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The Impact of Economic Corridor and Tourism on Local Community's Quality of Life under One Belt One Road Context

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Abstract

Economic corridors unlock new economic opportunities and tourism development in the region to achieve sustainable development goals. Green economic growth is conducive to environmental sustainability. Economic mega-projects of CPEC promote tourism that leads to communities' well-being and better quality of life. Modern infrastructure development contributes significantly to economic growth and tourism activities. This study's objectives emphasize exploring tourism and sustainable development pursuits under OBOR economic projects that open doors to improving residents' quality of life. The growing world is an eyewitness to a continuous rise in emissions and its severe consequences for humankind. It is necessary to show off the leading factors that result in tourism and

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Data Availability Statement included at the end of the article

economic activities causing environmental pollution rather than blame policymakers. Undoubtedly, many studies previously focused on demonstrating the influence of socio-economic factors that lead to better environmental quality. However, the empirical literature on tourism, social well-being, foreign direct investment, and the Environment in Belt and Road developed economies needed improvement. This research applied a series of advanced estimators that help demonstrate the study's probable results. This study explores the role of Social well-being (HDI), tourism development, FDI, renewable energy, information & communication technology (ICT), and urbanization on CO2 emissions in Belt and Road (BRI) developed economies.Estimated results exhibited the significant contribution of ICT and renewable energy to sustainability. Besides, FDI contributes to emissions reduction after its threshold level. Conversely, urbanization and tourism activities contribute to environmental pollution. The study outcomes stated inverted/EKC U-shaped hypotheses related to specified economies. Finally, the analysis based on the D-H panel causality test constructs exciting results.The present study concludes that economic corridor plays a vital role in tourism development, the community's well-being, and SDGs goals (sustainable development) impact on environmental safety. The findings suggest essential and applicable policies to attain the desired sustainability level. Findings contribute to the literature on tourism, well-being, and sustainability. Further studies can use insights using this methodology.

Keywords

BRI Economic Corridors, Social Well-being, Tourism development, ICT, Renewable energy

Highlights

- ❖ Tourism and urbanization significantly contribute to CO_2 emissions.
- ❖ This study shows core determinants of CO_2 emissions in BRI Developed Countries.
- ❖ The inverted U-Shaped EKC hypothesis is validated for selected economies.
- ❖ ICT and renewable energy consumption decline the level of emissions.
- ❖ Environmental awareness and regulations are highly recommended.

Introduction

Since the last few decades, economic progress has remained a priority agenda for growing economies (Abaalzamat et al., 2021; Al-Sulaiti et al., 2021; Awan et al. 2020, 2022; Li, Qiao, et al., 2022). Therefore, economies across the globe have keenly focused on reaching their peak level in development at any cost of environmental damage (Iorember et al., 2022; Micah et al., 2023; Zhuang et al., 2022). In this theme, numerous theories have been proposed using different economic development proxies such as income, happiness index, and human development index (HDI) (Naqvi et al., 2020). However, the HDI has focused on people-oriented policies describing economic growth and social outcomes. Undoubtedly, a rising awareness from earth to sky among development economists never thoroughly explains the aspects of social development, food issues, and communities' mental wellbeing (Balsalobre-Lorente et al., 2023; Hafeez et al., 2019; Jawad et al., 2023). However, there has been a direct link between social well-being and the energy sector (Local Burden of Disease 2021; Moradi et al., 2021; Schmidt et al., 2022). Energy transition has become a need of time to secure the future generation from a dirty environment (Jiakui et al., 2023; Zafar et al., 2022).

Over time, energy thirst is increasing, and to meet energy demand, economies are compelled to use traditional fuels in their production process, which causes environmental degradation (ED). Besides the development and energy sectors, foreign direct investment (FDI) is linked with ED (Mamirkulova et al., 2020). However, the Belt & Road Initiatives Economies (BRI) are based on foreign investment projects and may deteriorate the ecological quality (Aman et al., 2022; Paulson et al., 2021). Besides, FDI brings tourism and technological development to the host economy for rapid growth (Aman et al., 2019; Liu, Dilanchiev, et al., 2022). By keeping all views in mind, it is essential to demonstrate the role of "socio-economic" factors toward environmental sustainability in BRI economies (Madurai Elavarasan et al., 2023). Thus, this empirical research has the following contribution. Firstly, this study's leading contribution is adding the human development index (HDI) to the environment model and trying to answer whether emissions will reduce or increase via the inclusion of HDI (Al-Sulaiti & Aldereai, 2022). However, in the literature, there is a core environment-development theory known as Environment Kuznets Curve (EKC), first proposed by (Grossman and Krueger 1995). It has been divided into two types, such as U-shaped and inverted U-shaped EKC-curve. Thus, to be straightforward, the "inverted U-shaped EKC hypothesis" refers to an increase in emissions by a rise in income level but declines after its threshold level and vice versa (U-Shaped EKC-curve). However, few studies have examined this notion using BRI economies' income per capita. Still, they neglected the leading countries in this belt and did not try to add social well-being factor [refers: (Li, Al-Sulaiti, et al., 2022; Rauf, Liu, Amin, Ozturk, Rehman, & Hafeez, 2018; Zuo et al., 2022)]. However, it may be a leading contribution by focusing on well-developed economies under the BRI belt and keeping a solid view that social well-being (HDI) may cause to secure the environmental quality (Batool et al., 2022; Chang et al., 2022; Zhang & Dilanchiev, 2022).

Secondly, the selected belt has been introduced via massive investment of China to host regions (Sattar, 2022a, 2022b; Sattar et al., 2020). Therefore, it is a core variable that may deteriorate or secure the Environment (Latief et al. 2021, 2022; Sattar, 2022a, 2022b). The current literature divides FDI's environmental impact into two theories known as the "Pollution Haven Hypothesis" (PHH) and the "Pollution Halo Effect." irrefutably, the FDI works as an engine for development, employment, and modernization, making countries more competitive in the global market and achieving better living standards. Similarly, the PHH refers to the rise in CO_2 emissions due to outdated technologies imposed by donor countries (Mert & Caglar, 2020). Besides, "the Halo effect" states that multinational companies spread superior knowledge, which implies eco-friendly practices and causes environmental (Repkine & Min, 2020). Thus, FDI's impact on sustainability in BRI countries' developed economies has not been studied. This research tests the mentioned FDI's theories in selected regions, which may help remaining economies to secure environmental quality.

