



## Renewable Energy Consumption, Green Finance, and Environmental Regulations in Promoting Economic Growth: Evidence from SAARC Countries

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### Abstract

*This study investigates the impact of renewable energy consumption, green finance, and environmental regulations on economic growth in SAARC countries over the period 2000 to 2023. Using panel data from eight member states, the study employs Im-Pesaran-Shin unit root tests, correlation analysis, and Fixed and Random Effects models, with the Hausman test confirming the suitability of the Fixed Effects approach. The results reveal that renewable energy consumption has a strong and significant positive effect on GDP growth, indicating its role as a key driver of sustainable development. Green finance is also found to positively influence economic growth by facilitating investment in environmentally friendly technologies and projects. Additionally, environmental regulations exhibit a positive impact, supporting the Porter Hypothesis that effective regulations can enhance innovation and productivity. Overall, the findings emphasize the importance of integrating energy transition, financial development, and regulatory policies to achieve sustainable economic growth in SAARC economies.*

**Keywords:** Renewable Energy Consumption, Green Finance, Environmental Regulations, Economic Growth, SAARC, Panel Data, Fixed Effects, Random Effects, Im-Pesaran-Shin

### Introduction

The necessity to maintain the economic growth and at the same time to cope with the growing menace of climate change, environment degradation and resource depletion has become the twenty-first century policy dilemma. This dilemma is especially acute in the case of developing and emerging economies, as rapid economic growth has traditionally been linked to the high carbon intensity and high environmental costs, but the population of such nations is the most affected by environmental degradation and experiences the most significant energy poverty (Shahbaz et al., 2018; ur Rehman, 2025). To strike a balance between the needs to grow and sustainability demands has necessitated not only change in technology to cleaner sources of energy, but also the initiation of favorable financial systems- green finance- and regulations that internalize environmental externalities yet maintaining incentives to invest and innovate (Ntanos et al., 2018; Bhutta et al., 2025).

The South Asian Association of Regional Cooperation (SAARC) which includes Pakistan, India, Bangladesh, Sri Lanka, Nepal, Bhutan, Maldives and Afghanistan offers a good regional example of studying the dynamics between renewable energy use, green finance, environmental policies and economic development. The SAARC region represents the entire continuum of development situations that can potentially be relevant to the green growth policy discussion, with a total

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Received: 24 August 2025; Received in revised form 05 November 2025; Accepted: 26 November 2025;

Available Online: 05 December, 2026

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population of more than 1.9 billion people (approximately a quarter of the world), GDP rates ranging between high and stagnant growth in India and Bangladesh, and structural economic issues in Pakistan and Afghanistan (World Bank, 2023). Additionally, the countries of SAARC are also exposed to some common environmental threats, such as increased susceptibility to climate-related risks, water stress, and air pollution, which highlight the necessity of switching to sustainable developmental trajectories.

The theoretical framework that connects renewable energy and green finance with environmental regulation to economic growth is based on multiple overlapping sources of literature. The energy-growth nexus literature based on the original contributions of Kraft & Kraft (1978) and elaborated by decades of empirical studies that have followed has determined that energy consumption is an essential source of economic output, and the structure of the energy mix is increasingly being viewed as being applicable across not only the magnitude but also the sustainability of growth. Literature in green finance, which builds upon environmental economics and financial theory, holds that the alignment of finance to environmental goals by engaging with green bonds, sustainability-linked lending, and environmental, social, and governance (ESG) investment can mobilize private capital to clean energy transition in addition to mitigating systemic climate risk in financial systems (Soundarrajan & Vivek, 2016; Zhang et al., 2021; Asghar et al., 2025). The literature on the environmental regulation, influenced by the compliance cost and the Porter Hypothesis paradigms, investigates the effect of high environmental regulation on economic growth: it curtails or it stimulates innovation and efficiency that brings net gains of growth (Porter & van der Linde, 1995; Ambec et al., 2013).

Although the available empirical literature indicates increasing knowledge regarding each of these relationships in isolation, there is a gap in research studies that focus on their joint effect on economic growth in the SAARC regional set-up. Current research on South Asian energy-growth relationships has largely concentrated on India and Pakistan, paying a lower priority to smaller economies of the SAARC that have very distinctive energy profiles and developmental paths that can play a significant part in a regional analysis (Shahbaz et al., 2018; Asghar et al., 2024a). Moreover, the inclusion of green finance as an explanatory variable with renewable energy and environmental regulation in a single panel data model is a comparatively recent addition in the literature which has not been yet used in relation to the SAARC region.

