Examining the temporal impact of stock market development on carbon intensity: Evidence from South Asian countries

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Abstract: The growing size of stock market in the South Asian countries might have contributed to raising the level of industrial production and energy consumption. This upturned energy usage might have widened the scope for carbon emissions because these nations heavily rely on fossil fuels. In this milieu, therefore, in the present study, we assessed the impacts of stock market development, per capita income, trade expansion, renewable energy solutions, and technological innovations on carbon intensity in the four South Asia countries from 1990-2016. The empirical results based on the CS-ARDL approach revealed that stock market development, per capita income, and trade expansion invigorated carbon intensity in the South Asian countries. On the contrary, the increased usage of renewable energy solutions and technological advancement helped in reducing the energy-led carbon intensity. Further, the interaction of stock market with renewable energy, and subsequently with technological advancement delivered insignificant coefficients, which indicates the inefficacy of renewable energy and technological advancement in regulating stock market-led carbon intensity during the study period. Therefore, by considering the need for complementarity between economic growth and environmental targets, we proposed a multipronged policy framework, which may help the selected countries to attain the Sustainable Development Goals, with a special focus on SDG 7, 8, 9, and 13.

Keywords: Stock Market Development, Carbon Intensity, South Asian Countries, Technological Innovations, Renewable Energy, CS-ARDL
JEL Classification: O3, C5, F6, I18

Nomenclature

LCE	Low-Carbon Economy
SMC	Stock Market Capitalization
SDGs	Sustainable Development Goals
G-7	G-7 is used for a group of countries namely Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States
EKC	Environmental Kuznets Curve
MENA	Middle East and North Africa
CAI	Carbon Intensity
PCI	Per Capita Income
TIN	Technological innovations
TRE	Trade expansion
REE	Renewable energy
CD	Cross-sectional Dependency
LM	Lagrange Multiplier
RP	Research Period
NC	Number of Countries
pc	Pair-wise Correlation
CADF	Cross-Sectional Augmented Dickey-Fuller
CIPS	Cross-Sectional Im-Pesaran-Shin
UM	Unobserved Matrix
CS-ARDL	Cross-Sectional Autoregressive Distributed Lag

1. **Introduction**

By ensuring the uninterrupted flows of financial resources, a well-developed stock market strengthens the economic process of a country because it allows the timely interaction of investors and savers and fulfills the financial requirements of the industries (UNCTAD 2017, Zafar et al. 2019a). Therefore, to ensure the productive contribution of financial institutions, the developing regions like South Asia revamped the operational mechanism of their stock market and banking sector so that both domestic and international investors can be attracted and the economy can be pumped up with fresh investments. In this process, due to the modernization and demutualization of stock markets, trade volume and trade transactions in the South Asian countries witnessed a sharp rise, especially in the preceding two decades. For instance, in 2002, the average market capitalization of the four South Asian nations namely India, Pakistan, Sri Lanka, and Bangladesh was 22.63%, whereas, in 2016, it reached to 47.64% (World Bank, 2021). At the same time, in terms of per capita income and domestic production, these nations witnessed consistent upward trends. Resultantly, the region turned into one of the most sought-after destinations for foreign investors (Ponomarenko, 2019), which subsequently complemented the demand for financial resources through share markets (Sharma and Kautish, 2020). Thus, it can be contemplated that stock market development might have facilitated the free movements of financial resources, which in turn, might have enlarged investment, production, employment, per capita income, and consumption opportunities in these nations (Samarakoon, 2016; United

Nations, 2018). At the same time, however, it cannot be denied that the increased production and investment supported by stock market development might have intensified the level of environmental pollution because, during the same period, environmental quality of these nations exacerbated significantly. As, the liberal trade policies, stock market and banking sector development (Sharma and Kautish, 2020), technological shift (Li and Piachaud, 2019), demographic dividend (Rahman et al. 2020), and energy supply (Nasreen and Anwar, 2014) might have given support to economic growth endeavors. But, by elevating the usage of energy solutions, these developments might have also exerted negative spillover impacts on biodiversity in the region.

