

Article

Sustainable Use of Energy Resources, Regulatory Quality, and Foreign Direct Investment in Controlling GHGs Emissions among Selected Asian Economies

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Abstract: “United in Science” is the recent slogan of the United Nations climate summit in 2020. A collective effort of institutional governance, energy resources utilization, foreign inclusion, and regional collaboration is required for the Sustainable Development Goal (SDGs) of achieving a clean environment. In reaching this objective, this study investigates the sustainability of Regulatory Quality (RQ), Energy Consumption per capita (ECpc), Foreign Direct Investment (FDI), and their interaction in reducing the Greenhouse Gases (GHGs) Emissions. This study considered 27 Asian economies, covering the more extensively undertaken regional investigation, in the time period from 2001 to 2018. The results of the two-step system Generalized Method of Moments (GMM) show that RQ has a strong positive significant impact on GHGs emissions reduction. It further indicates that FDI inflows support the institutions to enhance their institutional capacities. Simultaneously, ECpc has negative impacts on GHGs emissions. Furthermore, RQ interaction with ECpc and FDI also have a strong significant positive impact on GHGs emissions reduction in Asia. The study concludes that the Asia region has been implementing aggressive and prudent policies towards environmental up-gradation to achieve sustainability. However, FDI inflows should be more allocated to environmental quality and energy efficacy to clean the climate and promote regional collaboration.

Keywords: Sustainable Development (SD); Greenhouse Gases (GHGs) Emissions; Regulatory Quality (RQ); Energy Consumption per capita (ECpc); Foreign Direct Investment (FDI); Asian economics; GMM; clean environment; United Nations (UN)

1. Introduction

“A Race We Can Win, A Race We Must Win” was the recent United Nations (UN) 2019 Climate Summit slogan. The summit was themed on Climate Action, what betterment could be made, and how collectively all countries must vigorously strive to remediate the harm inflicted on nature. Global warming and environmental deterioration have not been addressed as persistently and with as much emphasis as they have been in the past few years. According to the World Meteorological Organization (WMO) and the UN collaborated report called “United in Science 2020,” most global activities were disturbed in 2020. However, environmental deterioration, global warming, and Greenhouse Gases (GHGs) emissions (emissions from the earth in Carbon Dioxide, Methane, Nitrite Oxide,

and others accumulating in the atmosphere and increasing global warming) have been growing [1,2]. In achieving the Sustainable Development Goal's (SDGs) objective, GHGs emissions are among the most significant hurdles that deteriorate the environment with time [3–5]. Countries worldwide have been struggling to reduce GHGs emissions by deploying their state capacity and expertise. However, GHGs emission is accelerating due to incompetence and inadequacy, human settlement, and financial determinants. Besides, to affect the environment, GHG Adversely affects human health. A vital instrument of SDG's clean environment would be to reduce the GHGs emissions and suppress its effect.

Clean environment and quality air are the essential agenda of the UN's SDGs. Apart from various other initiatives, the "Clean Air Initiative" is one of the UN 2019 Summit's primary initiatives. The summit urges national and subnational governments to Air quality that is safe for citizens and align climate change and Air pollution policies by 2030. In recent days, environmental quality and protection have become a global concern. All Developed, developing, and under-developed countries affect various types of environmental hazards. Due to increasing population, human and industrial activities in the city can be described as having a collective socio-economic impact [3–5].

As per the UN SDGs, the socio-economic system is the driving force to deplete the megacities' environment quality [6]. This socio-economic system has become the integration of humans and rapid industrial progression. Furthermore, state regulations and prudent environmental policies contribute to all kinds of institutional quality and services and reduce GHGs emissions [7]. Simultaneously, human settlement by energy consumption and related activities affects the environment through GHGs emissions [8,9]. Along with state and human settlement determinants, foreign investment also enhances the environment, and research and development measures to control GHGs emissions [10].

China has been an active member of the UN Summit and has shown impressive improvements in the past many years to mitigate low air quality [11]. On the other hand, other developing and emerging Asian states have struggled to achieve SDGs despite various political and resource constraints. However, China and world-leading agencies, e.g., World Bank, United Nations, International Monetary Fund (IMF), have given continuous financial and technical support to control GHGs emissions to other struggling countries. As per the IMF global outlook report [12], the Asian economies have been performing extraordinarily in the last two decades and remain an attractive venture for foreign investors.

There is plenty of research on the global perspective and single country study that examined the GHGs emissions with different variables. However, literature has scarcely searched and explored panel Asian economies in this perspective [13]. A recent study by Akbar et al. [9] tried to enter this untapped area and studied the GHGs emission and energy analysis; however, they also used a small sample of developing Asian countries only with fuel energy.

Based on the importance of climate cleanliness and SDG, this study has been designed to explore the impact of state, human, and financial determinants of GHGs emissions in Asia. Owing to this fact, and the study gap, Asia's environmental and development progress make this research a vital instrument in this regard. This study has considered developed, developing, and emerging Asian economies based on the updated data and trends by the European Union and World Bank database [14,15], which has not been studied from an Asian panel perspective yet as per the author's knowledge. Thus, the research in this study is a novel and a vital contribution. This study will help explore the factors that affect the GHGs emissions and, simultaneously, help draft and amend the policies accordingly, leading the developing and emerging economies to achieve the SDG of a clean and healthy environment.

2. Literature Review and Hypotheses Development

Sustainable Development (SD) is the long-term development plan to fulfill the next generation's needs through planning today. SD is a notable notion worldwide, especially in developing and emerging countries [16]. One of the vital SDGs is to protect the environment and promote climate purification. In achieving this objective, policymakers and think-tanks have focused on making an in-depth analysis of environmental deterioration determinants with optimum resource utilization and drafting a comprehensive policy by deploying state and human settlement factors. Greenhouse Gases (GHGs) Emissions are the global concerns in this regard. Various hazardous elements deteriorate the environment, e.g., Particular Matters (PM2.5, PM10), Ozone depletion, and carbon dioxide emission [17–19].