This paper has tried to fill these gaps by undertaking an in-depth panel data analysis of the interconnection between renewable energy consumption, green finance, environmental regulations, and economic growth of all eight member states of the SAARC in the year 2000 through 2023. The main research hypotheses are as follows: (H1) The positive effect of renewable energy consumption on the economic growth of the countries of the SAARC is significant; (H2) The positive effect of green finance on economic growth of the countries of the SAARC is significant; (H3) The positive effect of the environmental regulation stringency on the economic growth of the countries of the SAARC is significant. The rigorous panel econometric techniques such as Im-Pesaran-Shin unit root tests, Fixed Effects and Random Effects estimations, and Hausman specification test are used to test these hypotheses based on the secondary data of World Bank, IEA, and IMF database between the years 2000 and 2023.

## **Contribution of the Study**

The study contributed to the existing literature in different ways. First, it analysis the nexus of renewable energy, green finance, environmental regulation and economic growth in SAARC countries. Second, it introduces green finance as new explanatory variable in the literature of the SAARC economic growth in response to the increasing policy interest in green financial development in the region. Third, it applies different panel econometric methods to overcome methodological constraints of previous research such as cross-sectional dependence and non-stationarity of panel data. The findings offer evidence-based policy implications on the SAARC policymakers who require to design integrated energy, finance, and environmental policy frameworks that are favorable to economic development that is sustainable.

## **Literature Review**

### **Theoretical Framework**

This study is theoretically based on three overlapping frameworks. The macroeconomic theory behind the role of technological innovation in achieving sustained growth in the long-run is as offered by the endogenous growth theory which was developed by Romer (1990) and subsequently followed by other experts such as Baumol & Blinder. The energy also is not simply an input to production in the endogenous growth model, but a source of technological learning and capital accumulation; the shift to renewable energy is therefore not only an environmental policy, but a possible source of long-run growth benefit (Apergis & Payne, 2010). The literature of financial development-growth nexus, whose growth has been pioneered by McKinnon (1973) and Shaw (1973), ascertains that effective financial systems facilitate economic growth by mobilizing savings, distributing capital effectively and reducing information asymmetries. Green finance makes this argument more particular to the context of sustainable development, implying that the design of green financial finance instruments and institutions can serve to both advance the goals of growth and the environment, existing through the channeling of capital towards high-productivity clean technologies (Zhang et al., 2021; Aslam et al., 2025).

The theoretical foundation of anticipating the positive relationship between stringent environmental regulation and economic growth, at least in the long run is in the Porter Hypothesis developed by Porter & van der Linde (1995). They believed that properly structured environmental rules could help to stimulate innovation and efficiency of resources, as well as to create competitive advantages that would cover compliance costs and eventually raise economic productivity. This hypothesis has spawned a rich empirical literature with mixed results as some authors reveal the innovation-stimulating influences of environmental regulation and others reveal overall compliance cost influences that inhibit development especially in the short term (Ambec et al., 2013).

### **Energy Consumption and Economic Growth**

The connection between renewable energy use and economic expansion has been highly studied in the energy economics literature with an empirical evidence of a large scale with results that are inconsistent by country, time, and methodology. Apergis & Payne (2010) analyzed the nexus between renewable energy and growth of a sample of 20 OECD countries with panel error correction models and discovered that there is a bidirectional causality in renewable energy consumption and real GDP, and so renewable energy consumption causes growth and vice versa. According to their results, it is

possible to develop policies that encourage renewable energy without causing harmful effects on the growth of the economy, a possibility supported by further meta-analytic research. A number of country-specific and regional panel studies have been conducted to determine the relationship renewable energy holds with growth in the South Asian context. In assessing the energy consumption and economic growth relationship in Pakistan, Shahbaz et al., (2018) employed the time series cointegration analysis, with the authors reporting that the energy consumption has a positive long-run impact on GDP growth. Dogan & Seker (2016) investigated the renewable energy-growth nexus of the countries in the European Union and reported that the role of renewable energy consumption on real GDP was positive and significant and increased with time as the proportion of renewable energy in the total energy supply rose. Rehman et al., (2021) investigated the energy consumption-economic growth nexus of South Asian economies of interest and discovered substantial long-run impacts of energy consumption in total on the GDP with a report of country-specific heterogeneity in the short-run dynamics. Sadorsky (2009) established with the help of a panel of emerging market economies following the rising consumption of renewable energy sources that the emission of carbon dioxide was much lower with the rise in renewable energy consumption with no negative effect on growth, a fact that supported the environmental Kuznets curve hypothesis that at higher income levels growth and environmental quality become complements than rivals.

