



Saba Aziz¹, Dr. Zahid Pervaiz²

¹PhD Scholar, National College of Business Administration and Economics (NCBA&E), Lahore,

Email: sabaaziz27@gmail.com

²Associate Professor, Department of Economics, National College of Business Administration and Economics

(NCBA&E), Lahore, Email: drzahid@ncbae.edu.pk

KEYWORDS	ABSTRACT
Carbon emissions, Environmental Kuznets Curve, Economic growth, Institutional quality, South Asian economies	Climate change mitigation is now a global concern of key importance, especially in developing regions where economic growth, urbanization and rising energy consumption are driving up carbon emissions. Sustainability is a complex issue in South Asian economies, where achieving economic growth and tackling environmental degradation are intertwined challenges. In this study, institutional quality, economic growth, squared economic growth, foreign direct investments and urbanization are explored as key determinants of the carbon emissions for seven South Asian economies comprising Bhutan, Pakistan, India, Maldives, Nepal, Bangladesh and Sri Lanka, for time period of 2002-2024. The quality of institutions is captured in an index combining government effectiveness, rule of law, control of corruption and regulatory quality. The panel quantile regression results show that there is a consistent negative linkage between institutional quality and environmental degradation at every level, indicating that sound institutional governance is crucial for environmental sustainability. Economic growth first does raise emissions and the negative impact of squared income validates the Environmental Kuznets Curve hypothesis. Additionally, foreign direct investment and urbanization leads to higher emissions, due to carbon-intensive investment processes and rapid urbanization in the region. The results highlight the need to build institutional capacity to support the implementation of effective climate policies and to speed up low-carbon development pathways. This study contributes to the Sustainable Development Goals (SDGs) and identifies governance-led solutions to sustainable environmental management.
ARTICLE HISTORY Date of Submission: 15-08-2026 Date of Acceptance: 16-09-2026 Date of Publication: 21-09-2026	
Correspondence	Saba Aziz
Email:	sabaaziz27@gmail.com
DOI	https://doi.org/10.59075/jsrd.v7i7.519
Volume/Issue	7(7), 2026, 207-224

2026 Journal of Social Research Development

Introduction

Globally, climate change has emerged as one of the most serious environmental issues of the 21st century, feared to have severe consequences for ecosystems, economies and people. Global warming, along with associated climate risks such as warming, extreme weather, rising sea level, and degradation of ecosystems, has risen as a result of the persistent growth of greenhouse gas (GHG) emissions, especially carbon dioxide (Filonchyk et al., 2024; Bashir et al., 2026). Carbon emissions (CE) are the largest anthropogenic contributor to climate change among other anthropogenic contributors because of their close association with energy generation, industrial processes, transportation and fossil fuel usage. Rapid industrialization and rising energy demand, and economic development, have further heightened the global reliance on carbon-intensive energy systems, leading to continued growth in the concentration of carbon in the atmosphere (Akram et al., 2026; Sindhu et al., 2018). Technological progress, renewable energy use, and energy efficiency are key issues in emission reduction, but for long-term environmental sustainability, more knowledge is needed about structural aspects that affect the emissions (Zhang et al., 2025). The ability of countries to respond to environmental pressures is the result of a mix of economic activities, demographic shifts, investments and governance arrangements. So, besides technological solutions, strong institutional structures are required to develop, implement and enforce sustainable environmental policies to counteract climate change. In this context, carbon emissions are important measures of environmental performance and the main dependent variable used to evaluate factors affecting climate sustainability.

South Asia is a region of great importance for the study of carbon emission dynamics because of its rate of economic change and rising energy demand and environmental pressures (Hassan et al., 2025, Akhtar et al., 2024). Among the countries that comprise the region, the economies of Bhutan, Pakistan, India, Maldives, Nepal, Bangladesh, and Sri Lanka have all seen significant economic growth. The region's energy demand has greatly grown in terms of fossil fuel consumption for electricity generation, transportation and industries, which has also altered the carbon emission patterns in the region. In addition, increasing population and urbanization have added strain to energy and natural resource systems, which has posed further obstacles in sustainable development. Even though the contribution of emissions from SA countries to global emissions is small, while some effects of climate change are still very high in these countries, such as extreme weather events and future changes in precipitation, temperature, and sea level. Given the context of this study, the author selects a group of seven South Asian economies to examine the role of these four factors in determining carbon emissions.

An increase in the amount of energy consumed and resources extracted is one of the most significant contributors to environmental change, and economic growth tends to be accompanied by an increase in production activities, industrial expansion and consumption patterns (Rehman et al., 2022; Huang et al., 2023). In the developing economies, economic development comes with the rising CE for the reliance on fossil fuels. The correlation however, between economic growth and environmental pollution is not necessarily linear. The EKC hypothesis implies that the environmental pressure rises as the economy grows, but can decrease when the income level passes

a critical point as a result of technological progress, energy efficiency, structural change and environmental awareness (Lau et al., 2025). In the South, where development goals are still strongly tied to industrialization and economic growth, the growth–emission nexus is of special significance (Abbas and Pervaiz, 2020). As economies develop, some develop carbon emissions more rapidly during the early stages due to greater energy demands and production, while others enable investment into cleaner technologies and sustainable management practices. Hence, this study adds the nonlinear effect to the linear effect of economic growth to investigate that how the economic development helps in emission reduction.

