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How Economic Growth Contributes to CO_2 Emissions in the Presence of Globalization and Eco-Innovations in South Asian Countries?

Usman Mehmood [1,2,*], Salman Tariq [2], Zia Ul Haq [2], Muhammad Umar Aslam [2] and Ali Imran [2]

1 Department of Political Science, University of Management and Technology, Lahore 54792, Pakistan
2 Remote Sensing GIS and Climatic Research Lab, National Center of GIS and Space Applications, Lahore 54792, Pakistan
* Correspondence: usmanmehmood.umt@gmail.com; Tel.: +92-300-419-6671

Abstract: Many nations made pledges at the Paris climate conference to eventually become carbon neutral. As a result, the effects of eco-innovations (ECO), globalization (GLO), and economic growth (GDP) on CO_2 emissions in a panel comprising India, Pakistan, Bangladesh, Nepal, Sri Lanka, and Bhutan are assessed in this work. This study employs a unique panel (QARDL) methodology to data from 1980Q1 to 2018Q4 for analysis. The purpose of this study is to find the relation between GDP, GLO, ECO and CO_2. The results show that environmental quality is being harmed because of GLO and GDP. Climate-change-causing CO_2 emissions are decreasing globally thanks to ECO. Furthermore, the Environmental Kuznets Curve (EKC) theory in developing nations has been confirmed by this work. This study implies that the selected South Asian countries should switch to renewable energy sources to improve environmental quality. In addition, governments will need to rethink their approach to global trade. Importing effective technologies for producing renewable energy should be a priority. The future looks bright for these nations, as rising environmental consciousness will likely lead to the adoption of stringent environmental rules.

Keywords: eco-innovations; CO_2; globalization; South Asian countries; QARDL

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1. Introduction

Today, the world economies strive hard to reduce air pollution without hurting GDP. Environmental problems are becoming more severe in developing countries due to rapid industrialization. The sustainable development goal (SDG) 13 has stressed the need to reduce environmental pollution until 2030 [1,2]. The innovation term considers different dimensions of radical and incremental innovations. Environmental innovation has also become important worldwide. This includes innovations in environmental technologies in societies and economies. According to [3], environmental innovations consider those economic practices which do not pollute the environmental quality.

According to [4], strict environmental regulations tend to adopt ECO in industries. Over the last few decades, developed and developing countries have been striving to reduce environmental pollution. Among the available options, ECO are essential for reducing air pollution [5]. ECO help economies adopt efficient energy production technologies and reduce CO_2. In this way, developed and developing nations enable themselves to adopt efficient technologies for renewable energy production [6,7]. ECO can also reduce environmental pollution by capturing CO_2 [8]. Therefore, ECO are suitable for the economies to adopt environmentally friendly technologies [9,10].

Past literature has investigated the linkages of GLO and CO_2 and presented that GLO affects CO_2 in three ways: scale, composition, and income effect. The income effect posits that as the economy globalizes, its income also increases, which enhances industrial production and CO_2 [11]. The scale effect posits that economies boost their production due to more exports, which degrades the environment [12]. GLO also increases the structure and composition of the economy, which may increase CO_2 [13].

GLO enhances the pace of GDP, and this growth increases energy consumption. However, the effects of GLO on environmental pollution are mixed [14]. Ref. [15] explained that GLO is degrading the environmental quality of the Indian economy. Similar results were found by [16] in NAFTA countries.

Due to income and technological developments, GLO can reduce the concentration of CO_2. This is due to the movement of the industrial-based economy towards a service-based economy. A service-based economy is less energy-intensive as compared to a production-based economy. Ref. [17] found the inverse association between GLO and CO_2 in developing countries. From the above discussion, it is evident that GLO can affect environmental quality in dual ways.

This work has selected critical variables for selected South Asian countries. Pakistan, India, Bangladesh, Sri Lanka, Nepal, and Bhutan are developing rapidly in the South Asian region. Moreover, these countries are facing drastic climatic changes. These countries are globalizing their economies at a rapid pace. They aim to provide maximum employment opportunities to their citizens. In this effort, these countries are compromising their environmental quality. Every year, thousands of people die due to asthma and other diseases. In this scenario, it is essential to revise the economic policies to save people's lives without hurting economic growth. The contribution of this work is to highlight some essential factors of environmental pollution.