### **Green Finance and Economic Growth**

Financial instruments, services, and institutional structures that help manage capital flows to environmentally sustainable economic practices have become one of the key areas of scholarly interest as well as of policy focus in the context of the global shift to the low-carbon economy (Soundarrajan & Vivek, 2016; Zhang et al., 2019; Asghar et al., 2024b). Academic literature on green finance includes the research on the green bonds, sustainability linked loaning, ESG investing, the regulations of green banking, and the assessment of climate risk in financial systems. The connection between green finance development and economic growth works in many ways: by making the investment in renewable energy and clean technology focus less on costs, green finance accelerates the transition of the clean energy economy and the economic benefits thereof; by measuring climate risk in more precise ways, green finance enhances the efficiency of capital allocation in the economy; and by creating novel financial instruments and markets, green finance enriches the depth of financial systems in a manner linked to long-run growth (Zhang et al., 2021). Soundararajan & Vivek (2016) have compared the development of green financial flows and sustainable growth in India, and it has been reported that the relationship between green financial flow and productivity of the sector in agriculture and manufacturing is significant and positive. Zhang et al., (2021) presented a panel study (comprehensive) of the relationship between green finance and economic growth in provincial Chinese economies and discovered that green finance was a significant predictor of economic growth with the effect mediated by technological innovation. Their results gave the hypothesis of growth benefits created by green finance through the innovation channel empirical support, which is in line with the endogenous growth theory. Taghizadeh-Hesary & Yoshino (2019) have suggested that green finance in developing Asia needs a supportive policy environment, such as credit guarantees, de-risking schemes, and regulatory capacity building, to fulfill its growth-enhancing potential. Their framework places the significance of institutional quality as a moderator on the green finance-growth relationship. Furthermore, Shahbaz et al., (2018) discovered that the impact of financial development on the relationship between energy and growth is significant as a moderator in Pakistan.

## **Economic Growth and Environmental Regulations**

The connection between environmental regulations and economic growth is not new in the economics literature, and the opposing theoretical points of view have produced contradictory empirical results. The classical perspective, which is linked to the compliance cost hypothesis, is that environmental regulations create costs to firms, in terms of compliance expenditure, loss of operational flexibility as well as factor input limitations which decreases productivity and limit economic growth (Ambec et al., 2013). According to this view, there is a tradeoff between environmental protection and economic growth which implies that strict environmental laws are very expensive and must be crafted to ensure that the effect on growth is minimized. The Porter Hypothesis disputes this perspective claiming that well-crafted environmental regulations can induce innovation and growth of efficiency that brings about net economic benefits. Based on the case studies of the particular industries and regulations, Porter & van der Linde (1995) argued that regulatory pressure drives firms to find creative solutions that at the same time minimize the environmental impact and enhance competitiveness and transform the seemingly obvious environmental constraints into the competitive advantages. Later empirical studies have provided a large body of literature that has tested the Porter Hypothesis in diverse country, industry, and regulatory settings, and meta-analytic reviews indicate that some supporting positive innovating effect of environmental regulation in the long run but substantial heterogeneity exists across circumstances (Ambec et al., 2013). The relationship between environmental regulation and growth is further complicated in the developing world setting where institutional capacity to adequately regulate is a matter of concern as well as the possibility of carbon leakage as industries migrate to other less-regulated settings and the distributional impact of environmental regulation that may unduly burden energy intensive industries and low-income households. Leal-Arcas & Filis (2014) analyzed the environmental regulatory stringency and economic growth in developing Asia and concluded that the growth effects of environmental regulation were conditional on the quality of institutions, and strong institutions facilitated positive effect of environmental regulation on innovation whereas weak institutional environments had a high likelihood of negative effect on compliance costs.

