Research article

Nexus between environmental, social and economic development in South Asia: evidence from econometric models

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ABSTRACT

This study investigates the impact of various economic, social and environmental indicators on economic growth in South Asian countries. Using the data throughout 1990–2017, a panel data estimation method is adopted with sophisticated econometric approaches. The obtained results indicate a long-term positive effect of biological capacity, financial development, human development index, income inequality on economic growth while the effect of energy use is the opposite. The findings of the study suggest that governments and associated bodies must promote financial development, human development, and biocapacity to not only attain economic growth in the long-run and but dissuade ecological footprint, and income inequality at the same time while matching the energy consumption with the bio-capacity of each economy.

1. Introduction

Economic growth is considered to be a powerful tool to create employment, reduce poverty and improve the living standards (Azam, 2019). Therefore, economic growth has been a major policy agenda of developing countries where the poverty level is high and widespread (Rahman et al., 2019). South Asian region, in particular, is experienced with a high poverty level that varies among the counties. India has shown the highest rate of poverty, followed by other countries in South Asia (World Bank, 2017). The 17 Sustainable Development Goals (SDGs) of the 2030 Agenda has a broad scope of action covering the three dimensions of sustainable development i.e. societal, economic and environmental. The SDGs address many issues including – eradication of poverty and inequality, creation of inclusive economic growth and ensuring the preservation of the planet. The issues addressed by SDGs are not only linked but are also interdependent (World Health Organisation, 2015, 2016). Sustainable development calls for balancing societal (SDG 3, 4, 10), economic (SDG 8, 9, 12 and 17) and environmental (SDG 6, 7, 13 and 15) factors (M. A. Khan and Ozturk, 2020). Therefore, the governments at all levels i.e. regional, country and global levels need to minimize trade-offs between goals while implementing them. For example, a country that intends to improve energy access to achieve SDG 7, may end-up accelerating the climate change or acidifying the oceans,

disrupting SDG 13 or SDG 14. Hence, actions that are mutually reinforcing should be taken without ignoring the overlaps among the goals. Quality education for girls (SDG 4) shall help achieve poverty eradication (SDG 1), gender equality (SDG 5) and economic growth (SDG 8) in the long-run (Nilsson et al., 2016). Therefore, there is need to think systematically about these interactions and how these goals affect each other.

Klapper et al. (2016) argue for the need to look for societal, economic and environmental factors that affect economic growth. The past empirical results revealed by the researchers are inconclusive, the reason being the studies have adopted ad-hoc approaches, used different country-specific characteristics or there exists omitted variable bias. Previous studies have not considered all the relevant variables for growth studies in South Asia (see Kashem and Rahman, 2019; Rahman et al., 2019; Rahman et al., 2020). Therefore, the present study aims to answer the research question i.e., what are the impacts of various economic, social and environmental indicators on economic growth in South Asian countries? The paper has adopted and tested different econometric techniques such as first and second-generation unit root test, cross-sectional dependence test, D&H Granger non-causality test, Westerlund cointegration test, Dynamic Ordinary Least Squares (DOLS), Fully Modified Ordinary Least Squares (FMOLS), Canonical Cointegrating Regression (CCR) and Augmented Mean Group (AMG) estimations to

have the answer of our research question. This study has conducted an empirical assessment to examine the relationship of various societal, economic and environmental factors with the economic growth in SAARC countries over the period of 1990–2017. The main findings of the study suggest that (1) income inequalities and regional inequalities must be reduced in order to achieve greater economic growth by providing employment opportunities or focussing on redistribution of wealth (2) there is a need to shift to renewable sources of energy (Awan et al., 2020) that are clean, reliable and cost-effective to reduce the ecological footprints (3) in order to compete with the developed markets, it has become imperative to focus on economic prosperity and this can be achieved by increasing the imports of capital goods. Policies related to trade openness and pollution emissions must be reconsidered by the governments of the countries under study (4) a balance must be maintained between ecological footprint and biological capacity. The findings of the study shall help the SAARC countries to achieve their social, economic and environmental goals simultaneously.

SAARC contributes to 3.8% of the global Gross Domestic Product (GDP), covers 3% of the world's area and 21% of the total world's population. Although the poverty levels in many South Asian countries are high, it is interesting to note that the South Asian Association for Regional Cooperation (SAARC) region shows increasing growth and development. Also, the real GDP growth of South Asian countries exceeds the growth in other regions (IMF, 2018). Therefore, the above discussion provides a strong basis to look for various factors that affect economic growth in SAARC countries. The present study empirically investigates the factors affecting economic growth in SAARC countries except for Afghanistan, Bhutan and Maldives. The datasets for the countries were selected in line with the availability of data. The results of the study shall benefit countries under investigation as well as the other developing nations, especially countries form Asia and Africa, which face more or less similar experience in terms of growth, environmental problems, poverty and inequality.

The United Nations have defined sustainable development goals for both the developed as well as for the developing countries to be achieved by 2030. The significant contribution of the study helps the governments across the globe to integrate the efforts towards societal, environmental and economic development, simultaneously to achieve the broader set of sustainable development goals. Although the developed countries have already attained the economic goals, there still remains to progress on the front of environmental goals. The study has shown how environmental factors may adversely affect the economic growth in the long-run, therefore, this study provides important implications for the developed as well as developing countries. Also, (Nathaniel et al., 2019) opine that the energy consumption in developing countries has been increasing at an increasing rate which can surpass the consumption in developed countries, causing severe effects on the environment. Therefore, there is a dire need for the countries around the globe to join hands and take affirmative action.

This study shall benefit policymakers, regulatory bodies, potential businessmen, foreign institutional investors in framing policies at their respective levels, to improve the well-being of people. The policymakers and regulatory authorities may formulate policies and developmental programs for enhancing the macroeconomic performance, which impacts both the societal and environmental development of a country. Development in the macroeconomic environment of a country would induce potential business ventures to establish their operations in the country with a conducive environment and established markets. Similarly, investors look towards the growing economies where there are ample opportunities to invest while earning handsome returns on investments. Societal development implies an improvement in literacy rate, reduction in poverty and inequality which, in turn, improve the living standards and well-being of people.