In addition to the economic and demographic characteristics, quality of institutions is now considered as a fundamental factor that effects the role of policy design, institutional enforcement, and resource management, which in turn is crucial to environmental sustainability (Li et al., 2022). However, production activities and patterns of energy usage are not the only underlying drivers of ecological challenges like the effectiveness and robustness of institutional arrangements is key to how countries are able to respond and manage these challenges. Effective environmental governance is facilitated by strong institutions, which can help design effective policies, improve regulatory compliance, strengthen monitoring and regulate, and thus promote sustainable long-term decision-making. Weak institutional structures can, on the other hand, lead to high emissions as a result of ineffective regulation, corruption, inadequate policy implementation and inefficient resource allocation (Akpan and Kama, 2024). Countries with unaccountable and/or weak enforcement systems might not be able to enforce environmental laws, which can result in unsustainable industrial activities and over-exploitation of natural resources. Hence, institutional quality is an important policy lever for governments to affect carbon emission path. This study bases on the institutional dimension by incorporating it in a comprehensive institutional quality index thus pointing to the governance-based channels through which institutional improvement can play a role in reducing carbon emissions in South Asian economies.

Foreign direct investment (FDI) and urbanization are key socioeconomic drivers that have impacts on carbon emissions, especially in developing nations. FDI could impact environmental quality either in positive or negative ways. According to the Pollution Haven Hypothesis, developing nations with weaker environmental regulatory framework may attract pollution-intensive industries, resulting in high carbon emissions. Whereas, the Pollution Halo Hypothesis states that foreign investment may lead to a better environment through the transfer of more advanced technologies, cleaner production processes and better environmental management (Liu et al., 2024; Kisswani and Zaitouni, 2023). Thus, the effects on the environment of FDI are to a large extent dependent on institutional capacity and type of FDI flows. Likewise, the process of urbanization has an impact on carbon emissions by driving up energy consumption, transportation, infrastructure development and waste (Pu et al., 2022; Malik et al., 2024). But with appropriate urban development, the use of public transport, the efficiency of resource management and sustainable infrastructure can improve environmental efficiency. The impacts of FDI and urbanization on carbon emissions are context dependent, as South Asian economies have very different developmental conditions. Hence, the present study adds these two variables, namely FDI and urbanization as other factors to affect the carbon emissions.

Literature on carbon emissions has tended to focus on economic and socioeconomic factors, such as economic growth and energy use, as well as trade and FDI, and environmental role of institutional quality is overlooked. This study fills this gap by highlighting governance capacity as one of the key factors affecting environmental sustainability in the South Asian economy. In addition, existing studies have tended to focus on specific governance indicators, rather than on building up a more complete governance quality framework, which would account for several aspects of governance. The current study builds upon the previous research by developing an institutional quality composite indicator which is computed as a function of four factors; namely the government effectiveness, control of corruption, rule of law, and regulatory quality. It also combines institutional performance and economic growth, FDI and urbanization under a single panel for seven economies of South Asia for time span of 2002-2024. The results have policy implications as they show the potential of enhanced institutional capacity to assist effective carbon management and ensure low carbon development pathways in the region.

Literature Review

Institutional Quality and Carbon Emissions

Traditionally, the determinants of carbon emissions have been analyzed in the context of economic growth, energy usage, industrial expansion and globalization. In recent years, however, environmental economics literature increasingly points to the fact that variations in emission patterns within a group of countries of comparable development cannot solely be explained by economic factors. Institutional quality is also a key structural determinant as environmental sustainability is highly dependent on environmental policies that are well-designed, well-implemented and well-enforced by institutions. Cao et al. (2022) and Fatima et al. (2022) pointed out the influence of globalization, economic growth and energy-related factors on emissions, which are strongly shaped by institutional capacity in their environmental impacts. Likewise, Yang et al. (2022) highlighted the importance of governance structures on the link between socioeconomic inequalities and development processes and their environmental impacts. More recently, Erena et al. (2026) concluded that institutional effectiveness is a key determinant in the relationship between globalization, industrialization, and environmental quality, which implies that the governance structure is crucial to control the environmental impacts of economic transformation. Institutional quality has been the subject of growing interest as it is possible to strengthen environmental regulation, build up the credibility of policies and diminish environmentally harmful activities. To join in this discussion, Amin et al. (2022) created an extensive index of institutional quality and found that an index of institutional performance is more reflective of institutional quality than single indicators alone, where all individual indicators enhanced ecological quality. Likewise, Adedoyin et al. (2022) tried to explore the linkage between financial development and the other factors as well as the influence of institutional quality on the association between FDI and emissions, and they found that the IQ parameters have a role in whether a link between FDI and carbon emissions is positive or negative. The results suggest that institutions are a channel through which policies have a significant impact on their success or failure. Maduka et al. (2022) examined whether IQ had a moderating effect in the relationship between economic

growth and carbon emissions, and concluded that higher institutional quality is an effective way to mitigate negative ecological implications of the growth process. Building on this, Kinuthia et al. (2025) analyzed the relationship between economic growth, financial development and emissions, finding that the environmental impacts of development processes depend on the quality of the institutions. The studies reveal governance quality as a part of the overall socioeconomic factors should not be considered as such but as a basic governance framework by which countries conduct carbon-intensive growth.

Economic Growth and Environmental Degradation

This is because growth has always been important in environmental research, as development of industry, energy use, transportation demand, and infrastructure tends to grow as income rises. The EKC hypothesis states that ecological pollution worsens in the initial phase of development but improves when a higher level of income is reached as a consequence of technological development, structural change and increased environmental consciousness. The validity of the EKC, however, is still under debate, especially for developing countries where growth is often driven by fossil fuel-intensive industries. Institutional quality has been recognized as a key factor in shaping an economic development path as sustainable or not, in recent studies. Nguyen et al. (2026) found an inverted U-shaped curve of economic growth and carbon emissions in developing nations and highlighted the role of institutional development for the transition towards cleaner development. Likewise, Nwobu et al. (2026) concluded that the quality of institutions and energy intensity are two mechanisms that jointly determine the emission outcome in the BRICS economies and therefore, economic growth is of no consequence towards the improvement of the environment. The IQ plays a supportive role between structural transformation and carbon emissions in emerging economies as well (Hamrouni et al., 2025). Furthermore, Alam et al. (2025) revealed that IQ is a balancing factor between economic development and ecological sustainability in BRICS region. These results warrant the presence of GDP per capita and its square to account for potential nonlinear growth–emission relationships.