Thirdly, this study introduces the social factor, that is, urbanization that supports the level of development. Over time, the majority of people have migrated to well-organized cities because of better opportunities regarding employment, health, and education (Fan et al., 2019; Hafeez et al., 2023; Shah et al., 2023). Consequently, the level of development often correlates with urbanized progress (Bakirtas & Akpolat, 2018). Similarly, an unprecedented increase in this phenomenon caused environmental damage. Furthermore, the growing world and its urban economic & human activities are directly associated with energy that may cause environmental degradation (Cui et al., 2023; Wang, Dilanchiev, & Haseeb, 2022; Wang, Yang et al. 2022, 2022; Xin et al., 2023). The existing studies have not cleared this ambiguity in developed regions. The current study explores whether the urbanized sector is eco-friendly or causes harm (Dilanchiev et al., 2023; Liu, Lan, et al., 2022; Sun et al., 2023). Fourthly, to date, many empirical researchers have investigated the energy-development nexus or energy-environment nexus, but these studies have not focused on the *energy-environment nexus* by considering the social well-being in well-developed belt road economies (Chen & Taylor, 2020; Shah et al. 2021, 2022; Yao et al., 2019; Zhang, Shah, & Yang, 2022). For that reason, the central focus of mentioned studies was examining the dynamic link of development with the Environment and energy used as a side variable. Simply put, none of the studies has investigated the influential role of

RE in environmental sustainability. Thus, the current study fills out this gap by focusing on a solution to ecological deterioration in selected economies.

Fifthly, different circumstances impact macro indicators of environmental quality; therefore, the countries try to manage all non-productive human & economic activities that minimize environmental degradation. For instance, the globe has introduced information & communication technology (ICT) that helps in various sectors, for example, education, health, transport, businesses etc. However, there has not been a single opinion; some studies proved it an eco-friendly instrument (Gong, Zhang et al., 2020), while some proved it a dirty instrument (Ishida 2015). Besides, it is based on sector characteristics, and we believe it supports social well-being and investment inflows; therefore, it may help environmental sustainability. However, it will be more interesting to check out its impact on CO_2 emissions in BRI-developed regions in the presence of social well-being and investment inflows. Sixthly, as the globe is interconnected, all economies bring massive tourism, which is considered a leading factor in boosting development (Abbas et al., 2022; Jaffar et al., 2021). For instance, the development-emissions nexus may be incomplete without the tourism sector; thus, the present study includes tourism as an explanatory variable to investigate its impact on carbon emissions.

Furthermore, the present study employs an advanced series of econometric techniques that may control the problems of panel data, such as cross-sectional dependency tests and slope of homogeneity tests. In addition to the data integration and long-term co-integration among selected variables, this study performs the CADF & CIPS unit root tests and Westerlund co-integration test. Similarly, we employ the Common Correlated Effect Mean Group (CCE-MG) and Augmented Mean Group (AMG) to investigate the long-run impact on an explained variable. Finally, we used the D-H panel causality test to demonstrate the causal effect.

However, the given sections are organized as follows; literature review, data & methods, results & discussion, and a conclusion with policy recommendations.

Literature Review

This section is vital because it can deliver a clear message concerning what has been done by past studies. Therefore, the current research summarizes the past case studies into three sub-sections, that is, 1) nexus of information & communication technology with environmental quality. In this sub-section, the current research tries to compile relevant studies with emissions and ICT from 2020 to 2023. However, in the summarized studies, there have been numerous opinions by the researcher; for example, some are considered an essential solution for environmental sustainability, while others are against this view. Likewise, the subsection provides a glimpse of relevant studies on tourism and emissions (Ge et al., 2022; Yu et al., 2022; Zhang, Husnain et al., 2022). However, comprehensive studies have pointed out that a significant rise in tourism causes emissions across different regions (Jaffar et al., 2021; Liu et al., 2021). Finally, 3) sub-section tries to summarize the case studies from 2018 to 2023 concerning EKC-hypothesis (the Environment Kuznets curve), "Pollution Haven Hypothesis" (PHH) and "Pollution Halo Effect (PHE)." In this subsection, all of the studies have not the same opinion regarding the contribution of economic development and foreign direct investment across the various regions. Besides, from the theoretical point of view, this research summarizes all EKC and PHH or PHE studies from the Belt & Road Initiative economies (BRI). Such information may be able to guide us in the right direction. However, Table 1 summarizes the past studies related to this topic. See Table 1, which outlines the new literature on the study area.

However, this study has the following contributions. Firstly, according to our best knowledge, none of the existing studies tries to consider the developed economies from the BRI belt. Primarily, studies have attempted to investigate the mentioned theories by using the overall belt and road economies; therefore, it is impossible to compare all economies in a single row. Thus, the current study tries to capture the original picture of BRI economies by considering the developed economies. Developed economies may convey a clear message concerning environmental sustainability because all economies have their country's interests. At this stage, emerging and developing economies try to cover up speedy growth to compete with other nations. Besides, developed economies have already attained their threshold level, and they think about their clean & green Environment. It is a leading contributor to existing literature, and other economies can follow up these economies to grow faster. Secondly, existing literature for BRI countries performs very well, but all the mentioned studies don't try to utilize HDI as a proxy of development for the EKC hypothesis. However, most countries try to care about their income level; they don't care about their social well-being. Developed economies have been trying to settle their social/human well-being objectives during development. Therefore, this is another advantage of this research to clarify whether HDI is green or harms environmental sustainability. Thirdly, for the first time, the present study investigates the two theories for well-developed economies known as PHH and EKC hypotheses. Furthermore, the fundamental goal of current research is to seek the proposed study's objectives by using different econometric techniques and trying to cover the problems of panel data. Thus, this study could be considered a new chapter of research that forthcoming studies must follow to support our contribution to the literature.

Table 1. It Displays Some Relevant Literature.