Researchers have extensively used human development as an important societal determinant of economic growth. Human development is considered to be an essential input for the economic growth of

any country and affects economic growth in the long-run. The purpose of human development index is to persuade economies to make people-centric policies rather than focusing on national income accounting (Arabi and Abdalla, 2013). Another important societal factor impacting economic growth is income inequality. The nexus between income inequality and economic growth has been investigated by many researchers who have found a negative relationship between the two. However, Panizza (2002) argues that the quality of data used for income distribution is poor. Therefore, for this study, we have used the GINI index to measure income inequality. Economic indicators like trade openness and financial development index also have effect on economic growth. In this connected world, economic growth is impacted by globalisation. Therefore, it is imperative to include this variable since it impacts the economic growth of any country. Globalisation has been represented by trade openness in this study (Rahman et al., 2017). Financial development positively impacts economic growth. It includes the promotion of activities like increasing banking activities, increasing foreign direct investment and an increase in stock market activities (Sadorsky, 2010). Financial development has been represented by the financial development index. Financial development index ranks the countries relatively on the basis of depth, access and efficiency of their financial markets and financial institutions (International Monetary Fund, 2020). Various environmental factors that affect economic growth include carbon dioxide emissions (CO_2), bio-capacity and energy use. CO_2 is a major greenhouse gas that has captured attention of researchers and policymakers due to its detrimental effects (Rahman, 2017). Since CO_2 emissions is a negative indicator, we use ecological footprint which is a more aggregate indicator to measure environment quality (Nathaniel et al., 2019; Nathaniel et al., 2020). Bio-capacity includes the land and sea area that is biologically productive (Smulders and Nooij, 2003). Reduction in energy use affects economic growth seriously. There is a need to look for some energy conservation policies so that the trade-off between the reduction in energy use and economic growth becomes less severe (Smulders and Nooij, 2003).

The study employs Breusch and Pagan (1980) and Pesaran (2004) tests to check for cross-sectional dependence in the series. We applied cross-sectionally augmented Im, Pesaran and Shin (CIPS) test and cross-sectionally augmented Dickey-Fuller (CADF) unit root test to check for stationarity in the series An advanced form of Granger causality test i.e. Dumitrescu and Hurlin (2012) test has been used to detect causality relationship in the panel dataset. We, then applied panel cointegration test (Westerlund, 2007), to test long-run equilibrium relationship between the variables. Dynamic Ordinary Least Squares (DOLS), Fully Modified Ordinary Least Squares (FMOLS) and Canonical Co-integrating Regression (CCR) are applied to check for robustness and to obtain fully efficient estimation in the long-run. The long-run impacts of the variables for overall panel as well as for each country is estimated using Augmented Mean Group (AMG) estimation. Our empirical results confirm the presence of cross-sectional dependence and heterogeneity among the variables, implying the unidentified shocks or geographical effects. The unit root tests testify that the variables of our study show stationary, encouraging to go for further panel data analysis. D&H Granger non-causality test exhibits that the regressors employed in the econometric model could be used to predict per capita GDP which is particularly necessary to enhance economic growth. By employing Westerlund cointegration and long-run estimation approach (FMOLS, DOLS, CCR), we establish a long-run equilibrium relationship and cointegration among our variables. For giving robust estimates and explaining heterogeneity, AMG estimation provides results for country-wise effects.

The study contributes to the existing body of knowledge in two ways. First, this is the first-ever study in South Asia, to the best of our knowledge, that explores the impact of environmental indicators (biological capacity, ecological footprint and energy use), societal indicators (GINI index and HDI index) and economic indicators (trade openness and financial development index) on economic growth (measured in terms of

GDP per capita) in South Asia at a time. Hence, our study is comprehensive and inclusive in terms of relevant variables selection. Second, this study uses robust and reliable econometric methodologies, including- first and second-generation unit root test, cross-sectional dependence test, D&H Granger non-causality test, Westerlund cointegration test, DOLS, FMOLS, CCR and AMG estimations. These methods provide a conclusive result in having holistic and comprehensive policies not only in the countries under study but also beyond.

The rest of the study is structured as follows. Section 2 presents the review of existing literature; section 3 explains the methodology of the paper; section 4 provides the results; section 5 presents the conclusion of the paper with policy implications.

2. Review of literature

Quite a few research efforts have been made to relate various societal, economic and environmental variables to economic growth. However, very limited literature is available on relating these variables aggregately. Hence, it becomes imperative to conduct a research taking into account all the aspects (societal, economic and environmental) aggregately. Our study takes into consideration all the societal, economic and environmental factors, namely - GDP, HDI, GINI, energy use, trade openness, financial development index, ecological footprint and biocapacity that have an impact on economic growth. Bassanini and Scarpetta (2001) estimated the effect of human capital on economic growth for 21 OECD countries using the data from 1971–98, leaving aside the effect of various environmental and economic factors that impact economic growth. Similarly, Ndambendia and Njoupouognigni (2010) have investigated the role of foreign aid and foreign direct investment in attaining economic growth without considering the environmental and societal aspects. On the other hand, Narayan and Smyth (2008) have studied the link between capital formation, energy consumption and real GDP. They have used economic and environment related variables and did not consider the societal aspect.

This study has employed various robust and reliable econometric techniques that most of the studies have missed. For example - Narayan and Smyth (2008) used panel unit root test, panel cointegration test, Granger causality test and long-run structural estimation to examine the link between energy consumption, capital formation and real GDP for G-7 countries. Roberts et al. (2018) used time-series data of four regions of the world and find a stronger correlation between the region's energy cost-share and gross national income per capita than the correlation between the region's energy cost-share and GDP change. To explain the causal link between energy consumption and GDP of the country, multiple studies applied different methodologies such as panel data approach (Huang et al., 2008; Lee, 2005; Zeb et al., 2014), Johansen cointegration technique (Belloumi, 2009) and Granger's technique (Dumitrescu and Hurlin, 2012; Pao and Tsai, 2011; Yang, 2000).