Foreign Direct Investment and Environmental Degradation

The other important factor which affects the environmental quality is FDI, which is ambiguous from the theoretical context. It is critical to note that the developing countries with less stringent regulatory mechanisms could become a pollution haven for polluting industries, which would be a detrimental effect for the reduction of CE. Moreover, developing countries with less stringent regulatory mechanisms could be a pollution haven for polluting industries, which would be a detrimental effect for the reduction of carbon emissions, as described in the Pollution Haven Hypothesis. However, the Pollution Halo perspective highlights that FDI can lead to better ecological performance by means of technological transfer, better management practices and cleaner production techniques. Thus, the influence of FDI on the emissions is heavily dependent on institutional capacity and regulatory environment. Huang et al. (2022) analyzed the impact of regulatory quality on the link between FDI and emissions and concluded that IQ is a significant moderator in developing the favorable role of FDI for reducing emissions. Likewise, Bouchoucha

(2024) revealed that the institutional quality in the MENA economies can counteract the adverse ecological consequences of FDI, thus highlighting the need for institutional protection to attract sustainable FDI. Khan et al. (2026) used PQR method and found that the effect of FDI on the environment varies by income groups, which indicates that the impacts of FDI are not homogenous. Wang et al. (2023) further elaborated the discussion by revealing that the institutional quality modifies the impact of FDI on the economic and environmental outcomes. Additionally, Jahanger et al. (2023) noted that good governance is essential to ensure that the use of resources and globalization are not degrading the environment but promoting sustainable development.

Urbanization and Environmental Pollution

Urbanization is also a significant contributor to carbon emissions, notably in developing areas where a changing population and infrastructure is accelerating. Urban sprawl leads to more energy use associated with transportation, residential living, building construction and industrial production. The effects of urbanization, however, are highly dependent on how efficiently it is designed, how effective the institutions are, and the quality of the infrastructure. Khan et al. (2023) conclude that although urbanization is likely to produce emissions in general, but better IQ can reduce the environmental impacts of urbanization by enhancing regulation and planning. Likewise, Lee et al. (2022) found that the non-uniform impacts of urbanization and IQ on GHG emissions in BRI region indicate that institutional differences drive GHG emission disparities in urban areas. Wang et al. (2026) also highlighted the association between urbanization, green finance and institutional quality in Asian economies in driving low-carbon transitions. Governance-related measures for supporting renewable energy investments and mitigating ecological risks in ASEAN economies also demonstrated by Zheng et al. (2026), underscoring the significance of governance-based sustainability strategies.

Research Gap

While previous research has significantly advanced the understanding of determinants of carbon emissions, there are still several gaps. First, many studies have been conducted on countries that have joined the OECD, BRICS, ASEAN, Belt and Road, MENA, and a few individual countries, with South Asian economies being still relatively under-researched even though they are undergoing a rapid economic transformation and facing high climate risks. Second, many studies use individual governance indicators instead of measuring quality of institutions; this may not be sufficient to measure multidimensional performance of the institutions. Third, research so far is largely based on average relationships, thereby failing to acknowledge variation between low and high emission economies. The current study seeks to overcome these drawbacks by analyzing seven South Asian economies from 2002–2024 with a composite measure of institutional quality that combines government effectiveness, rule of law, control of corruption and regulatory quality. Moreover, the usage of panel quantile regression allows to determine the heterogeneous impacts of institutional quality, economic growth, FDI, and urbanization at different levels of carbon emission. This study brings together governance, economic, investment and demographic components in one

package, to generate new evidence of the role that institutional strengthening can play in supporting low carbon development pathways in South Asia.

Data and Methodology

Model Specification

This study examines the association between institutional quality and carbon emission for a balanced panel of seven South Asian countries in the time span 2002-2024. These countries have been chosen because they share some common attributes, such as the high rate of economic change, the growing need for energy, urbanization and different degrees of institutional maturity. All variables are identified from theoretical relevance and empirical works found in relevant literature in environmental economics. The empirical analysis is conducted in a framework of panel data econometrics that takes into account the impact of the IQ on emissions, while accounting for economic and demographic factors. Variable description is given in Table 1.

Table 1. Variable Description

Variable Name	Position of variables	Symbol	Proxy	Data Source
CO2 Emissions	Dependent	CE	CO2 emissions (metric tons per capita)	World Bank, 2025
Institutional Quality	Independent	IQ	Institutional quality index (based on 4 sub-components including government effectiveness, rule of law, control of corruption, and regulatory quality)	WGI, World Bank, 2025
Economic Growth	Independent	EG	GDP per capita (current US\$)	World Bank, 2025
Squared Economic Growth	Independent	EGSQ	Squared GDP per capita (current US\$)	World Bank, 2025
Foreign Direct Investment	Independent	FDI	FDI Net Inflows (Share of GDP)	World Bank, 2025
Urbanization	Independent	URB	Urban Population (Share of Total Population)	World Bank, 2025

Functional and econometric forms of the model are given in equation 1 and 2.

