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TOWARDS GREEN GROWTH: MONITORING PROGRESS AND INVESTIGATING ITS DETERMINANTS IN SOUTH ASIA

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ABSTRACT

Keeping in view the global environmental emergency Green Growth assessment will show policymakers how to maximize economic outcomes while ensuring environmental sustainability. This study aims to construct a Green Growth (GG) Index and empirically test its long-run and short-run determinants for the time series data from 1990 to 2021 in the case of Bangladesh, India and Pakistan. A set of nineteen indicators covering three dimensions, including resource productivity, environmental quality and economic and social aspects, is used to develop the GG index through the principal component methodology. Given the mixed order of integration, Autoregressive Distributed Lag (ARDL) method is utilized to check the co-integration relationship of variables. The results of this study depict that in the case of Bangladesh, there are three significant determinants in which urbanization and forest area are positively associated with GG and trade openness negatively. In India, GG is significantly and positively influenced by urbanization and forest area, while socio-economic conditions impair it. For the third country, Pakistan, urbanization, trade openness, law and order have significant and positive associations with GG, while socio-economic conditions have significant but negative relationships. Based on the study's outcomes, dependent variables show divergence from their short-run equilibrium with error correction terms -0.726, -0.914 and -0.439 for Bangladesh, India and Pakistan, respectively. Therefore, this study suggests implementing policies related to urbanization, trade openness, forest area, law and order and socio-economic conditions to stimulate GG.

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INTRODUCTION

Climate change is a real threat to economic activities for developing countries of South Asia as it is likely to impact the GDP to an extent reducing to 1.8% per year by 2050, and if this is unaddressed, it will make up to 8.8% by 2100, (ADB, 2013). The environmental and economic problems are interconnected and cannot be tackled solely without mitigating others (World Bank, 2014; Change, 2014). The Increasing concern about the population growth rate results in more resource demand, which further invades environmental challenges and unsustainable economic growth fuels the need for inclusive and greener growth (Ofori et al., 2022). There is a need for a collective approach to global implementation to address possible environmental damage (Stern, 2006). GG aims to provide a smart future associated with increased well-being and decreasing inequalities with improved economic growth and a better environment (OECD, 2018). The idea of the valuation of Green Growth has arisen as an emerging concept in new avenues of growth patterns at the fifth Ministerial conference on environment and development (ESCAP, 2005). The action response of this initiative came to us as a GG strategy with a framework which simultaneously considered economic, technological, social, developmental and environmental aspects (OECD, 2009). This framework aims to assist with basic tools, indicators and monitory progress mechanisms and attempts to review the literature on GG. The GG is the core idea of development (OECD, 2013).

GG is the engine of sustainable development if addressed differently based on regional needs to assure inclusive outcomes (Panel, 2012) and technological revolution under green technology, which aims at providing economic growth while covering external environmental costs (Albekov et al., 2018). In the case of developed economies, after reaching an optimal level of growth, it either decreases or remains steady as they reach their biocapacity level (Juknys et al., 2018). But with the countries like Bangladesh and India, there is still greater scope for growth as they are still trying to upgrade from low-income to middle-income countries. The major concern of economists in the applicability of GG is to reach an agreed point for its valuation method. A large number of sets of indicators have been designed over the years, and institutions dominant in the race are the Green Growth Knowledge Platform (GGKP), The Global Green Growth

Institute (GGGI), Organization for Economic Cooperation and Development (OECD) and United Nations Environment Programme (UNEP). The selection criteria to choose indicators should be based on a standardized approach to make them comparable internationally and through conceptual and theoretical understanding (Ness et al., 2007). The general GG performance trend varies among South Asian countries. There is an element of green in their traditional growth patterns, while some countries are trying to move towards a GG transition. South Asian countries chosen for our model are Bangladesh, India and Pakistan, which share a mutual history of culture and growth until 1947. It would be interesting to comparatively analyse their growth response.

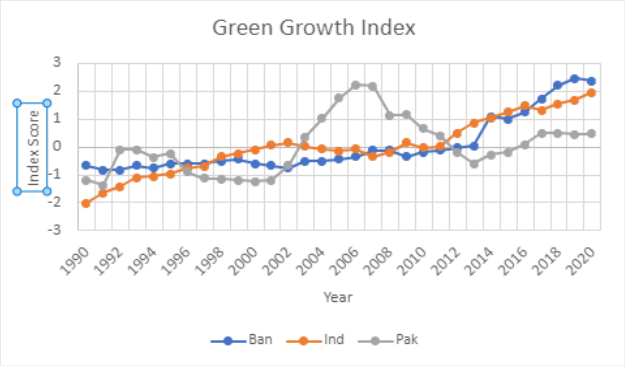


Figure 1. Green Growth (GG) Performance Score (1990-2020); Source: The authors constructed.

Figure 1 shows the GG performance trend from 1990 to 2020 developed using OECD GG indicators for Bangladesh, India and Pakistan, respectively. The GG performance of all three countries not only varies along the period of sample observations but is also inconsistent across the countries. It shows the multivariate nature of GG and its dependence on regional and structural circumstances. All the countries showed a very slow growth trend over the years, also followed by a negative coefficient of GG in certain years. Besides showing the most satisfactory performance in the GG index score, Bangladesh has the impact of regional disparities on its performance index. The major problem Bangladesh is facing in the path of GG is social inequity (EDGG[1], 2016). India's fiscal cooperation is still prioritized on the capital growth side, and there is still a long way to GG. Pakistan's GG score pattern has been highly inconsistent over the years, highlighting the lack of impact of GG policies. Besides the fact that Pakistan is abundant in natural resources, insufficient skill development is seizing the possible utilization of these resources (ESCAP[2], 2013).