Rahman and Mamun (2016) conducted unit root test and ARDL cointegration analysis and did not find any long-run relationship between energy use, per capita GDP and per capita international trade while they have found Granger causality between international trade and GDP growth for Australia. Smulders and Nooij (2003) have studied the impact of energy conservation policies on aggregate economic growth and found that the energy policies, in the long run, reduce the rate at which energy is being used thereby, leaving long-run economic growth unaffected. Energy consumption has been considered as a determinant of sustainable economic development (Bojnec and Papler, 2011). Therefore, the large quantity of stable and high quality energy must be supplied to match its increasing demand (X. Wang and Feng, 2013). Danish et al. (2019) have looked for the link between ecological footprint and economic growth as they relate to biocapacity and human capital and concludes that there exists a neutral causal relationship between biocapacity and ecological footprint and between ecological footprint and economic growth. Bio-capacity impacts the relationship between ecological footprint and economic growth. If ecological footprint exceeds bio-capacity,

it can impact the economic growth and thereby, impacts the sustainability of that country. Holtz-Eakin and Selden (1992) argue that CO_2 has a direct impact on economic growth and hence, reducing the CO_2 emissions would hamper the economic growth. Although, the extant literature have used CO_2 emissions, Wachernagel and Rees (1998) conceptualize ecological footprint and use ecological footprint rather than CO_2 emissions to establish the relationship between environment and economic growth. EKC hypothesis has been validated by many researchers (Destek and Sarkodie, 2019; Osabuohien et al., 2014; Sarkodie, 2018) while others fail to validate it (Jaforullah and King, 2017; Neve and Hamaide, 2017; Rehman and Rashid, 2017). The results depend upon various factors, namely - models specified, variables used, and the techniques used (Stern and Common, 2001).

Panizza (2002) found a strong negative relationship between income inequality and economic growth in a cross-state data set. Rahman et al. (2017) investigated the impact of population growth, trade openness and environmental quality on economic growth. They have found a bi-directional relationship between trade openness and economic growth. Population growth and trade openness have a positive impact on economic growth. Jalil and Feridun (2011) used principal component analysis (PCA) to investigate the relationship between financial development and economic growth and suggested that there exists a positive relationship between financial development and economic growth. Newman and Thomson (1989), in their model of lagged dependent variable, confirm the presence of correlation between societal and economic developments. They showed that economic development is positively affected by the index for physical quality of life. Suri et al. (2011) explored the bi-directional relationship between human development and economic growth and found that human development is a critical input to economic growth. Human development contributes in a significant way in achieving and sustaining economic growth.

The literature stated above shows that no past study has covered the three-dimensional factors (economic, societal and environmental) in general. In particular, such study is totally absent in South Asia. Most of the studies have suffered from omitted variable bias. Therefore, there is need for a study that uses more comprehensive variable selection and provides generalizable results. Also, the past literature have used simple methodological techniques and have ignored heterogeneity and cross-sectional dependence (CD). Therefore, the study has employed robust methodologies to compute the results, namely - first and second-generation unit root test, cross-sectional dependence test, D&H Granger non-causality test, Westerlund cointegration test, Dynamic Ordinary Least Squares (DOLS), Fully Modified Ordinary Least Squares (FMOLS), Canonical Cointegrating Regression (CCR) and Augment Mean Group (AMG) estimations. To the best of our knowledge this methodology has not been used in the literature. Therefore, our study is unique in the literature in terms of conceptualization as well as methodology.

Based on the literature provided by the study, the following hypothesis has been formulated –

H_0: Biological capacity, ecological footprint, energy use, GINI index, HDI index, financial development index and trade openness impact economic growth.

The above hypothesis is further explained by the following sub-hypotheses -

H0a. Biological capacity negatively impacts economic growth

H0b. Ecological footprint negatively impacts economic growth

H0c. Energy use negatively impacts economic growth

H0d. GINI index negatively impacts economic growth

H0e. HDI negatively impacts economic growth

H0f. Financial development index negatively impacts economic growth

H0g. Trade openness negatively impacts economic growth

3. Methodology

3.1. Model and data

The present paper explores the relation among the indicators of economic, societal and environmental performance in South Asian countries, namely- Bangladesh, India, Nepal, Pakistan and Sri Lanka – from 1990 through 2017. For this purpose, secondary data are collected for GDP, HDI, GINI, energy use from World Development Indicators (WDI, 2019), trade openness from Our World in Data (OWID, 2020), financial development index from International Monetary Fund (International Monetary Fund, 2020), ecological footprint and bio-capacity from Global Footprint Network (GFN, 2019).

This study engages panel data estimation, which analyses the dynamic behaviour of the parameter, and considers heterogeneity explicitly. We used a better modelled technique of Panel data regression over cross-section and time-series data in handling all the evidence obtainable, which cannot be measured in pure cross-section and time-series (Plumper et al., 2005). The balanced panel data of five countries covering 18 years includes 3 macroeconomic indicators- GDP, Trade Openness, Financial Development Index (Rahman et al., 2019); 2 societal development indicators- HDI, GINI (Kubiszewski et al., 2013) and 3 environmental development indicators- Ecological footprint, Bio-capacity, Energy use (Wackernagel et al., 2019). The countries are selected from SAARC region, excluding– Afghanistan, Bhutan and Maldives – due to unobtainability of data for our chosen variables and time period. We analysed the estimated results based on the data period of 1990–2017, the most prolonged period for which data is available.