CE = f(EG, EGSQ, IQ, FDI, URB) (1)

CE_{it} = α_i + β₁EG_{it} + β₂EGSQ_{it} + β₃IQ_{it} + β₄FDI_{it} + β₅URB_{it} + ε_{it} (2)

Panel Quantile Regression Method

The study uses panel quantile regression (PQR) analysis to investigate the differential effects of IQ and other socioeconomic factors on CE at various levels of emissions. The panel quantile regression model can estimate the effect of explanatory variables on the carbon emissions at different quantiles of the conditional distribution of carbon emissions, which is different from the conventional panel regression model that estimates only the average effect. This method is especially appropriate for the South Asian region, where there are significant variations in emission intensity across countries, and the level of institutional capacity and development experiences. The model estimates the impacts of IQ, economic growth, squared economic growth, FDI and urbanization at various quantiles (0.10, 0.20, ..., 0.90), providing a better understanding of the impacts of governance factors in low and high emission economies. The quantile-based approach offers more solid and policy-relevant evidence by testing if enhancing institutional quality leads to the same level of environmental benefit across all parts of the emission distribution. This approach allows the study to go beyond average effects and to give a holistic view on the dynamics of carbon emissions in South Asia as driven by governance.

Econometric form of the PQR technique is shown in equation 3.

$$CE_{it} = \beta_g X_{it}^\circ + \varepsilon_{it}; \text{Quant}_g(CE_{it}|X_{it}) = \beta_g X_{it}^\circ \quad (3)$$

The X° in above equation, contains vector of independent variables comprising EG, EGSQ, IQ, FDI, and URB, and ε is error term. Whereas, $\text{Quant}_g(CE_{it}|X_{it})$ represents conditional quantile dependent variable carbon emissions.

Results and Discussion

Descriptive statistics

Table 1. Descriptive Statistics of Variables

	CE	EG	EGSQ	IQ	FDI	URB
Mean	3.131203	7.471234	56.61139	-0.384281	2.105591	15.94687
Median	2.883711	7.338448	53.85282	-0.341634	0.879528	16.68873
Maximum	8.056373	9.501468	90.27789	0.688012	16.78347	20.05642
Minimum	-0.739401	5.476009	29.98668	-1.193575	-0.638806	11.37549
Std. Dev.	2.573186	0.892750	13.54222	0.455602	3.216375	2.745675
Skewness	0.301831	0.207979	0.484803	0.395620	2.503280	-0.255330
Kurtosis	2.025258	2.631820	2.775625	2.333505	8.736141	1.749701
Jarque-Bera	8.818306	2.070048	6.644481	7.179779	388.8751	12.23614
Probability	0.012165	0.355218	0.036072	0.027601	0.000000	0.002203
Sum	504.1236	1202.869	9114.434	-61.86920	339.0002	2567.445
Sum Sq. Dev.	1059.406	127.5205	29342.65	33.21176	1655.211	1206.197
Observations	161	161	161	161	161	161

Table 1 shows descriptive summary of variables of the study for the seven South Asian economies over 23 years (period 2002–2024) with 161 balanced panel observations. The carbon emission index (CE) has an average of 3.131 metric tons per capita with a high variation between countries ranging from -0.739 to 8.056. The mean value of the variable EG is 7.471, and the mean value of the EGSQ is 56.611; that's why the study covers both the linear and the nonlinear effect of economic growth on environmental degradation. The institutional quality index (IQ) has an average score of -0.384, with the lowest score of -1.194 and the highest score of 0.688, indicating the wide differences in the performances of South Asian economies. IQ differences reflect differences in the effectiveness of institutions, regulatory capacity, and governance institutions. The mean value of foreign direct investment (FDI) is 2.106% of GDP, which is in the positive side with high dispersion, indicating that the amount of FDI received by the countries has varied over time and among them. The average value of URB is 15.947, showing a continuous urban development in the region. The descriptive findings show that there is significant cross-country variation, as well as between the economies of the South Asian countries, in environmental conditions, economic development, institutional strength, investment flows and urbanization levels. These differences offer a good basis for further econometric analysis by panels of the determinants of carbon emissions.

Unit Root Tests

Table 2. Results of Unit Root Tests

Indicator	Im, Pesaran, Shin test		ADF test	
	I[0]	I[1]	I[0]	I[1]
CE	0.34144	-3.73935***	9.79501	38.0492***
EG	-1.57116**	-4.69303***	21.5894*	49.0941***
IQ	-1.49534*	-5.73367***	28.1055**	59.0573***
FDI	-2.22412**	-7.93242***	25.9975**	82.5084***
URB	0.94483	-1.85383**	21.0627	27.4317**

“*, ** and ***” represents significant level at 10%, 5% and 1%, respectively.

The Im, Pesaran and Shin (IPS) and Augmented Dickey–Fuller (ADF) tests are used for stationarity check (Table 2). To prevent spurious regression results and to obtain reliable results from panel econometric analysis, it is necessary to test for stationarity. The results show that the variables have a mixed order of integration as the variables are stationary at level I(0) and others at level I(1). Considering the EG, IQ, and FDI, the IPS and ADF results show that all three series are stationary, making them suitable for further analysis. For some specifications, the variables of CE and urbanization (URB) are found to be non-stationary at level and stationary at first difference, which is equivalent to integration of order one. Importantly, no variables are integrated across more than I(1), thus fulfilling the necessary condition for applying the panel estimation methods.

