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RESEARCH ARTICLE

Determinants of economic growth and environmental sustainability in South Asian Association for Regional Cooperation: evidence from panel ARDL

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Abstract
Considering the importance of green economic growth and environmental sustainability in the discussion, it is crucial to understand its critical contributing factors and to draw results implications for the green policy. This research used the data of the South Asian Association for Regional Cooperation (SAARC) member countries for a period from 2005 to 2017. It adopted the panel autoregressive distributed lag technique to examine the hypotheses. The findings revealed that environmental sustainability is strongly and positively associated with national scale-level green practices, including renewable energy, regulatory pressure, and eco-friendly policies, and sustainable use of natural resources. Conversely, in our model, the "regulatory pressure" has an insignificant effect on economic growth. A necessary contribution of the present study is that a positive effect of green practices on national scale economic and environmental variables, particularly in the scenario of SAARC member states, can be noticed. At the end of the present study, we have provided policy implications for regulatory authorities and discussed potential areas for future research.

Keywords Renewable energy · Economic growth · CO_2 emission · Regulatory pressure · Panel-ARDL

Introduction

The definition of green supply chain management (GSCM) is well associated with the environmental sustainability in supply chain management practices and is an essential factor that induces organizational settings for green business outlay (Chin et al. 2015). Commonly, the use of GSCM practices often noticeable in the manufacturing sector has given a wakeup call to environmentalists to develop policies for the enhanced environment and sustained economic growth, which, in turn, has impacted the operational performance of firms (Khan et al. 2018). Effective resource management, waste recycling, and re-use resource inputs to reduce production costs and to support the sustainable agenda in the long-term are the channels through which the firms may adopt the GSCM mechanism (Global Supply Chain Group 2015).

The 1990s is a decade widely accepted for the pronunciation of GSCM in diversified economic settings. Kumar et al. (2012) and Li et al. (2020) prompted the need for green management that created a competitive edge between companies

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and defined the necessity for a sustainable corporate strategy for long-term business growth. Liu et al. (2020) emphasized mostly operational researchers the desirability of incorporating environmental issues in the supply chain process and devising long-term sustainable business growth strategy for green business. The strict environmental regulation and environmental accountability are the two key predictors that considerably affect the supply chain process. However, efficiently implementing green strategies in a company's long-term vision and growth is substantially needed. Conversely, contributing factors of CO_2 emissions are fossil fuel and nonrenewable energy consumption. At the same time, renewable energy and green practices not only help to enhance environmental sustainability but also prompt economic activities in the long-run (Moutinho et al. 2018).

The critical difference between GSCM and traditional SCM is eco-friendly practices based on the triple bottom line (society, economy, and environment). Traditional SCM activities mainly based on resource input to the finished form and then deliver to the end customers (Yu and Ramanathan 2014), while during this supply chain process, environmental issues compromised, with the natural environment deteriorated. The policies should be developed in a way to reduce ecological concerns from SCM activities. GSCM is the emerging concept that is vital for reducing the environmental risk of supporting the organizational philosophy of green business (Zhu et al. (2013).

The adoption of GSCM in firms helps enhance environmental performance, which further translated to company decision-making, especially in green purchasing, green product design, and collaboration with producers and suppliers. However, these actions would only occur due to a robust regulatory mechanism that forces companies to adopt environmental preservation by supply chain activities for green business growth (Mirhedayatian et al. 2014; Jabbour and de Sousa Jabbour 2016). However, customer pressure is also an essential factor that enhances the adoption of internal GSCM practices. The regulatory burden works as a catalyst to monitor environmental performance to adopt GSCM practices in organizational settings (Zaman and Shamsuddin 2017; Li et al. 2019a).

Researchers cannot ignore the countries cultural, political stability, consumer behavior, and role of country legal institutions. In developed countries, consumers prefer to buy eco-friendly products, but in developing countries, most consumers are more willing to buy the low-cost product. Also, developed countries' legislation is robust compared with developing countries, for example, "one-policy-fit-all with (Chen et al. 2015; Li et al. 2019b) lowest bribery rate." Furthermore, developing countries have poor logistics infrastructure compared with developed countries, which restricts green practices implementation. Thus, logistics in developing countries becomes a significant contributor to environmental degradation through more fossil fuel and energy consumption and low-efficiency logistics activities (Li et al. 2019c; Khan and Zhang 2020). People in SAARC countries have many similarities in culture, language, food, political systems, and poor logistical infrastructure. Therefore, we select these countries to be our research sample.