The study proposes a simple production function where GDP and its influencing variables are modelled as:

$$GDP\_PC_{it} = f\ (BIOCAP_{it}, EFPC_{it}, EUSE_{it}, FDI_{it}, GINI_{it}, HDI_{it}, TO_{it})\quad(1)$$

where, the subscripts i and t denote country and time period respectively. Here, GDP_PC is the Gross Domestic Product (constant 2010 US dollars per capita); BIOCAP is the Bio-capacity (productivity of ecological assets of a country measured as global hectare per person); EFPC is the Ecological footprint (area needed to produce the material consumed and to absorb the waste generated, measured as global hectare per person); EUSE is the energy use (kg of oil equivalent per capita); FDI is the

Financial Development Index as estimated by World Economic Forum (measures and evaluates the factors that enable various economies to develop financial systems and provides score and rank for the breadth, depth, and efficiency of these financial systems); GINI is Global Inequality Income Index as estimated by World Bank (measures the distribution of income across a population); HDI is the Human Development Index (measures the average achievement in 3 key dimensions of human development- health, education and standard of living); and TO is the Trade Openness (Ratio of exports and imports to GDP).

Eq. (1) can be parameterized as follows:

$$GDP\_PC_{it} = BIOCAP_{it}^{\beta 1i}EFPC_{it}^{\beta 2i}EUSE_{it}^{\beta 3i}FDI_{it}^{\beta 4i}GINI_{it}^{\beta 5i}HDI_{it}^{\beta 6i}TO_{it}^{\beta 7i}\quad(2)$$

The data series is transformed into natural logarithm to avoid the issues with dynamic properties and to interpret each resulting coefficient of a regression equation, as elasticities (Hassine and Harrathi, 2017). The empirical equation developed is, as follows:

$$ln\ GDP\_PC_{it} = \beta 1i\ ln\ BIOCAP_{it} + \beta 2i\ ln\ EFPC_{it} + \beta 3i\ ln\ EUSE_{it} + \beta 4i\ ln\ FDI_{2it} + \beta 5i\ ln\ GINI_{it} + \beta 6i\ ln\ HDI_{it} + \beta 7i\ ln\ TO_{it} + \phi it\quad(3)$$

where, $\beta 1i$, $\beta 2i$, $\beta 3i$, $\beta 4i$, $\beta 5i$, $\beta 6i$, $\beta 7i$ are elasticities of GDP with respect to other respective variables and Φ is the error term.

3.2. Econometric approaches

Figure 1 represents the flowchart diagram for dealing with panel data analysis used in this research.

3.2.1. Cross-sectional dependence (CSD)

The CSD test uses coefficient of correlation between the time-series for each country in our panel (Pesaran, 2007) to check whether the cross-sectional dependence exists within our panel variables (Breusch and Pagan, 1980; Pesaran, 2004). To solve the problem of mutual interactions of variables, CSD test is resolved with equation:

$$CSD = \sqrt{\frac{2t}{z(z-1)}}\left(\sum_{i=0}^{z-1}\sum_{j=i+1}^{z-1}\rho ij\right)\quad(4)$$
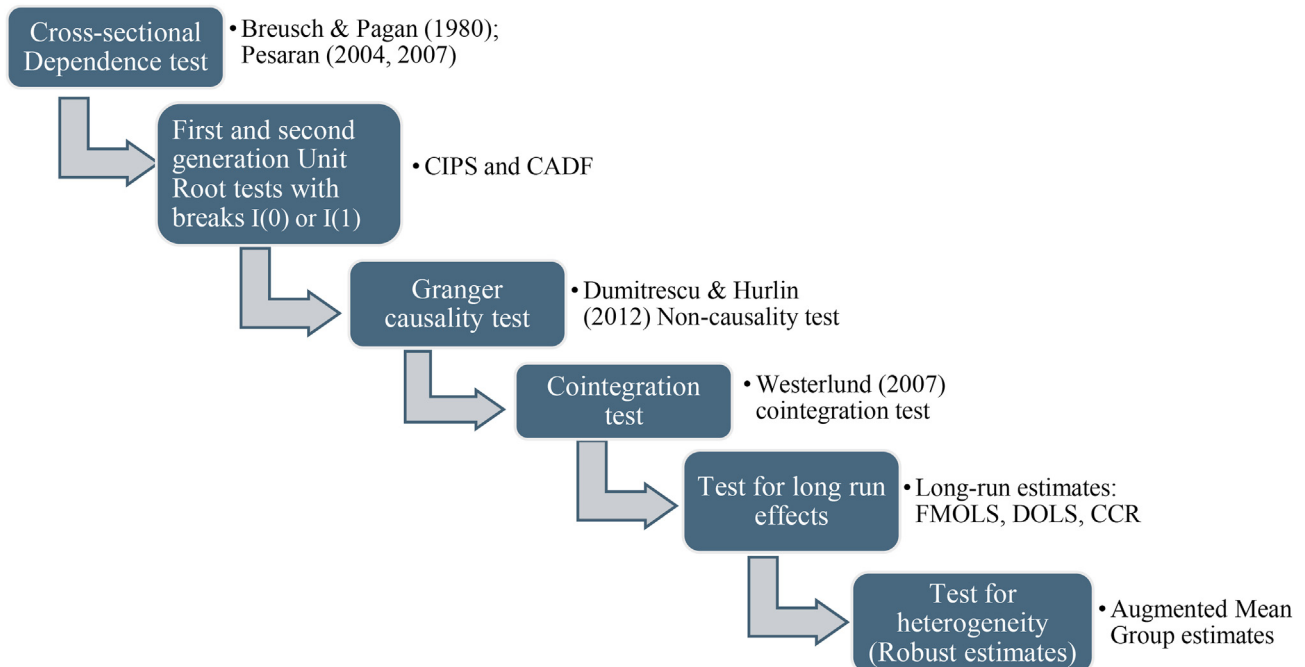

Figure 1. Flowchart summary of Panel Data Analysis.

Where, CSD = cross sectional dependence; z = cross-sections in the panel data; t = time horizon; and pij = cross-sections correlation of error between i and j. Consequently, the LM test to study the CSD is equated as:

$$y_{it} = \alpha_{it} + \beta_i x_{it} + \varepsilon_{it} \tag{5}$$

Where, t = time horizon; and i = the cross-section in the panel. For both the methods, the null hypothesis states that there is cross-sectional independence among the variables under study. The null hypothesis for this test is that the cross-sectional dependence does not exist among the variables, whereas the alternate hypothesis states that the cross-sectional dependence exists.

