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Control of Carbon Emissions by Promoting Economic Growth and Renewable Energy in Newly Emerging Economic Block

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ABSTRACT

This research examines the effects of economic growth and energy consumption in the new developing economic block of Silk Road on carbon emissions (SERB). The energy consumption is further synthesized into renewable and non-renewable energy sources to distinguish their role in carbon emissions. This study considered panel data (1995-2014) of twenty-four middle-income countries along the Belt and Road initiative for empirical analysis. The fixed effect, random effect, and GMM methods were performed to confirm the cointegration relationship. Results highlighted the role of economic growth, renewable energy, and nonerasable energy on carbon emissions in the short and long run. Thus, it can be concluded that the newly emerging block resulting from Belt and Road initiative could get the maximum economic benefits of this project by using renewable energy sources. The new renewable energy projects may help increase clean energy and reduce carbon emissions in the emerging economic block due to the Belt and Road initiative.

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1. Introduction

Economic growth and a sustainable environment are the most concerned topics in the world of today. Productive and stable GDP growth is the need of present times. To stand with modern societies, economic well-being is necessary. It is not just the need for emerging economies or less developed or third-world countries but also for developed societies. The emerging countries are much concerned about their growth processes to compete with other high-income countries and increase their economic development pace. So, one can judge them for economic growth in this modern time. Therefore, the emerging economies are primarily concerned about their low GDP growth (Abbas et al. 2020a). These economies rely on their growth-generated resources to grow further and somewhat about the stability of their farfetched GDP growth. In 2013, China proposed jointly building a new economic domain, 'Silk Road Economic Belt (SREB)', to promote economic integration and regional cooperation in the Middle East, Europe, Central Asia, and West Asia. Before the industrial revolution, the emerging economies were much engaged with their agriculture sector. The agriculture sector was the most substantial or considered the central pillar of their economy (Anser et al. 2020a). In modern times, the emerging economies have changed their growth channel from agriculture to more advanced sectors.

Likewise, the emerging countries, especially the Asian and African emerging nations, are focusing on their industrial sectors to support their growth targets (Iqbal et al. 2020b). The objectives of the SREB scheme are also to stimulate and construct significant marketplaces by emerging a mutual understanding amongst the member countries. It is expected that emerging economies would heavily rely on energy resources to progress and streamline their production processes to help support their manufacturing capacity, which will help promote their economy. Moreover, aside from economic development, the primary concern of the SERB initiative is to develop cooperation in the member countries to tackle global warming issues. The neglected environmental conditions in the emerging countries under the umbrella of the SREB initiative are enervating and creating global issues (Baloch et al. 2020). However, it is anticipated that the SERB scheme can enhance the economic growth of member countries by increasing the trade volume. While the extensive reliance on energy sources and mostly inappropriate environment planning might be the reasons that could fail the synchronization of GDP growth with environmental preservation; and the result could be a more polluted environment (Iram et al. 2020).

In this modern era, the interlinkages of energy and GDP growth have great significance. The environmental damages associated with higher income are a severe problem for sustainable development. Environmental quality is an externalized and non-negligible component of economic development. Energy resources are classified into Renewable (RE) and Non-Renewable (NER) segments having substantial impacts on the environmental quality. Economies like those in the developing world are increasingly dependent on non - renewable resources like oil and natural gas (Anser et al. 2020b). The rationale is that NRE resources are economical and readily available to these third-world economies. Due to much dependence on the NRE resources, the greenhouse gases and CO_2 outflow have enhanced, particularly in emerging nations (Li et al. 2020).

A high carbon dioxide emission predominantly causes global warming, climate change, and environmental damage. Emerging countries over the last decade have averaged unacceptably high figures of NRE energy consumption and CO_2 emission (Qayyum et al. 2019). In the Southeast Asian region, Malaysia has 96.77 percent reliance on NRE usage, and per capita, CO_2 discharge is recorded at 7.38 metric tons, which is the highest in the region. Also, India is consuming 70.19 percent of NRE resources, and per capita, CO_2 discharge is about 1.39 metric tons in this region. In the Central Asian region, Kazakhstan has a high dependence on NRE that is about 98.93 percent, and per capita, CO_2 discharge is recorded at 14.18 metric tons. Iran ranks number one among countries with the most significant consumption of NRE, and per capita, CO_2 emissions are 7.57 metric tons (World Bank, 2017). Emerging societies all want stable GDP growth and a sustainable environment.