Green Growth and its Determinant Relationship

Urbanization is an emerging trend in the global age to improve living standards (Hammer et al., 2011) which is strongly linked with the core idea of GG. In literature, trade openness is usually linked with GG in the context of the trade energy nexus (Sadorsky, 2012; Shahbaz et al., 2013) and trade carbon emission nexus (Reinaud, 2009). Forest areas play a crucial role in creating an ecological growth environment (UNEP, 2012). Forest and agriculture cover nearly 24% of the world's greenhouse gas emissions and account for the second largest emitters (Change, 2014). It has been estimated that about 180 billion tons of emissions are absorbed by forests (Parajuli et al., 2019). Law and order are important indicators of governance that directly impact a state's social, political and economic structure (Buterin et al., 2017). GG is to regulate economic growth, which is also favourable in prospering the future environment. The socio-economic index is the real measure of economic growth relevant to human development as; individuals have a comparative advantage of shared knowledge and implement it by keeping the environment less harmful. Individual behaviour is largely influenced by the socio-economic setup they are living in; a high score value depicts growth and responsible consumption (Khan and Hou, 2021). Forest and agriculture cover nearly 24% of the world's greenhouse gas emissions and account for the second largest emitters (Change, 2014). It has been estimated that about 180 billion tons of emissions are absorbed by forests (Parajuli et al., 2019). Law and order are important indicators of governance that directly impact a state's social, political and economic structure Buterin et al. (2017), which advocates the regulatory role of GG. The socio-economic index is the real measure of economic growth relevant to human development as; individuals have a comparative advantage of shared knowledge and implement it by keeping the environment less harmful. Individual behaviour is largely influenced by the socio-economic setup they are living in (Khan and Hou, 2021).

The main objectives of this study are to construct a composite index of GG using Principal Component Analysis (PCA) covering dimensions based on regional growth patterns and to empirically investigate the long-run and short-run determinants of GG in Bangladesh, India and Pakistan for their comparative analysis in terms of GG score and its determinants. The idea of GG has widely been in literature in dispersed forms usually associated with sustainable development, inclusive growth and green economy, but now it is the need of the hour to move towards the development of a common approach towards GG. The analysis of the long-run relationship of GG determinants helps policymakers to carefully manage and implement activities which are promoting GG while considering their possible impact. This research is limited to three South Asian countries, leaving a gap for a collective effort to measure all of them together and incorporate variables related to the regional growth perspective. This research is structured after the introduction literature of this study is organized in the following way. Section 2 presents the conceptual framework of GG and its theoretical linkage with the independent variables. Section 3 is based on the data and methodology of the empirical testing. Section 4 is about results and discussions. Finally, the last section is about the conclusion and policy implications for future adjustments. This section of studies addressed literature pertaining to the Measurement of GG. Kim et al. (2014) measured the GG for 30 OECD countries via cross-country comparison while keeping

[1]Economic Dialogue on Green Growth

[2]The Economic and Social Commission for Asia and the Pacific

South Korea in focus which stands at 17 percentiles among the 30. Sun et al. (2020) measured the Chinese inclusive GG comprising 285 cities from 2003 to 2015. DDF-SBM[3] were combined to construct an evaluation model of inclusive green economic growth. Khan et al. (2020) indicated the importance of green practices and the regulatory role of the policy side for a sustainable economic future. They found renewable energy, natural resources, regulatory pressure and green policies as important determinants for the greening of the economy. ARDL regression analysis has been performed on eight south Asian emerging economies (Pakistan, Afghanistan, Bangladesh, Sri Lanka, Nepal, India, Bhutan, and the Maldives) based on panel data from 2005-2017. Houssini and Geng (2022) found out the GG performance of Morocco increased over the years marking 0.26 in 2000 and increasing to 0.60 in 2016. They used the Data envelopment analysis (DEA) for 2000-2018 to measure GG. They categorized their findings based on the input-output framework) indicating the importance of green practices and the regulatory role of the policy side for a sustainable economic future. They found renewable energy, natural resources, regulatory pressure and green policies as important determinants for the greening of the economy. ARDL regression analysis has been performed on eight south Asian emerging economies (Pakistan, Afghanistan, Bangladesh, Sri Lanka, Nepal, India, Bhutan, and the Maldives) based on panel data from 2005-2017. Ates and Derinkuyu (2021) applied the ranking technique of the I-distance[4] approach to OECD countries to rank them based on their performance on GG. They used the OECD framework of indicators to test the multivariant nature of GG.

Consequently, the study suggested Official development assistance, GDP per capita and green patents as the key drivers of GG. It revealed that countries with high GDPs as New Zealand, Korea and the United States, can have a bad rank of GG performance due to inefficient environmental and social policies. Baniya et al. (2021) made a dedicated attempt to measure GG in Nepal and Bangladesh. To measure GG time series data set 1985-2016 quantitatively analysed by normalized Index. The indicator used includes carbon productivity, the percentage of GDP from services, energy productivity, the share of renewable energy, and material productivity. Results show that Nepal and Bangladesh do not meet the target to achieve GG. Houssini and Geng (2022) found out the GG performance of Morocco increased over the years marking 0.26 in 2000 and increasing to 0.60 in 2016. They used the Data envelopment analysis (DEA[5]) for the period 2000-2018 to measure GG and categorized their findings based on the input-output framework.