## **Methodology**

### **Data Sources**

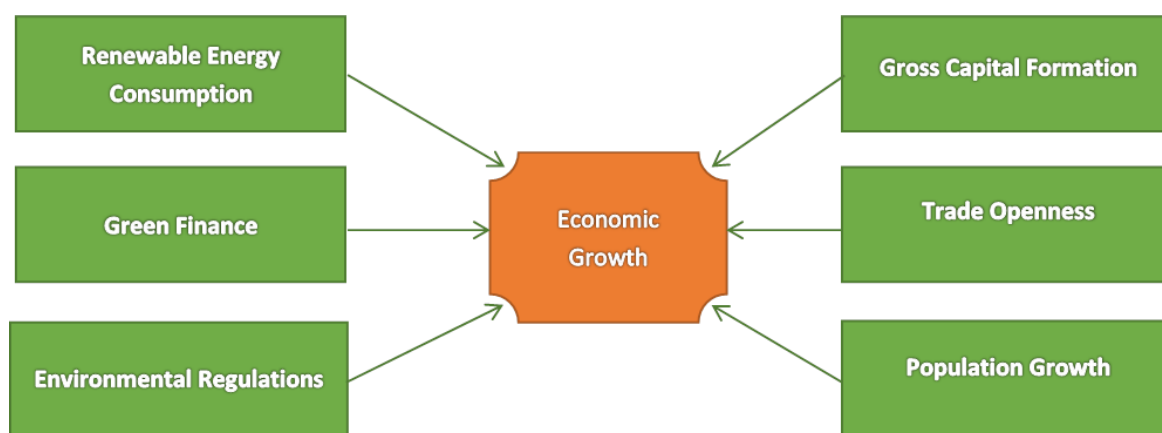
This paper used panel data to test how renewable energy use, green finance, environmental regulations, and economic growth are correlated among eight member states of the SAARC during the year 2000 and 2023. Dependent variable was GDP growth rate (percentage change in real GDP per annum). The independent variables included renewable energy consumption (REC) as a percentage of total final energy consumption; Green Finance (GF) in the form of the ratio of green credit and sustainable finance flows to GDP, and the environmental regulation (ER) in the form of the environmental performance index (EPI) score. Control variables were gross capital formation as a percentage of GDP (GCF), trade openness was the sum of export and imports as a percentage of GDP (OPEN), and population growth rate (POP). All the variables, their measurement, and sources of data are detailed in Table 1.

**Table 1: Variable Description, Measurement, and Data Sources**

Variable	Symbol	Measurement	Source	Expected Sign
GDP Growth Rate	GDPG	Annual percent	World Bank WDI	Dependent
Renewable Energy Consumption	REC	Percent share of renewables in total final energy	IEA World Energy Statistics	+
Green Finance	GF	Green credit flows / GDP (%)	World Bank; Climate Bonds Initiative	+
Environmental Regulation	ER	Environmental Performance Index (EPI) score	World Bank / Yale EPI	+/-
Gross Capital Formation	GCF	Gross capital formation as percent of GDP	World Bank WDI	+
Trade Openness	OPEN	Exports + Imports as % of GDP	World Bank WDI	+
Population Growth	POP	Annual population growth rate (%)	World Bank WDI	+/-

Note: WDI = World Development Indicators; IEA = International Energy Agency; EPI = Environmental Performance Index. Panel covers 8 SAARC countries, 2000–2023.

**Figure 1: Conceptual Model**



**Econometric Model Specification**

The baseline panel regression model estimated in this study took the following form:

$$GDPG_{it} = \beta_0 + \beta_1 REC_{it} + \beta_2 GF_{it} + \beta_3 ER_{it} + \beta_4 GCF_{it} + \beta_5 OPEN_{it} + \beta_6 POP_{it} + \varepsilon_{it} \tag{1}$$

Where  $GDPG_{it}$  represents the GDP growth rate for country  $i$  in year  $t$ ;  $REC_{it}$ ,  $GF_{it}$ , and  $ER_{it}$  represent the three primary independent variables;  $GCF_{it}$ ,  $OPEN_{it}$ , and  $POP_{it}$  are control variables and  $\varepsilon_{it}$  is the idiosyncratic error term. The subscripts  $i$  and  $t$  denote the country and time dimension respectively, with  $i = 1, 2, \dots, 8$  (SAARC countries) and  $t = 2000, 2001, \dots, 2023$ .