Among various hazards of the environment, GHGs emission detrimentally affects the environment. Since the UN's Millennium Development Goals 2000, countries have focused on controlling GHGs emissions irrespective of their development status and applied distinct mechanisms [20,21]. Because industrial states and countries with industrially oriented affect the environment, they need to control the emission. However, after the launching of SDGs 2015, world-leading agencies and member states of the UN observed a more attentive and focused approach required for environment purification and protection [22–24]. Nanaki et al. [25] and Skrócaný et al. [26] studied the various policy implication and their effects on European states. They showed that, in achieving prudent sustainability, policies are needed irrespective of their state development status.

Other studies by Zeng et al. [27] and Sinha, Sengupta, and Alvarado [28] studied the technology and state policies on GHGs environment assessment in a small sample Asian and African economies. They examined that countries have been focusing more on their policy mechanism on sustainability and SDG achievement. Since the SDGs' launch, scholars have evaluated state policy implications and concentrated approach and recommended various policy implications to achieve all SDGs through optimum state resource utilization [29,30].

As per the UN's SDG agenda, by 2030, one of the vital tools of resource utilization and Human settlement and their impact on GHGs emissions is Energy consumption [31,32]. However, prudent policy enforcement can determine how cleanly and efficiently energy consumption is used in attaining SDGs. Delrue et al. [33] applied an innovative pathway model for environmental sustainability from a global perspective. They observed that low carbon energy consumption has a significant positive impact on the environment and can help in reducing GHGs emission. Alkhathlan and Javid [34] observed energy per capita and GHGs emission per capita through a further study's linear logarithm model. They observed that GHGs emission has a monotonical effect on rising energy consumption per capita in the long-run, which deteriorates the environment. However, alternative energy consumption patterns, e.g., nuclear energy and renewable energy consumption, can be excellent approaches in controlling GHGs emissions [35]. Begum et al. [36] examined the energy and GHGs relationship and economic growth in Malaysia. They applied ADRL and DOLS models in 1970–2009 and examined that a long-run energy consumption per capita pattern affects environmental deterioration. Furthermore, it can be reduced through renewable energy consumption and energy efficiency to achieve sustainability [37–39].

GHGs emission mitigating strategies have been implemented in various parts of the world, and somehow their impacts are significant. Since the SDGs initiative, these strategies speed up environmental protection in all aspects. Chang, Hwang, and Wu [40] examined the energy and GHGs nexus in China and observed that energy consumption through biofuels has a significant impact on GHGs emission reduction; however, other sources have a negative impact. In a further study in Turkey, Pata [41] applied the ADRL approach and showed that renewable energy consumption has no effect on CO₂ emission and does not affect GHGs emission. He further stated that accumulated energy has less impact on GHGs emissions in Turkey than in other regions.

A recent work of Su et al. [42] empirically analyzed the BRICS and G7 countries and their Energy and GHGs emission trends. They observed that the GHGs emission situation improved with time; however, more aggressive policies were needed in developing countries to control GHGs emissions with prudent and efficient energy policies. The studies of Sarkodie et al. [43] and Mukhlis [44] applied ADRL and VECM models in Australia and Indonesia. They observed that energy consumption affects GHGs emission and is associated with economic progression. However, alternative energy policies can control GHGs emissions in long-run sustainable development.

In achieving the SD environment protection objective, sound regulations and quality governance significantly impact environmental protection [45]. Samimi, Ahmadpour, and Ghaderi [7] examined the regulation quality and ecological degradation through CO₂ emission proxy in the MENA region and applied panel regression model. They observed that sound and aggressive policies are in dire need in developing countries to safeguard their climate abnormalities and promote the SD. A further study by Khan, Yaseen, and Ali [46] applied the GMM approach in upper-middle-income countries in Asia, Europe, and America. They observed that Asian policymakers should revise their policies enforcement and add some policy reforms to climate up-gradation [47].

In recent work in BRICS countries, scholars undertook an analysis by applying the PMG-ADRL approach that regulatory quality significantly impacts GHGs emission or CO₂ reduction, which has been witnessed in the past couple of years [48]. Stef and Jabeur [49] examined the institutional quality and environment degradation in a panel study and applied a dynamic panel approach through regulation quality and GHG/CO₂ emission proxies. They discussed that regulation has a significant positive impact; however, some other institutional quality determinants and financial elements are associated with this impact. Furthermore, the studies mentioned earlier analyzed the regulation concerning energy consumption and their effect on GHG emission. However, they observed their impact separately on hazardous emission in the environment [7].

According to Waldo's Public Management Theory, state development depends on national natural resources and institutional capacity [50,51]. However, the New Public Management Theory stated that state resources, human interaction, and foreign inclusion also support institutional development [52–54]. Owing to this foreign inclusion, Foreign Direct Investment (FDI) is also considered an essential determinant of state development; however, FDI inflows and GHG emission will not have an extensive literature unless and until they interact with other explanatory variables. Pao and Tsai [55] examined that FDI inflows and GHGs emissions in BRICS and observed that FDI inflows positively enhance the institutional capacity and investment for GHGs emission reduction measures.

However, another study that examined panel developing countries and applied a fixed effect. They showed that FDI and GHGs emissions have an insignificant impact unless and until another institutional governance determinant interacts with it, e.g., corruption and regulatory control [13]. Chinese Scholars Zhou et al. [10] analyzed the FDI and GHG emissions in Chinese cities and found that in the short run, FDI has a negative impact on environmental quality; however, it is beneficial in the long run in reducing the emissions by adding technology and strategic measures. By applying the ADRL approach in Pakistan, the study says that FDI positively impacts GHG emission reduction in the long run by enhancing environmental control measures and technology [56].