The next part of the literature is based on estimation techniques of GG concerning analysing its relationship with its determinants. You and Huang (2013) investigated the GG determinants and their trend in future for thirty provinces in China. The study is based on two main steps: establishing a green development index followed by the OECD framework. In the second step, a spatial dynamic panel model has been applied to test the key drivers of newly constructed green development index data comprising 1997-2011. The findings of the paper concluded that innovation and green reforms were positively associated with the green development index, while instability in the political system deteriorated the effectiveness of GG in the long run. Ohlan (2015) applied the ARDL bounding test approach on time series data based on environmental and economic indicators over 1970- 2013 to test the long-run and short-run relationship of economic growth, energy consumption, trade openness, and population density on CO_2 emissions in India. Their paper suggests that with the increased level of population density, the chances of an increase in pollution and emission rise with an increase in energy consumption and economic growth. Tawiah et al. (2021), using data from 123 developed and developing countries, tested the combined impact of economic factors, Internalization and energy-related factors on the environment and extracted the main determinants of GG. The sample sizes expanded from 2000 to 2017 using the fixed effect estimation technique and subsampling to ensure the effectiveness of results among developed and developing countries. Orhan et al. (2021) studied the nexus between environmental sustainability and economic growth in India from 1965 to 2019. The variables used in the empirical testing include economic growth, trade openness, agriculture, energy use and CO_2 emissions. The study's findings suggest a positive and significant correlation between CO_2 emissions with all the variables except for trade openness. Sultana et al. (2022) studied the impact of the socio-economic condition, control of consumption and renewable energy consumption on the quality of the environment for 13 developing countries over the years 2002 and 2019. The empirical methodology they followed includes Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS). The results suggested that socio-economic conditions, control of consumption and renewable energy consumption decrease the emission pertaining to ecological footprints and emission but increase the nitrogen emission. From previously reviewed literature, we found that ample literature is available on GG in the context of developed countries; however, limited evidence is found on the subject matter in developing countries of South Asia. This paper is aimed at measuring GG with a new combination of countries and highlighting its important determinants.) applied the ARDL bounding test approach on time series data based on environmental and economic indicators over the year 1970-2013 to test the long-run and short-run relationship of economic growth, energy consumption, trade openness, and population density on CO_2 emissions in India. The finding of their paper suggests that with the increased level of population density, the chances of an increase in pollution and emission rise with an increase in energy consumption and economic growth. Tawiah et al. (2021), using data from 123 developed and developing countries, tested the combined impact of economic factors, Internalization and energy-related factors on the environment and extracted the main

[3]DDF (Directional Distance Function) and SBM (Slack- based measurement of efficiency)

[4]It summarizes the results based on review of multiple literature.

[5]Mathematical technique to generate output of estimations.

determinants of GG. The sample sizes expanded from 2000 to 2017 using the fixed effect estimation technique and subsampling to ensure the effectiveness of results among developed and developing countries. Orhan et al. (2021) studied the nexus between environmental sustainability and economic growth in India from 1965 to 2019. The variables used in the empirical testing include economic growth, trade openness, agriculture, energy use and CO_2 emissions. The study's findings suggest a positive and significant correlation between CO_2 emissions with all the variables except for trade openness. Sultana et al. (2022) studied the impact of the socio-economic condition, control of consumption and renewable energy consumption on the quality of the environment for 13 developing countries over the years 2002 and 2019. The empirical methodology they followed includes Fully Modified OLS (FMOLS[6]) and Dynamic OLS (DOLS[7]). The results suggested that socio-economic conditions, control of consumption and renewable energy consumption decrease the emission pertaining to ecological footprints and emission but increase the nitrogen emission. From previously reviewed literature, we found that ample literature is available on GG in the context of developed countries; however, limited evidence is found on the subject matter in developing countries of South Asia. This paper aims to measure GG with a new combination of countries and highlight its important determinants.

Conceptual Framework

GG is merely an extension of old growth models that decouple traditional GDP growth from carbon emission and resource usage (Hickel and Kallis, 2020). GG is the modern concept of economic development which aims to provide resources without deteriorating the natural ecosystem (OECD). It aims at providing sustainable solutions to environmental and climate change problems CO_2 while ensuring social equity and efficient distribution of resources (GGGI[8]). GG can be read with traditional growth models, as in the neo-classical growth model, in increasing capital by substituting physical capital with natural resources and productivity with a sustainable future and avoiding external costs. The nexus between human capital and environmental quality has a positive association (Ahmed, 2017). Theoretical models also suggest that consumption is related to capital formation and technical change (Benchekroun and withagen, 2011). The conceptual linkage of GG pertaining to its indicators and determinants used in this research is presented in Figure 2. Theoretical models also suggest that consumption is related to capital formation and technical change (Benchekroun and Withagen, 2011). The conceptual linkage of GG pertaining to its indicators and determinants used in this research is presented in Figure 2.

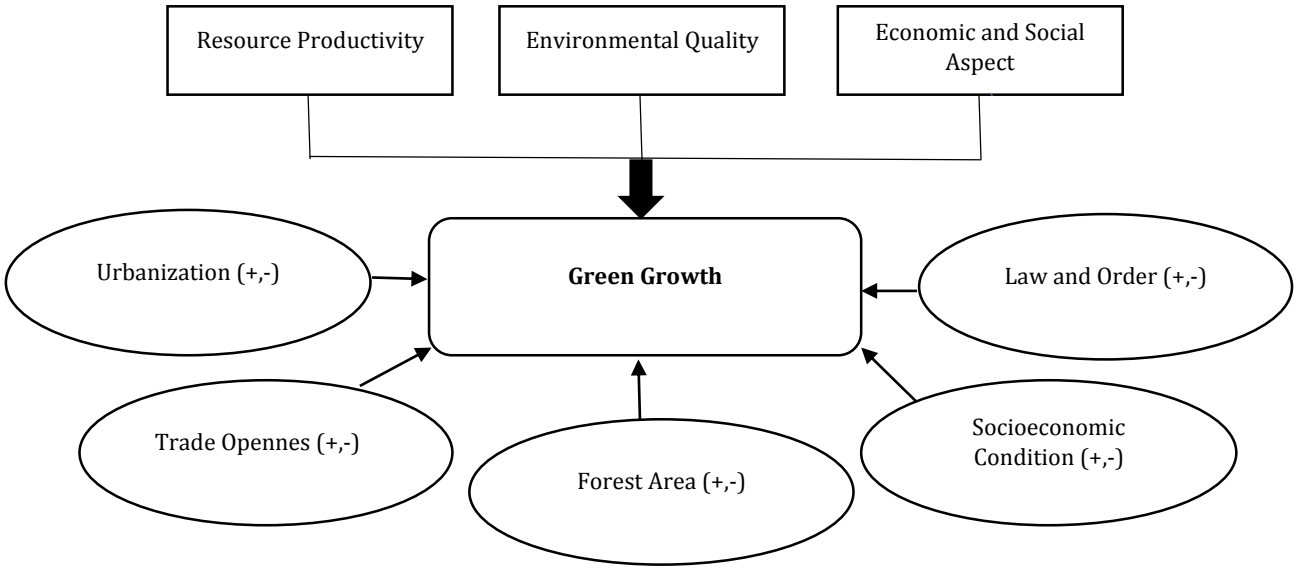


Figure 2. Conceptual framework.

