show that a rise in urbanization leads to a high level of production and raise carbon emission Ghisellini and Ulgiati (2020); Nguyen, Nguyen et al. (2018); Canh (2019);Khan, Weili et al. (2022). Carbon emissions are expressed as metric tons per capita in terms of environmental quality or degradation. This proxy has been used recently by Ibrahim D. Raheem (2019) and Khan, Weili et al. (2021). Similarly, it is generally accepted that the independent variable for considering its impact on carbon emissions is urbanization. Economic growth is measured as per capita GDP Aritenang (2021); Bouchoucha (2021, Hamdaoui, Ayouni et al. (2021); Khan, Weili et al. (2021). Previous studies claim that carbon emission is increased and the environment is polluted by the higher economic growth (Danish et al.,2018c; Ozcan and Apergis (2018). Likewise, it's been argued in previous research that a rise in economic growth rise carbon emission and degrade environmental quality. Krueger and Grossman (1995) ; Apergis and Li (2016); Bai, Feng et al. (2020) indicate that per capita income is a vital factor that affects the level of carbon emission. Several studies in the preceding literature used the square terms of GDP per capita to testify to the Environmental Kuznets Curve Stern (2004); Mader (2018). The environmental Kuznets Curve indicates that in the initial stage of growth rise carbon dioxide while when the country reaches a certain level of development, the emission level goes down. Based on the preceding studies, this study also adds the quadratic function of economic growth to test the non-linear effect of per capita growth on carbon dioxide emission.

Table 1. Variables description

Variables description	Symbols
carbon dioxide emissions (metric tons per capita)	CO2
Urbanization taken as total population	URB
Per capita gross domestic product	GDP
Industrialization	IND
Energy consumption	ENR
Trade	TR

Table 2. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
CO2	4.325272	4.150806	0	26.89927
URB	51.15108	18.30245	6.668	92.501
GDP	2.940403	5.59511	-45.32511	24.97367
IND	30.62608	8.436977	12.17161	64.00978
ENR	1822.165	1299.566	105.4537	6232.732

TR	82.0442	39.42683	8.384615	220.4068

Table 3. Correlation matrix

	CO2	URB	GDP	IND	ENR	TR
CO2	1.0000					
URB	0.7289	1.0000				
GDP	-0.0893	-0.0814	1.0000			
IND	0.1557	-0.0247	-0.0134	1.0000		
ENR	0.9569	0.7480	-0.0814	0.1047	1.0000	
TR	0.2726	0.2540	0.0615	-0.0430	0.3429	1.0000

Results and discussions

Panel unit root tests

Before the formal analysis using static and dynamic panel models, the stationarity of the variables was firstly checked employing CADF and CIPS unit root tests. These are second generation tests where its is assumed that each time series in the panel is distributed across each cross sections.

Table 4. Second Generation Panel unit root results

	CIPS		**CADF**	
Variables	**I(0)**	**I(1)**	**I(0)**	**I(1)**
CO2	-1.667	-3.575 ***	-0.284	-3.831***
URB	-1.629	-2.402***	-2.547***	-2.110**
GDP	-3.641***	-5.167 ***	-3.064***	-4.299***
IND	-2.308	-5.070 ***	-2.049	-3.723***
ENR	-1.310	-4.093***	-0.891	-3.130***
TR	-1.793	-4.813***	-1.834	-3.931***

Note: **, *** shows significance level at 5 percent and 1 percent respectively

Pesaran (2007) proposed second generation tests based on average lag and first difference of single series to enhance ADF regression. Thus, the single common factor is filtered out. There is a unit root in the panel in each country and thus it is tested alternatively the countries differences. The results are presented in table 4. All the variables are stationarity in first difference and in level.

After checking the stationarity of data, this study further forward to the formal econometric analysis using static and dynamic panel model. Table 5 present the direct effect of urbanization on carbon dioxide emission. The results indicates that the lagged dependent variable carbon dioxide is positive significant and the AR1, AR2 and Sargan test also fulfil the model requirements.

The findings shows that the sample countries urbanization leads to high carbon dioxide emission and worsen environmental quality. Considering the two-step system GMM results, a rise in the level of urbanization in the belt and road countries increase carbon dioxide emission by 0.004 percent if urbanization goes upward by one percent. The findings of this study are similar to Al-Mulali, Solarin et al. (2016); Khoshnevis Yazdi and Golestani Dariani (2019) regarding the effect of urbanization on carbon dioxide.

The findings shows that the sample countries economic growth also leads to high carbon dioxide emission and worsen environmental quality. Considering the two-step system GMM results, a rise in the level of economic growth in the belt and road countries increase carbon dioxide emission by 0.027 percent if there is a one percent increase in economic growth. Adebayo, Adedoyin et al. (2021) found similar results.