Author	Region	Technique	Span	Outcome
Information & communication technology (ICT)-environment nexus				
(Nguyen et al., 2020)	G-20	FMOLS	2000-2014	EKC, ICT ↓ CO_2
(Ulucak and Khan 2020)	BRICS	CUP-FM & CUP-BC	1990-2015	ICT ↓ CO_2
(Charfeddine & Kahia, 2021)	MENA	IRF	1980-2019	ICT ↑ CO_2
(Wang et al., 2021)	20 OECD	DFM	2000-2018	ICT investment ↑ CO_2
(Altinoz et al., 2021)	10 emerging economies	PVAR	1995-2014	ICT ↑ CO_2
(Appiah-Otoo et al., 2022)	ICT countries	IV-GMM	2000-2018	ICT ↓ CO_2
(Nwani et al., 2022)	African economies	Q-GMM	1995-2017	ICT ↓ CO_2
(Weili et al., 2022)	BRI	GMM, GLS	2000-2019	ICT ↑ CO_2
(Shobande & Ogbeifun, 2022)	OECD	PFE	1980-2019	ICT ↓ CO_2
(Jin & Yu, 2022)	China	LASSO method	1997-2017	ICT ↑ CO_2
(Awad & Mallek, 2023)	44 SSA	GMM	2003-2020	ICT ↑ CO_2
Tourism-environment nexus				
(Akadiri et al., 2020)	OECD	SUR	1995-2014	TR ↑ CO_2
(Luo et al., 2020)	China	Structural decomposition	2007-2010	TR ↑ CO_2
(Mishra et al., 2020)	USA	Wavelet coherence technique	2001-2017	TR ↑ CO_2
(Huang et al., 2021)	China	Spatial econometric technique	2005-2016	TR ↑ CO_2
(Razzaq et al., 2021)	Top 10 GDP	Q-GMM	1995-2018	TR ↑ CO_2
(Sun et al., 2021)	Turkey	Q-ARDL	1995-208	TR ↑ CO_2
(Erdoğan et al., 2022)	Tourist economies	PQR	1995-2018	TR ↑ CO_2
(Raihan & Tuspekova, 2022)	Turkey	DOLS	1990-2020	TR ↑ CO_2
(Yang & Jia, 2022)	China	Process analysis method	2010-2020	TR ↑ CO_2
(Shah, Naqvi, et al., 2022)	Top Asian tourist economies	CS-ARDL & AMG	1995-2017	TR ↑ CO_2

(continued)

Table 1. (continued)

Author	Region	Technique	Span	Outcome
EKC and PHH in BRI economies				
Author	Region	Technique and Span	EKC	PHH
(Rauf, Liu, Amin, Ozturk, Rehman, & Sarwar, 2018)	BRI economies	CCE-MG, AMG & PMG	Yes	N/A
(Rauf, Liu, Amin, Ozturk, Rehman, & Hafeez, 2018)	—	FMOLS & DOLS	N/A	N/A
(Liu & Kim, 2018)	—	PVAR	Yes	Yes
(Hafeez et al., 2019)	—	Driscoll–Kraay standard error	N/A	N/A
(Khan et al., 2019)	—	AMG & CCE-MG	Yes	Yes
(Saud et al., 2019)	—	DSUR	Yes	N/A
(Aibai et al., 2019)	—	Ambiguous	N/A	Yes
(Baloch et al., 2019)	—	DKP	N/A	N/A
(Khan, Chenggang, Bano, et al., 2020)	—	PVAR-GMM	N/A	N/A
(Ahmad et al., 2020)	—	DKP	Yes	N/A
(Abban et al., 2020)	—	AMG	N/A	N/A
(Khan, Chenggang, Hussain, et al., 2020)	—	GMM	Yes	N/A
(Hussain et al., 2020)	—	AMG & CCE-MG	N/A	N/A
(Zhuang et al., 2021)	—	CS-ARDL	Yes	N/A
(An et al., 2021)	—	G-GMM	N/A	Yes
(Majeed et al., 2022)	—	AMG	Yes	N/A
(Wei et al., 2022)	—	Spatial Durbin model	N/A	Yes
(Li, Al-Sulaiti, et al., 2022)	—	GLS	Yes	N/A
(Wang et al., 2023)	—	PTM	N/A	Yes

Note: ↑: Increases, ↓: Decreases, EKC: Environment Kuznets Curve, ICT: Information & communication technology, TR: tourism, PHH: Pollution Haven Hypothesis, FMOLS: Fully Modified Ordinary Least Square, Cup-FM: Continuously updated fully modified, IRF: Impulse response function, DFM: Decoupling-factor model, PVAR: Panel Vector Autoregressive Distributive Lag model, Q-GMM: Quantile Generalized Method of moments, GLS: Generalized Least Square, PFE: Panel Fixed Effect, SUR: Seemingly uncorrelated regression, Q-ARDL: Quantile Autoregressive Distributive Lag model, DOLS: Dynamic Ordinary Least Square, CS-ARDL: Cross Sectional ARDL, AMG: Augmented Mean group, PMG: Pooled Mean Group, CCE-MG: Common Correlated Effect Mean Group, DKP: Driscoll–Kraay panel regression, PTM: Panel Threshold Model.

Data and Methods

This Study's Theoretical background

The choice of BRI economies is based on several important aspects. First, this flagship initiative covers almost all continents globally, and the "belt road" countries have high growth rates and do not eliminate environmental pressure. Second, the "One Belt, One Road" initiative covers more than 62% of the world's population, covers 8.5% of the country's land area, and contributes over 30% of the global GDP. The degree of environmental damage (CO_2) outside China is 33.7% (Khan, Hussain, Bano, et al., 2020). Another important reason is that the study will help develop policies to promote the concept of developmental economics under a strategy for reducing the environmental burden by adopting an adequate enabling environment. Hence, this research is innovative in the current research environment by considering human well-being and foreign direct investment that can provide gaudiness to environmental policymakers and legislators in these countries on a one-time basis.