While investigating the possible drivers of environmental pollution, the study in the past reported that the extensive usage of fossil fuels (Bekun et al. 2019, Zafar et al. 2019b), techniques of production (Sinha et al. 2017), foreign direct investment (Shahbaz et al. 2019), trade expansion (Shahbaz et al. 2015), urbanization (Lin and Wang, 2021), and population growth (Mendonça et al. 2020) tend to fortify environmental pollution. Among South Asian countries, however, the combustion of fossil fuels appears to be a major substance of environmental pollution because carbon-intensive energy resources dominate the energy baskets of these nations (Sharma et al. 2020). In conformity to the statement, the report of the Economic Times (2019) ascertained that the seven out of ten most polluted cities across the globe are situated in the South Asian countries. The excessive concentration of transportation channels and nonrenewable energy-based industries appear to be the main causes of growing pollution in these cities. An annual 5% increase of fossil fuel-led carbon emissions from 2000-01 to 2009-10 indicates that the region is failed to achieve climatic goals because such an alarming increase in pollution level is not safe for the established ecosystem (Cervarich et al. 2016). As per the report of the Intergovernmental Panel on Climate Change (IPCC), both developed and developing nations require reducing their gaseous emissions levels up to 25-30 $GtCO_2e$ $year^{-1}$ by 2030. And to achieve this level, in comparison to 2010, the GHG emissions should be reduced by 25% (Fawzy et al. 2020). Otherwise, the global temperature will likely to increase by 1.5 °C in the coming two decades, and many species will extinct from the earth due to global warming.

To achieve these ambitious climatic targets, the South Asian countries have started the decarbonization process by migrating towards alternative safer-energy solutions. Besides, governments have encouraged energy companies to accumulate necessary financial resources from the open markets so that the commercial viability of the renewable energy could be ensured and consumption of fossil fuels could be reduced (Climate Analytics, 2019). However, in this process, governments might have ignored the harmful environmental contribution caused by the indirect economic channels such as stock market and banking sector development. The literature supports that these channels often invigorate industrial production, energy consumption, and subsequently carbon emissions in the long run (Paramati et al. 2017, Zafar et al. 2019a). In other words, besides working as growth drivers, stock market and banking sector expansion can work as a catalyst for carbon emissions. In the case of the South Asian nations, the impact of stock market expansion on carbon emissions cannot be denied because more than 50% of the total energy demand is being fulfilled by fossil fuels (Shukla et al. 2017).

In 2015, the Sustainable Development Goals (SDGs) and the Paris Accord came into existence almost concurrently. However, the SDG objectives can be considered as an extension of the discussion points of the Paris Agreement. Now, the commitments made by the South Asian economies regarding the Nationally Determined Contributions (NDCs) are yet to be fulfilled. The economic growth trajectory attained by these economies is exerting the negative environmental externality. Internalization of these negative externalities and commitment to the NDCs require adequate financialization (UNESCAP, 2020). To achieve this financialization objective, active involvement of the domestic financial institutions is necessary. The considered developing nations of the South Asia have started promoting the extensive usage of renewable energy solutions so that without perturbing the growth momentum, environmental pollution can be marginalized. However, service-oriented industries such as banking sector and stock markets are yet to be covered in this ambit; and, here lies the major caveat. In general, through environmental protection measures, governments initially cover the dirtiest and carbon-intensive industries so that the direct environmental damage can be reduced (Sinha and Shahbaz, 2018). In this pursuit, the indirect channels are generally ignored from the environmental ambit because the sectors like stock markets are considered as low-carbon emitters. In this case, the ongoing economic growth strategy may form an exodus from the other sustainable development goals despite accomplishing the goal of economic growth. To navigate the negative environmental consequences of direct and indirect channels, there are two possible solutions: (i) the extensive usage of renewable energy in all sectors, and (ii) innovations in the field of energy so that the selected countries can achieve the status of a low-carbon economy. Importantly, the funding of both navigators can be carried out via stock market.

Dwell on the above discussion, in the present study, we intended to address three major questions: (i) whether stock market development raised the level of carbon intensity in the selected South Asian countries; (ii) whether the extensive usage of cleaner energy solutions and advanced technology reduced carbon intensity; (iii) whether the interaction between stock market and renewable energy and stock market and technological innovation reduced carbon intensity in the long run. In this pursuit, we selected the four South Asian countries namely India, Pakistan, Sri Lanka, and Bangladesh due to two reasons. Firstly, the stock market data for the other South Asian nations, i.e. Afghanistan, Nepal, Maldives, and Bhutan was not available. Secondly, during the considered study period (i.e. 1990-2016), stock markets and environmental footprints in India, Pakistan, Sri Lanka, and Bangladesh have shown upward trends. The consideration of carbon intensity as a proxy for environmental pollution appears relevant because stock market expansion, at the first stage, may lead to an increase in production and energy consumption; and subsequently may widen the scope for carbon intensity. Per capita income and trade expansion are employed as the controlled variables because these are closely associated with market expansion and environmental quality. Based on the long-run and short-run coefficients of stock market capitalization, renewable energy, and technological innovation, we intended to explore whether these variables have significantly influenced carbon intensity during the study period. Thereafter, the interaction effect of stock market capitalization and renewable energy and the interaction effect of stock market capitalization and technological innovations on carbon intensity are to be tested. By doing so, we intended to deliberate whether the possible negative impact of stock market capitalization on carbon intensity could be navigated by the usage of renewable energy solutions and technological innovations. Here it is imperative to mention that the level of carbon emissions and carbon intensity can vary significantly for a country in the long run. As former depends on the size of economy and prevailing production processes, whereas the latter depends on the types of energy solutions used at the production stage (Peng and Tao, 2018). In other words, a bigger economy can have low carbon intensity due to the extensive usage of low carbon-intense energy solutions but the level of carbon emissions can be very high; because economic actions in a larger economy may widen the scope for carbon emissions in the long run. Therefore, to assess this possible divergence, the impact of selected variables on carbon emissions has also been examined.