The four reasons for this study's stance on South Asia are (1) environmental pollution, (2) economic growth, and (3) globalization. Firstly, 27 of the 30 most polluted cities are found in South Asia, which is the area with the worst air quality. In total, 21 of those towns are inhabited by India. For PM2.5, using a weighted population average, Bangladesh emerges as the most polluted nation followed by Pakistan, Mongolia, Afghanistan, and India with deviations of less than 10% from each other. Among other things, the rise in air pollution has had a negative impact on people's health and tourist arrivals, which has resulted in decreased income and socio-economic shocks and spillovers. Secondly, even though growth in the area slowed from 7.2% in 2017 to 6.9% in 2018, the World Bank ranked it as the region with the fastest growth in the world. Additionally, the nations' diverse fiscal outlooks make comparisons inevitable. According to United Nations, Bangladesh, Bhutan, and India's economies are generally doing well, with positive GDP growth forecasts, in contrast to Pakistan. In addition, India's economy has been among the fastest growing in the world for much of the past ten years, and it will continue to be a major driver of future growth in global energy consumption.

These nations also have wide economic objectives, such as resource efficiency, financial cooperation, unrestricted trade, infrastructure integration, and economic liberalization and expansion. In 2015, the United Nations (UN) approved an agenda of Sustainable Development Goals (SDGs) for eliminating poverty, promoting socioeconomic inclusion embracing environmental preservation. Sustainable development calls for investments to be structured in a multi-layered framework because it is a global, multifaceted, and multidisciplinary objective. Thus, the chosen South Asian countries are the main subject of this research. Additionally, investing activities are required to support these participants' economic development and prosperity, and cooperation among member nations will also progress technology. Such economic endeavors, however, may have a negative impact on the environment. As a result, member nations now consider comprehending the environmental impacts in South Asian nations to be a crucial research priority. This research has a number of objectives, but we will only focus on those that are most pertinent here, as follows:

(1) to assess how certain South Asian nations' environments and globalization, associated;

(2) to examine the impacts of technological innovation on CO_2 emissions.

In defining the factors of CO_2, this work includes GLO and GDP. When a country globalizes its economy, it changes the structure and composition of its industry. This creates environmental problems if the economy is not adopting ECO [1]. South Asian countries are still consuming fossil fuels in industrial sectors, and the consumption of non-renewable energy sources is contaminating the climate. Therefore, it is an ongoing debate that economies should adopt innovative technologies to reduce the concentration of CO_2.

This research attempts to shed light on how GLO, GDP, and technical breakthroughs influence environmental degradation in a few selected South Asian countries, where both economic development and environmental deterioration have accelerated in recent decades. In addition, the QARDL method, an econometric tool, is used in this study. Under QARDL, the quantities of the parameters are estimated. As a result, this approach offers a comprehensive evaluation of the links between GLO, GDP, ECO, and CO_2.

QARDL is superior to the linear ARDL method because it provides asymmetric associations. This method provides quantile-based associations among dependent and independent variables. Therefore, the QARDL method is more suitable than the non-linear autoregressive distributed lag (NARDL) approach. Therefore, policymakers can clearly understand when and how to control environmental pollution. This work adds to the body of literature by investigating the impacts of eco-innovations and GLO on CO_2 in the context of Environmental Kuznets Curve (EKC)-selected South Asian countries.

This work is organized as follows: background literature is presented in Section 2, the data description with methodology is presented in Section 3, Section 4 consists of results and discussion, and Section 5 provides the conclusion and policy implications.

2. Literature Review

Today, policymakers are determined to explore new determinants of environmental degradation. Developed and developing countries are trying hard to mitigate environmental pollution without hurting GDP. Rapid GDP requires more energy, and energy is mainly generated from fossil fuels. In this context, the Paris agreement also tries to encourage the governments to lower environmental pollution.