Similarly, the BRI economies have settled their ambition to strictly follow the SDGs goals and try to achieve their targets by 2030. However, these goals have two leading dimensions such as socioeconomic and environmental development (Hafeez et al., 2023; Shah et al., 2023). But more shocking is keeping balance among specified measurements, which has become a severe challenge. For instance, past studies have considered the EKC theoretical background to reach an optimum level. However, they differentiate that level of development may cause to affect the Environment via three different effects: consumption, scale, and technical effects. The existing studies did not consider the aspects of human well-being for their environmental models. Thus, ignorance of human development associated with the Environment may cause biased outcomes because health, services, and education sectors are directly linked with the Environment. Likewise, the performance of foreign direct investment inflow is like an illusion, directly affecting environmental quality. Therefore, this study proposes some hints for an investor to develop clean & green societies by consideration of two sustainability components, that is, human welfare and a green environment. Undoubtedly, energy is a crucial factor that spurs human development, but at an environmental cost. The burning of traditional energies in daily human & economic activities has been considered a leading cause of global temperature. Therefore, the globe has insisted on utilizing modern energy for faster sustainability. Also, urbanization and information & communication technology (ICT) may have a different association with sustainability. The current paper explores the connection between RE, HDI, urbanization, digitalization, FDI, emissions, and tourism from 2000 to 2020. However, data have been collected from

World Development Indicator, except HDI (Table 2). Figure 1 shows the bees' boxplot graph for selected variables. Table 2 explains the study's chosen variables.

Model Specifications

It is crucial to add the human development index (HDI) to explore the link between social well-being and the Environment. Besides this model, we used URB, ICT, RE, and tourism as determinants of emissions. This study used the first model to inspect the interaction between HDI and environmental alarms to estimate the EKC behavior. The first specification could be written in the following way

$$CO_{2,i,t} = f\left(\beta_0, HDI^{\beta 1}, HDI_{i,t}^{2,\beta 2}, URB_{i,t}^{\beta 3}, RE_{i,t}^{\beta 4}, ICT_{i,t}^{\beta 5}, TR_{i,t}^{\beta 6}, \mu_t\right) \quad (1)$$

However, an earlier study (Liu et al., 2019) proposed the second function, given below

$$CO_{2,i,t} = f\left(\beta_0, FDI^{\beta 1}, FDI_{i,t}^{2,\beta 2}, URB_{i,t}^{\beta 3}, RE_{i,t}^{\beta 4}, ICT_{i,t}^{\beta 5}, TR_{i,t}^{\beta 6}, \mu_t\right) \quad (2)$$

Similarly, by taking the natural log for both models and transform models can be written as well

$$\begin{aligned} lnCO_{2,i,t} = \beta_0 + \beta_1\, HDI_{,i,t} + \beta_2\, HDI_{i,t}^2 + \beta_3\, lnURB_{,i,t} + \beta_4\, lnRE_{,i,t} \\ + \beta_5\, lnICT_{,i,t} + \beta_0\, lnTR_{,i,t} + \mu_t \end{aligned} \quad (3)$$

However, the second model can be written as well

$$\begin{aligned} lnCO_{2,i,t} = \beta_0 + \beta_1\, lnFDI_{,i,t} + \beta_2\, lnFDI_{i,t}^2 + \beta_3\, lnURB_{,i,t} + \beta_4\, lnRE_{,i,t} \\ + \beta_5\, lnICT_{,i,t} + \beta_0\, lnTR_{,i,t} + \mu_t \end{aligned} \quad (4)$$

Table 2. It Shows Study's Variables Description.

4. Variables	Description	Source
URB	Urbanization (urban population growth % annual)	WDI
RE	Renewable energy consumption (% of total energy)	WDI
HDI	Human development index	Knoema
FDI	Foreign direct investment, inflows (% of GDP)	WDI
ICT	Individuals using the internet (% of population)	WDI
TR	International tourism, number of arrivals	WDI
CO_2	CO2 emissions (kt)	WDI

Web sources: https://data.worldbank.org. & https://knoema.com.

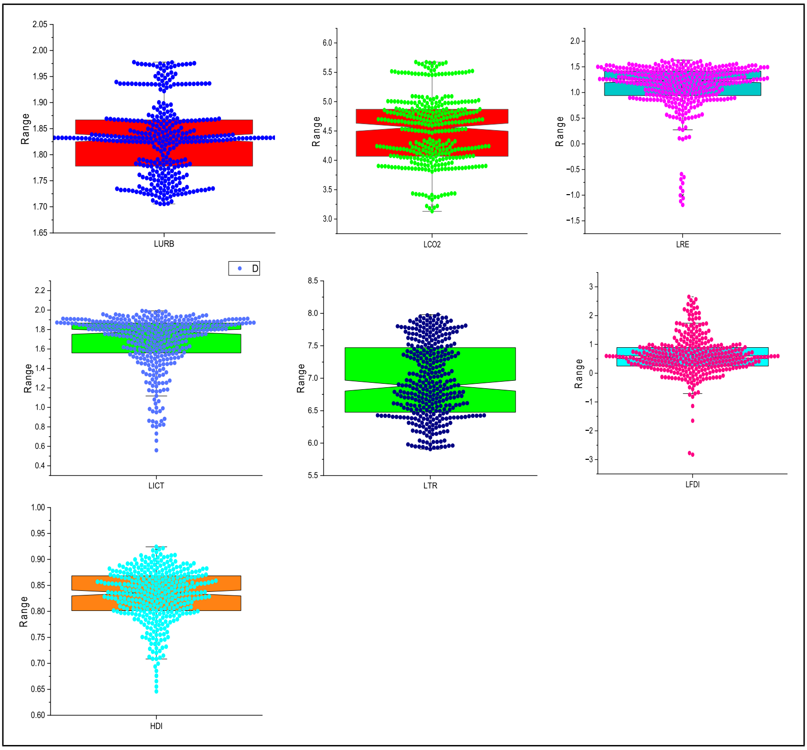

Figure 1. Bees Boxplots of the selected variable.

In the given models (equation 3 & 4), CO_2, $lnURB$, $lnRE$, $lnICT$, and $lnTR$ shows the natural log of CO_2 emissions, renewable energy, information& communication technology, and tourism, respectively. However, i shows cross-section numbers, and *"t"* is the time. However, in equation (3), there is seen *HDI* and its square; the present study tries to investigate EKC-hypothesis (Environment Kuznets curve, EKC) for the developed BRI economies. Similarly, in equation (4), there is the FDI and its square, which this study uses to investigate whether PHH is valid. Again, the current research proposes some hypotheses to check out the response of selected emission determinants. This study imagines that at the initial stage of human development, it would cause emissions, but after its threshold level, it significantly declines emission; therefore, the slopes would be ($\beta_1 > 0$ & $\beta_2 < 0$). Also, the supposition for FDI does not alter from the prior. Moreover, there has been a significant rise in urban areas and utilized the extensive amount of resources that may increase the emissions; thus, its slope would be positive ($\beta_3 > 0$). However, RE is considered the best solution globally to reduce significant emissions, and here we suppose its slope will be negative ($\beta_4 < 0$). Finally, ICT and tourism may cause to variate the environmental situation; therefore, their slope may be harmful ($\beta_5 < 0$) and positive ($\beta_6 > 0$).