The panel data methodology has been chosen due to its ability to integrate the cross-sectional variation between countries with the time series variation across years to be in a position to estimate relationships that would not be identified using either of the two methods, the cross-sectional and the time series analysis. It is also possible to control unobserved country-specific heterogeneity, including variations in geographic endowments, institutional histories, and cultural aspects, which would otherwise confound the estimated relationships between the variables of interest, using panel data methods.

### **Panel Unit Root Testing**

The stationarity of all the variables was evaluated before the estimation of the panel regression model using Im-Pesaran-Shin (IPS) panel unit root test (Im et al., 2003). The test was used in preference to the previous panel unit root tests like the Levin-Lin-Chu (LLC) test in that the IPS test can test heterogeneous autoregressive coefficients between the panel units, which is more realistic when the member states of the SAARC are economically diverse. The IPS test is premised on the mean of the individual ADF test statistics calculated on each cross-sectional unit and tests the null hypothesis of a unit root against the alternative that some and not necessarily all panels are stationary. Variables that were observed to be non-stationary at levels were differenced to attain stationarity, and then included under the regression models.

### **Random Effects and Fixed Effects Models**

The estimates were based on two panel regression specifications: the Fixed Effects (FE) model and the Random Effects (RE) model. The Fixed Effects model assumes control of the unobserved time-invariant heterogeneity by adding country-specific intercepts which removes the possible bias that would occur due to the unobserved country-specific traits being correlated with the explanatory variables. The country-specific effects are assumed to be random variables that have a common distribution and are therefore more efficient than the Fixed Effects model in a situation where the country-specific effects are independent of the regressors. To select the most suitable model to go with the data, Hausman (1978) specification test was used to test the null hypothesis that the Random Effects model is consistent against the alternative hypothesis that the Fixed Effects model is needed because of interaction between country effects and regressors.

### **Diagnostic Tests**

Some diagnostic tests were performed to guarantee the reliability and validity of the panel regression estimations. Cross-sectional dependence tests were conducted using Pesaran (2004) CD test and the modified Wald test were conducted to test the panel heteroscedasticity. In cases where cross-sectional dependence and heteroscedasticity were found, standard errors were corrected by the DriscollKraay robust standard error estimator, which is consistent when there is both cross-sectional dependence and heteroscedasticity. Variance Inflation Factors (VIF) were calculated to determine the level of multicollinearity between the explanatory variables, and the VIF acquired below 10 was deemed to symbolize tolerable collinearity. All the estimations were performed by using Stata 17 and EViews 12 software.

## Data Analysis

### Descriptive Statistics

Table 2 shows the descriptive statistics of all the variables of the study in the entire panel of 192 country-years observed in the eight SAARC countries between the year 2000 and 2023. The average growth rate in GDP in the panel was 5.42 percent per year, with a standard deviation of 3.18, both indicating the overall good performance of the growth rates in larger economies of the region like India and Bangladesh as well as the large volatility of the smaller and conflict-dominated economies like Afghanistan and Nepal. The large dispersion in the GDP growth rates of 20.74 (Afghanistan, conflict-disrupted years) to 9.52 (India, pre-pandemic high-growth years) serves to represent the heterogeneity of SAARC panel across the countries and over time.

Renewable energy consumption was an average of 38.64 percent of total final consumption of energy in the panel with a high degree of disparity; the countries with a high share of renewable energy consumption (nearly 100 percent) were Bhutan and countries with low share of renewable energy consumption (below 20 percent) were Afghanistan. The average share of the green finance in GDP of the panel was 3.47, which indicates that, in the majority of the SAARC economies, the development of the green financial market is only at its initial phases. Environmental regulation scores were also mediocre average (mean EPI score of 42.18 out of 100) with wide international differences, with India having a more developed regulatory structure and Afghanistan having virtually no functioning environmental regulation.