3.2.2. First and second-generation unit root test

If there is high cross-sectional dependence, all the tests tend to over-reject the null hypothesis. Hence, the standard panel unit root test that does not account for cross-sectional dependence could be biased. In our model, as the degree of cross-section dependence is sufficiently large (see Table 2), standard panel unit root test could not be used. Therefore, we conducted second generation unit root test with panel root t-statistic as cross-sectional augmented Im, Pesaran and Shin IPS (CIPS) test for each cross-section unit and cross-sectionally augmented Dickey-Fuller (CADF) unit root test for average individual statistics. As per Pesaran (2007), the unit-root test can be depicted as:

$$x_t = \alpha_{it} + \beta_i x_{it-1} + \rho_i t + \sum_{j=1}^{n} \theta_{ij} \Delta x_{i,\ t-j} + \varepsilon_{it} \tag{6}$$

Where, α_{it} = intercept; t = time horizon; Δ = the difference operator; x_{it} = variables under study; and ε_{it} = error term. The null hypothesis states that the series under study are non-stationary.

3.2.3. Heterogeneous panel causality test

The study employs the Dumitrescu and Hurlin (2012), Granger non-causality test through the bootstrap procedure (400) to establish the direction of causality. The test assumes that all the coefficients vary across cross-sections. This test could only be applied if the variables are stationary; therefore, we applied the test on the first difference of the series. Dumitrescu and Hurlin (2012) proposes the underlying regression equation:

$$y_{it} = \alpha_i + \sum_{k=1}^{K} \beta_{ik} y_{i,\ t-k} + \sum_{K=1}^{K} \gamma_{ik} x_{i,\ t-k} + \varepsilon_{it} \tag{7}$$

Where, it is assumed that the lag order of K is identical for all individuals and the panel should be balanced. The null hypothesis states that there exists no causality between the selected variables under study.

3.2.4. Panel cointegration test

Once the integration of variables in the series is confirmed by unit root in the panel, we shall apply panel cointegration test, to check the existence of a long-run equilibrium relationship between the variables. To examine the relationship, we applied panel cointegration test (Westerlund, 2007), since all of our variables are integrated of order one. The test is applied as per the following equation:

$$\Delta Y_{it} = \delta_i d_t + \alpha_i Y_{it-1} + \lambda_i' X_{i,\ t-1} + \sum_{j=1}^{pi} \alpha_{ij} \Delta Y_{i,\ t-j} + \sum_{j=-qi}^{pi} Y_{ij} \Delta X_{i,\ t-j} + \varepsilon_{it} \tag{8}$$

Where, d = model residuals; i = cross-section in the panel data; and t = time horizon. The null hypothesis under these tests states that the long-term relationship does not exist between the variables.

3.2.5. Long-run estimation approach (LEA)

FMOLS, DOLS and Canonical Cointegration Regression (CCR) models are used to obtain fully efficient estimation in the long-run (Wang and Wu, 2012). FMOLS and DOLS check for serial correlation and endogeneity, if any, in the model (Bhattacharya et al., 2016). CCR is a better estimator than FMOLS and DOLS as it exhibits lesser bias (Montalvo, 1995). The results exhibit the impact of all the variables on GDP, by conducting these three cointegration regression.

3.2.6. Augmented mean group (AMG) estimations

We have applied the first generation estimators for the panel time series- augmented mean group estimation. Pesaran and Smith (1995) proposes mean group estimator not considering the cross-sectional dependence by running a regression for each panel unit and the individual coefficients are averaged to obtain a mean group estimate (Musaad et al., 2017). The augmented mean group being a long-run cointegrating estimator, considers the heterogeneity and cross-sectional dependence among the countries (Bayar, 2016). The individual regression is:

$$y_{it} = \beta_i x_{it} + \delta_{xi} \overline{x_t} + \delta_{yi} \overline{y_t} + e_{it} \tag{9}$$

Where, $\overline{x_t} = Z^{-1} \sum_{1}^{Z} x_t$ is the cross-sectional average of the regressors, and $\overline{y_t} = Z^{-1} \sum_{1}^{Z} y_t$ is the cross-sectional average of the dependent variable.

4. Results and discussion

4.1. Descriptive statistics of the variables

Table 1 exhibits the basic features of the dataset under the study. BIOCAP, FDI and HDI show a low level of standard deviation which shows consistency among the panel countries. The mean values of all the variables are positive and closer to their medians, this shows a high economic growth is impacted by all societal, environmental and economic development indicators (S. A. R. Khan et al., 2019). The kurtosis statistics of all variables are closer to 3 (showing normal distribution) with only GINI having value of 4.8 showing leptokurtic distribution. Out of all the variables, EUSE and GDP per capita are negatively skewed. Energy use and trade openness show the most variability, while not much variation is observed in financial development index and bio-capacity of the selected South Asian countries.

4.1.1. The results of cross- sectional dependence test

Since the p-values (as shown in Table 2) is less than 0.01 (in almost all the cases), the null hypothesis stands rejected for all the variables except for two variables- BIOCAP and TO. The findings indicate that cross-sectional dependence exists among our panel variables. The LM results show the presence of heterogeneity across the cross-sections, and thereby, confirms the results of cross-sectional dependence tests. Our findings is consistent with Destek and Sinha (2020) and Hassine and Harrathi (2017).

4.1.2. The results of unit root test

Table 3 indicates the result of first-generation unit root test which reports that all the variables show stationarity at 99% level of significance under both CIPS and CADF. Also, the Table 4 findings indicate that all the variables (except EFPC and GDP_PC) are integrated with the same order and are non-stationary at levels, and stationary at their first-order differentials.

4.1.3. The results of causality test

Table 5 reveals the results of the Dumitrescu and Hurlin (2012) Granger non-causality test, with GDP_PC as the dependent variable. Consistent with the *p*-values in the same table, the null hypothesis of non-causality is rejected for all the independent variables, which means BIOCAP, EFPC, EUSE, GINI, FDI, HDI, and TO, all cause GDP_PC. Thus, it is ideal for the policy makers to focus on all the 3 goals- economic,

Table 1. Descriptive statistics.