Estimation Strategy

The baseline model of this study is constructed on five steps: the first step describes the cross-sectional dependence (CD) test. Therefore, this study uses three different tests to validate the prior expectations of the study, as suggested by Pesaran (2007), Friedman (1937) and Frees (1995). The second is the unit root test to check the stationary variables. However, the present study tries to utilize the advanced data integration test that may be unbiased in the presence of CSD; these integration tests are Covariate-Augmented Dickey-Fuller (CADF) and augmented cross-sectional IPS (CIPS) by (Pesaran 2007). The third is the panel co-integration test. Thus, to investigate the long-term co-integration among selected variables, the current study employs the Westerlund co-integration test proposed by (Westerlund 2007). Besides, by having the robust initial screening, this study tries to investigate the long-run impact of explanatory variables on explained and uses the Augmented Mean Group estimator suggested by (Bond & Eberhardt, 2013). Hence, for robustness, this study also runs the Common Correlated Effect Mean group (CCE-MG) offered by (Chudik et al., 2011). Finally, the current study uses the Dumitrescu Hurlin (D-H) Panel Causality Test to determine the causal association among selected variables (Dumitrescu & Hurlin, 2012). Figure 2 shows the study's estimation strategy.

Empirical Results

This section deals with empirical results that guide the association between environmental determinants. Table 3 depicts the descriptive statistics outcomes. The mean and median values were not significantly different. Therefore, outliers are unlikely to occur in the present panel data. See Table 3, which describes the descriptive statistics of this study. Table 3 displays outcomes based on descriptive statistics

Table 4 shows pairwise correlation results; all variables significantly correlate with the explained variable. However, not even a single variable has more than 0.80, which support our view of no multicollinearity in the given data. Table 4 illustrates the outcomes of the analysis based on the Pairwise Correlation test.

Table 5 shows the outcomes concerning the cross-sectional dependence test. The given results accept our alternative hypothesis: the presence of CSD amid mentioned variables. This study can use the "slope of homogeneity test" on behalf of CSD. See Table 5 here.

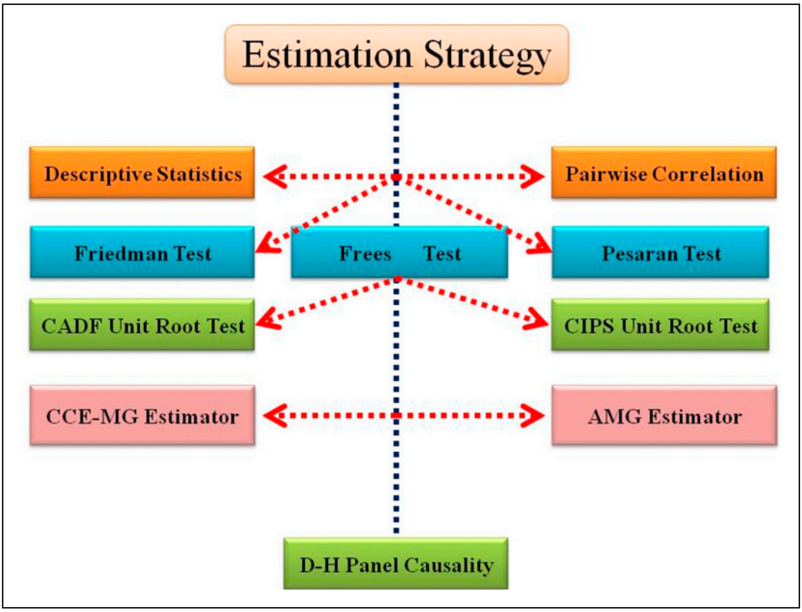

Figure 2. Estimation strategy.

Table 3. It Shows Study Analysis Based on Descriptive Statistics.

	lnCO2	*HDI*	*lnFDI*	*lnURB*	*lnRE*	*lnICT*	*lnTR*
Mean	4.5172	0.8291	0.6082	1.8293	1.1121	1.6686	6.9647
Median	4.6036	0.8351	0.5577	1.8318	1.2322	1.7683	6.8879
Maximum	5.6756	0.9243	2.6547	1.9777	1.6293	1.9918	7.9795
Minimum	3.1303	0.6458	−2.8328	1.7054	−1.1911	0.5579	5.9057
Std. Dev.	0.5767	0.0508	0.6780	0.0702	0.4501	0.2784	0.5689
Skewness	0.0216	−0.8351	−0.2161	0.3008	−2.4625	−1.5619	0.0720
Kurtosis	2.4811	3.7086	7.0192	2.4681	11.260	5.1822	1.8837
Jarque–Bera	3.8399	46.635	23.497	9.1348	13.280	205.71	17.947
Prob.	0.000	0.000	0.000	0.010	0.000	0.000	0.000

Similarly, Table 6 reports the outcomes for the slope of homogeneity. However, both models show the results according to the study's prior expectations. Therefore, the present research can follow the advanced data integration test to sort out the data integration. Table 6 describes the analysis based on the Slope of Homogeneity.

This study integrates data using CADF & CIPS unit root tests. Obtained outcomes suggested that all determinants are integrated at first difference

Table 4. Pairwise Correlation Test.

Variables	*lnCO2*	*HDI*	*lnFDI*	*lnURB*	*lnRE*	*lnICT*	*lnTR*
lnCO2	1.000						
HDI	−0.1375**	1.000					
	0.011						
lnFDI	0.5030*	0.0618**	1.000				
	0.000	0.005					
lnURB	0.3286*	0.4252*	0.3147*	1.000			
	0.000	0.000	0.000				
lnRE	−0.2226*	−0.0658**	−0.4480*	−0.5036*	1.000		
	0.000	0.021	0.000	0.000			
lnICT	−0.1288**	0.5848	0.0383*	0.1922*	0.2229*	1.000	
	0.017	0.000	0.000	0.000	0.000		
lnTR	0.7602*	−0.1727*	−0.4050*	−0.3661*	0.2592*	0.0051**	1.000
	0.000	0.001	0.000	0.000	0.000	0.006	

Note: * and ** show the level of significance at 1% and 5%, respectively.