It will be a pioneer study in its nature to measure the effect of sustainable policies and practices on the macrolevel. In previous studies, researchers measured the sustainable and green practices in a firm level to examine the effect of green and sustainable practices on organizational performance, whereas the scope of the present study is far beyond the previous studies. This research objective is to explore the effect of green practices on South Asian-based emerging countries' economic and environmental sustainability. To the best of our knowledge, the present study is the first to correlate the green practices with economic and environmental sustainability in a panel of SAARC countries (see the list of countries in Annexure 1 in Table 3).

Literature review and research hypotheses

Pollution preventive practices and economic growth

The concept of the green or sustainable supply chain is mainly based on the triple bottom line (Khan and Dong 2017). Since the industrial revolution, firms are under pressure of governmental bodies and consumers due to their polluted operations, which creating an alarming situation for environmental sustainability (Zhang et al. 2020). Linton et al. (2007) view the focus of sustainability has been shifted from firm-level to supply chain level because the logistical operation is mainly based on fossil fuel, which is the primary cause of air and water pollution (Sauer and Seuring 2018; Gong et al. 2019). A recent meta-analysis is containing 20 years of studies on the connection between sustainable practices in the supply chain and economic performance of the corporate sector. The results revealed that the overall effect of sustainable practices is positive with firms' economic growth/profitability (Vachon 2007; Torres et al. 2018). An empirical study conducted by Miroshnychenko et al. (2017) and explored the linkage between pollution preventive techniques/practices and financial performance. The survey collected the data of 3490 publicly traded enterprises from 58 different countries around the globe. The findings confirmed that eco-friendly practices improve economic and environmental performance and build a positive image of the firm.

Socially responsible suppliers are more effective and helpful for organizations implementing ecological practices in their supply chain processes (Inman and Green 2018). Since the last couple of decades, the corporate sector in emerging economies is more eager to adopt green practices in their business operations for the sake of quality improvement, saving of energy and resources, and cost reduction with better business opportunities in pro-environmentalist countries (Genovese et al. 2013; Zhu et al. 2010; Verbeke and Tung 2013). Regulatory practices for implementing reuse and recycling, disposal of waste materials, and eco-friendly packaging improve firms' image and spur financial performance (Hitchcock 2012), which also translates into a country's economic growth in the long-run.

Pollution preventive and green practices are mainly focused on mitigating harmful effects on environmental sustainability, but it also eliminates the waste from the supply chain processes, which improved the efficiency and quality of the products (Kassinis and Vafeas 2006; Khan et al. 2017; Mitra and Datta 2014). Some studies were conducted in different sectors and reported a positive connection between green practices in supply chain and businesses' financial goals, for instance, in Pakistan (Khan and Dong 2017; Khan et al. 2016) and the United Kingdom (Yu and Ramanathan 2014). However, the results in published literature can be categorized in three main strands including the positive impact of GSCM practices on economic performance (Prakash et al. 2019; Tseng et al. 2015; Khan and Dong 2017; Walton et al. 1998; Zhang and Awasthi 2014). Few of articles found a negative relationship between GSCM and performance (Borin et al. 2013; Christmann 2000; Zaabi et al. 2013; Hillman and Keim 2001), while Zhang and Yang (2016) and Luchs et al. (2010) reported the insignificant relationship between green practices and financial goals. The general conclusion derived from published literature suggests a positive correlation between eco-friendly practices and the corporate sector's performance.

H1: Pollution preventive practices are strongly and positively linked with the economic growth of the countries

Pollution preventive practices and environment

Due to consumer demand and governmental pressure, adopting green practices in supply chain operations become a strategic imperative. Zhu and Sarkis (2004) conducted empirical work, and the outcome revealed that firms could improve their environmental performance and create further business opportunities with greening their supply chain processes. Eco-friendly processes and packaging allow the corporate sector to reduce its supply chain cost through a reduction in usage of resources and materials (Akhtar et al. 2015; Gouda and Saranga 2018). In the manufacturing firms, strong collaboration between suppliers and manufacturers significantly enhances the employees' knowledge of preventive pollution practices, which translate into better environmental performance (Gualandris and Kalchschmidt 2015; Zhu et al. 2005).