With respect to the dimension of GG, resource productivity improvises to deal with sacred resources globally. It enhances growth patterns by incorporating technological factors towards energy and green resources and promotes social equity in creating jobs (UNIDO,[9] 2013). Resource productivity is the ideal condition for both economic and environmental gains (Giljum et al., 2011). The negative impact of environmental quality directly disrupts human capital, which abruptly disturbs the traditional growth models (OECD, 2013). Economic and social aspects of GG help to indulge the real growth along with socially adjusted factors in this study; all three countries are facing major population growth in an unsustainable manner; we included population as one of the social indicators of GG for the actual valuation of growth trends as suggested by the OECD (2017).

With respect to determinants, Urbanization is an ideal situation for GG if the problems related to infrastructure,

[6]Multiple time series model adjusted for endogeneity and used to test co-integration

[7]Helps in dealing with order of integration

[8]Global Green Growth Institute

[9]United Nations Industrial Development Organization

waste management, emissions and green spaces are tackled in a sustainable manner (Bartone et al., 1994; Baylon et al., 2006). It is in man's control how he responds in a particular environment to build a positive or negative impact while continuing to create financial means (Turner and Buckingham, 2008).

Trade Openness promotes GG if there is an effective policy to manage the liberalization of trade (Jacobs, 2012). De-regularization of trade can also result in income parity (Deardorff et al., 1996). Theoretically, trade openness and the environment are linked based on three main effects under the composite effect trade openness is effective in sustainable growth only under environmentally friendly industry, technique effect helps in bringing environmentally friendly technology, which reduces emissions in contrast, scale effect increases emission as in case of more exports more will be the economic activity (Antweiler et al., 2001).

Forest area is a way forward for the policymakers to manage forest-related activities for a sustainable carbon and energy future (UNEP, 2021). Forests are the main source of sustainable energy resources like renewable energy, biodiesel, and wood to meet the increasing energy demand and good subsidies for the conventional means of energy harm not only the environment but also human health (Waheed et al., 2018).

Institutional quality is measured using different indicators, and the most common sources include the governance indicator of WDI, which further divides into subgroups, including the rule of law (Wawrzyniak and Doryn, 2020). The Law-and-order situation of a country is the true picture of how well its institutions are performing and the steps through which they can keep track of possible environmental degradation elements (Hassan and Rousselière, 2022). Castiglione et al. (2012) studied the nexus between the rule of law and Environmental Quality, stating that the rule of law has a possibly direct positive impact on pollution and an indirect negative impact on per capita income by seizing growth beyond the point where environmental hazards exist. A higher value of socio-economic variable predicts better living conditions one such example is the socio-economic gradient, people with more money enjoy longer life expectancy (Fitzpatrick et al., 2015). The environment cannot be protected before protecting the people by creating employment opportunities, dealing with poverty and producing a demand and supply balance. In this paper, the Socio-economic condition variable is the composite effect of three sub-variables, poverty, unemployment and consumer confidence, usually used to measure inclusive growth, which is more sustainable and more related to a social-economic aspect of GG.

METHODOLOGY

This study applies the time series annual data of three South Asian[10] countries named Bangladesh, India and Pakistan, for thirty-one years from 1990 to 2020. This study uses the OECD indicators framework 2017 to form a composite index for the performance of GG based on a total of nineteen indicators covering three main dimensions of GG. The variables selected for this study are restricted to data availability and are shown in Table 1.

Table 1. Description of variables.

Variable			Explanation	Symbol	Source	Unit of Measurement
Green Growth Index	Dimensions	Source				
	Resource Productivity[11]	OECD	Index constructed using PCA based on three dimensions.	GG_t	Author's constructed Index	(-2 to 2.5)
	Environmental Quality[12]	OECD				
	Economic and Social Aspects[13]	OECD				
Urbanization			Urban population (% of total population)	URB_t	WDI	Percentage
Trade Openness			Sum Imports and Export as % of GDP	TO_t	WDI	Percentage
Forest Area			Growth rate of forest area	FOR_t	WDI	percentage
Law and Order			Index constructed using ICRG methodology	LAO_t	ICRG	score (0-4)
Socio-economic Condition			Index constructed using ICRG methodology	SE_t	ICRG	score (0-6)

Econometric Model

This study uses the following linear model to examine the important long-run and short-run determinants of GG of selected South Asian countries. The same variables have been chosen for all three countries for comparative analysis.

$$GG_t = \alpha_0 + \alpha_1 URB_t + \alpha_2 TO_t + \alpha_3 FOR_t + \alpha_5 LAO_t + \alpha_4 SE_t + \varepsilon_t$$
$$(+,-) \quad (+,-) \quad (+,-) \quad (+,-) \quad (+,-)$$

In the first step, we construct the index using PCA using indicators by the OECD framework (2017), a novel approach combining the set of indicators applied as a multivariate approach to reduce the dimension of the desired variable. This methodology is more commonly used in designing variables and analysing social-economic conditions (Matteson and Tsay, 2017). It manages the multi-collinearity problem and chooses

[10]Countries are selected based on three largest economies of south Asia along with considering the population factor and regional current political developments.

[11]Production-based CO2 productivity and Intensity, Energy productivity, Renewable electricity, Energy consumption in services, transport and industry, non-energy material productivity, Biomass % of DMC, Metals, % of DMC.