Cointegration Estimations

Table 3. Panel Cointegration Estimates

Test Statistics	Statistic	Prob.	Weighted Statistic	Prob.
Pedroni Test (Within-dimension, Panel based)				
v-statistic	~ 2.0069	0.9776	-1.4013	0.9194
rho-statistic	-2.7206	0.0033***	-1.5702	0.0502**
PP-statistic	-5.7837	0.0000***	-4.4151	0.0000***
ADF-statistic	0.3163	0.6241	0.0591	0.5236
Pedroni Test (Between-dimension, Group based)				
rho-statistic	-5.0137	0.0017***	—	—
PP-statistic	~ 3.3029	0.0005***	—	—
ADF-statistic	-0.0503	0.4799	—	—
Kao Residual Cointegration Test				
ADF statistic	-3.1913	0.0007***	—	—
** and *** represents significant level at 5% and 1%, respectively.				

Table 3 summarizes the cointegration outcomes to check whether there is a long-term equilibrium linkage among carbon emissions and explanatory variables, such as IQ, economic growth, FDI and urbanization. This analysis is done with the Pedroni residual cointegration tests (Pedroni, 1999) as well as with the Kao residual cointegration test (Kao, 1999). The results of Pedroni test indicate that there is strong evidence of cointegration between the variables. The Panel rho-statistic and the Panel PP-statistic with a 1% confidence level are significant, rejecting the null hypothesis of no cointegration. The weighted Panel PP-statistic also supports the significant long run association among the variables. In spite of the insignificance of the Panel v-statistic and Panel ADF-statistic, most of the other test statistics agree with the cointegration hypothesis. The results in between dimensions also support these findings as both Group rho statistic and Group PP statistic are significant at 1% level confirming the long-run dependence between individual South Asian economies. Additionally, the Kao residual cointegration test yields a significant ADF statistic ($p < 0.01$) suggesting further stability of the long-term relationship. In conclusion, the cointegration results validate that the relationship among carbon emissions, institutional quality, economic growth, foreign direct investment and urbanization is a long-run relationship. Hence, panel regression analysis is suitable for estimating long-term effects of IQ and other socioeconomic variables on carbon emissions in the SA economies.

Panel Quantile Regression Analysis

Table 4. Panel Quantile Regression method

	Quantile	Coefficient	Std. Error	t-Statistic	Prob.
EG	0.100	2.345012	1.864674	1.257599	0.2104
	0.200	4.079483	1.452462	2.808668	0.0056***
	0.300	3.689653	1.020936	3.613989	0.0004***
	0.400	3.668082	0.886819	4.136224	0.0001***
	0.500	3.676383	0.828659	4.436544	0.0000***
	0.600	2.163297	2.578697	0.838911	0.4028
	0.700	1.142832	1.320411	0.865513	0.3881
	0.800	0.960637	1.179082	0.814733	0.4165
	0.900	-0.251364	1.543930	-0.162808	0.8709
EGSQ	0.100	-0.091086	0.123764	-0.735966	0.4629
	0.200	-0.205082	0.095617	-2.144841	0.0335**
	0.300	-0.204772	0.068503	-2.989254	0.0033***
	0.400	-0.210300	0.060810	-3.458334	0.0007***
	0.500	-0.210893	0.056432	-3.737093	0.0003***
	0.600	-0.110670	0.169473	-0.653027	0.5147
	0.700	-0.046155	0.087316	-0.528596	0.5978
	0.800	-0.037974	0.078125	-0.486069	0.6276
	0.900	0.035019	0.102028	0.343226	0.7319
IQ	0.100	-1.157090	0.303632	-3.810832	0.0002***
	0.200	-0.831908	0.139344	-5.970189	0.0000***
	0.300	-0.834036	0.099476	-8.384326	0.0000***
	0.400	-0.731293	0.081468	-8.976428	0.0000***
	0.500	-0.670440	0.085766	-7.817052	0.0000***
	0.600	-0.630740	0.114627	-5.502531	0.0000***
	0.700	-0.636709	0.096318	-6.610493	0.0000***
	0.800	-0.779138	0.139441	-5.587584	0.0000***
	0.900	-0.841608	0.104804	-8.030327	0.0000***
FDI	0.100	0.055522	0.043175	1.285956	0.2004
	0.200	0.052104	0.022115	2.356015	0.0197**
	0.300	0.084655	0.025047	3.379908	0.0009***
	0.400	0.095877	0.030870	3.105871	0.0023***
	0.500	0.109439	0.025854	4.233034	0.0000***
	0.600	0.099213	0.034053	2.913481	0.0041***
	0.700	0.093315	0.021270	4.387179	0.0000***
	0.800	0.088866	0.024790	3.584712	0.0005***
	0.900	0.094660	0.036128	2.620090	0.0097***
URB	0.100	1.172215	0.032226	36.37432	0.0000***
	0.200	1.127037	0.027422	41.09907	0.0000***

0.300	1.090328	0.017732	61.48983	0.0000***
0.400	1.077120	0.016327	65.97123	0.0000***
0.500	1.070046	0.014328	74.68200	0.0000***
0.600	1.070194	0.015373	69.61299	0.0000***
0.700	1.064940	0.012313	86.48722	0.0000***
0.800	1.059578	0.021216	49.94298	0.0000***
0.900	1.042265	0.019705	52.89476	0.0000***

“*, ** and ***” represents significant level at 10%, 5% and 1%, respectively.

The panel quantile regression results in Table 4 show that the impact of institutional quality, economic growth, FDI, and urbanization on carbon emissions is heterogeneous depending on the emission level. With quantile regression, the effect of the determinants is estimated in the full range of countries in the distribution of carbon emissions, as opposed to only the average effect as in other regression approaches.