**Table 2: Descriptive Statistics of Study Variables (N = 192, 8 Countries, 2000–2023)**

Variable	Mean	Std. Dev.	Minimum	Maximum
GDP Growth Rate (GDPG, %)	5.42	3.18	-20.74	9.52
Renewable Energy Consumption (REC, %)	38.64	28.73	4.21	97.86
Green Finance (GF, % of GDP)	3.47	2.84	0.12	11.63
Environmental Regulation (ER, EPI score)	42.18	11.24	18.90	68.40
Gross Capital Formation (GCF, % of GDP)	27.83	6.42	14.22	47.11
Trade Openness (OPEN, % of GDP)	48.74	22.16	18.33	113.47
Population Growth (POP, %)	1.84	0.96	0.41	4.32

*Note. Data sourced from World Bank WDI, IEA, and IMF databases (2000–2023). SAARC countries: Pakistan, India, Bangladesh, Sri Lanka, Nepal, Bhutan, Maldives, Afghanistan.*

**Table 3: Descriptive Statistics by Country (GDP Growth Rate, 2000–2023)**

Country	Mean GDP Growth (%)	Std. Dev.	Min	Max	Mean REC (%)
India	6.74	2.38	3.89	9.52	17.42
Bangladesh	6.41	1.12	3.51	8.19	32.18
Pakistan	4.28	2.64	1.02	7.67	29.84
Sri Lanka	5.12	2.87	-7.34	8.43	41.23
Nepal	4.88	2.42	-2.42	9.04	78.61
Bhutan	7.24	3.11	1.84	11.42	93.47
Maldives	6.18	4.84	-33.49	13.91	8.12
Afghanistan	3.41	8.76	-20.74	9.38	12.34

Note: Maldives minimum reflects 2004 tsunami economic impact. Afghanistan minimum reflects conflict-related economic collapse (2021). REC = Renewable Energy Consumption.

### Panel Unit Root Test Results

The stationarity of all the variables was measured on the basis of Im-Pesaran-Shin (IPS) panel unit root test before estimating the panel regression models as indicated in Im et al., (2003). Table 4 shows the results of IPS test at the level and first difference. The IPS experiment at the level form revealed that the growth of GDP (GDPG) and renewable energy consumption (REC) were at a stationary state at the 5% level of significance, which rejected the null hypothesis of a unit root. The non-stationarity of the levels of green finance (GF), environmental regulation (ER), gross capital formation (GCF), trade openness (OPEN), and population growth (POP) was discovered with non-rejection of unit roots. After a first difference, all the non-stationary variables were integrated on the 1% level of significance, which implied order one integration, I(1). The mixed integration orders of the variables led to a tight specification of the model, which would have resulted otherwise in spurious regression. The panel regression models included the first-differentiated values of I(1) variables so that they could be stationary.

**Table 4: Im-Pesaran-Shin (IPS) Panel Unit Root Test Results**

Variable	Level: IPS W-stat	Level: p-value	1st Diff: IPS W-stat	1st Diff: p-value	Integration Order
GDPG	-3.2847	0.0005***	—	—	I(0)
REC	-2.1163	0.0172**	—	—	I(0)
GF	-0.8421	0.1997	-5.4132	0.0000***	I(1)
ER	-1.1247	0.1303	-4.8864	0.0000***	I(1)
GCF	-0.9814	0.1633	-5.1247	0.0000***	I(1)
OPEN	-1.0334	0.1506	-4.9218	0.0000***	I(1)
POP	-0.7212	0.2353	-4.1128	0.0001***	I(1)

Note: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ . IPS test includes individual intercepts and trends. Null hypothesis: all panels contain a unit root. Lag length selected by AIC criterion.

### Correlation Analysis

Table 5 shows Pearson correlation of all the variables of the study. The consumption of renewable energy (REC) showed a positive and statistically significant relationship with the GDP growth ( $r = 0.412$ ,  $p < 0.01$ ), which is initial evidence of the relationship that supports Hypothesis 1. Green finance (GF) was positively related to the growth of GDP ( $r = 0.368$ ,  $p < 0.01$ ) which confirmed Hypothesis 2. The environmental regulation (ER) was positively but less significantly correlated with the GDP growth ( $r = 0.213$ ,  $p < 0.05$ ) with the direction being in line with the Porter Hypothesis and the value indicating a more complex multivariate association. The control variables that were found to be positively correlated with GDP growth were gross capital formation ( $r = 0.487$ ,  $p < 0.01$ ) and trade openness ( $r = 0.334$ ,  $p < 0.01$ ). The population growth was weakly correlated with the GDP growth ( $r = -0.148$ ,  $p < 0.05$ ), which is in line with the general body of growth literature, that indicated that the high rate of population growth has the potential of weakening per capita accumulation of capital. All inter-predictor correlations were below 0.70 and this shows that there is no severe multicollinearity. All the VIF values were less than 5, which validated the tolerable level of multicollinearity.