The selection of these countries is justified because, in these four nations, per capita income, stock market capitalization, and environmental pollution witnessed an upturn during the preceding years. Countries like Nepal, Bhutan, and Afghanistan appear to be outliers, as the size of stock market, and per capita income has remained relatively very less than the selected countries.

The study contributes to the existing literature in several manners. Firstly, by departing from the previous studies (Nasir et al. 2019, Zafar et al. 2019), we investigated the possible association between stock market development and energy-led carbon intensity. This approach is advantageous as it will reveal whether stock market development intensifies energy consumption and subsequently level of carbon emissions in the selected nations. If the association between stock market development and carbon intensity is found direct then it can be inferred that stock market's upside movements by intensifying carbon-intense energy consumption, might have exacerbated air quality in the selected nations. Except for a few studies (Zeqiraj et al. 2020), this kind of approach is not been followed in the literature. Secondly, by using stock market capitalization as a determinant of carbon intensity, we intended to highlight the role of indirect economic channels on the quality of environment. Thirdly, by using renewable energy and technological innovations in carbon intensity function, we sought to display whether these are possible solutions for achieving a low-carbon economy. Lastly, we proposed a long-term policy framework to reduce carbon intensity; and here lays the actual novelty of the present study. In the absence of a long-term strategy, the negative channels such as stock market development might continue to enlarge the level of carbon emissions. While proposing the long-term strategy, we considered the SDGs so that by adopting a multipronged and phased approach, SDG-7 (clean energy), SDG-9 (industrial growth and innovation), SDG-8 (economic growth), and subsequently SDG-13 (environment protection) can be pursued. Due to the possibility of political, economic, and social commonalities, it requires addressing the issue of cross-country convergence; and to do so, we employed the latest econometric procedure, i.e. the cross-sectional augmented autoregressive distributive lag approach (Chudik et al. 2013). Thus, the results based on this advanced computational procedure can be used safely for policy formulation.

Subsequently, Section-2 provides the literature support for the study. In Section-3, we mentioned the theoretical underpinning, data types, and methodology. Thereafter, in Section-4, the computed results are reported. In Section-5, we provided an extensive discussion on the results. In the end, Section-6 is devoted to the conclusion and policy formulation.

2. **The literature survey**

2.1. The nexus between financial sector development and environmental pollution

The growing interconnectedness among countries has expedited the free-play of financial resources where banking sector and financial markets have played a crucial role because both sectors help in bridging the demand-supply gap and facilitate fresh investments (Sharma and Kautish, 2020a). As a result, countries across the world have witnessed an increase in investment and energy demand (Sadorsky, 2010). Due to this possible association, many studies reported the direct relationship between financial sector development and energy consumption (Aslan et al. 2014, Doğan et al. 2020). In this process, the increased energy demand may lead to an increase in carbon emissions, especially if additional energy demand is fulfilled by fossil fuels (Kumar and Majid, 2020). The literature reveals that energy combustion is one of the major drivers of environmental pollution (Pandey et al. 2020, Sharma and Kautish 2020a); therefore, it can be presumed that stock market expansion may have an indirect influence on environmental quality where energy consumption may work as a mediator (Nasir et al. 2019, Amin et al. 2020). In conformity with this assumption, Zeqiraj et al. (2020) reported that the increased stock market capitalization led to an increase in environmental pollution in European countries. Furthermore, their empirical outcome confirmed that the interaction between stock market and renewable energy usage reduced carbon emissions in both periods. Similarly, using the quantile approach, Godil et al. (2020) confirmed that the increased intensity of share market contributed to damaging biodiversity in Turkey because the development of the former might have widened the scope for energy consumption, which in turn, might have exerted negative pressure on the ecosystem. By considering bank credit and number of listed companies as proxies for financial sector development, Nasir et al.'s (2019) study reported that the increased bank credit and number of listed companies exerted negative stress on air quality in the ASEAN countries.