2.1. Eco-Innovations and CO_2 Emissions

According to earlier research on the topic [18–23], there is a favorable correlation between eco-innovation and CO_2. In addition to these studies, ref. [24] described how renewable energy helped a few Sub-Saharan African (SSA) nations reduce their CO_2. Empirical findings show that green energy reduces CO_2 in these countries. Additionally, globalization is aiding in the decline of CO_2 in the chosen group. Ref. [25] examined the relationship between eco-innovation and CO_2 in nations that import oil. The empirical results show that one of the most significant sources for improving environmental quality in the chosen countries is eco-innovation. By utilizing data for the highly fiscal decentralized nations from 1990 to 2018, ref. [26] also hypothesized that eco-innovations are negatively associated with CO_2 levels. Ref. [27] revealed that from 1990 to 2017, the effect of export diversion on the level of emissions in G7 countries decreased when eco-innovation was present. Ref. [28] examined the same connection for the 27 nations that make up the European Union. The empirical results are consistent with the idea that eco-innovation contributes to a decrease in CO_2. Further, [19] also illustrated that eco-innovation is one of the most prominent variables to eliminate CO_2 in the selected panel [29] considering the G7 economies' council. The research used third-generation panel data estimation techniques and found that one key strategy for reducing CO_2 in G7 economies is to invest in eco-innovations. The effect of eco-innovations on CO_2 was also demonstrated in a study of a comparable nature for the G7 economies [30]. The study's empirical results demonstrate how those eco-innovations are reducing environmental degradation in the chosen countries.

2.2. Globalization and CO_2 Emissions

For policymakers looking to define CO_2 predictors, globalization has emerged as an intriguing topic of debate over the past ten years. We have discovered a fairly obvious connection between globalization and CO_2. The income and production levels rise as a result of globalization, which boosts CO_2. However, there are scant actual data on the effects of globalization on CO_2 available in the literature at the moment. For instance, the QARDL model was used to expand on the effect of globalization on CO_2 for the Netherlands and Ireland in an intriguing empirical study [14]. The research found a link between globalization and CO_2 that was favorable. Ref. [31] described how CO_2 is declining in Malaysia as a result of globalization. Evidence of an inverted U-shaped relationship between globalization and CO_2 was discovered in an intriguing research [32]. Additionally, many studies in the literature [10,33–35] backed up the beneficial effects of globalization on CO_2. Other studies postulated an insignificant link between globalization and CO_2. Refs. [36,37] supported the negative effect of globalization on CO_2. Ref. [33] used trade openness as a surrogate for globalization for a sample of chosen SSA countries and deduced that trade openness is one of the main factors contributing to rising CO_2 in these countries. The study also discovered that these nations have EKCs. The FADL cointegration test was applied to the BRICS economies [38], and the results showed that one of the most important variables driving the acceleration of environmental degradation is globalization. In another notable research [39], the QARDL approach was utilized, which highlighted that globalization is an essential factor that is responsible for environmental degradation in China. Similar to this, another research [40] illustrated the relationship between globalization and environmental degradation using the example of 15 developed economies. According to the research, globalization is a significant factor in the rise in environmental degradation. Ref. [41] also investigated Malaysia's relationship with globalization and CO_2. The research demonstrated that globalization is one of the main factors influencing CO_2 by using various proxies for globalization.

2.3. Economic Growth and CO_2 Emissions

Grossman and Krueger (1991) [39] had established the concept of EKC, and following their pioneer study, a lot of researchers have investigated the existence or nonexistence of EKCs for distinct nations worldwide, for example [42–44], for the USA [34], for newly in industrialized nations, and [45] for Malaysia. EKC advocates explain that economic growth increases CO_2, but that the connection between economic growth and CO_2 turns negative beyond a certain threshold. The history of why these two concepts go together fascinates us. As their economies develop, they prioritize green policies. For instance, they may put money into the service industry or initiate green technology or renewable energy-based initiatives. Validation of the EKC was also highlighted for the example of the G7 economies [30]. Additionally, ref. [46] conducted a fascinating investigation by employing the QARDL model and providing clarification on the EKC's substantiation in the context of Pakistan. To the same end, Aziz et al. (2021) [1] examined the MINT countries and came to the same conclusion: the MINT economies support the validity of EKC. Much recent research supports the EKC hypothesis for the Turkish economy [39]. Similar arguments for the presence of EKC in the American economy were made in [47].