However, there is a substantial divergence in this growth strategy. To quantify the effects of renewable and non-renewable energy sources on CO_2 emissions and GDP growth in the 24 emerging countries on the Silk Road, Economic Belt Initiative is the primary goal of this study. In contrast to the work of (Abbas et al. 2020b) (Sun et al. 2020a), This study adds to the body of knowledge by investigating the effects of renewable energy on carbon discharges in the economies of SREB. The theory of the EKC says that the quadratic term of per capita GDP (GDP) is added to determine if the relationship is linear. Though GDP growth in emerging economies is frequently connected to a higher amount of radiation, the two are not necessarily linked. It can also lead to new ecological discoveries since technology advancements, and heavy usage of non-renewable energy go hand in hand. This study concluded that environmental pollution follows a rising trend due to economic activity, and when the economy grows, the number of carbon emissions may go down. These emerging SREB economies also need to show how their growth patterns are negatively impacting the environment. Until recently, little was known about the relationship between carbon emissions in SREB economies and renewable energy's ability to power those countries. By applying these findings, policymakers and practitioners in emerging economies will better design pollution reduction policies and conduct a less disruptive transition from fossil fuels to clean energy.

Further, the SREB is one of the world's most prominent projects, contributing 40% of the world's GDP and accounting for a quarter of the global prevalence. To accomplish Sustainable Development Goal 17, "increasing global cooperation for sustainable development" (UNDP, 2018). Based on these findings, we can conclude that a panel dataset covering the years 1995 to 2014 was studied using an Autoregressive Distributed Lag (ARDL) model to generate valuable insights that can aid in designing carbon control strategies in the economies of rising countries. In the final section of the investigation, the following portions will be described.

The literature review has been presented in the next section; after that data and methodology, the discussion of results estimation and conclusion with policy implication has been given in the subsequent sections.

2. Literature Review

Countries around the globe have different levels of growth and have different targets for growth to succeed economically. To get the rank of advanced economies requires a balanced growth of the economy, efficient labor, upgraded technology, efficient capital formation, and, more importantly, a clean and healthy environment (Iram et al. 2019). Like other emerging countries, the nations in the Silk Road Economic Belt initiative are also facing similar economic and environmental issues. Likewise, their production process is slow because of outdated technology, less skilled labor, and low capital formation. All these hurdles have affected their growth rates over the years. So, the dream of being a developed nation is still a far cry under these circumstances. While it is true that most of the emerging countries are agrarian and are dependent on their agriculture output, it is also true that to increase the amount of production; there is a need to promote the industrial sector. It is found that most of the emerging countries are now focusing on their industrial sector, and it is expected that one belt one road initiative will expedite the industrial growth in the member countries. The emerging countries have increased the productivity of industrial sectors by using higher energy resources. Despite the outdated technology and limited resources in the emerging countries, the energy resources undoubtedly have supported their production process and the cost of a polluted environment (Asbahi et al. 2019). Environmental sustainability has been exaggerated by more energy consumption causing more emissions of greenhouse gases like CO_2 discharge. (Iqbal et al. 2019) have confirmed that GDP growth, inequality, and poverty are significant factors in emerging countries that deteriorate the natural environment. More or fewer research scholars believe that advanced economic activities, modern industrial practices, and higher utilization of energy sources are significant CO_2 emissions in emerging states.

(Sun et al. 2021) performed the Granger Causality analysis to explore the links among CO_2 discharge, GDP growth, and energy usage in MENA countries. The results showed a positive unidirectional causality direction from energy usage to CO_2 discharge for the MENA region. While, in the case of GDP growth to CO_2 discharge, there exists no causal link in Latin American economies. There are several studies that have observed the unidirectional causal relationship of energy consumption and CO_2 release in emerging nations. These studies have shown the reliance on fossil fuel is a primary cause of environmental depletion in developing economies (Sun et al. 2020a) have described the role of RE and NRE consumption on CO_2 emissions by examining the data from emerging nations. They found that the usage of NRE has improved GDP growth and enhanced environmental pollution in emerging countries. They concluded that high reliance on NRE to improve GDP growth in emerging countries is the primary source of CO_2 discharge and environmental hazards. (Sahban and Abbas 2018) have examined the influence of RE on GDP growth and found no influence of RE on GDP growth. (Iqbal et al. 2020a) have explored the role of NRE usage on CO_2 discharge by using panel data from fifteen emerging economies of Asia. They found that NRE usage has increased CO_2 release in emerging countries. (Ali et al. 2021) observed that MENA, nations renewable usage has been less effective in controlling CO_2 discharge. While, considering emerging Asian economies, NRE usage and GDP growth have strongly enhanced CO_2 discharge. However, the study found that GDP square and CO_2 discharge are negatively correlated. Thus, the results confirmed the hypothesis of EKC for emerging Asian countries (Hanif et al. 2019). To analyze developed and developing countries together may lead to biased results. Therefore, the present study aims to bridge the literature gap by investigating the role of RE on CO_2 discharge by following the EKC hypothesis. To avoid the estimation biased, the current study considers only the panel data of emerging nations from the SREB.