Population control is also one of the SDG concerns, and for the sake of facilitation, the urban population has been increasing much higher than the rural population due to urbanization. As per the UN, by 2050, more than 70% of the world population will live in urban areas, which will create issues for basic needs and affect environmental quality and energy consumption demand [57]. Liu, Gao, and Lu [58] studied this phenomenon of urbanization in China and analyzed urbanization's impact on per capita GHGs emissions. They observed that urbanization has been increasing the population density in urban areas, which affect the GHGs emission. Cross-country panel data from 1971–2012 via thresh-

old model approach has shown that urbanization significantly influenced GHGs emissions. However, it does not directly affect them [59]. The recent work of Liobikienė and Butkus [60] studied the Urbanization and GHGs emission in panel data of 147 countries and applied GMM in time horizon 1990–2012. They observed that urbanization has no direct effect on GHG emissions. However, in another study of 186 countries, panel data for 1980–2015 through the Granger Causality approach found that urbanization affects environmental degradation. However, its intensity varies from country to country in different income groups [61,62].

Hypotheses Development

Based on the above discussion and literature review, this study has developed the following hypotheses:

H1: *Energy Consumption per capita negatively influences Greenhouse Gases Emissions.*

H2: *Foreign Direct Investment has a positive impact on Greenhouse Gases Emissions*

H3: *Regulatory Quality has a positive impact on Greenhouse Gases Emissions*

H4: *Energy Consumption per capita and Regulatory Quality interaction positively affect Greenhouse Gases Emissions*

H5: *Foreign Direct Investment and Regulatory Quality interaction positively affect Greenhouse Gases Emissions*

3. Method and Material

3.1. Data Variables

This study has taken GHGs emission per capita as the dependent variable and Energy Consumption per capita, Foreign Direct Investment as independent variables, and Regulatory Control as the moderating variable. Moreover, the urban population growth rate has been taken as the control variable. This study has made a novel contribution by integrating Regulatory control with Foreign Direct Investment and Energy Consumption per capita. The time horizon has taken from 2001 to 2018 by considering 27 Asian developed, developing, and emerging economies as the study sample (mentioned in Appendix A). The study was based on the GHGs emission dataset and notable trends by World Bank and European Union in the last two decades and regional efforts after the (MDGs) 2000 and (SDGs) by the UN [14,15]. Data description is detailed in Table 1.

Table 1. Data Variables, Descriptions, and Impacts.

Variable	Capacity	Description	Source	Period	Expected Impact
GHG Emission Per Capita (GHGpc)	Dependent Variable	% of GHG consumption per capita in the country annually in Metric Ton	European Union database and World Bank database	2001–2018	-
Energy Consumption per Capita (ECpc)	Independent Variable	% of Energy consumption from all sources per capita in the country annually on Gigajoule scale	European Union database and World Bank database	2001–2018	-
Regulatory Quality (RQ)	Moderating Variable	The ability of the government in implementing sound and prudent policies and promote the development	World Governance Indicator by the World Bank	2001–2018	+

Foreign Direct Investment (FDI)	Independent Variable	It is a % of net FDI inflows to GDP per annum	World Development Indicator (WDI) by the World Bank	2001–2018	+
Urban Population Growth (PGu)	Control Variable	The annual urban population growth rate	World Development Indicator (WDI) by the World Bank	2001–2018	-
Regulatory Quality * Foreign Direct Investment (RQ * FDI)	Integrating Variable	How does the government use the FDI in drafting and implementing sound and prudent public policies			+
Regulatory Quality * Energy Consumption per Capita (RQ * ECpc)	Integrating Variable	How does the government control and manage the energy consumption pattern in the country with regulations	Authors Estimation		+

Source: European Union database and World Bank database.

3.2. Research Framework

Based on the study discussion, background, and hypotheses development, the below-mentioned research framework has been designed for this study. Regulatory Quality (RQ) is used as a state capacity determinant with a moderating effect and has an expected positive impact on GHG emission per capita (GHGpc) and promotes the SD. Energy Consumption per capita (ECpc) is considered a human settlement factor and negatively affects the GHG emission and hinders SD. FDI takes as foreign inclusion and positively impact in controlling GHG emission. Simultaneously, two interaction terms, RQ * FDI and RQ * ECpc, promote the SD and help control GHG emissions. In Figure 1, arrows depict the individual effect of determinants on GHG emission (a positive and negative sign of expected effects mentioned in boxes), and Bold arrows with the 'IV' sign demonstrate the integrating effects.

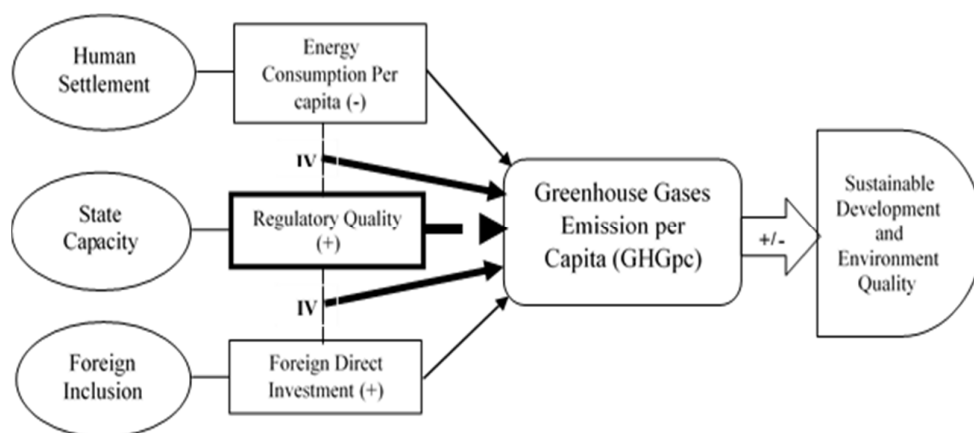


Figure 1. Conceptualized Research Framework. Based on Literature and Author's Estimation.