For gaining a competitive advantage, many firms are involving in sustainable practices to reduce their consumption of resources and increase the customer satisfaction with better product quality and image ((Field and Sroufe 2007; Cabral et al. 2012), but the primary benefits achieve by eco-friendly practices are to mitigate the carbon emission and protect the conservation eco-system without compromising on profitability (Ondemir 2012; Fahimnia et al. 2014). However, in the last few years, due to consumer awareness on environmental problems, the emerging markets of Asia, including China and India, are also penetrating by green/sustainable practices (Li et al. 2015; Jayaram and Avittathur 2014). Firms of emerging economies actively participate and conduct seminars and programs on "sustainable practices" to build their employees' knowledge (Khan et al. 2020; Hörisch et al. 2014). Green supply chain practices are necessary, as the environmental risk is increasing due to global warming and climate change (Khan and Dong 2017). A research was conducted in Korea and revealed that GSCM practices provide tangible and intangible benefits with improved consumer satisfaction, sales growth, and explore new markets Caniëls et al. (2013). Based on the abovecited papers, we hypothesize that:

H2: Pollution preventive practices are significantly and negatively correlated with environmental deterioration and climate change.

Research methodology

We use annual data for eight South Asian-based developing countries, which is also called SAARC including, Pakistan, India, Bangladesh, Sri Lanka, Nepal, Bhutan, Afghanistan, and the Maldives, covering 13 years from 2005 to 2017. The data are gathered from the WDI website, the most authentic database built and organized by the World Bank (2018). The list of dependent and independent variables, together with their descriptive statistics, is presented in Table 1, and the correlational matrix is displayed in Annexure 2 in Table 4. Furthermore, the theoretical model is shown in Fig. 1. First, we have converted the sample data into the format of panel data because the panel data comprise detailed information with fewer collinearity issues between the variables, greater efficiency in the estimates, and a higher number of degree of freedom (Silva et al. 2018).

This research primarily aims to examine the effect of explanatory variables (REC, ESP, SRC, WASTE, and RP) on economic growth and environmental sustainability. The present study does not use pooled least squares method, as all the variables are not stationary at the level and cointegration test

Table 1 The definition of variables and descriptive statistics

Variable name	Unit	Symbol	Definition	Mean	Median	Minimum	Maximum	Std. dev.
Renewable energy consumption	% of GDP	REC	Renewable energy consumption (% of total final energy consumption).	56.77927	47.10248	37.63448	91.31227	18.21555
Combustible renewables and waste	% of total energy	Waste	Combustible renewables and waste (% of total energy). It includes industrial waste, liquid, and solid biomass, and municipal waste.	45.6815	34.92539	22.63288	87.7209	21.9232
CO_2 emissions	Metric tons per capita	CO_2	CO_2 are those stemming from the burning of fossil fuels.	0.576486	0.475262	0.189944	1.085416	0.32563
Shipments reach consignee within the scheduled time	Index (1 = low to 6 high)	SRC	The frequency with which shipments reach consignee within the scheduled or expected time. Shipment delay is a primary cause of burning extra fossil fuel in the cross border supply chain.	3.056456	3.06643	37.63448	91.31227	18.21555
Trade (% of GDP)	Exports+ imports/GDP	TOP	Trade is the sum of exports and imports of goods and services measured as a share of GDP.	44.76398	45.13277	30.90124	68.60651	9.50232
Environmental policies and sustainable use of natural resources	Index (1 = low to 6 high)	ESP	Environmental policies foster the protection and sustainable use of natural resources and the management of pollution 1 = low to 6 = high.	3.138889	3	2.5	4	0.447396
Regulatory pressure	Index (1 = low to 6 high)	RP	Business regulatory environment rating 1 = low to 6 = high.	3.472222	3.5	3	4	0.401183

CO_2 and TOP both are the dependent variables, and used to measure environmental performance and economic growth respectively in SAARC countries

shows a long-run relationship between the variables; for that reason, pooling the least squares seems not suitable (Delmas and Toffel 2004; Khan et al. 2019; Geffen and Rothenberg 2000). The autoregressive distributed lag (ARDL) approach, proposed by Pesaran and Shin (1998) and Pesaran et al. (2001), is the most appropriate statistical method to test our research hypotheses. In our research, we used the Eviews 10 software to run all the analyses. Furthermore, higher consumption of renewable energy and the adoption of eco-friendly practices in countries are hypothesized to prompt economic growth and environmental sustainability in the long-run. Pesaran and Smith (1995) suggested adopting the panel ARDL model if the variables might not be stationary on the level but stationary on 1(1). In the panel sample, the number of the period (years) is more than countries (Pesaran et al. 1999). As per the abovecited researchers, the benefits of the panel ARDL model over remaining dynamic models, including GMM and fixed effects, are that these statistical models may generate unreliable results of the average value of the parameters except that the coefficients are identical across countries.