3. Data and Methodology

The panel data from World Development Indicators (WDI) cover the period between 1995 and 2014 has been utilized to examine the effect of the economic growth on nonrenewable energy usage and the use of renewable energy in the developing economies from the Silk Road Economic Belt. Following the World Bank country classification, panel data of 24 upper-middle, lower-middle- and low-income countries have been established for empirical analysis.

Table 1: Variables of the study

Variable Name	Symbol	Measuring Unit
Carbon Discharge	(CO_2)	per-capita metric tons
Renewable Energy Usage	REE	per capita in a kilogram of oil equivalent
Fossil Fuel Energy Usage	FFE	per-capita in a kilogram of oil equivalent
Economic Growth	GDP	Real per capita GDP in US$2010
Squared GDP Growth	GDP^2	Real per capita GDP in US$2010
Gross Capital Formation	GCF	gross capital formation in US$

3.1 Model Specification

The functional form of the proposed model based on the EKC hypothesis can be written as follows:

$$CO_2 = f\ (GDP^{\theta 1}, GDP^{2\ \theta 2},\ Z^{sn}) \qquad (1)$$

After incorporating the error term, the model as mentioned above will be:

$$logCO_2 = \theta_0 + \theta_1 logGDP_{it} + \theta_2 logGDP_{it}^2 + s_n logZ_{it} + u_{it} \quad (2)$$

In equation (2) θ_0 indicates the intercept term, $'\theta 1'$ and $'\theta 2'$ are the slope of GDP and GDP square. Here, Z^{sn} represents the set of expected energy and economic variables. The model is written as follow:

$$logCO2_{it} = \theta_0 + \theta_1 logREE_{it} + \theta_2 logFFE_{it} + \theta_3 logGDP_{it} + \theta_4 logGDP_{it}^2 + \theta_5 logGCFit_{\ it} + u_{it} \quad (3)$$

Here, θ_0 is an intercept term, $\theta_1, \theta_2, \theta_3, \theta_4, and\ \theta_5$ denote the coefficients of independent variables, and 'u_i' denotes error term. While subscript '*i*' *and* '*t*' are used for cross-sections and time-frequency in terms of the number of years, respectively.