Table 5. CSDs Test.

Variable	Friedman	Frees	Pesaran
lnCO_2	200.420*	5.817*	30.007*
HDI	336.832*	16.484*	54.150*
lnFDI	62.694*	2.737**	6.990*
lnURB	68.074*	10.577*	7.854*
lnRE	278.816*	10.952*	46.048*
lnICT	339.765*	16.805*	53.512*
lnTR	267.274*	10.645*	42.730*

Note: * and ** show the level of significance at 1% and 5%, respectively.

except the CO_2 emissions, HDI, and urbanization. Therefore, the results are depicted in Table 7.

In the presence of CSD, traditional co-integration approaches may produce biased outcomes; therefore, this study uses advanced co-integration to prove co-integration between variables. See Table 8.

Long Run Estimation Results by AMG Estimator

Table 9 reports the estimated outcomes Augmented Mean Group (AMG). However, this study uses two different models to demonstrate the role of mentioned variable toward sustainability. Model 1 shows the association of

Table 6. Slope of Homogeneity.

Statistics	Delta	*p*-value
Model 1		
Δ	8.832	0.000
Δ Adj.	11.114	0.000
LM	249.4	0.000
LM Adj.	4.347	0.000
LM CD	6.595	0.000
Model 2		
Δ	5.513	0.000
Δ Adj.	7.067	0.000
LM	223.6	0.000
LM Adj.	2.982	0.029
LM CD	6.179	0.000

Table 7. CADF & CIPS Unit Root Tests.

	CADF Unit Root		CIPS unit Root	
Variables	Level	1st Difference	Level	1st difference
lnCO$_2$	−1.958	−3.807*	−1.999	−2.967**
HDI	−1.901	−2.209**	−1.228	−3.956*
lnFDI	−3.377*	−4.494	−3.882	−4.247*
lnURB	−1.912	−3.318*	−1.912	−3.612*
lnRE	−2.852*	−3.389	−2.902*	−3.135
lnICT	−3.011*	−3.949	−3.241*	−3.138
lnTR	−2.399**	−4.250*	−2.999*	−3.838

Note: * and ** show the level of significance at 1% and 5%, respectively.

human well-being and its square with carbon emissions. We can conclude that HDI is positively correlated, but its square shows harmful. It demonstrates that a 1% change in HDI would increase emissions by 13.039%, while its square would cause a decline in emissions by −7.501%, respectively. Such exciting results for selected BRI economies validate the inverted U-shaped EKC hypothesis. This phenomenon can be explainable; over time, with a rise in income, people try to reach their optimum point of human development and don't care for environmental quality, while after the threshold effect, they care for their environmental sustainability, which reduces emissions. With a rise in human development, countries don't compromise with the dirty Environment and insist that consumers should use green & clean sources in their activities that secure the Environment. Likewise, it may be reasoned that in the early stages of growth, countries aim to maximize progress on behalf of traditional energy that spurs tremendous pollution. However, at a later stage of development, governments tried to reduce environmental pollution by using green & clean products. Thus as economic development increases, non-renewable energy consumption went down significantly compared to RE. ED problems could be resolved by using more eco-friendly and green technologies. These outcomes are endorsed by (Kassouri & Altıntaş, 2020), (Li, Qiao, et al., 2022), and (Shah, Naqvi, et al., 2022).

Model 2 demonstrates the FDI's role in environmental pollution to validate the pollution haven hypothesis (PHH) for selected BRI economies. To understand PHH, the quadratic term of FDI is introduced for emissions. Results approved the inverted U-shaped PHH as FDI, and its square is "positively"

Table 8. Westerlund Cointegration Test.

Statistics.	Value.	Z-Value.	*p*-value.	Robust *p*-Value.
Model 1.				
G_t	−2.628	2.484	0.994	0.000
G_a	−2.051	8.400	1.000	0.000
P_t	−7.454	5.103	1.000	0.000
P_a	−2.144	6.888	1.000	0.000
Model 2.				
G_t	−1.915	5.747	1.000	0.000
G_a	−2.254	8.311	1.000	0.000
P_t	−4.734	7.837	1.000	0.000
P_a	−2.054	6.928	1.000	0.000

Table 9. Results of AMG Estimator.

	Coefficient	Std. Error	Coefficient	Std. Error
Variables	Model 1		Model 2	
HD I	13.039*	20.740	—	—
HDI^2	−7.5012*	12.686	—	—
lnFDI	—	—	0.0061**	0.0367
lnFDI^2	—	—	−0.0094*	0.0175
lnURB	13.830*	8.9058	9.8757**	5.5177
lnRE	−0.1788**	0.0615	−0.1884*	0.0651
lnICT	−0.0935*	0.0508	−0.0661**	0.0434
lnTR	0.2353*	0.1558	0.1634*	0.1090
Cons.	29.130**	25.835	15.383*	10.738

Note: * and ** show the level of significance at 1% and 5%, respectively.

and "negatively" associated with CO_2, respectively. In the case of AMG, the coefficient of FDI ($\beta_1 > 0$) and the FDI^2 ($\beta_2 < 0$) advised that a 1% increase in this factor results in a 0.006% upsurge in emissions, while the square of FDI declines ED by 0.009%. Moreover, this describes that foreign direct investment in selected economies may not cause intensive pollution and tries to increase energy efficiency and faster growth. Therefore, the BRI-developed economies have followed the pattern of inverted u-shaped. It is a standard view in the existing literature that less developed economies did not pursue clean & green technologies and relax the environmental regulations to boost their development, in contrast with development economies (Balsalobre-Lorente et al., 2019). Besides, it may not be less valuable that developed economies have attained their development level up to optimum level; now, they focus on energy efficiency via technological effect. Moreover, it is fascinating that developed economies have the absolute advantage in pollution & energy intensive over the developing economies. This outcome is also similar to those (Sarkodie & Strezov, 2019) and (Destek & Okumus, 2019).