[12]Welfare costs of premature mortalities from exposure to ambient PM2.5, Welfare costs of premature mortalities from exposure to ozone, Welfare costs of premature deaths from exposure to lead, Welfare costs of premature mortalities from exposure to residential radon, Annual surface temperature change since 1951-1980.

[13]Real GDP, Nominal exchange rate, GDP deflator, Population, Total fertility rate children per woman.

variables which add more to the variance (McNamara and Duncan, 1995). A composite index is then developed to measure the overall GG performance of three developing countries, Bangladesh, India and Pakistan, for the years 1990-2020. In the second step of estimations, pre-estimation tests have been applied to check the suitability of techniques which will be used to conduct the main regression analysis. First, starting with the stationarity test, which is designed to test the unit root problem of data using an autoregressive model (Dickey and Fuller, 1979). In case the order of integration is mixed, we can proceed further with Autoregressive Distributed Lags bound test approach. If the F-statistic value is more than the upper bound long-run relationship exists, and lower than the lower bound, no long-run relationship exists. And the value which exists in between is indecisive; it can move either way (Pesaran et al., 2001). The long-run and short-run relationships are estimated based on the following equations.

Long Run Equation:

$$\Delta GG_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, GG_{t-i} + \sum_{i=m}^{q1} \beta_{2i}\, URB_{t-i} + \sum_{i=m}^{q2} \beta_{3i}\, TO_{t-i} + \sum_{i=m}^{q3} \beta_{4i}\, FOR_{t-i} + \sum_{i=m}^{q4} \beta_{5i}\, LAO_{t-i} + \sum_{i=m}^{q5} \beta_{6i}\, SE_{t-i} + \varepsilon_t \quad (1)$$

Short Run Equation:

$$\Delta GG_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, \Delta GG_{t-i} + \sum_{i=m}^{q1} \beta_{2i}\, \Delta URB_{t-i} + \sum_{i=m}^{q2} \beta_{3i}\, \Delta TO_{t-i} + \sum_{i=m}^{q3} \beta_{4i}\, \Delta FOR_{t-i} + \sum_{i=m}^{q4} \beta_{5i}\, \Delta LAO_{t-i} + \sum_{i=m}^{q5} \beta_{6i}\, \Delta SE_{t-i} + \theta ECM_{t-i} + \varepsilon_t \quad (2)$$

Equation 1 shows the coefficient in the long run based on optimal lag length at a level where 0, 1, 2, 3, 4, 5 and 6 are the coefficient of regressors, t is the stochastic term with constant mean and variance, p lag length of dependent and q1, q2, q3, q4 and q5 lag length of independent variables respectively. Equation 2 shows the coefficient in the short run constructed through the error correction model, where Δ represents the first difference is the coefficient of ECM, generally known as the coefficient of adjustment to equilibrium in the results of shocks or disturbance, and it must be negative and less than zero. Therefore, ECM is taken with the period difference to depict the speed required to move back from the previous period to the current period. Hence equation 3 illustrates the speed of ECM to reach equilibrium.

$$ECM_t = GG_t - \beta_0 - \sum_{i=1}^{p} \beta_{1i}\, GG_{t-i} - \sum_{i=m}^{q1} \beta_{2i}\, URB_{t-i} - \sum_{i=m}^{q2} \beta_{3i}\, TO_{t-i} - \sum_{i=m}^{q3} \beta_{4i}\, FOR_{t-i} - \sum_{i=m}^{q4} \beta_{5i}\, LAO_{t-i} - \sum_{i=m}^{q5} \beta_{6i}\, SE_{t-i} \quad (3)$$

In the last step, to check the robustness of our results, we apply the post estimations techniques, including a normality test conducted to check if data follows the normal distribution or not and how the independent variables behave. The test used in this study is based on the Jarque Bera test, which after regressing the data generate the residuals and these residuals are then predicted for p-value and tested for the skewness of data. Similarly, autoregressive conditional hetero-skedasticity is conducted to test the ARCH effect in data. Cumulative sums of the recursive residuals test for the stability of parameters which is helpful in detecting the biasness of data and an important post-diagnostic test (Galpin and Hawkins, 1984).

RESULTS AND DISCUSSION

Descriptive Statistics, Unit Root Results and ARDL Bound Test Results

In this section, we are going to discuss pre-estimation test results, ARDL long-run and short-run estimations and post-estimation results for determinants of GG. All tests are conducted using the Stata 16 software on the time series data. Descriptive statistics make it easy to analyse the data more meaningfully, and, in our study, it includes mean, minimum, maximum and standard deviation and is presented in Table 2. Correlation matrix has been illustrated in Table A1 in appendix. Table 3 (Bangladesh, India and Pakistan) shows the results of unit root testing performed on time series data using the Augmented Dickey-Fuller Test, while the lag order is based on the Akaike information criterion (AIC). The table shows results for both levels and the first difference, which confirms the mixed order of integration. The results of the bound test in Table 4 show the value of F-statistics 4.072, 9.288, 13.799 more than the upper bound at 90% and 95% confidence intervals for Bangladesh, India and Pakistan, which confirms the long-run relationship between a dependent variable and independent variables.

Table 2. Descriptive statistics.

Variables	(BAN)				(IND)				(PAK)			
	Mean	S.D	Min	Max	Mean	S.D	Min	Max	Mean	S.D	Min	Max
GG_t	4.19	1	-0.86	2.42	-3.87	1	-2.03	1.91	3.87	1	-1.38	2.20
URB_t	27.6	5.7	19.8	38.1	29.5	2.85	25.5	34.9	33.94	1.93	30.57	37.1
TO_t	33.0	8.5	18.8	48.1	35.3	12.7	15.5	55.7	32.07	3.92	25.30	38.4
FOR_t	-0.06	0.07	-0.16	0	0.40	0.11	0.27	0.57	-0.90	.297	-1.63	-0.00
LAO_t	2.12	0.06	1	3.25	3.86	0.76	1.08	4.5	2.90	0.67	1	3.91
SE_t	3.04	3.04	2	6	4.94	0.84	3.5	7	5.41	0.59	4.25	6.54

Source: Author's own estimates

Table 3. ADF unit root test results.