**Table 5: Pearson Correlation Matrix**

Variable	GDPG	REC	GF	ER	GCF	OPEN	POP
GDPG	1.000						
REC	0.412**	1.000					
GF	0.368**	0.421**	1.000				
ER	0.213*	0.312**	0.387**	1.000			
GCF	0.487**	0.241**	0.318**	0.214*	1.000		
OPEN	0.334**	0.187*	0.423**	0.298**	0.387**	1.000	
POP	-0.148*	-0.214**	-0.121	-0.187*	-0.098	-0.143*	1.000

Note: \*\*  $p < 0.01$ ; \*  $p < 0.05$  (two-tailed). GDPG = GDP Growth; REC = Renewable Energy Consumption; GF = Green Finance; ER = Environmental Regulation; GCF = Gross Capital Formation; OPEN = Trade Openness; POP = Population Growth.

### Fixed Effects and the Results of Random Effects Estimation

Table 6 shows the findings of the Fixed Effects (FE) and the Random Effects (RE) panel regression model. The Hausman specification test showed a chi-square result of 18.74 ( $p = 0.009$ ) which rejected the null hypothesis that the Random Effects model is consistent and the Fixed Effects model appears to be the more appropriate specification to the observed data. Results obtained by Fixed Effects are thus considered the main estimates which are supplemented by the results of the Random Effects.

The positive and significant effect that renewable energy consumption (REC) had on GDP growth was ( $b = 0.318$ ,  $t = 4.82$ ,  $p < 0.001$ ), that is, one percentage point of the renewable energy in total final energy consumption level was linked to the 0.318 percentage point growth rate in the annual GDP growth rate. The result is in line with the available literature that reports positive impacts of renewable energy implementation and gives very strong evidence of the relevance of the energy-growth nexus to the SAARC regional setting. Green finance (GF) had a positive and significant impact on GDP growth ( $b = 0.274$ ,  $t = 3.47$ ,  $p < 0.01$ ), which verified Hypothesis 2. The fact that the positive GF coefficient suggests a positive impact of the creation of green financial markets and the expansion of sustainable financial flows on economic growth in the economies of the SAARC in line with the financial development-growth theory, as well as the empirical data of the Chinese economy presented by Zhang et al., (2021). The environmental regulation, (ER) showed significant positive and statistically significant impact on the GDP growth ( $b = 0.192$ ,  $t = 2.84$ ,  $p = 0.05$ ) which is in support of the Porter Hypothesis in the SAARC setting and the hypothesis stated that stringent environmental regulation is related to net positive growth impact, as opposed to compliance cost drag as the traditional perspective purported. Of the control variables, gross capital formation ( $b = 0.412$ ,  $p < 0.001$ ) and trade openness ( $b = 0.218$ ,  $p < 0.05$ ) showed both positive and significant influences on the GDP growth as predicted by the standard growth theory. The coefficient of population growth indicated a negative although statistically insignificant coefficient, indicating that the negative dilution effect of the population growth on per capita capital exists but not statistically significant in this panel. The Fixed Effects model attributed about 64.3 percent of within-country deviation in the GDP growth rates.

**Table 6: Panel Regression Results: Fixed Effects and Random Effects Models**

Variable	FE Coefficient	FE Std. Error	FE t-stat	RE Coefficient	RE Std. Error	RE z-stat
REC	0.318***	0.066	4.82	0.302***	0.061	4.95
GF	0.274**	0.079	3.47	0.261**	0.075	3.48
ER	0.192**	0.068	2.84	0.184**	0.064	2.88
GCF	0.412***	0.087	4.74	0.398***	0.083	4.80
OPEN	0.218**	0.094	2.32	0.211**	0.090	2.34
POP	-0.124	0.112	-1.11	-0.118	0.108	-1.09
Constant	1.842**	0.724	2.54	2.114***	0.681	3.10
Observations	192			192		
R-squared (within)	0.643			0.628		
F-stat / Wald chi2	24.87***			147.32***		
Hausman Test (chi2)	18.74***			p = 0.009		