The findings reveal that the effect of institutional quality on carbon emissions is consistently negative (in all quantiles from 0.10 to 0.90) and statistically significant. The coefficient is negative, ranging from -1.157 at the 10th quantile to -0.842 at the 90th quantile, and is significant at the 1% level across the board. The fact that it is confirmed that more robust institutions are associated with fewer carbon emissions in this finding validates the core hypothesis of the study. Better governance, in terms of effective implementation of policy, enforcement of regulations, corruption control and legal accountability, seems to positively affect environmental management of South Asian economies. Similar outcomes are found by Salman et al. (2019) in case of Thailand, North Korea, and Indonesia. The negative correlation across all emission levels indicates that institutional quality continues to be an important driver for low-carbon development.

The middle quantiles show a positive and significant relationship between economic growth and Carbon emissions. The impact is substantial at the 20th to 50th quantiles, suggesting that economic growth drives up emissions, especially for economies with moderate emissions. The values of the coefficients at the higher quantiles, however, are relatively small, indicating a diminishing effect of economic growth for economies with high emissions. The squared economic growth term exhibits negative and significant value for economic growth at quantiles ranging from 0.2 to 0.5, thus lending some support to the EKC hypothesis. This means that beyond a certain point of economic development, continued economic growth can help reduce emissions by virtue of improved technologies and structural development (Rock Voda et al., 2026; Akar et al., 2025).

The results show that foreign direct investment positively affects carbon emissions from the 20th to 90th quantile and the relationship is statistically significant. The coefficients are positive at all quantiles which indicates that more foreign investment leads to more emissions in the economies of South Asia. This finding is consistent with the Pollution Haven Hypothesis, implying that some FDI inflows could be linked with the pollution-intensive industrial sectors in developing countries with less developed regulatory regimes (Ha et al., 2026; Islam et al., 2026).

Carbon emissions are influenced by urbanization with highly significant coefficients in all quantiles and the relationship is positive. This finding is consistent with existing literature (Saxena, 2025; Lohwasser et al., 2025). The coefficients are always greater than 1.04 across the entire distribution, meaning that there are always larger emissions associated with urban expansion. This discovery implies that speedy urbanization in South Asia has led to increased energy consumption, transportation need, infrastructure growth, and resource utilization.

Entirely, the panel quantile regression findings indicate that the quality of institutions is an important factor in lowering carbon emissions, whereas economic growth, FDI, and urbanization drive additional environmental pressures. The results highlight the importance of improving governance systems for sustainable development and handling environmental impacts of economic transition in the economies of South Asia.

Conclusion and Policy Suggestions

Conclusion

The study examines the effect of institutional quality, economic growth, square of economic growth, FDI, an urbanization on the carbon emissions of seven South Asian economies (Bhutan, Pakistan, India, Maldives, Nepal, Bangladesh, and Sri Lanka) for the time period of 2002–2024. The results of panel quantile regression framework show that in both stages of emissions, across the different categories, institutional quality is an important and consistent factor influencing environmental performance. The negative and statistically significant results indicate that the higher the institutional quality, the lower the carbon emission, which suggests that better governance mechanisms lead to emission reduction through better regulatory effectiveness, policy implementation, accountability and environmental management capacity. The results also reveal that economic growth first boosts carbon emissions, but that the negative impact of squared economic growth offers partial support for the Environmental Kuznets Curve hypothesis, indicating that increased levels of economic development may lead to cleaner production and technological advancements. On the other hand, foreign direct investment and urbanization are found to be increase carbon emissions in most quantiles, suggesting that current investment pattern and urbanization process in South Asia are more carbon intensive. Entirely, study emphasizes that institutional arrangements are important for achieving environmental sustainability in the process of economic development. Improvement of the quality of governance should thus be regarded as an integral part of climate mitigation measures in South Asia. This study offers empirical evidence that governance-based strategies are crucial for low-carbon development pathways in the region when considering institutional quality and economic and socioeconomic factors.

Policy Implications

The findings have several policy implications for the economies of South Asia, broadly speaking, and more specifically, by region and technique. Governance capacity should be considered a fundamental climate policy tool because it has a consistently negative impact on carbon emissions across all quantiles. Specifically, governments should enhance the environmental regulatory

institutions by enhancing the regulatory quality and enforcement system, such as the use of digital monitoring system for industrial emissions, automation of compliance reporting and transparent environmental impact assessment (EIA) system. There is a need to improve the rule of law mechanisms to allow industries to meet the emission standards and for environmental offences to be meted out effectively.

In the context of the negative correlation between institutional quality and emissions, the South Asian countries should design institutional climate governance systems that will bring environmental agencies into the financial, industrial and energy regulatory bodies. Better performance of government can facilitate coordination between ministries with energy transition and industrial development and climate policy implementation. Furthermore, it is essential to address corruption as it can facilitate industry activities that damage the environment, illegal resource extraction and violations of pollution laws and standards, if the governance is weak.

The positive effect of FDI on carbon emission suggests the need for green investment screening mechanism. Proposals for revising the FDI approval process for South Asian economies should include carbon intensity measures, compulsory environmental performance standards, and technology transfer. Investment policies should be shifted to the sustainable production and consumption of energy, energy saving production, industries with low carbon emissions and away from the polluting industries.

The beneficial impact of urbanization on emissions indicates that urban development policy needs to be re-structured. Governments need to adopt low carbon urban planning measures such as large scale public transport systems, energy efficient building codes, smart electrical grids and waste management. Urbanization is a significant emission driver on all quantiles and future urbanization should be linked to measurable carbon reduction targets.

Last, the economic growth policies shall be directed at making the transition to the second phase of the EKC curve quicker, which indicates in the policy domain the proliferation of a more sustainable approach to energy generation, green innovation and cleaner industrial technologies. Developing institutional capacity can thus be not only a governance reform agenda but also a precondition for the economic development of South Asian economies to be climate resilient.