Descriptive	$BIOCAP_{it}$	$EFPC_{it}$	$EUSE_{it}$	FDI_{it}	GDP_PC_{it}	$GINI_{it}$	HDI_{it}	TO_{it}
Mean	0.4585	0.9133	378.7169	0.2411	3.5052	34.0771	0.5363	41.7932
Median	0.4500	0.8550	399.8247	0.2159	3.3488	33.2000	0.5185	41.8875
Maximum	0.6200	1.5900	687.2595	0.4698	9.0039	43.8000	0.7700	75.7423
Minimum	0.3300	0.4600	115.4773	0.1178	-2.2437	27.6000	0.3780	15.9247
Std. Dev.	0.0694	0.2466	131.3086	0.0931	2.1412	3.3394	0.1043	14.2752
Skewness	0.4297	0.6396	-0.3584	0.8164	-0.2512	1.1519	0.6517	0.3105
Kurtosis	2.5161	3.2386	2.6651	2.5342	2.8553	4.8753	2.4981	2.1817

Table 2. Cross section dependence.

Variable	Breusch-Pagan LM	Pesaran scaled LM	Pesaran CD
$BIOCAP_{it}$	44.4334***	7.6995***	-0.3707
$EFPC_{it}$	153.1578***	32.0110***	11.3534***
$EUSE_{it}$	203.4115***	43.2481***	14.1363***
FDI_{it}	63.0458***	11.8614***	6.9509***
GDP_PC_{it}	19.9659**	2.2285**	3.1768***
$GINI_{it}$	34.2522***	5.4229***	2.4187**
HDI_{it}	275.9857***	59.4762***	16.6127***
TO_{it}	80.0797***	15.6703***	0.7724

Note: '*', '**', '***' signify 90%, 95% and 99% level of statistical significance, respectively.

Table 3. First generation unit root (on log).

Variable	IPS	ADF-Fisher
$BIOCAP_{it}$	-6.1845***	55.0098***
$EFPC_{it}$	-5.5999***	49.6483***
$EUSE_{it}$	-5.1466***	45.5413***
FDI_{it}	-5.5967***	49.0479***
GDP_PC_{it}	-12.1739***	109.775***
$GINI_{it}$	-5.5139***	48.2357***
HDI_{it}	-2.8541***	25.4764***
TO_{it}	-4.9094***	43.1610***

Note: '*', '**', '***' signify 90%, 95% and 99% level of statistical significance, respectively.

Table 4. Second generation unit root (on log).

Variable	Level		First Difference	
	CIPS	CADF	CIPS	CADF
$BIOCAP_{it}$	-1.652	-0.724	-5.967***	-4.286***
$EFPC_{it}$	-2.686***	-2.461*	-4.932***	-2.738**
$EUSE_{it}$	-1.136	-1.136	-4.175 ***	-2.409*
FDI_{it}	-2.108	-2.097	-4.547***	-4.049***
GDP_PC_{it}	-4.261***	-3.358***	-6.19***	-5.522***
$GINI_{it}$	-1.764	-1.784	-5.108***	-3.386***
HDI_{it}	-1.469	-1.107	-4.408***	-2.407*
TO_{it}	-1.851	-1.855	-4.573***	-3.138***

Note: '*', '**', '***' signify statistical significance at 10%, 5% and 1% levels, respectively.

societal and environmental goals, simultaneously. The South Asian countries are densely and diversely populated, indicating towards income inequalities and find that there runs a bi-directional causality from GDP_PC to GINI which is contradictory to (Risso et al., 2013). The bidirectional causality between GDP_PC and Trade openness; GDP_PC and

Energy use is consistent with the previous findings of (Kasman and Duman, 2015; Shoaib et al., 2020). The income inequality has an impact on the Human Development Index of the country, previous studies have shown a positive relation between HDI and GDP (Wackernagel et al., 2019) and a negative relation of GINI and GDP (Mitrut et al., 2015). This indicates a long-run equilibrium relationship among the variables which could be further confirmed through panel cointegration test.

4.1.4. The results of cointegration test

We have applied bootstrap resampling procedures at 400 re-estimations for the Westerlund panel cointegration test which provides us with robust p-values. This is required to avoid misleading inference in case of cross-member correlation. It provides four test statistics: Gt, Ga, Pt and Pa, where Gt and Ga represent the group mean tests, and Pt and Pa test statistics consider the panel mean tests. When the results, as shown in Table 6, are evaluated, Gt and Pt statistics strongly reject the null hypothesis (no long-term relationship exists), whereas the Ga and Pa statistics confirm it. Therefore, it can be inferred that the model parameters are cointegrated and confirm the long-term relationship between the variables. To understand the long-term impact on the GDP_PC, we proceed to FMOLS, DOLS and CCR tests.

4.1.5. The long run effects of variables

Table 7 shows that FMOLS results indicate that all the variables are at 99% level of significance and that 1% rise in FDI would increase GDP_PC by 9.94% while 1% increase in HDI would increase GDP_PC by 13.46% (lead to rejection of H_{0e} and H_{0f}). Also, an increase of 1% of EUSE would negatively affect the GDP_PC by 0.006% (lead to acceptance of H_{0c}). It is clearly visible that the FMOLS and CCR coefficients are almost same for the variables EUSE, FDI and HDI at 99% level of significance whereas only FDI and HDI are significant in case of DOLS results, indicating that policymakers shall focus on improving the FDI and HDI and at the same time control the energy consumption to enhance a sustainable economic growth of these countries. BIOCAP and GINI drive GDP_PC at 90% level of significance under FMOLS result, thus rejecting H_{0a} and H_{0d}. This implies that a country's capacity to utilise its ecological assets along with its energy use impacts the overall GDP of the nation (Ghosh and Chakma, 2018; Kubiszewski et al., 2013). Our results are consistent with (Rahman, 2017; Soytas and Sari, 2003), confirming the impact of energy use (oil consumption at both households and industrial level) on economic growth in the long-run. However, if the GDP_PC is increasing with a higher GINI coefficient, it implies that an improved income is not being encountered by majority of the population. However, previous researches conclude that the economy's growth and its GINI coefficient would show positive relationship in short-run, whereas, if we consider longer panel data, eventually, the relationship becomes negative (Barro, 2000; Forbes, 2000; Grijalva, 2011). The efficient income distribution by the government shall resolve the issue of income inequality and simultaneously, enhance the economic growth of the country. Our results also show the negative growth effect of trade openness (supporting H_{0g}), though it is not significant in any of these estimates is a mere concern. South Asian countries rely more on manufacturing units which lack maturity compared to developed regions, which make them incompetent

Table 5. D&H Granger non-causality.