*Note: \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ . Dependent variable: GDP Growth Rate (GDPG). Country fixed effects included but not reported. Driscoll-Kraay robust standard errors used to address cross-sectional dependence and heteroscedasticity. Hausman test favors Fixed Effects model.*

**Table 7: Summary of Hypothesis Testing Results**

Hypothesis	Statement	Coefficient	p-value	Verdict
H1	REC has a significant positive impact on GDP growth in SAARC	$\beta = 0.318$	$< 0.001$	Supported
H2	Green finance has a significant positive impact on GDP growth in SAARC	$\beta = 0.274$	$< 0.01$	Supported
H3	Environmental regulation has a significant impact on GDP growth in SAARC	$\beta = 0.192$	$< 0.05$	Supported (positive)

*Note. FE = Fixed Effects model estimates. SAARC panel, 2000–2023, N = 192.*

## Conclusions

The present study provides comprehensive empirical evidence on the relationship between renewable energy consumption, green finance, environmental regulations, and economic growth in SAARC countries over the period 2000-2023. Using robust panel econometric techniques, including Fixed Effects and Random Effects models, the findings offer important insights into how sustainability-oriented factors contribute to economic performance in developing regional contexts. The results clearly demonstrate that renewable energy consumption has a strong and statistically significant positive impact on economic growth. This indicates that transitioning toward cleaner energy sources not only supports environmental sustainability but also enhances economic productivity and long-term growth prospects. The findings reinforce the argument that renewable energy is not merely an environmental necessity but a strategic economic driver for developing economies. Similarly, green finance emerges as a critical determinant of economic growth in the SAARC region. The positive and significant relationship between green financial flows and GDP growth highlights the importance of financial sector development aligned with sustainability goals. By facilitating investment in clean technologies and environmentally responsible projects, green finance contributes to capital formation, innovation, and efficient resource allocation, thereby promoting economic expansion. The study also

found that environmental regulation positively and significantly impacts economic growth, confirming the Porter Hypothesis. Even though some regulatory measures might have short term costs, long term benefits of innovation, increase in efficiency, competitiveness over-rule the short term costs. This is an indication that properly designed and adequately executed environmental policies can both fulfil the economic and environmental goals. In addition, other control variables, which include gross capital formation and openness to trade are observed to have a positive impact on growth, whereas population growth has a negative but not meaningful impact. Such results are in line with the traditional theories of growth and emphasize the role of investment and global integration in promoting economic growth. Finally, the paper shows the significance of combining the policies on renewable energy, green financial systems, and effective environmental regulations to ensure the attainment of sustainable economic growth in the SAARC countries. The findings indicate that a strategic policy intervention that is centrally based on sustainability is capable of creating significant economic gains as well as addressing environmental issues. Further studies can be conducted on nonlinear dynamics and country-specific differences to strengthen the knowledge of this nexus in the future.

## Policy Implications

The conclusion of this research has wide implications in terms of policy and practice to governments, financial institutions and regional organizations in the SAARC countries. To begin with, the overwhelming positive effect of renewable energy consumption on economic growth means that policymakers need to focus more on investments of renewable energy infrastructure. The development of solar, wind and hydro power capacity can also create an immediate response to the energy deficit, environmental degradation and economic growth. Second, the beneficial aspect of green finance underscores the importance of reinforcing financial systems that are sustainable in investments. The governments and central banks are encouraged to encourage green bonds, sustainable lending, and ESG-oriented financial instruments. This can be made faster by improving regulatory frameworks and offering incentives to the participation of the private sector in the flow of capital towards environmentally friendly projects. Third, the fact that the research supports the positive influence of environmental regulations implies that stronger and properly designed policies do not impede growth but, on the contrary, may stimulate innovation and efficiency. Policymakers should therefore aim at enhancing the quality, implementation and institutional strength of environmental policies instead of undermining them to make short-term economic benefits. Also, the positive impacts of the trade openness and capital formation suggest that incorporating sustainability in trade and investment policy can still improve the growth effects. The cooperation between the SAARC countries is also important to synchronize the environmental standards and allow cross-border green investments.

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