Findings from a review of the relevant literature show that no previous research has examined the effects of GLO, ECO, and economic expansion on the sample of South Asian countries.

Electricity consumption in South Asian countries is among the lowest worldwide. Furthermore, there is a wide range in annual per capita consumption rates across South Asia, from a low of 134 kWh in Afghanistan to a high of 3219 kWh in Bhutan [33].

Annual per capita consumption in India is around 1010 kWh, which is 2.6 times lower than that of China and 13 times lower than that of the United States. The annual per capita consumption in Bangladesh and Pakistan is around the same (around 450 kWh). Below 1000 kWh, yet nearly double that of Bangladesh and Pakistan, is where Sri Lanka's electricity consumption stands. Besides the Maldives and Bhutan, every country in South Asia suffers from chronic power outages. Installed power production capacity in South Asia is 0.50 kW per person on average.

2.4. South Asia

In South Asia, there is a great potential for optimal energy resources to create and consume electricity through cross-border power trade and exchange. Since the peak power demand in India, Pakistan, Bangladesh, and Nepal changes greatly throughout the year, the seasonal fluctuations in their generation capacities and consumption might be useful [48].

Time of year in Bhutan and Afghanistan. For the four months between November and February, for instance, Bangladesh enjoys a power surplus thanks to new installations; however, Bhutan and Nepal must import electricity since their hydropower is inoperable due to snow and ice. Within these four months, Bangladesh would be able to sell electricity to both Nepal and Bhutan. From May to September, when Bangladesh and northern and northeastern India experience severe power shortages owing to summertime peak demand, Nepal and Bhutan are able to meet domestic demand more easily. Power from Bhutan and Nepal may be used to supplement that of Bangladesh and India. In January and February, Pakistan's electricity output capacity exceeds its needs, whereas western and southern India see increased power demand. In this way, Pakistan may provide India with electricity at various times of the year [42].

During the months of June through September, India may also provide Pakistan with electricity (four months). In addition, with the help of India and Bangladesh, the amount of electricity that can be generated from hydropower in Nepal and Bhutan may be increased significantly while still being environmentally friendly [34].

Pakistan, Bangladesh, India, and Sri Lanka are rapidly growing nations. These economies have increased their industrial production in the context of GLO. Moreover, these countries are trying to increase ECO for a cleaner environment. Therefore, our study contributes by applying the novel method of QARDL. This method provides the associations in different quantiles. The findings of this work will be helpful for policymakers to improve environmental quality in South Asian countries.

3. Theoretical Framework, Methodology and Data

The prime object of this work is to find the impacts of GLO, ECO, and GDP in selected South Asian countries in different quantiles. This work utilizes the number of patents as a proxy of ECO obtained from the World Bank. The selection of countries is restricted due to the unavailability of data. Some missing values are added by taking averages of the past values. The data on GLO are obtained from the KOF institute. All the data are converted into quarterly data by the summation sum method. Table 1 shows the variables and their description. This method is used in [49]. This method provides long-run equilibrium in different quantiles.

Table 1. Variables and their sources.

Abbreviation	**CO_2**	**GDP**	**ECO**	**GLO**
Indicator name	Carbon emissions	Economic growth	Number of Patents	GLO
Measurement scale	Per capita	GDP per capita (constant 2010 $ US)	Resident and non-resident	Overall Index
Source	WDI	WDI	WDI	KOF economic institute