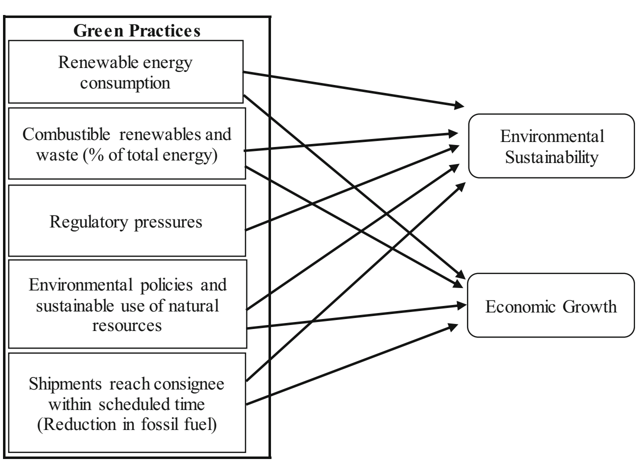

Fig. 1 Theoretical model

The model assessed has the method of an ARDL model (p, q, q,…,q).

Economic growth model

The general functional form of the model is below.

$$EG = f(\mathrm{REC, ESP, SRC, WASTE, RP}) \quad (1)$$

$$EG_{it} = \beta_o + \beta_1(REC_{it}) + \beta_2(ESP_{it}) + \beta_3(SRC_{it}) + \beta_4(WASTE_{it}) + \beta_5(RP_{it}) + \mu_{it} \quad (2)$$

where

EG economic growth
REC renewable energy consumption

ESP environmental policies and sustainable use of natural resources
SRC shipments reach consignee within the scheduled time
WASTE combustible renewables and waste
RP regulatory pressure

$$\Delta EG_{it} = \sum_{j=1}^{p} a_{ij} EG_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}{}' \mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad (3)$$

In the equation, i denotes cross-sectional unit, t represents time period, j denotes optimal lags, X_{it}denotes independent variables, for example, REC, ESP, SRC, WASTE, and RP, and $\mu_i$shows fixed effects. In addition, p and q indicate the panel could be unbalanced. The above equation can be written as by re-parameterization in form of ECM.

The error correction equation written is followed by grouping the variables in level.

$$\Delta EG_{it} = \varphi_i \left(EG_{i,t-1} - \beta_i{}' \mathrm{X}_{it} \right) + \sum_{j=1}^{p-1} a_{ij}^{*} \Delta EG_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*}{}' \Delta \mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad (4)$$

ϕ_i denotes long-run equilibrium association between Υ_{it} and X_{it}, while $\beta_i^{'}$is the long-run parameters. The ϕ_iECT indicates the speed of adjustment, which tells about the speed of convergence of dependent variable towards long-run equilibrium due to shock in explanatory variables. A negative and significant value of $\phi_i$shows long-run causality among dependent and independent variables.

Environmental sustainability model

$$\mathrm{ES_{it}} = \beta_0 + \beta_1 (REC_{it}) + \beta_2 (ESP_{it}) + \beta_3 (SRC_{it}) + \beta_4 (WASTE_{it}) + \beta_5 (RP_{it}) + \mu_{it} \quad (5)$$

$$\Delta ES_{it} = \sum_{j=1}^{p} a_{ij} ES_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}{}' \mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad (6)$$

In the equation, i denotes cross-sectional unit, t represents time period, j denotes optimal lags, X_{it}denotes independent variables, for example, REC, ESP, SRC, WASTE, and RP, and $\mu_i$shows fixed effects. In addition, p and q indicate the panel could be unbalanced. The above equation can be written as by re-parameterization in form of ECM.

The error correction equation written is followed by grouping the variables in level.

$$\Delta ES_{it} = \varphi_i \left(ES_{i,t-1} - \beta_i{}' \mathrm{X}_{it} \right) + \sum_{j=1}^{p-1} a_{ij}^{*} \Delta ES_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*}{}' \Delta \mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad (7)$$

ϕ_i denotes long-run equilibrium association between Υ_{it} and X_{it}, while $\beta_i^{'}$are the long-run parameters. The ϕ_iECT indicates the speed of adjustment, which tells about the speed of convergence of dependent variable towards long-run equilibrium due to shock in explanatory variables. A negative and significant value of $\phi_i$shows long-run causality among dependent and independent variables (Fig. 2).

The vector of interest, which calculate the long-run result of the exogenous variables on the economic growth (Eq. 3) and environmental sustainability (Eq. 6). The remaining parameters are the short-run coefficients. The disturbance is independently disseminated across error i and t (time and countries). To apply the panel ARDL approach, all variables should be stationary on the mixture of I(0) and I(1), and the presence of cointegration between variables. Therefore, we will test stationary of the exogenous and endogenous variables and then check the presence of cointegration and lastly will apply panel ARDL regression to test our hypotheses.