3.3. Econometric Strategy

This study has applied the two-step system Generalized Method of Moments (GMM) estimation. GMM consider an excellent choice for panel data analysis and control endogeneity, autocorrelation, and measurement errors. For the essential criteria for the GMM approach, the number of cross-section groups should be greater than the period ($N > T$; N

= 27 > T = 18) [63,64]. In checking the instrument validity and over-identifying restrictions, robustness Hansen-Sargan tests are also applied [65–67].

According to Roodman [64], GMM limitations and accuracy can be analyzed from AR (1) and AR (2) at the first points for autocorrelation at the first and second time periods. AR (1) should be 0.1% to 0.30%, while the AR (2) value must be equal to or greater than the 5% significant interval. However, a recent study by Ali et al. [68] observed that model validly relies more on the AR (2) value, and the insignificance of AR (1) does not affect the results. Moreover, the J statistics value must be less than the number of cross-section groups, and the Hansen value must be between 0.1–0.30% while the Sargan value is 0–0.1% [64]. GHGs Emissions Nexus with energy and urbanization has been investigated in panel studies by the researchers through GMM [46,49,60]. By checking the system co-integration, the Westerlund and Padroni test and ADF Fisher Unit Root tests have been applied [69–72]. Driscoll-Kraay standard errors have been applied for robustness check [58,73].

3.4. Econometric Equation

Econometric Equation

$$GHGpc = \int (ECpc, FDI, PGU, RQ) \quad (1)$$

Direct Channel

Static Equation:

$$GHGpc = \beta_0 + \beta_2 (ECpc)_{i,\tau} + \beta_3 (FDI)_{i,\tau} + \beta_4 (PGU)_{i,\tau} + \mu_{-}(i,\tau) \quad (2)$$

Dynamic Equation:

$$GHGpc = \beta_0 + \beta_2 (GHGpc)_{i,\tau-1} + \beta_3 (ECpc)_{i,\tau} + \beta_4 (FDI)_{i,\tau} + \beta_5 (PGU)_{i,\tau} + \mu_{-}(i,\tau) \quad (3)$$

Indirect Channel

Static Equation:

$$GHGpc = \beta_0 + \beta_2 (ECpc)_{i,\tau} + \beta_3 (FDI)_{i,\tau} + \beta_4 (PGU)_{i,\tau} + \beta_5 (RQ)_{i,\tau} + \beta_6 \text{Integ} (ECpc * RQ)_{i,\tau} + \beta_7 \text{Integ} (FDI * RQ)_{i,\tau} + \mu_{-}(i,\tau) \quad (4)$$

Dynamic Equation:

$$GHGpc = \beta_0 + \beta_2 (GHGpc)_{i,\tau-1} + \beta_3 (ECpc)_{i,\tau} + \beta_4 (FDI)_{i,\tau} + \beta_5 (PGU)_{i,\tau} + \beta_6 (RQ)_{i,\tau} + \beta_7 \text{Integ} (ECpc * RQ)_{i,\tau} + \beta_8 \text{Integ} (FDI * RQ)_{i,\tau} + \mu_{-}(i,\tau) \quad (5)$$

In the above equations; β_0 = constant, GHGpc = Greenhouse Gases per capita, ECpc = Energy Consumption per capita, ECpc = Energy Consumption per capita, FDI = Foreign Direct Investment, PGU = Urban Population Growth, RQ = Regulatory Quality, μ = Error term, i = Country and t = time period, Integ = Integration

4. Data Analysis and Discussion

4.1. Trends and Observations

Figure 2 demonstrates the average GHGs Emission per capita and average energy consumption per capita in the Asia region. Trends show that in the last decade, from 2001 to 2010, energy consumption and GHGs emission positively correlated and increased and have affected the environment quality in the last decade. Since the SDGs enforcement in 2015, a gradual increase in energy consumption has been observed in Asia. However, a notable scenario shows that GHGs emission has been decreasing, which shows the energy efficiency and environmentally-friendly energy usage in Asia tends towards sustainability.

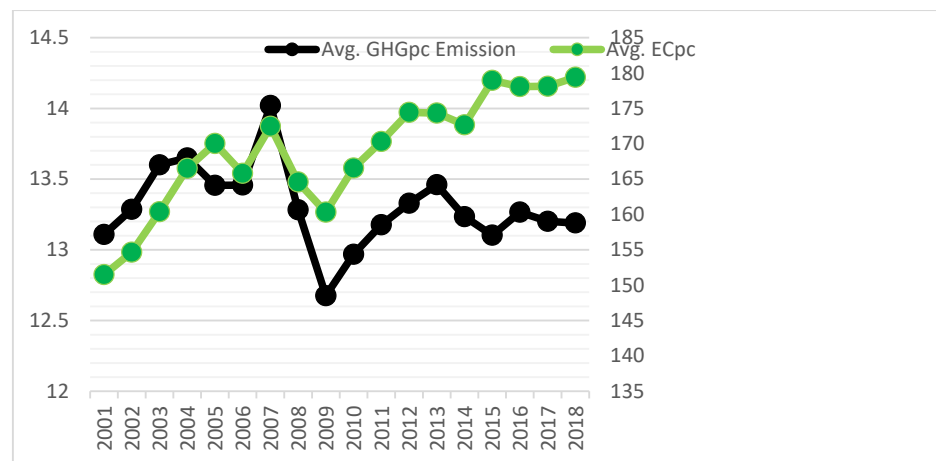


Figure 2. Average GHGpc Emissions and Average Energy Consumption per capita (ECpc) of the Asia region. Data Source: [14].