Therefore, the traditional ARDL framework is explained as follows:

$$Y_t = \beta_0 + \sum_{i=1}^{p} \alpha_1 X_{1(t-i)} + \sum_{i=1}^{q} \alpha_2 X_{2(t-i)} + \sum_{i=1}^{q} \alpha_3 X_{3(t-i)} + \sum_{i=1}^{q} \alpha_4 X_{4(t-i)} + \sum_{i=1}^{q} \alpha_5 X_{5(t-i)} + \varepsilon_t \quad (1)$$

where p and q are the numbers of lags and ε_t represents white noise residual, while Y represents CO_{2t} and X_1, X_2, X_3, X_4 up to X_5 represents GLO_t, ECO_t, $GDP_t GDP2_t$, which are the natural logarithmic forms of GLO, ECO, economic growth, and its square term. Now, the adjustment of Equation (1) for quantile ARDL is as follows:

$$Q_{Y_t} = \beta(\tau) + \sum_{i=1}^{p} \alpha_1(\tau) X_{1(t-\mathrm{i})} + \sum_{i=1}^{q} \alpha_2(\tau) X_{2(t-\mathrm{i})} + \sum_{i=1}^{q} \alpha_3(\tau) X_{3(t-\mathrm{i})} + \sum_{i=1}^{q} \alpha_4(\tau) X_{4(t-\mathrm{i})} + \sum_{i=1}^{q4} \alpha_5(\tau) X_{5(t-\mathrm{i})} + \varepsilon_t \quad (2)$$

where $\varepsilon_t(\tau) = Y_t - Q_{X_{1t}}(\tau/\varepsilon_{t-1})$ () and $0 < \tau < 1$ is quantile. This study estimates the consecutive quantiles (τ) of (0.05, 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90).

For the serial correlations in the residuals, the quantile ARDL equations for both models are as follows:

$$\begin{gathered} Q_{Y_t} = \beta(\tau) + X_{1(t-1)} + \omega_1 X_{2(t-1)} + \lambda_1 X_{3(t-1)} + \theta_1 X_{4(t-1)} + \mu_1 X_{5(t-1)} + \sum_{i=1}^{p} \alpha_1(\tau) X_{1(t-\mathrm{i})} + \\ \sum_{i=1}^{q} \alpha_2(\tau) X_{2(t-\mathrm{i})} + \sum_{i=1}^{q} \alpha_3(\tau) X_{3(t-\mathrm{i})} + \sum_{i=1}^{q} \alpha_4(\tau) X_{4(t-\mathrm{i})} + \sum_{i=1}^{q4} \alpha_5(\tau) X_{5(t-\mathrm{i})} + \varepsilon_t \end{gathered} \quad (3)$$

The equations for error correction terms of quantile ARDL model are as follows:

$$\begin{gathered} QYt = \beta\tau + p\tau(X1(t-i) - \omega 1\tau X2(t-i) - \beth 1\tau X3(t-i) - \Theta 1\tau X4(t-i) - \mu 1\tau X5(t-i)) + ip\alpha 1(\tau)X1(t-1) + \\ iq\alpha 2(\tau)X2(t-1) + iq\alpha 3(\tau)X3(t-1) + iq\alpha 4(\tau)X4(t-1) + iq4\alpha 5(\tau)X5(t-1) + \varepsilon t \end{gathered} \quad (4)$$

The speed of adjustment (p) has to be significant and negative [36]. For the long and short-run impacts of independent variables on dependent variables, different quantiles can have different values in each era.

4. Results and Discussion

To find the associations between ECO (number of patents), GLO, GDP, and CO_2, this work collects data from world data indicators (WDI) except for the data on GLO, which are collected from the KOF economic institute. The annual data of 1980–2018 were converted into quarterly data for analysis by adopting a novel QARDL approach. The variables and their sources are in Table 1.

The data from WDI and its link are provided here https://databank.worldbank.org/source/world-development-indicators (accessed on 2 February 2023).

Table 2 presents the descriptive statistics, and it is noted that ECO have the highest value and CO_2 have the lowest value. Moreover, there is no problem with multicollinearity.

Table 2. Descriptive statistics.

	CO_2	ECO	GDP	GDP2	GLO
Mean	−0.296824	2.166598	2.960959	8.828805	1.640749
Maximum	0.259542	4.211894	3.596178	12.93250	1.791314
Minimum	−1.019497	0.778151	2.555646	6.531327	1.376759
Std. Dev.	0.310509	0.841306	0.248847	1.511339	0.108213
Observations	156	156	156	156	156

Table 3 shows the results of unit root tests of [50] unit root tests. It is noted that CO_2, economic growth, and its square term are integrated at first difference, but the data for eco-innovation and GLO are integrated at the level. This means that the variables have mix order of integration.