References

- Abbas, A., & Pervaiz, Z. (2020). Nexus between China-Pak Business Cycle Synchronization and Human Development in Pakistan. *Journal of Peace, Development and Communication*, 4(3), 445-468.
- Adedoyin, F. F., Bekun, F. V., Eluwole, K. K., & Adams, S. (2022). Modelling the nexus between financial development, FDI, and CO₂ emission: does institutional quality matter?. *Energies*, 15(20), 7464.
- Akar, G., Kaplan, E. A., Güler, İ., & Şahin, S. (2025). Has the Environmental Kuznets Curve hypothesis become stronger? A comparative analysis for OECD countries and selected

- late-industrializing Asian economies. *Journal of Environmental Management*, 394, 127575.
- Akhtar, M. Z., Zaman, K., & Khan, M. A. (2024). The impact of governance indicators, renewable energy demand, industrialization, and travel & transportation on urbanization: A panel study of selected Asian economies. *Cities*, 151, 105131.
- Akpan, U., & Kama, U. (2024). Does institutional quality really matter for environmental quality?. *Energy & Environment*, 35(8), 4361-4385.
- Akram, H., Li, J., & Watto, W. A. (2026). The impact of urbanization, energy consumption, industrialization on carbon emissions in SAARC countries: a policy recommendations to achieve sustainable development goals. *Environment, Development and Sustainability*, 28(4), 9635-9666.
- Alam, W., Kumar, P., Ahmad, G., Sulaiman, M., & Yadav, A. K. (2025). Balancing growth and sustainability: the role of institutional quality on economic growth and carbon emissions in BRICS countries. *Discover Sustainability*, 7(1), 143.
- Amin, A., Ameer, W., Yousaf, H., & Akbar, M. (2022). Financial development, institutional quality, and the influence of various environmental factors on carbon dioxide emissions: exploring the nexus in China. *Frontiers in Environmental Science*, 9, 838714.
- Bashir, M. F., Qaid, A., Bashir, M., & Mamadiyarov, Z. (2026). Digital economy-driven decarbonization pathways: analyzing how digital economy and globalization impact climate change in the top-10 digital economies. *Frontiers in Environmental Science*, 14, 1784967.
- Bouchoucha, N. (2024). Does institutional quality mitigate the effect of foreign direct investment on environmental quality: Evidence of MENA countries. *Journal of the Knowledge Economy*, 15(4), 16187-16205.
- Cao, H., Khan, M. K., Rehman, A., Dagar, V., Oryani, B., & Tanveer, A. (2022). Impact of globalization, institutional quality, economic growth, electricity and renewable energy consumption on Carbon Dioxide Emission in OECD countries. *Environmental Science and Pollution Research*, 29(16), 24191-24202.
- Erena, O. T., Kebede, T. N., & Abdilahi, H. A. (2026). Economic globalization, industrialization, institutional effectiveness and environmental quality: a global panel data analysis. *Cogent Economics & Finance*, 14(1), 2686524.
- Fatima, N., Zheng, Y., & Guohua, N. (2022). Globalization, institutional quality, economic growth and CO₂ emission in OECD countries: An analysis with GMM and quantile regression. *Frontiers in Environmental Science*, 10, 967050.
- Filonchuk, M., Peterson, M. P., Zhang, L., Hurynovich, V., & He, Y. (2024). Greenhouse gases emissions and global climate change: Examining the influence of CO₂, CH₄, and N₂O. *Science of the total environment*, 935, 173359.
- Hamrouni, D., Hasni, R., & Ouerghi, I. (2025). The moderating effect of institutional quality on the relationship between structural change and CO₂ emissions in emerging economies. *Environmental and Sustainability Indicators*, 27, 100817.

- Hassan, M. U., Siddique, H. M. A., Sumaira, & Alvi, S. (2025). Impacts of industrialization, trade openness, renewable energy consumption, and urbanization on the environment in South Asia. *Environment, Development and Sustainability*, 27(11), 28087-28110.
- Huang, Y., Chen, F., Wei, H., Xiang, J., Xu, Z., & Akram, R. (2022). The impacts of FDI inflows on carbon emissions: Economic development and regulatory quality as moderators. *Frontiers in Energy Research*, 9, 820596.
- Huang, Y., Xu, F., Abbas, A., Cong, P. T., Zhang, Y., & Kim, E. (2023). Empirical impact of China-Pak business cycle synchronization on environmental degradation in Pakistan. *Frontiers in Environmental Science*, 10, 1030408.
- Islam, S., Toma, L. T., Bhowmik, R. C., Rahman, Z., Uddin, M. N., & Hasan, R. (2026). Environmental Health and Sustainability in South America: Assessing the Impacts of Foreign Direct Investment and Energy Choices Through the N-Shaped EKC and Pollution Haven Lens. *Sustainable Development*, 34(3), 4489-4508.
- Jahanger, A., Usman, M., & Ahmad, P. (2023). Investigating the effects of natural resources and institutional quality on CO₂ emissions during globalization mode in developing countries. *International Journal of Environmental Science and Technology*, 20(9), 9663-9682.
- Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of econometrics*, 90(1), 1-44.
- Khan, H., Chen, T., Bibi, R., & Khan, I. (2023). Does institutional quality influence the relationship between urbanization and CO₂ emissions?. *Plos one*, 18(10), e0291930.
- Khan, U. A., Benotsmane, R., Şahin, M., Yilmaz, M. K., Güloğlu, B., & Zaim, S. (2026). The impact of foreign direct investment, institutional quality, and industrialization on carbon emissions: Evidence from high-income and upper-middle-income countries. *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, 20(1), 152-182.
- Kinuthia, P., Onyango, J., & Adaramola, M. S. (2025). Economic growth, financial development and carbon emissions. Does institutional quality matter?. *The Journal of Financial, Accounting, and Economics*, 2(2), 63-79.
- Kisswani, K. M., & Zaitouni, M. (2023). Does FDI affect environmental degradation? Examining pollution haven and pollution halo hypotheses using ARDL modelling. *Journal of the Asia Pacific Economy*, 28(4), 1406-1432.
- Lau, L. S., Yip, K. J., Ng, C. F., Tan, Y. L., & Yiew, T. H. (2025). Environmental Kuznets curve (EKC) hypothesis: A bibliometric review of the last three decades. *Energy & Environment*, 36(1), 93-131.
- Lee, H. S., Arestis, P., Chong, S. C., Yap, S., & Sia, B. K. (2022). The heterogeneous effects of urbanisation and institutional quality on greenhouse gas emissions in Belt and Road Initiative countries. *Environmental Science and Pollution Research*, 29(1), 1087-1105.
- Li, D., Bai, Y., Yu, P., Meo, M. S., Anees, A., & Rahman, S. U. (2022). Does institutional quality matter for environmental sustainability?. *Frontiers in Environmental Science*, 10, 966762.
- Liu, P., Ur Rahman, Z., Jóźwik, B., & Doğan, M. (2024). Determining the environmental effect of Chinese FDI on the Belt and Road countries CO₂ emissions: an EKC-based assessment in