The average GHGpc emissions and average regulatory quality in Asia are graphically expressed in Figure 3. This shows that RQ has been inconsistent with time and resulted in no significant improvement observed in Asia in the last half-decade. However, for a couple of years, a substantial improvement in regulations has been observed, which has steadied or controlled the GHGs emissions in Asia, which is a positive sign towards sustainable development and a sense of responsibility among the UN's member states.

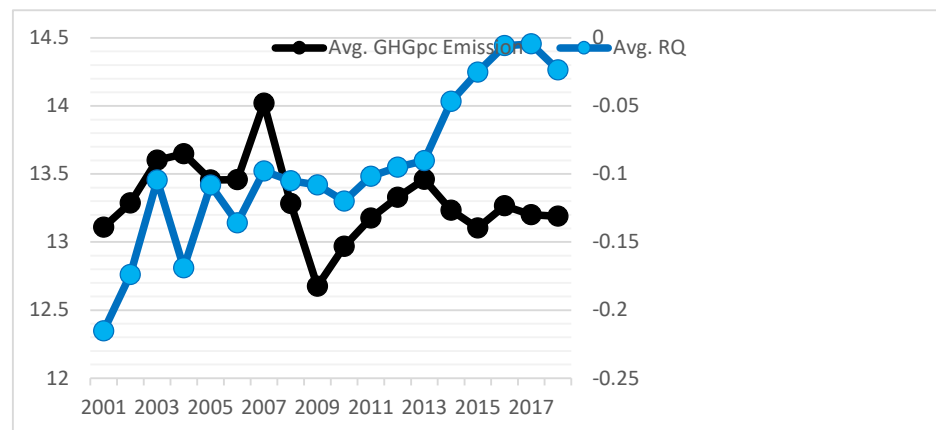


Figure 3. Average GHGpc Emissions and Average Regulatory Quality (RQ) of Asia region. Data Source: [14,15].

Comparative average GHGs emissions per capita and average FDI inflows to GDP have been depicted in Figure 4 in Asia. As per statistics and trends, a prominent insignificant relation has been observed in Asia since 2015. However, to the commitment of environment up-gradation and sustainability, a positive upward trend in FDI inflows and downward trend of GHGs emissions have been observed. To achieve the SD objective, consistent efforts and FDI inflows can substantially contribute to GHGs emission reduction.

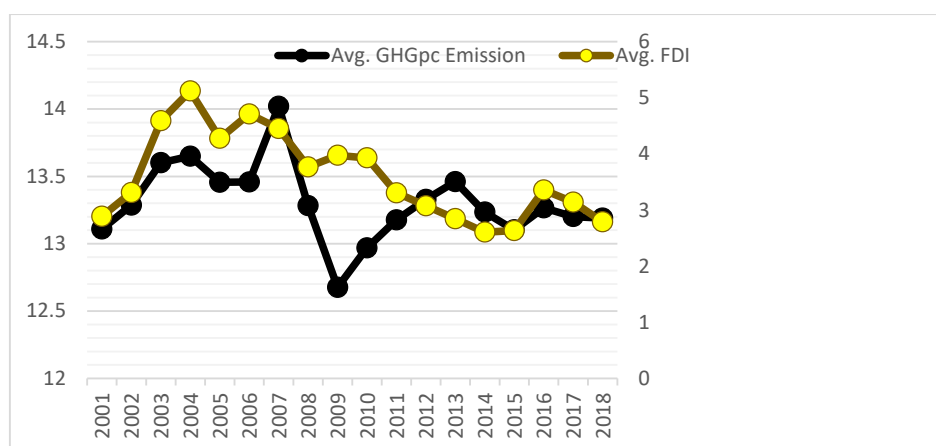


Figure 4. Average GHGpc Emissions and Average Foreign Direct Investment (FDI) of Asia region. Data Source: [14,15].

4.2. Descriptive Statistics

Table 2 demonstrates the descriptive statistics of the study sample.

Table 2. Descriptive Statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
GHGpc	486	11.996	10.911	1.119	41.887
ECpc	486	161.127	170.062	4.689	597.834
RQ	486	−0.123	0.847	−2.09	1.27
FDI	486	3.044	3.395	−2.574	13.013
PGu	486	2.513	1.487	−0.341	6.291
ECpc_RQ	486	48.385	188.246	−446.33	759.249
FDI_RQ	486	−0.193	4.789	−26.547	16.527

Source: Authors Estimation.

4.3. Correlation Analysis

Pearson's pairwise correlation statistics are explained in Table 3. Results show that Explanatory variables FDI inflows and ECpc have positively correlated with GHGs emissions with a 99% confidence interval. Simultaneously, the control variables of urban population growth are also positively related to GHGs emissions with a 99% confidence interval. Moreover, RQ's moderating variables are positively correlated to GHGs emissions, and interaction RQ with ECpc is more strongly correlated to GHGs emissions than interacting with FDI. In a nutshell, the overall results are backed by the study objective and validate the study model.

Table 3. Pearson's Correlation Analysis.