Variables (Bangladesh)	Statistics (At level)	P-Value (At level)	Statistics (At 1st Difference)	P-Value (At 1st Difference)	Order of Integration
GG_t	0.564	0.577	-4.348	0.000*	I (1)
URB_t	-3.690	0.023*	-1.411	0.858	I (0)
TO_t	0.077	0.939	-4.479	0.000*	I (1)
FOR_t	-3.952	0.000*	-3.317	0.001*	I (0)
LAO_t	-2.138	0.042*	-3.406	0.003*	I (0)
SE_t	-3.734	0.020*	-5.327	0.000*	I (0)
Variables (India)	Statistics (At level)	P-Value (At level)	Statistics (At 1st Difference)	P-Value (At 1st Difference)	Order of Integration
GG_t	-0.238	0.814	-3.499	0.002	I (1)
URB_t	0.964	0.345	1.927	0.066	I (1)
TO_t	0.344	0.733	-4.564	0.000	I (1)
FOR_t	-1.620	0.0587*	-5.232	0.000	I (0)
LAO_t	1.064	0.299	-3.327	0.002	I (1)
SE_t	-3.019	0.007*	-2.587	0.009	I (0)
Variables (Pakistan)	Statistics (At level)	P-Value (At level)	Statistics (At 1^{st} Difference)	P-Value (At 1st Difference)	Order of Integration
GG_t	-2.243	0.034*	-2.958	0.007	I (0)
URB_t	1.901	0.070	0.033	0.974	I (1)
TO_t	-0.751	0.459	-5.513	0.000*	I (1)
FOR_t	-6.816	0.000*	-4.852	0.000*	I (0)
LAO_t	-0.131	0.897	-3.833	0.001*	I (1)
SE_t	-2.650	0.006*	-5.221	0.000*	I (0)

Source: Author's own estimates.

Table 4. Bound test results.

Critical Values	Bangladesh		India		Pakistan	
	F statistics = 4.072		F statistics = 9.288		F statistics =13.799	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
90% confidence interval	2.26	3.35	2.26	3.35	2.26	3.35
95% confidence interval	2.62	3.79	2.62	3.79	2.62	3.79

Source: Author's own estimates.

ARDL Long run Results

Table 5 shows the long-run results of all three countries, Bangladesh, India and Pakistan. Our results show that urbanization has a highly significant and positive relationship with GG in all three countries. A 1% increase in urbanization, on average, has increased GG by 0.24 units in Bangladesh, 0.32 units in India and 0.28 units in Pakistan, respectively, in the long run, if all other variables remain constant during the period 1990-2020. Our findings are similar to Wan and Kahn (2014), as there is a positive nexus between growth and urbanization. Ali et al. (2019) drew a positive impact of urbanization in combating carbon emissions. Similarly, urbanization is the symbol of better living conditions (Hardoy et al., 2013). Chen et al. (2008) found low population density results in inefficient transport use, and their findings suggest urbanization is the solution to per capita carbon emission. The economies of scale impact of urbanization promote environmental sustainability (Zhang et al., 2020). Our findings are in contrast with Alberti and Susskind (1996), who finds urban population growth does not match the available urban resources along with bad institutional performance and infrastructure.

Trade openness shows a significant association with Bangladesh and Pakistan but is insignificant in India. A 1% increase in trade openness on average has decreased the GG of Bangladesh by -0.05 units and increased Pakistan by 0.18 units keeping all other variables constant in the long run during the period 1990-2020. Trade openness tends to have both a positive direct and a negative indirect impact on carbon emissions (Chen et al. 2021). Trade openness helps in lowering pressure on the environment (Kohler, 2013; Shahbaz et al., 2017; Ghazouani et al., 2020). The insignificant behaviour is similar to the studies that confirm the insignificant relationship between trade openness and CO_2 emission, an important indicator of GG (Mutascu, 2018; Sun et al., 2019; Dauda et al., 2021). The inverse relationship between trade openness and GG is similar to a study stating struggling trade openness offsets sustainability (George and Krikpatrick, 2004).

Table 5. Long run results.

Long-Run Estimation	(Ban) Lag order (1,0,1,1,0,0) Dependent variable= GG_t		(Ind) Lag order (2,0,2,2,2,1) Dependent variable = GG_t		(Pak) Lag order (1,1,1,0,2,2) Dependent variable = GG_t	
Regressors	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
URB_t	0.244	0.000*	0.326	0.000*	0.281	0.019*
TO_t	-0.058	0.000*	-0.006	0.310	0.181	0.031*
FOR_t	2.493	0.010*	2.983	0.002*	0.162	0.811
LAO_t	0.134	0.156	0.379	0.136	-1.874	0.000*
SE_t	0.024	0.672	-0.383	0.000*	2.074	0.001*
R^2	0.545		0.844		0.863	
Adj R^2	0.372		0.688		0.760	
Root MSE	0.193		0.099		0.241	

Source: Author's own estimates.

Our results suggest a positive association in the coefficient of forest area with GG in all three countries. Among these countries, the coefficient of forest area is significant in Bangladesh and India and insignificant in Pakistan. A 1% increase in the value growth rate of the forest of Bangladesh and India on average improved GG by 2.49 units and 2.93 units in the long run during the period 1990-2020, respectively, if all other variables remain constant. Forest is an important tool in combating carbon emissions (Parajuli et al., 2019). Forest area has a crucial role in attaining sustainable development goal, most relevant to GG (De Jong et al., 2018; Baumgartner, 2019). In contrast, a negative association with GG is evident in a study that observed the negative effect of forest cover on economic growth in the unplanned allocation of land area as it suppresses the possible gains from agricultural land (Krause and Tilker, 2022). Forests are crucial as a resource of clean energy (Ollikainen, 2014).