Table 3. Unit root tests.

Variable	Levin-Lin-Chu		Im, Pesaran, Shin	
	I(0)	I(1)	I(0)	I(1)
$lnCO2_t$	−1.96	−5.38 ***	−1.09	−3.16 ***
ECO_t	−3.22 ***	−5.82 ***	−4.45 ***	−4.45 **
$lnGLO_t$	−2.57 ***	−5.33 ***	−2.90 ***	−4.72 ***
$lnGDP_t$	−1.70	−3.92 ***	−1.39	−4.01 ***
$lnGDP2_t$	−1.91	−3.85 ***	−1.45	−4.91 ***

*** is significant at 1%, ** is significant at 5% respectively.

Table 4 shows the co-integration test, which shows strong co-integration in the long run because the null hypothesis of no co-integration is rejected.

Table 4. Fisher co-integration test.

Hypothesized	Fisher Stat.*		Fisher Stat.*	
No. of CE(s)	(From Trace Test)	Prob.	(From Max-Eigen Test)	Prob.
None	76.78 ***	0.00	56.12 ***	0.00
At 1	30.50 ***	0.00	13.61 **	0.09
At 2	21.84 ***	0.00	13.66 **	0.09
At 3	14.92 **	0.06	10.62	0.22
At 4	17.99 **	0.02	17.99 **	0.02

*** is significant at 1%, ** is significant at 5%, * is significant at 10%, respectively.

After the confirmation of co-integration among the panel data, the next step provides the estimation results of panel QARDL, and the results are shown in Table 5. It can be noted that ECO are environmentally friendly in all quantiles. ECO provide new technologies for clean energy production. Clean energy is environmentally friendly and does not contaminate the environment. These findings are similar to those of [26]. The authors showed that ECO are environmentally friendly.

GLO is increasing CO_2 from the 5th to 40th quantiles, which means that GLO has increased industrial production, and industry is using traditional energy means. It is also noted that GLO improves air quality in the 80th and 90th quantile; however, this association is insignificant. These results are similar to the findings of [51]. Ref. [52] also reported that GLO is enhancing CO_2 in China.

GDP accelerates CO_2 in all quantiles; however, this linkage is significant in 50th to 90th quantiles. This finding shows that GDP is increasing CO_2, and this effect is increasing significantly in later quantiles. The coefficient value of the square of DP is negatively associated with CO_2 in all quantiles. This finding confirms the existence of the EKC hypothesis. As GDP reaches a certain point, people start to care about their surroundings and demand strict environmental regulations. These demands further make the governments implement environmental regulations. This finding is similar to the findings of [53]. To check the robustness of these findings, this work presents the graphical shape in Figure 1.

Table 5. The impacts of ECO, GLO, and GDP on CO_2.

Quantiles (τ)	Constant	Long-Term Estimates			
	$\alpha_*(\tau)$	$B_{ECO}(\tau)$	$B_{GLO}(\tau)$	$B_{GDP}(\tau)$	$B_{GDP2}(\tau)$
0.05	−7.45 *** (−5.03)	−0.18 *** (−9.41)	1.90 *** (6.68)	2.26 (2.60)	−0.36 *** (−2.52)
0.10	−5.47 *** (−4.08)	−0.19 *** (−16.78)	1.75 *** (9.34)	1.14 (1.28)	−0.18 *** (−3.29)
0.20	−5.27 *** (−3.40)	−0.225 ** (−2.21)	0.18 *** (17.06)	0.99 (0.86)	−1.60 *** (−3.86)
0.30	−6.19 ** (−2.56)	−0.19 ** (−14.62)	1.53 ** (5.08)	1.80 (0.99)	−0.28 *** (−4.98)
0.40	−8.18 *** (−2.65)	−0.20 *** (−11.39)	1.26 *** (2.75)	3.37 (1.44)	−0.54 ** (−1.12)
0.50	−11.59 *** (−2.27)	−0.21 *** (−7.17)	0.79 (0.90)	6.13 * (1.71)	−0.98 ** (−1.62)
0.60	−4.93 (−0.63)	−0.15*** (−4.67)	2.17 (0.13)	0.82 ** (0.13)	−0.18 ** (−3.20)
0.70	−13.51 *** (−2.58)	−0.11 *** (−6.27)	0.05 (0.06)	8.43 *** (2.03)	−1.30 ** (−2.08)
0.80	−12.04 (−4.76)	−0.10 *** (−0.67)	−0.11 (1.30)	7.10 *** (3.90)	−1.08 *** (−3.79)
0.90	−11.49 *** (−5.79)	−0.09 *** (−11.53)	−0.03 (0.20)	6.84 *** (5.01)	−1.03 *** (−4.09)