Variables	GHGpc	ECpc	RQ	FDI	PGu	ECpc_RQ	FDI_RQ
GHGpc	1.000						
ECpc	0.862 ***	1.000					
RQ	0.034	0.209 ***	1.000				
FDI	0.394 ***	0.323 ***	−0.07	1.000			
PGu	0.270 ***	0.474 ***	0.063	0.006	1.000		
ECpc_RQ	0.309 ***	0.665 ***	0.214 ***	0.126 ***	0.804 ***	1.000	
FDI_RQ	0.026	0.387 ***	0.043	0.056	0.675 ***	0.785 ***	1.000

Source: Authors Estimation; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

4.4. Unit Root and Co-Integration

Co-integration tests apply on non-stationary panel data to investigate the long-run and stable relationship among study variables. Simultaneously, the Unit Root test is applied to find out the presence of a unit root in the panel data and presence of non-stationary variables, which can affect the results. Westerlund, ADF, Phillips-Perron, and Padroni co-integration tests have been used in this study [34,55,61,69–72,74]. The study's Unit Root and Co-integration tests and Tables 4 and 5 evidenced that some panel data are the co-integrating, and the null hypothesis of no integration is rejected. Table 4 depicted that dependent, independent, and moderator variables rejected the unit root presence's null hypothesis. However, the control variable PGU rejected the null hypothesis of the Unit root at the first-order-differenced.

Table 4. Augmented Dicker Fuller-Fisher Unit Root Test.

Unit Root Test			
Variables	Lag	ADF Fisher Chi-Squared	Decision
GHGpc	Level	5.048 ***	(I0)
ECpc	Level	9.101 ***	(I0)
RQ	Level	6.255 ***	(I0)
FDI	Level	6.489 ***	(I0)
PGU	Level	0.721	(I1)
	First Difference	13.562 ***	

Standard errors in parentheses * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ Source: Authors Estimation.

Table 5. Co-Integration tests.

Wester Lund Test for Co-Integration	Statistics	p-Values	Decision
Variance ratio	48.248	0.000	Ha: Some panels are co-integrated

Panel means: Included

Time trend: Included

AR parameter: Panel specific

Number of panels = 27

Number of periods = 18

Pedroni Test for Co-Integration	Statistics	p-Values	Decision
Modified Phillips-Perron t	7.146	0.000	Ha: Some panels are co-integrated
Phillips-Perron	−14.615	0.000	
Augmented Dickey-Fuller t	−6.849	0.000	

Note:

Panel means: Included

Time trend: Included

AR parameter: Panel specific

Number of panels = 27

Number of periods = 18

For Pedroni: Kernel: Bartlett; Lags: 2.00 (Newey-West); Augmented lags: 1

Source: Authors Estimation.

4.5. Baseline Regression Analysis of Two-Step System GMM

Columns 1–4 in Tables 6–9 demonstrate the Static and Dynamic Ordinary Least Square (OLS) and Fixed Effect (FE) diagnostic test and are overall R² values are significant to GHGs Emissions. Column 5 depicts the results of the two-step system GMM—the nexus of explanatory and control variables to GHGs emissions explained in the first model in Table 6. The Explanatory variable ECpc has a significant impact with 95% significance

on GHGs emissions. Simultaneously, another explanatory variable, FDI and Control variable Urban Population growth with 99% significance, has insignificant effects on GHGs emissions. For model fitness and validity, AR (1) and AR (2) show that autocorrelation is first order-differenced and the null hypothesis of second-order differenced calculation is rejected. Hansen's value also backed the model fitness and supported the study objective.

Table 6. Two-step system Generalized Method of Moments (GMM) Regression analysis baseline results.

	S.OLS	S.FE	D.OLS	D.FE	Two-Step System GMM
VARIABLES	GHGpc	GHGpc	GHGpc	GHGpc	GHGpc
GHGpc			1.010 *** (0.005)	0.806 *** (0.020)	1.019 *** (0.014)
ECpc	0.055 *** (0.002)	0.039 ** (0.015)	−0.001 *** (0.000)	0.008 *** (0.001)	0.001 ** (0.000)
FDI	−0.442 *** (0.072)	−0.105 ** (0.041)	0.020 ** (0.009)	−0.004 (0.013)	0.006 (0.005)
PGu	0.786 *** (0.169)	0.291 * (0.161)	−0.077 *** (0.020)	−0.105 *** (0.029)	−0.164 *** (0.019)
Observations	486	486	459	459	459
R-squared	0.776	0.502	0.997	0.892	
AR(1)					−2.507
AR(1)-p					0.0122
AR(2)					−0.490
AR(2)-p					0.624
Sargan					97.45
Sargan-p					0.000
Hansen					21.78
Hansen-p					0.114
J					20
Chi(2)					173,688
Chi(2)-p					0
Number of Group		27		27	27

Standard errors in parentheses * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; Source: Authors Estimation.

Table 7. GMM regression results with a moderator.

	S.OLS	S.FE	D.OLS	D.FE	Two-Step System GMM
VARIABLES	GHGpc	GHGpc	GHGpc	GHGpc	GHGpc
GHGpc			1.008 *** (0.006)	0.796 *** (0.020)	1.022 *** (0.071)
ECpc	0.061 *** (0.002)	0.039 ** (0.015)	−0.001 ** (0.000)	0.007 *** (0.001)	0.006 *** (0.002)
FDI	−0.477 *** (0.068)	−0.105 ** (0.041)	0.019 ** (0.009)	−0.001 (0.013)	0.094 *** (0.024)
PGu	0.567 *** (0.164)	0.291 * (0.161)	−0.079 *** (0.020)	−0.082 *** (0.030)	−0.341 ** (0.138)
RQ	−2.207 *** (0.306)	1.305 * (0.718)	−0.034 (0.039)	0.439 *** (0.167)	−1.517 *** (0.458)
Observations	486	486	459	459	459
R-squared	0.797	0.502	0.997	0.893	

AR(1)			−2.419
AR(1)-p			0.0156
AR(2)			−0.167
AR(2)-p			0.868
Sargan			54.140
Sargan-p			0.000
Hansen			12.38
Hansen-p			0.260
J			16
Chi(2)			2926
Chi(2)-p			0
Number of Group	27	27	27

Standard errors in parentheses: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; Source: Authors Estimation

Table 8. GMM regression results with the first interaction model.