Given the coefficient value of URB is positively associated with carbon emissions in specified economies. It concludes that a 1% significant increase in URB would cause of augment in emissions by 13.83% & 9.87%, respectively. This connection can be explained with an economic explanation. Firstly, most people have migrated from rural to urban areas in the urbanization process, resulting in massive construction and development activities. Therefore, the labor force has relocated to urban areas and tries to support the view of two sector economy (Balsalobre-Lorente et al., 2023). However, in emerging cities, the populous may use traditional energies in their human & economic activities. Therefore, more emissions have been increased in urban areas compared with the agricultural sector. Likewise, the logic behind the emissions is urban families' massive use of commercial products and services (Shah, Zhang, & Al-Sulaiti, 2023). Thus, energy use in heating, cooking, and electric equipment causes emissions (Shah, Zhang, Balsalobre-Lorente et al., 2023). Besides, the rising demand for public transport in the city areas also causes emissions. Also, the increasing demand for infrastructure development and energy use in its process is driven by urban emissions. This outcome is supported by (Zhang et al., 2017) and (Shah et al., 2020).

However, RE declines the environmental degradation, which implies that emissions may decrease by 0.178% and 0.188% repressively via a 1% rise in RE under both estimated models. Thus, to secure the Environment, this growing world has taken many initiatives; however, all initiatives aim to ensure world temperature is less than 2 ^{0}C. It is time to save our future generation from the hurdle we face. Therefore, the economies are trying to maximize their green energy use and share of total energy. However, over time the economies are facing severe challenges in renewable energy, especially from the financial sector. Besides, higher authorities must focus on a public-private partnership to resolve such financial constraints and maximize renewable energy usage.

On the other hand, a significant decline in emissions by RE tries to show a clear message that environmental awareness has been penetrated towards the consumer of products. With a rise in development, developed countries' populace becomes rational and raises demand for a clean & green environment. This finding also supports the outcomes of (Adams & Acheampong, 2019); (Saidi & Omri, 2020), and (Zhang, Shah, & Yang, 2022).

Regarding the coefficient ICT, it is inversely associated with CO_2 emissions. It implies that a 1% significant change in digitalization would cause to reduce the level of emissions by 0.093% and 0.066% for the specified models. However, ICT advancement is generally thought to have a positive role in reducing environmental pollution in two ways. Firstly, the maximum usage of ICT would cause a reduction in energy intensity that ultimately reduces ecological harm. Secondly, digitalization may help-out to produce green energies via accessible communication with other energy firms. Besides, in the era of digitalization, human & economic activities have been reduced to an extreme level. In this idea, three sectors may need it urgently to reduce their social, travelling, and time costs. Since 1995, digitalization tries to involve in daily life activities and ultimately achieved the target. Therefore, it has reduced education, shopping, and business activities that may harm the environmental quality. However, such an exciting outcome no longer affects ecological sustainability. Nowadays, the up and down in energy prices is a leading cause of energy demand, and lower prices may compete with RE sources in the long run. It's a core message to BRI-developed economies that the rebound effect is essential, with strict environmental laws and awareness to ensure advancement in ICT would reduce long-term emissions. However, this finding is also supported by (Zhou et al., 2019); (Appiah-Otoo et al., 2022) and (Shah, Naqvi, et al., 2022).

Finally, the given coefficient values of tourism (TR) positively contribute to emissions. It explains there would be a rise in emissions by 0.235% and 0.163%, respectively, due to a 1% rise in tourism activities. However, the number of tourists arriving in the homeland is essential. Therefore, economies face severe challenges in entertaining massive tourism and providing a clean & green environment. Thus, tourist arrivals would cause environmental damage in host economies; therefore, higher authorities must introduce ecological measures to control it (Shakouri et al., 2017). According to the different data sources, tourists move from home to other countries every year to spend their vacations or family functions. Thus the rising trend in tourism needs a massive amount of energy for different sectors such as transport. The transport sector plays a significant role in entraining the tourist and offering its services to move from one place to another, but outdated transport or energy-intensive transport further raises the environmental damage (Balsalobre-Lorente et al., 2021; Ghosh et al., 2022; Jahanger et al., 2022). Another possibility is that the domestic construction activities in the transport sector do not follow international standards. Therefore, residential facilities for a tourist may also contribute to environmental pollution (Dogan et al., 2017). However, tourists also cause carbon emissions via wastage, that is, water, natural resources etc. This result aligns with the study of (Ahmad et al., 2019) and (Liu, Sinha, et al., 2022). See Table 9 here, which provides the outcomes of the AMG Estimator.

Robust Check by CCE-MG Estimator

Table 10 exhibits the outcomes of the CCE-MG estimator, and this study tries to re-investigate the same models for robustness. According to the given results, under model 1, there exists an inverted U-shaped EKC hypothesis. Similarly, model 2 does not significantly differ from the prior estimation concerning the involvement of FDI with emissions. Moreover, RE and ICT significantly contributed to environmental sustainability in selected economies. Similarly, urbanization and tourism sectors cause ecological damage in the long run. See Table 10, which offers the outcomes of the CCE-MG estimator.

The D-H panel causality is employed (Dumitrescu & Hurlin, 2012) to demonstrate the causal association between selected variables. The results show the bi-directional association between the URB and carbon emissions for the selected economies. It infers that urban development and environmental policies are working together, and any significant change in URB

Table 10. Results of CCE-MG Estimator.