The findings shows that the estimated coefficient of industrialization is positive and significant that's leads to high carbon dioxide emission and worsen environmental quality. Considering the two-step system GMM results, a rise in the level of industrialization in the belt and road countries increase carbon dioxide emission by 0.006 percent with a one percent increase in industrialization in the belt and road countries. Khoshnevis Yazdi and Golestani Dariani (2019) also found that industrialization leads to carbon emission discharge.

Energy consumption is significant and positive. The estimated coefficient values indicate that a rise in the use of energy in the belt and road countries increase carbon dioxide emission. The findings further shows that when there is increase in carbon dioxide emission with the use of high amount energy worsen environmental quality. More specifically, 0.004 percent increase will occur in carbon dioxide if the use of energy increase by one percent. The findings confirm that energy use in the belt and road countries harms environmental quality by producing pollution.

International trade variables produce positive and significant coefficient. Thus the coefficient indicate that it reduce carbon emission and rise environmental quality. The findings shows that if there is increase in international trade in the sample countries will support the environmental quality enhancement. Specifically, taking the two-step system GMM model results, if a percent increase in the belt and road countries international trade occur, the environmental quality will be risen and the carbon emission will be reduced by 0.001 percent. Khoshnevis Yazdi and Golestani Dariani (2019) found opposite results for Asian countries.

Table 5. Urbanization and carbon dioxide emission

Variables	OLS	Fixed effect	2Steps Difference GMM	2Steps System GMM
Urbanization	0.009***	0.009***	0.003	0.004**
	(0.003)	(0.003)	(0.011)	(0.004)
Economic growth	-0.006***	0.006***	0.003***	0.027***
	(0.002)	(0.002)	(0.000)	(0.000)
Industrialization	0.029***	0.029***	0.015***	0.006***
	(0.002)	(0.002)	(0.002)	(0.001)
Energy consumption	0.002***	0.002***	0.001***	0.0004***
	(4.320)	(4.430)	(4.370)	(3.365)
International trade	-0.003***	-0.003***	-0.002***	-0.001*
	(0.000)	(0.000)	(0.0003)	(0.0002)
$CO2_{it-1}$			0.250***	0.804***
			(0.005)	(0.012)
Constant	-1.195***	-1.171***		0.001
	(0.228)	(0.148)		(0.002)
Observations	936	936	886	925
R-squared		0.903		
Number of id	37	37	37	37
AR1			-2.01	-2.22
			(0.045)	(0.027)
AR2			-1.42	-0.92
			(0.154)	(0.357)
Sargan test			1733.32	1377.01
			(0.020)	(0.121)

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The findings shows that the sample countries urbanization leads to high carbon dioxide emission and worsen environmental quality. Considering the two-step system GMM results, a rise in the level of urbanization in the belt and road countries increase carbon dioxide emission by 0.081 percent if urbanization goes upward by one percent.

As the effect of urbanization is positive and rise carbon dioxide emission however the estimated coefficient of the square term of urbanization shows that this coefficient give significant but negative sign thus indicates that urbanization will significantly reduce carbon dioxide emission when its reach a certain level in the belt and road countries. Thus, the findings confirm that there exist a U-shape association of urbanization and carbon dioxide emission.

The findings shows that the sample countries economic growth also leads to high carbon dioxide emission and worsen environmental quality. Considering the two-step system GMM results, a rise in the level of economic growth in the belt and road countries increase carbon dioxide emission by 0.027 percent if there is a one percent increase in economic growth. Consistent with findings from Zoundi (2017); (H. Khan, Weili & Khan, 2021b); economic growth increases emissions, further evidence from more researchers (Chien et al., 2021); Adebayo, Adedoyin et al. (2021). Economic growth reduces environmental quality. (Usman, Alola, and Sarkodie, 2020) also claim that economic growth puts upward pressure on the ecological footprint. Khoshnevis Yazdi and Shakouri (2017) obtained the opposite result. As the economic growth is positive and significant increase carbon dioxide however this study also tests the environmental Kuznets curve by taking the square of economic growth per capita. By checking the EKC hypothesis whether economic growth still increase or reduce emission when the countries reach a certain level of development, the results did not validate this hypothesis as the square term coefficient gives positive and insignificant results.

The findings shows that the estimated coefficient of industrialization is positive and significant that's leads to high carbon dioxide emission and worsen environmental quality. Considering the two-step system GMM results, a rise in the level of industrialization in the belt and road countries increase carbon dioxide emission by 0.001 percent with a one percent increase in industrialization in the belt and road countries.