	S.OLS	S.FE	D.OLS	D.FE	Two-Step System GMM
VARIABLES	GHGpc	GHGpc	GHGpc	GHGpc	GHGpc
GHGpc			0.999 *** (0.008)	0.799 *** (0.020)	1.080 *** (0.104)
ECpc	0.075 *** (0.001)	0.041 *** (0.013)	−0.000 (0.001)	0.007 *** (0.001)	0.008 *** (0.003)
RQ	3.407 *** (0.310)	1.806 (1.220)	0.036 (0.063)	0.257 (0.205)	−1.096 ** (0.505)
ECpc_RQ	−0.039 *** (0.002)	−0.003 (0.005)	−0.001 (0.000)	0.001 (0.001)	−0.004 *** (0.001)
FDI	−0.245 *** (0.047)	−0.107 ** (0.040)	0.018 ** (0.009)	0.000 (0.013)	0.124 *** (0.030)
PGu	0.680 *** (0.110)	0.263 * (0.150)	−0.072 *** (0.021)	−0.073 ** (0.030)	−0.512 *** (0.197)
Observations	486	486	459	459	459
R-squared	0.909	0.507	0.997	0.894	
AR(1)					−2.232
AR(1)-p					0.0256
AR(2)					−0.0637
AR(2)-p					0.949
Sargan					51.97
Sargan-p					0.000
Hansen					11.16
Hansen-p					0.265
J					16
Chi(2)					2071
Chi(2)-p					0
Number of Group		27		27	27

Standard errors in parentheses: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; Source: Authors Estimation.

Table 9. GMM regression results with the second interaction model.

	S.OLS	S.FE	D.OLS	D.FE	Two-Step System GMM
VARIABLES	GHGpc	GHGpc	GHGpc	GHGpc	GHGpc
GHGpc			1.006 *** (0.008)	0.795 *** (0.020)	1.117 *** (0.083)
ECpc	0.063 *** (0.001)	0.039 ** (0.015)	−0.001 (0.001)	0.007 *** (0.001)	0.003 (0.003)
FDI	−0.492 *** (0.050)	−0.096 ** (0.038)	0.018 * (0.009)	0.007 (0.014)	0.116 *** (0.031)
RQ	1.225 *** (0.281)	1.197 (0.758)	−0.025 (0.048)	0.351 ** (0.169)	−1.768 *** (0.585)
FDI_RQ	−0.951 *** (0.047)	0.042 (0.048)	−0.004 (0.011)	0.038 ** (0.015)	0.083 *** (0.015)
PGu	0.648 *** (0.120)	0.286 * (0.164)	−0.078 *** (0.021)	−0.084 *** (0.030)	−0.497 *** (0.131)
Observations	486	486	459	459	459
R-squared	0.891	0.504	0.997	0.895	
AR(1)					−2.677
AR(1)-p					0.007
AR(2)					−0.278
AR(2)-p					0.781
Sargan					49.79
Sargan-p					0.0000
Hansen					12.21
Hansen-p					0.202
J					16
Chi(2)					2061
Chi(2)-p					0
Number of Group		27		27	27

Standard errors in parentheses: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; Source: Authors Estimation.

4.5.1. Regression with Moderating Variable—Regulatory Quality (RQ)

Table 7 depicts the role of moderating variable Regulatory Quality. ECpc and FDI have both significantly impacted GHGs emissions with a 99% confidence interval. However, FDI has a positive value with an inverse or no effect on GHGs emissions. Moreover, the control variable urban population growth has an insignificant impact on GHGs emissions, with a 95% confidence interval. A moderating variable RQ has a 99% confidence interval and a significant impact on GHGs emissions. AR (1) and AR (2), Hansen and Sargan also supported the study model fitness and backed the study objective.

4.5.2. Regression with Interaction Energy Consumption per Capita (ECpc) and Regulatory Quality (RQ)

Table 8 demonstrates the interaction between the moderating variable RQ and ECpc. The results show that ECpc * RQ has negatively impacted GHGs emissions with a 99% confidence interval by incorporating the interaction term. AR (2) has a significant value in model fitness and validity, and AR (1) is also significant. Moreover, Hansen and Sargan tests also show that the over-identifying restriction is valid and validates instrument selection.

4.5.3. Regression with Interaction Energy Consumption per Capita (ECpc) and Regulatory Quality (RQ)

In another interaction analysis, Table 9 explains the FDI interaction with RQ. ECpc has positively significantly impacted GHGs emissions. FDI and PGU both show an insignificant impact, with a 99% confidence interval. FDI * RQ interaction has no significant impact on GHGs emissions. The results show that FDI has not been appropriately utilized to promote the SD and clean the environment. Explanatory variable RQ has a strong positive significant impact on GHGs emissions with a 99% confidence interval. For model fitness and validity, all requirements are valid and supported the study objective.

4.6. Robustness Check

For robustness check, this study has applied Driscoll-Kraay standard errors for investigating the heterogeneity and autocorrelation in the results [43,58,73]. The results are consistent and show that ECpc at 99% and FDI at 90% confidence intervals are significant to GHGs emissions. In model two, RQ at a 99% confidence level is positively significant to GHGs emissions reduction. In interaction models 3 and 4, ECpc * RQ and FDI * RQ are both significant at a confidence interval of 90%, while Control variable PGU remained insignificant in all models. The results of robustness statistics are mentioned in Appendix B.

4.7. Discussion

GHGs emissions are the global climate and sustainability concerns. Energy consumption per capita has a significant direct impact on GHGs emissions [75]. The previous study of Khan, Yaseen, and Ali [46] revealed that energy consumption per capita has less significantly impacted GHGs emission reduction in upper-middle-income countries of Asia than in Europe and America. This study evidenced that developing, emerging, and developed countries have somehow adversely affected the environment through GHGs emissions by their energy consumption pattern. Moreover, trends in Figure 2 explained that energy consumption trends had been improved with time in Asia, currently have less effect on GHGs emission than a couple of years ago, which shows a regional commitment towards sustainable development [14,42].