Law and order are insignificant in Bangladesh and India and significant in India only, with a positive coefficient among all three models. A one-unit increase in law and order in the long run on average results in a 2.07 unit increase in GG of Pakistan during the period 1990-2020 if all other variables remain constant also similar to the finding that Government expenditure for environmental protection is ineffective without the rule of law (Gholipour and Farzanegan, 2018). The road to transition in growth patterns passes through better institutions and policy designing (Khan et al., 2019). A study indicates the role of law and order in creating sustainable environmental conditions (Salman et al., 2019). In contrast, the rule of law increases carbon emissions (Abid et al., 2021).

Socio-economic conditions are insignificant in Bangladesh but highly significant in India and Pakistan. A 1-unit increase in socio-economic conditions on average has negatively impacted GG by -0.38 units in India and Pakistan by -0.02 units during the period 1990-2020 if all other variables remain constant in the long run. Developed countries try to transfer pollution elements to developing countries (Abban et al., 2020). Socio-economic conditions are the direct measure of economic development but with the cost of more carbon emissions (Aye and Edoja, 2017). Contrarily a country with better socio-economic conditions attracts foreign markets and revenue generation, which compels the institutions to design better policies to tackle environmental damage (Esty and Porter, 2005). Strietska-Ilina et al. (2012) studied that the induction of green policies has an impact on job creation with a net positive effect but an indirect negative impact as it creates a knowledge and skill gap. As results show that the significance level of different determinants varies among the countries so it could be safe to say that GG is more of a regional concept possibly impacted by international activities, and it depends on how green policies are formulated to deal with its complex nature.

Short Run Results

The short-run results in Table 6 show that the short-run coefficient error correction term in Bangladesh, India, and Pakistan have statistically significant values with a negative sign of 0.726, 0.914 and 0.439, respectively, at a 1% significance level. ECM term in our results confirms a long-run relationship of GG variables in all three countries of our study. ECM term coefficient of 0.726, 0.914 and 0.439 reads as a 1 % deviation in the long-run equilibrium between GG and its determinants will adjust back at the rate of 72%, 91% and 43% per annum. The time requires to attain a 100% adjustment rate for Bangladesh, India and Pakistan remains 1.3 years, 1.09 years and 2.5 years, respectively. The results of our short run are more or less similar to that of the long run results, which also confirms better long-run estimation. A 1% increase in urbanization has increased GG by 0.17 units keeping other variables constant, and trade openness decreases it by 0.02 units in 1st difference from 1990-2020. In India, all the determinants except law and order remain insignificant in of long run. Trade Openness becomes significant in the short run with a negative value of -0.03, while forest Area and socio-economic conditions are insignificant in the short run. Pakistan's one-unit increase in law and order and socio-economic conditions has increased GG by 0.206 units and decreased by 0.599 units, respectively, from 1990-2020 if all other variables remain constant. The results of post estimations have been provided in Table 7.

CUSUM and CUSUMSQ Test for Stability

CUSUM graph test for an upward and downward shift from the mean value. The area under V-mask depicts the stability of the coefficient and is called the control area. In this study, all these three countries, Bangladesh, India and Pakistan, are under control area, i.e., stability of the process as illustrated in Figure 3.

Table 6. Short run results.

Short-Run Estimation	(Ban) Dependent variable = GG		(Ind) Dependent variable = GG		(Pak) Dependent variable = GG	
Regressors	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
ΔGG_{t-1}	0 .266	0.195	-0.313	0.129	-0.150	0.442
ΔURB_t	0.179	0.083*	-	-	-10.679	0.019*
ΔTO_t	-0.013	0.369	-0.031	0.004*	-0.041	0.195
ΔTO_{t-1}	-0.029	0.059*	-.0111	0.188	-	-
ΔFOR_t	-0.099	0.927	-2.162	0.001*	0.071	0.809
ΔFOR_{t-1}	1.893	0.112	-1.637	0.005*	-	-
ΔLAO_t	0.104	0.231	0.146	0.043*	0.206	0.300
ΔLAO_{t-1}	-	-	-	-	0.398	0.104*
ΔSE_t	0.019	0.662	0.289	0.001*	-0.599	0.004*
ΔSE_{t-1}	-	-	.0744	0.068*	-0.596	0.002*
C	-3.647	0.000*	-9.242	0.001*	-6.805	0.065*
ECM	-.726	0.001*	-.914	0.001*	-0.439	0.001*

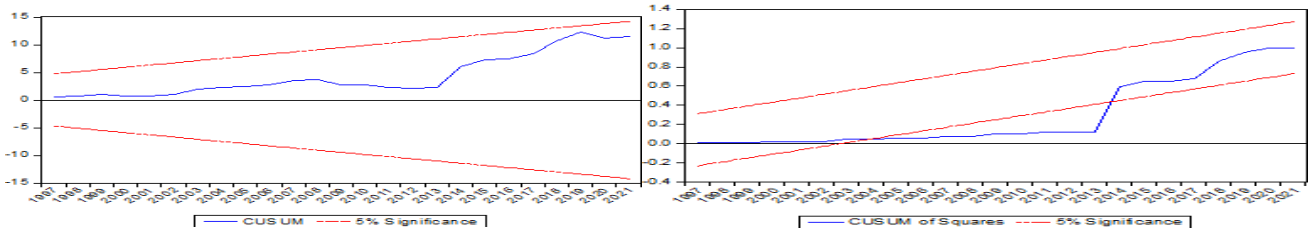
Source: Author's own estimates.

Table 7. Post estimations results.