*** is significant at 1%, ** is significant at 5%, * is significant at 10% respectively.

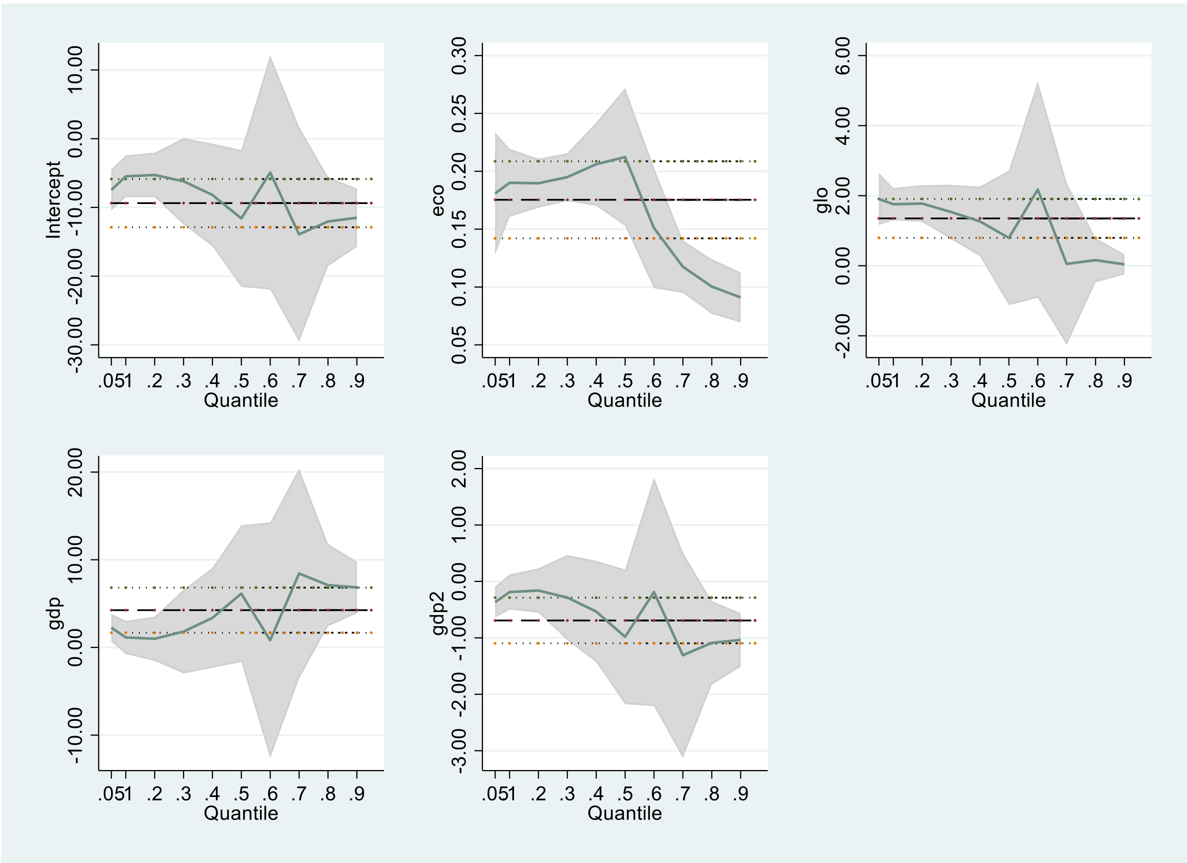

Figure 1. Variations in quantile regressions.