The effect of energy consumption on carbon dioxide shown positively by the coefficients. Thus, a rise in

energy use increase carbon dioxide. The findings further shows that when there is increase in carbon dioxide emission with the use of high amount energy worsen environmental quality. More specifically, 0.004 percent increase will occur in carbon dioxide if the use of energy increase by one percent. The findings confirm that energy use in the belt and road countries harms environmental quality by producing pollution.

Table 6. Nonlinear association between urbanization and carbon dioxide

Variables	OLS	Fixed effect	2Steps Difference GMM	2Steps System GMM
Urbanization	0.041***	0.043***	0.0572	0.081***
	(0.009)	(0.009)	(0.0488)	(0.085)
Urbanization Square	-0.000***	-0.000***	-0.000***	-0.000***
	(9.320)	(9.480)	(0.000)	(0.0006)
Economic Growth	-0.005**	-0.005**	0.004***	0.027***
	(0.002)	(0.002)	(0.000)	(0.000)
ECG Square	7.110	7.080	1.940	1.490
	(0.000)	(0.000)	(7.020)	(8.960)
Industrialization	0.026***	0.026***	0.016***	0.001***
	(0.002)	(0.002)	(0.002)	(0.002)
Energy consumption	0.002***	0.002***	0.001***	0.0004***
	(4.350)	(4.460)	(3.230)	(2.390)
International trade	-0.004***	-0.004***	-0.002***	-0.000**
	(0.000)	(0.000)	(0.000)	(0.0003)
$CO2_{it-1}$			0.247***	0.811***
			(0.0053)	(0.010)
Constant	-1.810***	-1.822***		0.001
	(0.286)	(0.225)		(0.001)
Observations	936	936	886	925
R-squared		0.905		
Number of id	37	37	37	37
AR1			-1.97	-2.25
			(0.049)	(0.024)
AR2			-1.43	-0.89
			(0.154)	(0.375)
Sargan test			1723.62	1380.07
			(0.000)	(0.000)

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Conclusion

The current study examines the linear and nonlinear effect of urbanization on carbon dioxide emission by including industrialization, energy consumption and economic growth in this association. The belt and road countries data for the period of 1976 to 2019 have been collected from the world development indicator and employed generalized method of moments estimator for analysis. The findings shows that urbanization, industrialization, economic growth and energy use increase carbon dioxide emission and degrade environmental quality however the effect of international trade on carbon dioxide emission is negative thus shows that international trade significantly reduce carbon emission and leads to environmental quality. The study further found the U-shape association between urbanization and carbon dioxide emission however the Environmental Kuznets curve is not validated in this study shown by the square term of per capita GDP.

From the findings, this study concludes that there is high level of urbanization in the belt and road countries and migration from rural areas to urban areas. This migration to cities effects the environment in the belt and road countries in several ways as the urban population increase, there will be increased air pollution, waste materials in cities and high population which worsen environmental quality. This urbanization in the belt and road countries can rise economic activities in cities however there is worsen environmental consequences. However, this urbanization in the sample countries increase pollution and worsen environmental quality in the initial stage while its will rise environmental quality when the urbanization reach a peak level. likewise, energy consumption for production and industrialization rise carbon dioxide emission in the belt and road countries as these sample countries are still developing or emerging countries that need to rise economic growth and living standard. Thus, increase energy use increase economic growth while both economic growth and energy rise carbon dioxide emission and degrade environmental quality. The environmental Kuznets curve isn't validated so thus it's a challenge for the belt and road countries to considered the environmental consequences while rising economic growth through production and industrialization that require high amount of energy. The solution maybe that the countries

need to invest in renewable energy to rise its use in production and industrialization so thus environmental degradation can be decreased as energy consumption, industrialization and economic growth all positively effect carbon dioxide in this study.

The countries are suggested to reduce the rapid growth of urbanization in order to control the rapid deterioration of environmental quality in urban areas. Likewise, the countries need to adopt strategies to use renewable energy in production and industrialization process to thus can minimize environmental consequences and well can attain economic growth. In case on the effect of industrialization on carbon emission, the countries should not fully be focused on increased industrialization in the initial stage to boost economic growth. alternatives should be investigated to keep economic growth increasing and to protect environmental quality. The international trade should be more advantageous to rise economic growth as well to increase renewable energy which can be the solution to economic growth and environmental problems. The findings concludes that most of variables in this study leads to high carbon dioxide emission except international trade and thus need proper attention. However, urbanization is beneficial for economic growth and the U-shape association between urbanization and carbon emission is also found thus indicates that its can rise environmental quality in later stages when its reach a higher level. while on the other hand, the economic growth EKC hypothesis is not validated thus the countries need special attention to economic activities.

This study is limited to the variables used. Future study may include institutional quality indicators and governance which may give important suggestion regarding economic growth activities such as the role of governance and institutions in conducting environmental regulation and economic activities rules to control the harmful effects of these factors on environmental quality.

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