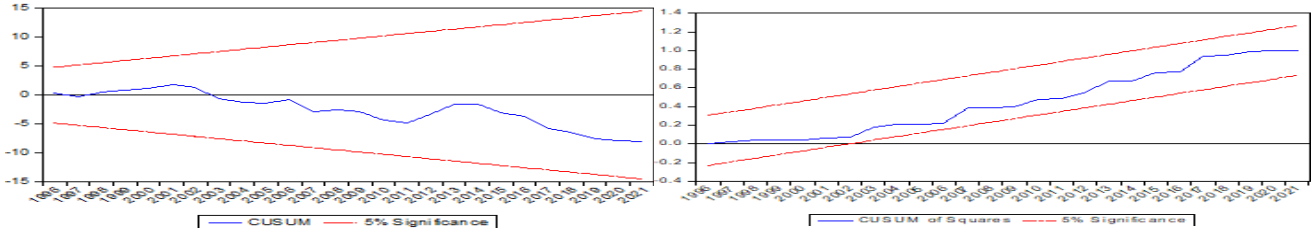
Test Name	Assumptions	F-Prob (Bangladesh)	F-Prob (India)	F-Prob (Pakistan)
ARCH LM-Test	H_0 = No ARCH effects (no serial correlation) H_1 = ARCH effects	0.132	0.401	0.204
White's test	H_0 = Hetero-skedasticity does not exist H_1= Hetero-skedasticity exist	0.0954	0.4887	0.2596
Jarque Bera Test	H_0 = Normally distributed H_1 = Not normally distributed	0.601	0.641	0.218

Source: Author's own estimates.

1 Bangladesh



2 India



3 Pakistan

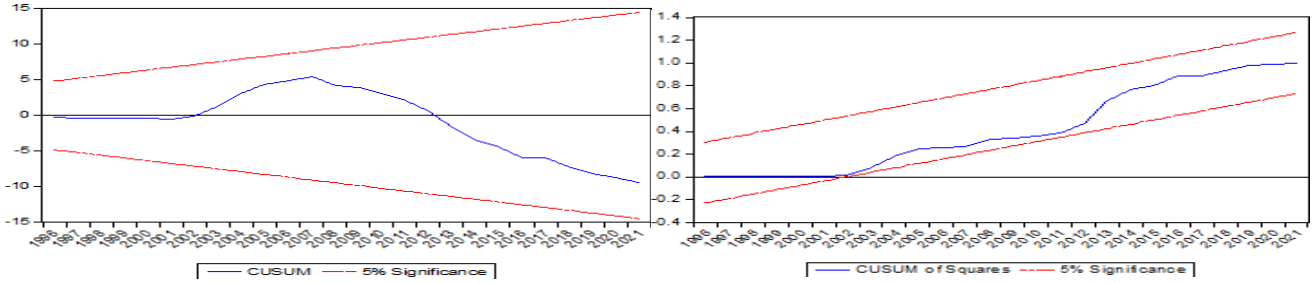


Figure 3. CUSUM and CUSUMSQ plots.

CONCLUSIONS AND RECOMMENDATIONS

South Asian countries share significantly less part of GHG emissions, but there is a constantly increasing trend of emissions in the region, creating an alarming situation. In the first step of this study, the PCA approach has been applied to nineteen indicators of GG on time series data from 1990 to 2021. The estimated index score has been incorporated into our model as a dependent variable. In the second phase, we tested the GG index for its determinants. First, we tested for the stationarity of variables which gave the mixed order of integration. The further bound test confirms the existence of a long-run relationship, and to test the co-integration effect of variables, we use the Autoregressive Distributed Lag (ARDL) methodology. Results confirmed the long-run and short-run relationship between GG and urbanization, trade openness, forest Area, law and order and socio-economic conditions in the context of Bangladesh, Pakistan and India. These countries are emerging economies and more vulnerable to climate change risk and global warming.

1) The results of this study for Bangladesh prompt the policymakers to improvise urban policies in the shape of smart cities, which are focused on the installation of innovative modern practices of communication and efficient management of emissions along with enhancing the trading strategy in replacement of imports of low-end goods and export of high-end goods will enhance economic efficiency and generate opportunity for GG.
2) In the context of India, the development of urban units, such as the health and education sectors in less developed regions, stimulate GG. Improving the production side of the forest area by improvising innovative and market-oriented product design practices will increase the demand for green products and ultimately promotes GG at large. Introducing a digital work environment and providing the work for home opportunities will enhance the worker's productivity and creates jobs to stimulate the social aspect of GG.
3) In Pakistan, developing low-carbon infrastructure in the transportation sector can help reduce the maximum level of emissions. Trade shifts towards the imports of green technology will help implement green practices. Law and order regulation in the form of designing environmental taxation policies can help to generate revenue and helps to invest in research and development. Skill development centres should be upgraded with relevant knowledge related to operating green technologies to create more employment opportunities and increase the worker's confidence in the workplace as it works along the GG agenda.

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Appendix

Table A1. Correlation matrix

BAN	GG_t	URB_t	TO_t	FOR_t	LAO_t	SE_t
GG_t	1.0000					
URB_t	0.8904	1.0000				
TO_t	0.4351	0.7516	1.0000			
FOR_t	0.2730	-0.0436	-0.3239	1.0000		
LAO_t	0.0151	-0.0241	0.1828	0.1413	1.0000	
SE_t	0.2030	-0.4654	-0.6218	0.4451	0.0231	1.0000
IND	GG_t	URB_t	TO_t	FOR_t	LAO_t	SE_t
GG_t	1.0000					
URB_t	0.9414	1.0000				
TO_t	0.6359	0.7715	1.0000			
FOR_t	0.5396	-0.5782	-0.7356	1.0000		
LAO_t	0.7290	0.6023	0.4985	-0.4515	1.0000	
SE_t	0.1915	-0.1144	-0.2571	0.5621	-0.0187	1.0000
PAK	GG_t	URB_t	TO_t	FOR_t	LAO_t	SE_t
GG_t	1.0000					
URB_t	0.4582	1.0000				
TO_t	0.0566	-0.6105	1.0000			
FOR_t	0.2765	-0.3461	0.2150	1.0000		
LAO_t	0.1912	0.5383	-0.2439	-0.5635	1.0000	
SE_t	0.3391	0.4083	-0.6398	-0.3446	0.3348	1.0000

Source: Author's own estimates.

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