It evidenced that prudent policies and implementations have a strong positive significant impact on GHGs emission reduction in developed Afro-Asian and European countries and some global perspective panel studies [7,48,49]. However, Stef and Jabeur [49] used institutional quality and energy interaction patterns in global data of 83 countries until 2014. This study has made a novel contribution in this chain and made a more-focused analysis of Asian countries through the interaction of Regulatory Quality and Energy Consumption effects per capita. This study revealed that ECpc adversely affects Asia's environment quality, while prudent and efficient public policies towards energy consumption and renewal resources utilization can be vital in GHGs emission reduction and national and regional sustainability.

Previous studies showed that, along with human settlement (consumption pattern), FDI inclusion positively and significantly impacts GHGs emissions reduction by enhancing the technology and environment cleaner measures [13,56]. However, this study's finding expressed that mere FDI has insignificant or no effect on GHGs emissions unless and until sound institutional policy interaction deploys these investments at the right ventures. This is another novel contribution of this study because it has not yet been conducted from this perspective. This study explored whether GHGs emission has not been affected much by urbanization, which means that urban areas have been using efficient environmental policies despite increasing human and industrial interaction in Asia.

5. Conclusions

The study investigated the role of independent variables Energy Consumption per capita, Foreign Direct Investment, and a moderator role of Regulatory Quality on Greenhouse Gases Emissions a way toward sustainable development in Asia from 2001–2018. This study's novel contribution involves analyzing the interaction between Regulatory

Quality and Energy Consumption per capita and Foreign Direct Investment. This study's findings showed that efficient and robust energy consumption and purification have improved the GHGs emissions situation in Asia and will be a vital instrument in achieving sustainable development goals. Moreover, FDI inflows towards environmental institutions, and reforms in climate policies also positively impact GHGs emissions reduction in Asia. In a nutshell, Regulatory Quality has significantly impacted environmental up-gradation and shows a strong commitment of a state towards SD from national and regional perspectives. For regional and national development, countries should collaborate with the lowest performing countries so their struggle can be mitigated, and lift them towards sustainability.

6. Limitation and Future Study Direction

This study focused on 27 Asian countries with a prominent trend in study variables due to data availability constraints. For future research, a regional comparative analysis of Asia with other regions to investigate global sustainable development progress would be an excellent approach. Moreover, investigating the nexus between FDI patterns and their interaction with energy consumption and associated variables with the sustainable development of GHGs emissions would also be meaningful.

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Appendix A

Table A1. List of Sample Countries.

List of Countries		
Azerbaijan	Kazakhstan	Singapore
Bangladesh	Kuwait	South Korea
China	Malaysia	Sri Lanka
India	Oman	Thailand
Indonesia	Pakistan	Turkey
Iran	Philippines	Turkmenistan
Iraq	Qatar	United Arab Emirates
Israel	Russian Federation	Uzbekistan
Japan	Saudi Arabia	Vietnam

Appendix B

Table A2. Regression with Driscoll-Kraay standard errors (Direct Impact).

Variables	Pooled OLS	Fixed-Effects Regression
ECpc	0.055 *** (23.380)	0.041 *** (15.630)
FDI	−0.442 *** (−5.000)	−0.120 * (−2.730)
PGu	0.786 * (2.560)	0.245 * (2.020)
R-squared	0.775	0.485
Root MSE	5.185	−
F(3,17)	7781.45	228.98
p-value	0.000	0.000
Number of groups	27	27
Number of Obs	486	486

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A3. Regression with Driscoll-Kraay standard errors (Moderating Effect).

Variables	Pooled OLS	Fixed-Effects Regression
ECpc	0.061 *** (23.380)	0.039 *** (15.150)
FDI	−0.477 *** (−5.690)	−0.105 * (−2.650)
PGu	0.567 * (1.980)	0.291 * (2.480)
RQ	−2.207 *** (−13.700)	1.305 *** (5.520)
R-squared	0.797	0.502
Root MSE	4.930	−
F(4,17)	7843.37	530.61
p-value	0.000	0.000
Number of groups	27	27
Number of Obs	486	486

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4. Regression with Driscoll-Kraay standard errors (Interaction of ECpc_RQ).

Variables	Pooled OLS	Fixed-Effects Regression
ECpc	0.075 *** (40.010)	0.041 *** (11.540)
RQ	3.407 *** (7.800)	1.806 *** (3.810)
ECpc_RQ	0.039 *** (17.360)	−0.003 * (−1.150)
FDI	−0.245 *** (−3.880)	−0.107 * (−2.660)
PGu	0.680 *** (3.780)	0.263 * (2.290)
R-squared	0.908	0.506
Root MSE	3.315	−
F(5,17)	14,200.70	415.28
p-value	0.000	0.000
Number of groups	27	27
Number of Obs	486	486

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A5. Regression with Driscoll-Kraay standard errors (Interaction of FDI_RQ).

Variables	Pooled OLS	Fixed-Effects Regression
ECpc	0.063 *** (25.390)	0.039 *** (14.980)
FDI	−0.492 *** (−7.030)	−0.096 * (−1.870)
RQ	1.225 *** (5.030)	1.197 *** (4.060)
PGu	0.648 * (2.650)	0.286 * (2.460)

FDI_RQ	−0.951 *** (16.660)	0.042 * (0.600)
R-squared	0.891	0.503
Root MSE	3.618	-
F(5,17)	4242.22	423.19
p-value	0.000	0.000
Number of groups	27	27
Number of Obs	486	486

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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