Empirical results and discussion

To check for stationarity, we adopted a variety of tests, including Levin-Lin-Chu, Im-Pesaran-Shin, and Fisher-ADF tests (Hertel and Wiesent 2013). Table 5 in Annexure 3 displays the tests result for the level, while Table 6 in Annexure 3 illustrates the outcomes for the first differences.

After the unit root tests, the findings confirmed that some variables were I(0) and I(1), one of the basic requirements of the panel autoregressive dynamic lag model. In the next stage, to check whether cointegration is present in our models or not, we have adopted a panel cointegration test. The alternative hypothesis of the test confirms “cointegration” in the models, while the null hypothesis confirms “no cointegration” in the models. Tables 7 and 8 in Annexure 4 display the panel cointegration tests for economic and environmental models. The results of the ADF and pp. group and panel statistics accepted the alternative hypothesis, which confirmed the presence of “cointegration” in both economic and environmental models. Furthermore, the Kao test, following the fundamental approach of Pedroni but with homogeneous coefficients, the Kao test also confirmed the presence of “cointegration” in our models.

Table 2 indicates the results of both economic and environmental models. We opted not to write down the short run, as we adopted the panel ARDL estimator that emphasizes on the homogeneity in the long-run estimators. Furthermore, for robustness, we have employed a Hausman test to examine whether the mean group is consistent. The Hausman test results accept the alternative hypothesis, providing the evidence that the PMG estimator is consistent.