	Coefficient	Std. Error	Coefficient	Std. Error
Variables	Model 1		Model 2	
HD I	37.8053*	31.536	—	—
HDI^2	−21.450*	18.380	—	—
lnFDI	—	—	0.0166**	0.0310
lnFDI^2	—	—	−0.0028*	0.0164
lnURB	17.012**	16.214	6.8743*	3.5017
lnRE	−0.2929*	0.0562	−0.1723*	0.0572
lnICT	−0.0587*	0.0641	−0.0143**	0.0547
lnTR	0.3871**	0.2368	0.0262**	0.1753
Cons.	27.182*	45.875	6.5600*	9.6428

Note: * and ** show the level of significance at 1% and 5%, respectively.

would cause ED (Local Burden of Disease 2021). Moreover, there exists a feedback hypothesis between tourism and emissions. Likewise, a one-way causal association exists between HDI to emissions. Also, CO2 emissions granger causes FDI. Finally, a uni-directional connection between ICT & TR to CO2 was seen. However, the graphical presentation is given below. Figure 3

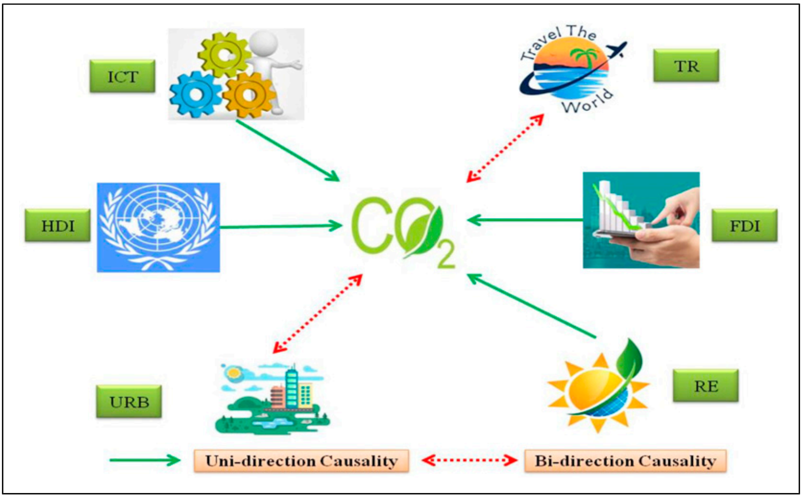

Figure 3. Graphical presentation of Granger causality.

Table 11. Results of D-H Panel Causality.

Null hypothesis:	W-Stat.	Zbar-Stat.	Prob.
$HDI \gg lnCO_2$	4.604	3.346	0.000
$lnCO_2 \gg HDI$	2.853	0.731	0.464
$lnFDI \gg lnCO_2$	2.994	0.811	0.417
$lnCO_2 \gg lnFDI$	3.846	2.011	0.044
$lnURB \gg lnCO_2$	4.900	3.789	0.000
$lnCO_2 \gg lnURB$	3.717	2.021	0.043
$lnICT \gg lnCO_2$	4.063	2.538	0.011
$lnCO_2 \gg lnICT$	2.350	−0.019	0.984
$lnRE \gg lnCO_2$	5.534	4.736	0.000
$lnCO^2 \gg lnRE$	3.294	1.390	0.164
$lnTR \gg lnCO_2$	4.194	2.735	0.006
$lnCO_2 \gg lnTR$	3.845	2.212	0.026

shows the visual representation of the GC test. See Figure 3 and Table 11 that explains results of D-H Panel Causality.

Conclusion

This empirical study highlights the critical factors of environmental degradation in selected developed economies under the Belt and Road Initiative (BRI). Therefore, the current research focuses on human well-being, FDI, urbanization, RE, tourism, and information & communication technology from 2000 to 2020. The estimated outcomes by AMG & CCE-MG estimators show the inverted U-shaped EKC hypothesis and pollution halo effect in specified economies. Moreover, renewable energy and ICT perform well in securing environmental quality. In contrast, urbanization and tourism cause environmental pollution. This study uses the D-H panel causality test to examine variable causation.

Some immediate policy recommendations for achieving environmental sustainability are provided. The current shape of the EKC curve indicates that the growth model in specified economies does not favor a sustainable environment. Because there has been an increasing trend in emissions with a rise in human development until the threshold point, the entire policymakers and higher authorities must focus on environmental policies in parallel with development plans. At this time, the green industry and its infrastructure are highly recommended. Urban development has seen overcrowding and non-productive human activities, which cause rising emissions. Therefore, specified economies must shift their metropolitan areas to green cities with all eco-friendly facilities. The FDI's inverted u-shaped relationship with emissions supports the PHH. In light of outcomes, it is a clear message by specified economies that at their initial level, they offer FDI inflows at every cost of environmental deterioration, but later they prefer sustainability. Moreover, the government should establish a carbon trading market that helps reduce emissions.

However, urbanization is positively associated with carbon emissions. Such a positive trend is a clear message to policymakers that BRI-developed economies have not achieved the scale effect contributing to environmental degradation. URB uses an immense ratio of energy-intensive products at this stage, which consume more energy and cause emissions. Moreover, urbanization also contributes to the economic progress of economies, but at the current location, the industrial sector is not energy efficient; therefore, consumption is dominant on the scale effect. Thus, higher authorities should encourage green urbanization and try to overlook development programs. However, green transport and energy-efficient technologies are highly recommended for the selected regions.

No doubt renewable energy performs well in reducing emissions, but there is still a need for more focus on such initiatives in parallel with development. Thus, subsidizing old energy sources must be reduced and green and clean energy should be promoted. Moreover, green development plans should include environmental regulations and awareness. However, the massive use of green energy in the total energy mixes benefits sustainability and may cause green development. Thus, policymakers must reshape their energy policy and insist consumers shift their energy taste from traditional to modern. Likewise, ICT significantly reduces emissions and can perform more accurately if higher authorities should focus on sustainable electricity for ICT equipment. Currently, the ICT network is playing on behalf of electricity produced by traditional energy sources. Thus, it is necessary to use green energy in ICT inputs to secure sustainability.

Similarly, tourism in specified economies is deteriorating environmental sustainability. It is a common belief that rising emission is due to a lack of adequate mitigation options in the tourism sector. Therefore, policy analysts should try to introduce energy-efficient tourism industry infrastructure that would cause emissions reduction. In the growing world, tourism is based on five sectors: shopping, catering, accommodation, entertainment, and transportation. However, engaging with an immense ratio of tourists and facilitating those remains a crucial challenge. There is a need to re-think the tourism policy and ensure clean & green facilities.

Similarly, the current study has some boundaries. Firstly, the present study employs an advanced estimation series superior to 1^{st} generation techniques, but future studies can follow some non-linear estimation techniques that may produce different results. Moreover, future studies can test our outcomes by utilizing various environmental measures such as ecological footprint, NO_X, and SO_2. Thus, it may be a chance that selected environmental determinants may behave differently in this region. Moreover, future studies should consider some governance factors, such as corruption, government stability, and the rule of law, which may produce different outcomes. However, other regions may have various consequences that must be considered.

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