5. Conclusions and Policy Implications

This study examines how a panel of four countries—Pakistan, Bangladesh, India, and Sri Lanka—are affected by ECO, GLO, and GDP on CO_2. In addition, the quarterly data from 1980Q1 to 1970Q4 are analyzed using the cutting-edge method of QARDL. In this study, we investigate whether EKC is present in a sample of people from Pakistan, India, Bangladesh, and Sri Lanka. The results show that GLO and economic progress are factors in South Asian countries' increasing environmental pollution. With the help of ECO, we can expect CO_2 to drop from the upper quantiles to the lower ones. The findings of this study provide further evidence that EKC is present in nations of South Asia.

A few novel insights on developing nations are presented in this study.

The research findings offer some useful policy recommendations for sustainable development. As we can see from the empirical findings, South Asian countries' environmental condition is not improving at a rate that is sustainable. The fact that these countries rely heavily on energy derived from fossil fuels could be the cause. India is one of the economies with the highest global emissions, according to the most recent BP study. More initiatives utilizing renewable energy sources need to be funded by these economies. By examining the research findings, we can create policy options for the various quantiles. We have seen that the turnaround points of EKCs are smaller at the low GDP quantiles than they are at the higher quantiles. Governments should implement a variety of legislative changes to enhance environmental quality. These economies have the capacity to create various initiatives based on the concept of green development. These governments must make investments in renewable energy projects to support the process of green development and meet the rising energy demand. The government should support businesses in adopting clean manufacturing techniques, and it is crucial to offer incentives for businesses to use green energy practices. A national awareness program encouraging people to live less resource-intensive lifestyles should also be launched by the government. The use of social media and mass media can assist in achieving the intended results. The national education curriculum needs to be revised, which is another crucial stage. It is crucial to cover a variety of subjects connected to how using renewable energy is good for the environment. This action will start a household-level learning process.

Our analysis also shows that globalization is having a beneficial impact on emissions levels. Globalization is currently having a beneficial impact on economic growth. By encouraging market efficiency, it reduces income inequality. To reduce the negative effects of globalization, governments must impose strict regulations and policies on foreign companies. It is not possible to stop the process of globalization in any country. Additionally, it is critical to separate the commercial, political, and social aspects of globalization. The next step is to determine which aspect of globalization is more closely related to carbon pollution. Following that, the analysis will be used to formulate the best strategy to achieve the goal.

Furthermore, through the three factors of income, size, and composition, globalization is causing a surge in CO_2 emissions. Finding out which of these three channels has the strongest relationship with CO_2 is crucial. The policy consequence for the environmental Kuznets curve hypothesis is that if CO_2 is rising through the income channel, it is more appropriate to concentrate on the income aspect of globalization. The economies must switch to cleaner production methods if CO_2 levels rise because of scale and composition impacts. Incentives for businesses to use ecologically friendly technologies, such as tax exemptions or subsidies, are crucial.

Another significant finding from our research is the contribution of eco-innovation to the improvement of environmental quality. The development of investment strategies in environmentally friendly innovations is a task for policymakers. The government should also start new initiatives and support the study and creation of environmentally friendly technologies. In this respect, the government should start fresh initiatives with the assistance of business. To address the problem of environmental degradation, it is also crucial to promote new and diverse sources of clean energy at the household and commercial levels. The results respond to the objective of this work that environmental quality is associated with globalization and eco-innovations. These countries should increase the research and development budgets. To accomplish this objective the role of globalization is fundamental. Globalization makes it possible to import new technologies from the developed nations.

In prospects to further investigate the effects of GLO and eco-innovations on environmental degradation, future studies can expand to include additional groups of emerging nations. Quantile-to-quantile regression can potentially be used in the future to conduct country-specific analysis.

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