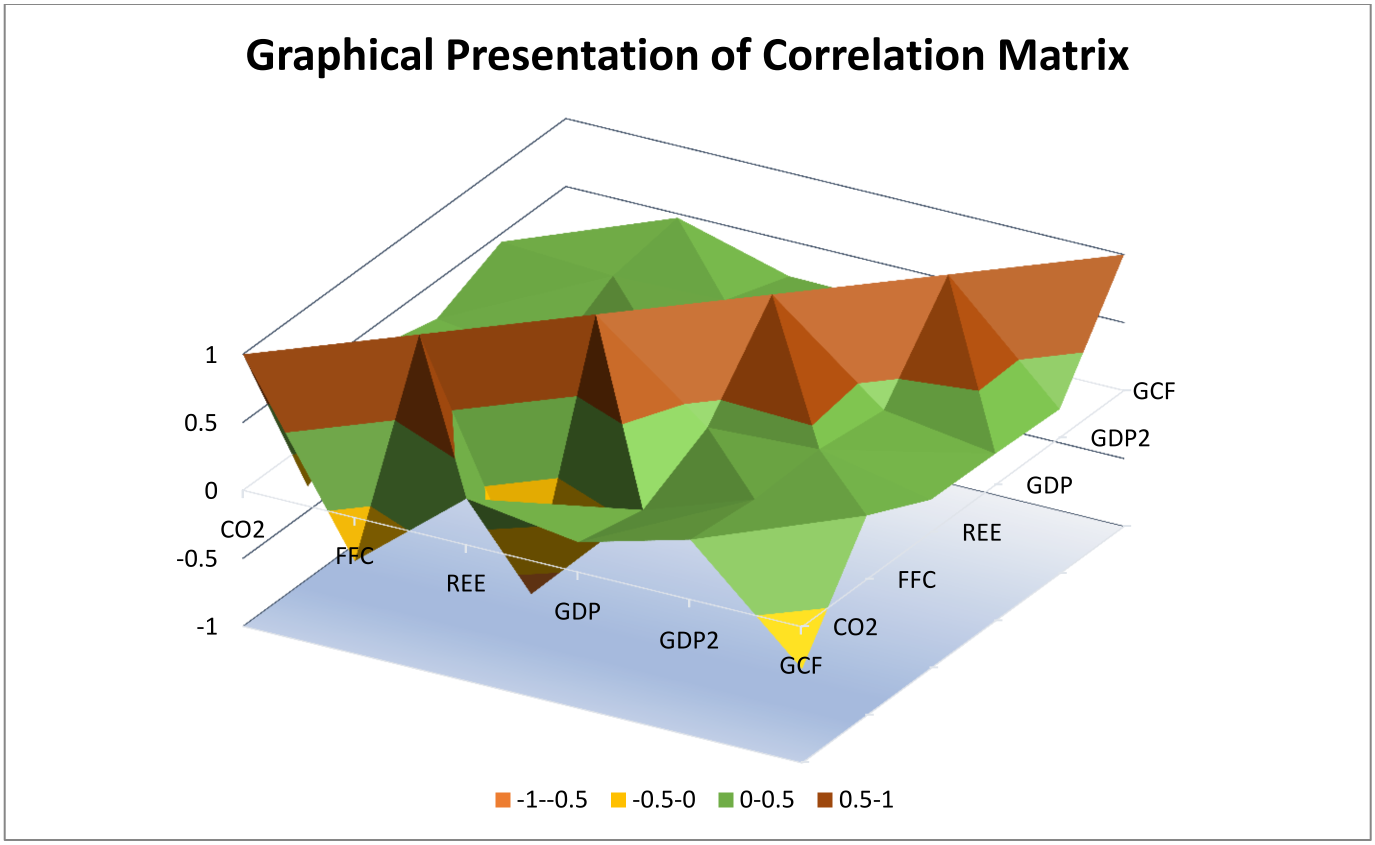
4. Empirical Results and Discussion

Table 2: Descriptive Statistics

	CO_2	REE	FFE	GDP	GDP^2	GCF
Mean	0.198	1.161	1.807	0.735	1.465	0.968
Median	0.259	1.442	1.881	0.781	1.561	0.986
Maximum	1.194	1.962	2.001	1.237	2.475	2.639
Minimum	-1.021	-0.358	0.932	-1.061	-2.123	-0.696
Std. Dev.	0.540	0.646	0.242	0.258	0.561	0.413
Observations	479	479	479	479	479	479

Source; Author's own Calculations

In order to investigate the incidence of multicollinearity, the findings of the correlation matrix are presented in Figure 1.



Source; Author's own Calculations

Figure 1: Graphical correlation matrix

The graphical presentation reveals that carbon emissions (CO_2) are weakly associated with economic growth (GDP), the log of the square of economic growth (GDP^2), consumption of fossil fuels (FFE), renewable energy consumption (REE), and gross capital formation (GCF). Therefore, the findings of the matrix show that there is no cross-linearity of the selected framework. In addition, the following was reported for the correlation matrix Table 3.

Table 3: Results of Correlation Matrix

	CO_2	REE	FFE	GDP	GDP2	GCF
CO_2	1.00					
RER	-0.32	1.00				
FFE	0.34	-0.71	1.00			
GDP	0.22	0.11	0.37	1.00		
GDP^2	0.44	0.39	0.41	0.35	1.00	
GCF	-0.31	0.47	0.24	0.23	0.21	1.00

Source; Author's own Calculations

In the next stage, we have checked the steadiness of the panel data series, which is required for valid findings to be calculated. We have employed the strongly recommended root test for Fisher type to diagnose unit root occurrence and, due to imbalanced panel data. Table 4 presents the findings.