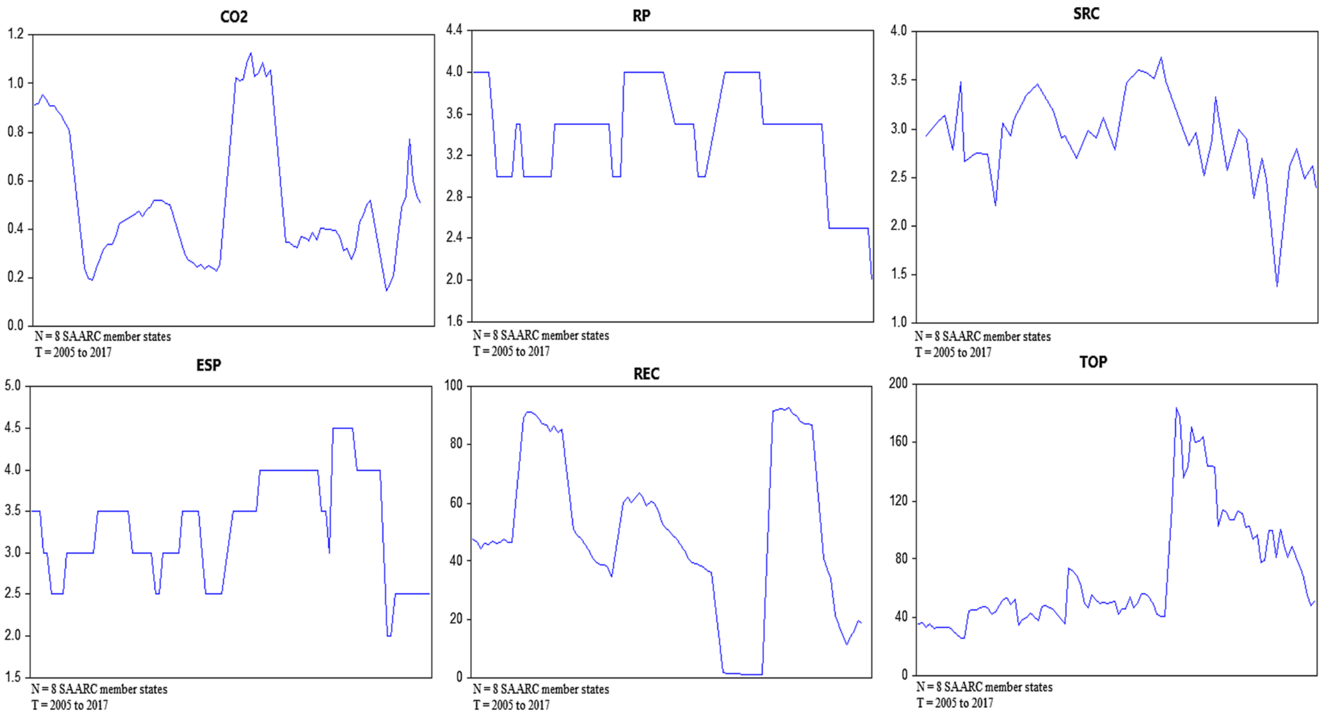

Fig. 2 Plots of level data

The results show that renewable energy consumption is positively and strongly associated with economic growth and environmental sustainability. In contrast, a 1% increment in renewable energy consumption will lead to 0.173% and 0.196% improvement in the SAARC member countries' economic and environmental performance. The findings also endorsed by previously published literature, Chiarini (2014) conducted a study with 800 European firms' data to observe the association between green practices (consumption of green energy and ISO 14001 certification) and firms' economic and environmental performance. Their results revealed that firms' ecological performance directly and significantly enhanced due to the adoption of green practices, while firms' profitability also improved. Khan and Dong (2017) and Li et al. (2018) highlighted that adopting green and eco-friendly practices in emerging economies increases, which enhances environmental sustainability and provides opportunities to firms by building a positive image and reputation. Koh et al. (2013) and Hu et al. (2015) warn that governmental bodies should be enforced and promote renewable energy usage, which will mitigate global warming problems without compromising economic growth. Raza et al. (2019) adopted the wavelet coherence spectrum technique to explore the linkage between energy demand, renewable energy, transportation, and environmental degradation. Their findings show that energy is a primary source of carbon emission, which pollutes the environment and creates several human-related diseases, including lung cancer and asthma. The results further highlighted that the usage of renewable energy protects to environmental sustainability.

The results also indicate that ESP, which is the "environmental policy and sustainable use of natural resources," is meaningfully and positively linked with economic growth and environmental sustainability on 5% and 1% confidence

Table 2 Panel ARDL long-Run PMG estimation

	Economic model			Environmental model		
	t statistic	Coefficient	*p* value	*t* statistic	Coefficient	*p* value
REC	4.49	0.173	***	5.13	0.196	***
SRC	5.94	0.062	***	3.05	0.044	**
ESP	4.18	0.004	**	3.41	0.063	***
RP	− 0.75	− 0.002	Insignificant	2.60	0.139	***
CRW	0.173	0.117	**	5.94	0.076	*

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

interval. A 1% improvement in the ESP will bring a 0.004% positive change in economic growth and a 0.0063% positive increment in environmental sustainability. In simple words, eco-friendly policies and sustainable usage of resources provide an opportunity to reduce the cost and bring a positive change in the ecosystem. Ghadge et al. (2018) collected 83 firms' data and used hierarchical multiple regression analysis. The results show that firms can reduce their operations cost due to the sustainable use of resources. Alizamir et al. (2016) highlighted that due to strict environmental friendly policies, governmental bodies could mitigate the unbalanced ecosystem and air pollution. Sauer and Seuring (2018) emphasized on the sustainability usage of natural resources, which can reduce the cost of business with better environmental sustainability. On the other hand, the findings revealed that regulatory pressure correlated with environmental sustainability on a 1% confidence level, which shows that regulatory pressure plays a positive role in the betterment of the ecosystem, and a 1% increase in regulatory pressure, would lead to 0.139% enhancement in environmental beauty. The previous studies also confirmed that regulatory pressure and strict eco-friendly policies reduce to the environmental issues and encourage firms to implement green practices in their businesses (Jayaram and Avittathur 2014; Esfahbodi et al. 2016; Gong et al. 2019; Ozturk and Acaravci 2010; Khan and Dong 2017; Tuni and Rentizelas 2018).

In our models, SRC has a positive and robust impact on environmental and economic growth models on 5% and 1% confidence level, respectively. The results indicate that 1% early shipments reach to consignees significantly improve economic growth and environmental sustainability by 0.062% and 0.044%. In the global supply chain, due to long distances/long lead-time, poor weather, and local customs inefficiencies, shipments late received to the consignee, which not only incur a considerable cost in the system but also burn excess fossil fuel/energy. Chelly (2018) highlighted that the supply chain operations are heavily based on burning fossil fuel and energy, while shipments delay can increase the cost of goods sold with weak environmental sustainability. Plambeck (2013) suggested shifting business operations towards renewable energy/biofuels to reduce air and water pollution with better economic sustainability. Zhang et al. (2019) directed research in Thailand to examine the linkage between transportation, environmental degradation, and the arrival of tourists. The results indicate that the transportation sector aggressively contributing to carbon emissions and global warming, while tourist arrivals are decreasing due to increasing air pollution. Furthermore, the researchers emphasized on regulatory authorities to formulate the strict environmental policy with the encouragement of the adoption of green practices and ISO 14001 in firms' operations.

Conclusions and policy implications

The present study aimed to identify the contributing factors of economic and environmental sustainability in the panel of SAARC member states. Most of these countries are emerging economies and have the potential for adopting green practices, including renewable energy, formulation of eco-friendly policies, and sustainable use of natural resources.