Independent Variable	W-bar	Z-bar
$BIOCAP_{it} \not\Rightarrow GDP\_PC_{it}$	3.3492***	3.7144
$EFPC_{it} \not\Rightarrow GDP\_PC_{it}$	4.0387***	4.8046
$EUSE_{it} \not\Rightarrow GDP\_PC_{it}$	3.3726***	3.7514
$FDI_{it} \not\Rightarrow GDP\_PC_{it}$	2.1013*	1.7413
$GINI_{it} \not\Rightarrow GDP\_PC_{it}$	2.2703**	1.9134
$HDI_{it} \not\Rightarrow GDP\_PC_{it}$	5.3873***	6.9370
$TO_{it} \not\Rightarrow GDP\_PC_{it}$	2.3868**	2.1927

Note: '*', '**', '***' signify 90%, 95% and 99% level of statistical significance, respectively. The symbol $\not\Rightarrow$ represents 'does not homogeneously cause'.

Table 6. Westerlund cointegration.

Statistic	Value	Z-Value
Gt	-4.856***	-5.326
Ga	-7.770	1.632
Pt	-11.080***	-5.301
Pa	-7.728	0.582

Note: '***' signify 99% level of statistical significance.

if kept too open; also, the import exceeds exports for these countries, hence justifying the negative impact of TO (Hassine and Harrathi, 2017; Rahman et al., 2020).

4.1.6. The results of country-wise effects

To avoid overgeneralisation, we conducted country specific analysis. Table 8 exhibits the country-wise augmented mean group estimates and reports significant impact of BIOCAP in the overall panel data, indicating its impact on GDP_PC by 23.45 units. Our findings further reveal that EFPC, EUSE and TO reduce GDP_PC (further supports H0b, H0c and H0g) insignificantly while FDI, HDI and GINI insignificantly increase per capita GDP (further rejects H0f, H0e and H0d). Additionally, impact of ESUE, FDI and GINI (positively); HDI and TO (negatively) on per capita

GDP is proven by augmented mean group estimates for Sri Lanka. We observe that in Pakistan, 4 out of 7 independent variables- BIOCAP, EFPC, FDI and HDI have significant impact on its GDP_PC. Bangladesh abides that FDI (significantly positive) and TO (significantly negative) impacts the GDP_PC. HDI has a positive impact on the economy of India and Pakistan whereas this impact is negative in Sri Lanka. This may be due to the higher ranking as per HDI values of Sri Lanka than India and Pakistan (Latha et al., 2019). FDI shows significantly positive impact in Pakistan and Sri Lanka (similar to Hassine and Harrathi (2017)) whereas abates GDP_PC of Bangladesh. Trade Openness significantly directs the GDP_PC of Bangladesh; however, decreases it for Sri Lanka. This is probably because both the countries have developed export-oriented policies but the trade deficit of Bangladesh is much more than that of Sri Lanka (THT, 2016). Nepal is the only country which does not show any significant effect of any variable on its GDP_PC in AMG results. The results show mixed impact of all the variables amongst the countries, implying policymakers to integrate the efforts towards societal, environmental and economic development, simultaneously.

5. Conclusion and policy implications

Previous researchers have focused on one-to-one relationship of economic factors with environmental factors and societal factors but unlike others, our empirical study investigates the nexus among economic, societal and environmental indicators for the SAARC countries for 1990–2017. The SAARC region has been showing increasing economic growth and development despite of having high levels of poverty, it became quite interesting to know the factors affecting their growth. Since, the data is unavailable for Afghanistan, Bhutan and Maldives, this study considers the remaining five countries i.e. Bangladesh, India, Nepal, Pakistan and Sri Lanka. This study is comprehensive and inclusive in terms of relevant variables selection, while using robust and reliable econometric methodologies. To achieve the desired objective, a model has been developed, to test these SAARC countries in the context of GDP_PC (the findings led to the acceptance of hypothesis H0b, H0c and H0g, while rejecting others). For each country (Bangladesh, India, Nepal, Pakistan and Sri Lanka), there is a need to measure and analyse the

Table 7. FMOLS/DOLS/CCR (GDP_PC as dependent variable).

Independent Variables	FMOLS		DOLS		CCR	
	Coef	Std Err	Coef	Std Err	Coef	Std Err
$BIOCAP_{it}$	4.9084*	2.551	9.0478	7.008	5.1255*	2.807
$EFPC_{it}$	-2.1524	1.508	-5.6782	4.108	-2.2092	1.641
$EUSE_{it}$	-0.006***	0.001	-0.0045	0.004	-0.006***	0.001
FDI_{it}	9.9492***	1.432	10.206***	3.851	9.9318***	1.518
$GINI_{it}$	0.0554*	0.034	0.0491	0.098	0.0536	0.036
HDI_{it}	13.4637***	2.936	20.1335***	8.074	13.6698***	3.244
TO_{it}	-0.0015	0.010	-0.0015	0.026	-0.0021	0.010

Note: '*', '**', '***' signify 90%, 95% and 99% level of statistical significance, respectively.

Table 8. AMG (GDP_PC as dependent variable).