Table 4: Unit Root Results

Ho: All panels contain unit roots							
AR parameter: Panel-specific Panel means: Included			Number of panels = 24 Avg. number of periods = 17.433				
		CO_2	REE	FFE	GDP	GDP^2	GCF
Inverse chi-squared	P	83.72	89.43	76.44	64.56	94.27	78.52
Inverse normal	Z	-6.52	-5.15	-6.18	-5.72	-7.58	-5.76
Inverse logit t	L*	-6.37	-5.04	-6.01	-4.96	-6.09	-4.35
Modified inv. chi-squared	Pm	29.52	23.51	22.89	19.57	31.01	23.04

Source; Author's own Calculations

Results demonstrate that the data set is without an issue of unit root and has remained at a level from the start of the test. We confirmed the homoscedasticity and endogeneity in the model before running the pragmatic and practical test. For homoscedasticity, the results of a Breusch-Pagan test (Breusch and Pagan, 1979) are described as follows.

$$Chi2(6) \quad = \quad 325.39 \quad ; \quad p-value \; > \; Chi2 \quad = \quad 0.00$$

The findings of the Breusch-Pagan test found that the null hypothesis did not support the equation since the variance was found to be varying (2). This lower p-value indicates that the alternative hypothesis should be accepted, and the null hypothesis should be rejected (i.e., stable, and consistent variance of the parameters). Therefore, the model's data series is exhibiting heteroscedasticity.

A Durbin-Wu-Hausman test for endogeneity is used to determine if the endogeneity is present in the framework, and the outcomes are as follows.

$$Durbin\;(score) \quad Chi2(6) = \; 47.32 \qquad ; \qquad p-value \; = \; 0.00$$

$$Wu-Hausman \;\; F\;(6,479) = \; 173.55\,; \qquad p-value \; = \; 0.00$$

The lower p-value means that the alternative hypothesis has been accepted, and the null hypothesis has been rejected, which implies the presence of endogeneity in the variables. Because of these two problems, the study implemented a more robust two-step system GMM estimator with moving averages. Using the two-step system-GMM and the results in Table 4, our selected data fully fulfill the criteria of the two-step system-GMM, and the results are listed in Table 4.

Additionally, Sargan Override Restrictions have been used to ensure the quality of the instruments developed in the system GMM. Another assumption we make here is that the beginning circumstances remain useful even if there are endogenous regressors present. Table 5 contains a second-order serial correlation test result showing that limitations employed in the framework had been overidentified.

Table 5: Results based on Fixed Effect, Random Effect, and GMM

Dependent Variable = CO_2; Number of Groups = 24			
VARIABLES	Fixed Effect	Random Effect	GMM
$CO_2(-1)$			0.907***
			(0.0232)
REE	-0.567***	-0.590***	-0.0482***
	(0.0496)	(0.0484)	(0.0138)
FFE	1.544***	0.955***	0.0206**
	(0.115)	(0.0909)	(0.00889)
GDP	-0.0289	-0.0268	0.0761*
	(0.0237)	(0.0251)	(0.0408)
GDP^2	0.0210*	0.0209*	-0.00329
	(0.0111)	(0.0118)	(0.0202)
GCF	0.00699	0.00690	0.0103
	(0.00760)	(0.00806)	(0.0125)
Constant	-1.753***	-0.748***	-0.00492
	(0.219)	(0.194)	(0.0210)
Observations	479	479	406
R-squared	0.525	--	--
Wald chi2(6)	--	--	43324.37 (p-value =0.00)
Arrelano Bond AR (1)	--	--	Z= -6.69 (p-value = 0.00)
Arrelano Bond AR (2)	--	--	Z= 0.31 (p-value = 0.76)
Sargan Overid. Restriction chi2(36)	--	--	62.08 (p-value = 0.00)
No. of Instruments	--	--	43