From this research work, we found that the adoption of green practices in business operations is meaningfully and positively linked with the countries' economic growth except for the "regulatory pressure," which shows an insignificant relationship with economic growth. Conversely, the results also revealed that environmental sustainability increased because of the enforcement of strict eco-sustainable policies, regulatory pressure, and renewable energy. In SAARC member states, green practices are in early stages, and the corporate sector is unwilling to adopt green practices voluntarily; in this context, regulatory pressure and strict eco-policies encourage firms to convert their polluted practices into green significantly enhanced environmental sustainability.

The following policy implications that are in line with the study's objectives are proposed:

i) The dependency of fossil fuel energy consumption should be replaced with clean energy sources to achieve industrial efficiency for green production. Furthermore, industrial reforms, waste recycling, renewable fuels, and smart appliances would highly support the vision to achieve sustainable development agenda.

ii) Eco-efficiently production practices would be desirable to minimize processing waste, whereas sustainable solid waste recycling of plastic and nonferrous waste materials is due to the sustainable manufacturing process, which is imperative for green production. The efficient way of waste management lessens the potential risk of water, oil, and air pollution. However, to attain this objective, there is certainly a need to change consumption patterns, shift from nonrenewable fuel to green fuels, and resolve urbanization waste disposal issues. There is a growing need for governmental legislations for mandatory recycling and composting services, which contributes to a country's sustainability agenda. It is, therefore, crucial to use low-cost clean advanced technologies for the treatment and management of toxic industrial wastes for protecting the natural environment and public health.

iii) Mitigation of Carbon and GHG emissions: the high abatement cost of carbon and GHG emissions damaged the country's national flora that ensured with cleaner production technologies, affordable and accessible green energy resources, and sustainable technological upgradation. Furthermore, strategic action plans, i.e., collaborative public–private partnership programs, need to develop renewable energy projects, which would help to make industrial energy efficiency in a country.

iv) Sustainable production and consumption: the contractionary economic policies would help achieve a clean production plan by the promotion of capital financial market, technological innovations, and the provision of environmental-based subsidies to mitigate adverse environmental externalities in the production and consumption sector.

v) Economic activities should be environmentally friendly and based upon cleaner production technologies, certified ISO certification, tax imposition of dirty polluting industries, subsidies given to environmental quality assurance companies, and healthy economic reforms across countries. Furthermore, a human development program should be initiated in a way to invest in human capital that translated in to achieving high economic growth and conserve the natural environment.

vi) Trade liberalization policies should be environmentally regulated to support the natural resource capital of a country. Furthermore, there is a legitimate need for examination of the sectoral performance of a country. It required specific policies and regulations to support industry value-added, mining industry, renewable energy market, and logistics activities, which could be achieved through green financing, establishing green economic zones, and the green R&D innovation process.

vii) The country-specific policy implications should be resulted oriented, i.e., the solutions can be found for bringing pollution to a tolerable level. However, it can only be achieved if the vehicle inspection and examiner department is strengthened by the federal government in consultation with the Ministry of Transportation. The electric power-assisted steering ensures the necessary condition of the vehicles on roads. With that, the quality control agency should help the provincial government. Various stations where gasoline is sold should be checked regularly to ensure quality.

viii) Governmental bodies should develop a policy structure for the conversion of dirty fuel, i.e., diesel on road transport to clean fuel. Petrol, diesel, liquefied petroleum gas (LPG), or compressed natural gas vehicle testing and tuning centers should be established in all the small and big cities. Fuel substitution strategy should adopt LPG, and supplies from in-house refineries should be increased. Furthermore, introducing a cheap urban transport system run on clean fuel would also decrease air pollution.

ix) The high energy demand is associated with the use of modern technologies that leads to the efficient management of natural resources. However, it subsequently raises a serious concern for the country's natural environment because of high mass carbon emissions. The country needs alternative energy sources that have zero carbon emissions. Therefore, the adoption of green energy sources in conventional energy sources would exert a positive change in the environment that further increases natural resource rents for the country.

x) The public–private partnership in the resource provision market is desired for sustaining long-term economic growth; hence, the need for the provision of insurance and commercial services is highly necessary to promote green growth.

xi) Carbon pricing is the sustainable policy approach that is effectively used to restrict dirty production by imposing high taxes on polluting industries. The country's natural resources could be protected through carbon pricing, and it would be further enhanced by the advancement in cleaner production techniques. The carbon pricing is effective in the resource constraint environment, which is ultimately helpful in achieving the environmental sustainability agenda of the country.

These 11 policy recommendations will help SAARC member countries to enhance their environmental sustainability goal without compromising the economic growth.