Variables	Overall	India	Pakistan	Nepal	Sri Lanka	Bangladesh
$BIOCAP_{it}$	23.4581**	10.8717	39.8318**	31.7055	29.5484	3.6430
$EFPC_{it}$	-0.0017	13.6811	-24.1836**	-5.8250	-0.0497	14.5567
$EUSE_{it}$	-0.0029	-0.0488	-0.0323	0.0072	0.0900***	-0.0024
FDI_{it}	20.6357	3.8915	11.7595**	42.3400	60.7477***	-13.8338*
$GINI_{it}$	0.1106	-0.1352	0.1977	0.0274	0.5233***	0.0784
HDI_{it}	59.1689	171.3765***	165.498***	53.5698	-107.8135**	6.2727
TO_{it}	-0.0627	-0.0883	-0.1799	0.0733	-0.2007***	0.0874*

Note: '*', '**', '***' signify 90%, 95% and 99% level of statistical significance, respectively.

linkages between the variables. In order to achieve sustainable development goals (SDGs), our empirical findings lead us to some primary observations that lead to phase-wise policy implications.

The main contribution of this study is the use of a more comprehensive set of variables considering societal indicators (GINI index and HDI index), economic indicators (trade openness and financial development index) and environmental indicators (biological capacity, ecological footprint and energy use) to measure the impact on economic growth. Also, the study has employed reliable and robust econometric techniques that provide conclusive result. This study makes a fresh attempt to explore the relationship between the variables using the econometric techniques that have proven to provide efficient and reliable results. The following policy implications can be derived from the findings: 1) the policymakers shall focus in reducing income and regional inequalities by redistributing the wealth through various programs (SDG 5 & 10) in the long-run. The government must encourage more employment opportunities, tax/subsidy benefits, etc. (SDG 8) to improve the income differences among the public. 2) the government of these countries must ensure that the business/industries/households efficiently produce, consume and conserve energy (SDG 12), this can be done by shifting to more secure, clean, reliable, integrated and cost-effective energy i.e. renewable sources of energy (SDG 7) with green technologies (SDG 9). This shall control the ecological footprints of the countries and gets us closer to sustainable world with economic growth. 3) South Asian countries should reconsider their strategies and policies related to trade openness (SDG 17) and pollution emissions (EFPC) (SDG 6, 14 & 15) as these are key elements of economic prosperity (Azam, 2016) but haven't shown much impact on economic growth in these countries. To make these countries mature enough to compete developed markets, import of efficient capital goods shall be encouraged which will lead to more export capacity, increased production, more employment and emissions. 4) The government of these highly populated countries shall develop more integrative designs and solutions to overcome ecological deficits to improve the Bio-capacity, thereby leading to self-sufficiency and sustainability. A higher rate of interest could be charged from the industries with higher level of ecological footprint, so that the cleaner industries get an incentive to exercise environment-friendly activities.

The policy makers while putting their efforts must strike a balance between the ecological footprint (being the demand side) and the bio-capacity (being the supply side). The bio-capacity of one nation affects its energy consumption proportionately which is inversely proportionate to the pollutant emissions (DeFries et al., 2012). In order to utilize the natural and restricted bio-capacity, the policymakers shall focus on sustainable ways for energy use which in turn affects the economic growth.

Understanding the nexus between these variables, helps these countries to attain the triple goals related to economic, societal and environmental development. These goals are the 3 pillars for sustainable development and should be focussed upon simultaneously, rather than one at a time. The suggested policy implications revolve around these 3 goals- the economic goals help in attaining decent work and economic growth (SDG 8: GDP_PC), industry, innovation, and infrastructure (SDG 9), responsible consumption and production (SDG 12) and partnerships for the goals (SDG 17: TO); the societal goals could be achieved by good health and well-being (SDG 3: composite of HDI), quality education (SDG 4: composite in HDI), reduced inequalities (SDG10: GINI); and the environmental goals focus on clean water and sanitation (SDG 6), affordable and clean energy (SDG 7: EUSE), life below water (SDG 13), and life on land (SDG 15).

To ensure sustainable economic development in the future, it is advisable for the authorities to make policies that encourage HDI, FDI, and trade openness; contemporarily dissuade ecological footprint and income inequality while matching the energy consumption with the bio-capacity of each economy.

The Pesaran's CD and CIPS tests confirm the existence of cross-sectional dependence among our panel variables (consistent with the results of Destek and Sinha (2020) and Hassine and Harrathi (2017)) and the possibility of long-run equilibrium relationship (since all of the variables are integrated with the same order). Further results show that all the other variables are stationary in level and first difference, with a statistical 99% level of significance for all the cases. Our findings indicate a long-run positive effects of biological capacity, financial development, human development index, income inequality on economic growth while the effect of energy use is opposite. All variables significantly cause GDP_PC, confirming the presence of cointegration and long run relationships which is consistent with the findings of (Kasman and Duman, 2015; Mitrut et al., 2015; Shoaib et al., 2020; Wackernagel et al., 2019), and contradictory to Risso et al. (2013). The Augmented Mean Group estimates of full panel data opine significant positive long run relationship between economic growth and Bio-capacity.

The future research may be directed to other South Asian countries or other economic region like ASEAN, BIMSTEC, etc and draw comparison with the findings of SAARC region. Researchers may employ extended or longer longitudinal data or move to experimental research (van der Meulen Rodgers et al., 2020). The classical studies have affirmed that the economic growth is pivotal in eliminating poverty and reducing inequalities (Shorrocks et al., 1976). The variables considered in our study do not focus much on poverty. Future research can be directed to study this nexus by considering other variables like poverty, urbanization, industrialization, CO_2 emissions, renewable/non-renewable energy, etc. Researchers are also motivated to enhance the current model using some control variables (for example, economic integration, exchange rates, consumer behaviour, financial innovation, government expenditures and average price level) in the EKC framework subject to the availability of data (Gozgor and Can, 2017).

Declarations

Author contribution statement

G. D. Sharma: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

S. Bansal: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

M.M. Rahman: Contributed reagents, materials, analysis tools or data; Wrote the paper.

A. Yadav: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

I. Garg: Performed the experiments; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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