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

In Table 5, the results of GMM show that renewable energy (REE) usage is significant at 1 percent, which means one percent addition in renewable energy usage has reduced the 0.04 percent of CO_2 emissions in the emerging countries of Silk Road Economic Belt if all other factors considered constant. Although a slight effect of renewable energy on CO_2 discharge has been found, its participation is constructive in environmental sustainability. The results highlight that renewable energy resources significantly impact the modern era because the higher dependence on non-renewable energy resources in emerging nations has instigated considerable environmental threats. Therefore, emerging countries are now turning their emphasis on renewable energy resources to control environmental pollution without truncating their GDP growth. Renewable energy is indeed costly compared to non-renewable energy usage, especially for those emerging economies with limited resources. But the use of renewable energy resources will control CO_2 discharge in emerging countries located in the Silk Road Economic Belt domain, as the neat and clean environment is the demand of any progressive society. The findings are in line with the work of (Yang et al. 2021), (Huang et al. 2020). Emerging countries on the Silk Road Economic Belt in all four areas demonstrated the necessity of renewable energy for environmental sustainability. Whereas the results reveal that fossil fuel's coefficient is statistically significant at 5% and a constructive correlation between FFE and CO_2 discharge, the results reveal that the coefficient of nuclear energy usage (NUE) is positive insignificant. In other words, one percent improvement in the usage of NRE has increased the CO_2 discharge by 0.02 percent in emerging nations of the Silk Road Economic Belt if all other factors are considered constant. Like other emerging countries, the emerging nations located in Silk Road Economic Belt also have a higher dependence on NRE; that is why fossil fuel combustion to meet energy demand is causing tons of CO_2 discharge every year. This optimistic connection between NRE usage and CO_2 discharge formerly has been confirmed by (Amin et al. 2021), (Hanif et al. 2019) (Safdar et al. 2020a). However, the effectiveness of RE in emerging economies of the SREB has been confirmed by the present investigation. So, the transition from nonrenewable to renewable resources is helpful to control CO_2 discharge and improve the benefits of SREB initiative to develop modern societies.

A recent study indicated that GDP has a favorable and substantial effect on CO_2 discharge in countries in the Silk Road Economic Belt, especially in rising economies. It highlighted that one percent expansion in GDP had increased the CO_2 discharge by about 0.07 percent, ceteris paribus. In detail, CO_2 discharge has amplified due to the growth of the industrial sector in emerging economies. The emerging economies are indeed promoting their growth process for better living standards, but the growth on the other side is causing the problem of environmental degradation. The considerable reliance on NRE resources has increased production and GDP growth, but side by side it is also creating the problems of environmental degradation, water pollution, and massive CO_2 emissions. These findings of the present study are endorsing the results of (Xia et al. 2020), (Shen et al. 2021) (Safdar et al. 2020b).

Furthermore, GDP square (GDP^2) is also regressed on carbon discharge to verify the EKC theory for SREB nations. The results showed that the coefficient is insignificant, and one percent improvement in GDP-square decreased CO_2 emissions by about 0.003 percent, ceteris paribus. Although the results are statistically insignificant, a negative relationship between squared GDP growth and CO_2 discharge found by the estimated model has validated the EKC hypothesis in emerging economies of the Silk Road Economic Belt, and thereby validating the findings of (Liu et al. 2021), (Zhang et al. 2020), (He et al. 2020). The results demonstrate that Gross Capital Formation's has a positive and insignificant association with carbon discharge. The rate of the GCF coefficient is 0.004, which means a 1 percent increase in gross capital formation in emerging countries of the Silk Road Economic Belt may encourage the CO_2 discharge by 0.013 percent. Moreover, results confirm that emerging economies are at the initial stage of development, prompting the industrial sector and relying on non-renewable energy sources. Hence, a positive association between gross capital formation and carbon emissions and findings is consistent with (Sun et al. 2020b) who argued that investment is determined by higher level of GDP in emerging counties that further depend on fossil fuel energy sources.

5. Conclusion

The relationship between GDP growth, NRE and RE usage, and CO_2 discharge in 24 emerging countries of the Silk Road Economic Belt has been investigated by covering 1995 to 2014. The research applied the ARDL approach to estimate results and applied various statistical tests to estimate reliable and robust results. The long-run results depicted that the increase in GDP growth increases CO_2 discharge. At the same time, an improvement in GDP (square term) decreases CO_2 discharge, thereby confirming the EKC hypothesis in emerging economies of the Silk Road Economic Belt. In addition, the gross capital formation has also been found helpful in reducing the CO_2 discharge in these economies.

In comparison, NRE and GDP growth have been found substantial elements of amplified carbon discharge in the countries under question. The short-run results have witnessed the increase in CO_2 discharge by NRE usage while declining CO_2 discharge by consuming RE. Thus, it can be concluded that the emerging countries from the Silk Road Economic Belt should focus on RE resources to overcome the environmental challenges emerging due to high CO_2 discharge and other greenhouse gasses. From the empirical results, it can be concluded that the transition from NRE to RE sources is inevitable to control CO_2 discharge and increase the benefits of the SREB initiative. Moreover, there is a need to design a policy framework for the development of regional cooperation to highlight the importance of RE and set the targets of a gradual reduction in the usage of NRE sources.

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