The main limitation of our research work was the missing data for most of the emerging Asian states, which was one of the reasons why we were able to conduct the study only on SAARC member states. Moreover, the SAARC countries' data of relevant variables are not available in 2018. However, it offers original insights and possibilities for future research. These include increasing the size of the sample used in this research, and future studies may also consider Association of Southeast Asian Nations member states.

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Annexure 1

Table 3 The list of SAARC member countries

S.No.	Country code	Countries name
1	AFG	Afghanistan
2	PAK	Pakistan
3	IND	India
4	LKA	Sri Lanka
5	MDV	Maldives
6	BTN	Bhutan
7	NPL	Nepal
8	BGD	Bangladesh

Annexure 2

Table 4 Correlational matrix

	CO_2	ESP	RP	REC	SRC	TOP	CRW
CO_2	1.000						
ESP	0.271	1.000					
RP	− 0.246	− 0.223	1.000				
REC	− 0.679	0.099	− 0.215	1.000			
SRC	0.569	0.065	0.097	− 0.701	1.000		
TOP	− 0.368	0.407	0.314	0.247	− 0.007	1.000	
CRW	− 0.687	0.086	− 0.228	0.997	− 0.729	0.223	1.000

Annexure 3

Table 5 Stationarity tests of the variables

		Levin, Lin, and Chu		Im, Pesaran, and Shin		ADF-Fisher	
Variable name	Symbole	Statistics	*p* value	Statistics	*p* value	Statistics	*p* value
Renewable energy consumption	REC	− 2.226	0.013	0.678	0.751	12.847	0.684
Trade (% of GDP)	TOP	− 1.779	0.038	0.624	0.734	20.728	0.189
CO_2 emissions	CO_2	− 0.467	0.320	0.489	0.688	14.641	0.551
Shipments reach consignee within the scheduled time	SRC	− 3.853	0.045	0.743	0.033	0.521	0.013
Combustible renewables and waste	CRW	− 1.659	0.049	1.262	0.897	3.992	0.948
Environmental policies and sustainable use of natural resources	ESP	0.239	0.595	1.203	0.885	9.385	0.670
Regulatory pressure	RP	0.841	0.800	1.594	0.945	2.811	0.986

Table 6 Stationarity tests of first differences of the variables

		Levin, Lin, and Chu		Im, Pesaran, and Shin		ADF-Fisher	
Variable name	Symbole	Statistics	*p* value	Statistics	*p* value	Statistics	*p* value
Renewable energy consumption	REC	− 4.462	0.000	− 2.763	0.003	35.774	0.003
Trade (% of GDP)	TOP	− 10.010	0.000	− 6.368	0.000	63.025	0.000
CO_2 emissions	CO_2	− 5.830	0.000	− 2.898	0.002	38.215	0.001
Shipments reach consignee within the scheduled time	SRC	− 7.841	0.000	− 3.421	0.000	41.294	0.000
Combustible renewables and waste	CRW	− 6.357	0.000	− 2.642	0.004	26.533	0.003
Environmental policies and sustainable use of natural resources	ESP	− 5.304	0.000	− 3.570	0.000	36.557	0.001
Regulatory pressure	RP	− 4.708	0.000	− 2.899	0.002	26.402	0.003

Annexure 4

Table 7 Panel cointegration for economic model

Pedroni residual test	Panel statistics			
	Statistic	Prob.	Weighted	
			Statistic	Prob.
V statistic	0.143	0.443	0.211	0.417
rho-statistic	0.980	0.837	1.269	0.898
pp-statistic	− 2.159	0.015	− 3.679	0.000
ADF-statistic	− 1.886	0.002	− 2.219	0.003
	Group statistics			
rho-statistic	2.473	0.993		
pp-statistic	− 5.488	0.000		
ADF-statistic	− 1.894	0.029		
Kao residual test				
	t statistic	Prob.		
ADF	− 1.718988	0.004		

Pedroni and Kao cointegration test

Null, no cointegration

Table 8 Panel cointegration for environmental model

Pedroni residual test	Panel statistics			
	Statistic	Prob.	Weighted	
			Statistic	Prob.
V statistic	− 1134.194	1.000	− 1.094	0.863
rho-statistic	0.955	0.830	0.983	0.837
pp-statistic	− 3.046	0.001	− 2.980	0.001
ADF-statistic	− 1.886	0.030	− 1.805	0.036
	Group statistics			
rho-statistic	1.844	0.967		
pp-statistic	− 4.025	0.000		
ADF-statistic	− 2.424	0.008		
Kao residual test				
	t statistic	Prob.		
ADF	− 1.888178	0.002		

Pedroni and Kao cointegration test

Null, no cointegration

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