- the context of pollution haven and halo hypotheses. *Environmental Sciences Europe*, 36(1), 48.
- Lohwasser, J., Bolognesi, T., & Schaffer, A. (2025). Impacts of population, affluence and urbanization on local air pollution and land transformation—a regional STIRPAT analysis for German districts. *Ecological Economics*, 227, 108416.
- Maduka, A. C., Ogwu, S. O., & Ekesiobi, C. S. (2022). Assessing the moderating effect of institutional quality on economic growth—carbon emission nexus in Nigeria. *Environmental Science and Pollution Research*, 29(43), 64924–64938.
- Malik, S., Abbas, A., Shabbir, M. S., & Ramos-Meza, C. S. (2024). Business cycle fluctuations, foreign direct investment, and real effective exchange rate nexus among Asian countries. *Journal of the Knowledge Economy*, 15(2), 5466–5479.
- Nguyen, Q. K., Phan, T. M. H., & Pham, N. T. N. (2026). An inverted u-shaped relationship between carbon dioxide emissions and economic growth: The role of institutional quality in developing countries. *Ho Chi Minh City Open University Journal of Science-Economics and Business Administration*, 59–75.
- Nwobu, N., Okoyeuzu, C. R., Ukpere, W. I., & Anowor, O. F. (2026). INSTITUTIONAL QUALITY, ECONOMIC GROWTH AND THE INTERACTIVE ROLE OF ENERGY INTENSITY ON CO₂ EMISSIONS IN BRICS ECONOMY. *Veredas do Direito*, 23(11), e237550–e237550.
- Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics*, 61(S1), 653–670.
- Pu, Y., Wang, Y., & Wang, P. (2022). Driving effects of urbanization on city-level carbon dioxide emissions: From multiple perspectives of urbanization. *International Journal of Urban Sciences*, 26(1), 108–128.
- Rehman, A., Ma, H., Ozturk, I., & Radulescu, M. (2022). Revealing the dynamic effects of fossil fuel energy, nuclear energy, renewable energy, and carbon emissions on Pakistan's economic growth. *Environmental Science and Pollution Research*, 29(32), 48784–48794.
- Rock Voda, D., Eggoh, J., & Diendere, L. J. B. (2026). Income, human capital and pollution: a multi-emission approach to the EKC hypothesis. *Cogent Economics & Finance*, 14(1), 2647869.
- Salman, M., Long, X., Dauda, L., & Mensah, C. N. (2019). The impact of institutional quality on economic growth and carbon emissions: Evidence from Indonesia, South Korea and Thailand. *Journal of Cleaner Production*, 241, 118331.
- Saxena, V. (2025). Water quality, air pollution, and climate change: investigating the environmental impacts of industrialization and urbanization. *Water, Air, & Soil Pollution*, 256(2), 73.
- Sindhu, M. A., Babar, Z. A., & Abbas, A. (2018). Analyzing the relationship of energy consumption, consumer expenditures and economic growth: a case study of Pakistan. *Journal of Research in Social Sciences*, 6(1), 2305–6533.
- Wang, J., Yang, J., & Yang, L. (2023). Do natural resources play a role in economic development? Role of institutional quality, trade openness, and FDI. *Resources Policy*, 81, 103294.
- Wang, Q., Ahmad, S., & Zehra, N. (2026). Green finance and environmental sustainability: evaluating the role of urbanization, energy, and institutional quality in Asia's low-carbon transition. *Scientific Reports*, 16, 16705.

World Bank. (2025). *World Development Indicators*. World Bank.

World Bank. (2025). *Worldwide Governance Indicators: 2025 revision*. World Bank.

Yang, B., Ali, M., Hashmi, S. H., & Jahanger, A. (2022). Do income inequality and institutional quality affect CO₂ emissions in developing economies?. *Environmental Science and Pollution Research*, 29(28), 42720-42741.

Zhang, H., Wang, Y., & Wang, W. (2025). Does renewable energy technology innovation achieve the synergistic effect of pollution and carbon reduction?. *Renewable Energy*, 250, 123329.

Zheng, Z., Zhe, L., & Huihui, W. (2026). The relationship between institutional quality, renewable energy investment, financial development, and ecological hazards: Evidence from ASEAN countries. *Journal of the Knowledge Economy*, 17(1), 2153-2181.