However, here it is required to mention that if a country has a well-established infrastructure for renewable energy then increased energy demand led by stock market expansion can be achieved by renewable energy solutions. In that case, stock market expansion may invigorate growth without exacerbating environmental quality (Campiglio, 2016). For example, using the sample of G-7 and G-11 countries, Zafar et al. (2019a) ascertained that air quality of G-7 countries deteriorated due to the expansion of stock market. However, due to the widespread usage of renewable energy in G-11 countries, stock market expansion improved environmental quality in the long run. Thus, it can be ascertained that if additional energy demand led by stock market is fulfilled by renewable energy solutions then it may contribute to economic growth and environmental conservation (Tamazian et al. 2009).

2.2. The nexus between economic growth and environmental pollution

As mentioned earlier, the increased domestic production widens the scope for the usage of additional factor inputs such as machinery, labor, raw material, and energy solutions (Dey and Tareque 2020, Nasir et al. 2021). In this process, environmental pollution may increase significantly if techniques of production are not energy-efficient (Ahmed et al. 2017) and energy solutions are carbon-intensive (Shahbaz et al. 2019). In the case of developing nations, both factors appear to be the catalyst for carbon emissions because economic growth targets dominate the long-term policies and environmental issues often remain unaddressed (Sharma et al. 2020). Treating the income-environment relationship differently, Padilla and Serrano (2006) confirmed that carbon emissions varied with the level of income in developed and developing nations. Furthermore, due to the differences in the concentration of income, the level of carbon emissions exhibited a different pattern among the sampled countries. Due to the possibility of a nonlinear association between economic growth and environmental quality, studies in the past have considered an inverted U-shaped (Shahbaz et al. 2015, Sinha and Shahbaz 2018) and N-shaped environmental Kuznets curves (Allard et al. 2018, Terrell 2020). Not only in developing (Asongu et al. 2020) but also in developed nations (Bekun et al. 2019a, Bekun et al. 2019), the growing domestic production influenced biodiversity negatively, which raised a question on the growth strategy of these nations. By considering a sample of South and South Asian countries, Sharma et al.'s (2021) study confirmed an N-shaped association between per capita income and carbon releases. Based on the delayed second turnaround point, it can be inferred that the quest to achieve large-scale production might have elevated the level of carbon emissions in the long run. Similarly, by employing the NARDL econometric procedure, Shahbaz et al. (2021) ascertained that the increased domestic production in India contributed to raising the level of CO_2 emissions, whereas the impact of downside variations in domestic production unable to reduce carbon emissions significantly. This study proposed a novel scheme to achieve SDG-8 and SDG-13 simultaneously because SDGs impose a tradeoff for the developing nations. In the case of developed nations, studies in the past have established the nonlinear relationship between the variables. For example, Özokcu and Özdemir (2017) revealed a nonlinear association between CO_2 emissions and per capita income in the 26 OECD countries.

However, the outcomes of Farhani and Ozturk's (2015) and Ali et al.'s (2017) studies rejected the possibility of the nonlinear association between the variables in Tunisia and Pakistan, respectively. It means the influence of economic growth on environmental quality may vary over time. The usage of carbon-intensive energy resources and obsolete technology may continue to damage environmental quality even with the increased per capita income. Contrary to this, by using the sample of Morocco, Hakimi and Hamdi's (2016) results confirmed that the increased per capita income helped to achieve a cleaner environment in the long run. Here it can be perceived that investment in environmental fortification might have matched other productive investments; otherwise, it might perturb on the established ecosystem in the long run. Such kinds of results reinforce the need for reexamination of the GDP-CO_2 nexus.

The literature supports that the increased trade volume and transactions may influence the environmental quality in the long run (Zaidi et al., 2019; Zafar et al., 2019b). By using a sample of G-7 countries, Khan et al. (2020) revealed a negative association between exports and carbon emissions, whereas the association between imports and carbon emissions is found direct in the long run. Similarly, the results of Ding et al.' (2021) study confirmed that the increased exports help in improving the air quality in the long run. However, the increased imports significantly raised the level of carbon emissions during the study period. While examining the case of 7 ASEAN nations, Salman et al. (2019) reported a harmful impact of trade expansion because both exports and imports led to an increase in carbon emissions during the considered time. These mixed results indicate that the role of exports and imports in determining the environmental quality may vary across countries and times. However, in the more open and developing economies like South Asia, the association between environmental quality and trade expansion is likely to be stronger because these economies tend to prefer economic goals over environmental issues (Sharma et al., 2020; Shahbaz et al., 2021).

2.3. The nexus between renewable energy, technological innovations, and environmental pollution

The literature supports that the wider usage of renewable energy solutions is relatively less harmful to the environment (Dogan and Seker 2016, Holma et al. 2018, Pham et al. 2020); therefore, its increased usage to be considered if a country is struggling to control air quality (Destek and Sinha, 2020). In this pursuit, technological advancement is vital because developing infrastructure for renewable energy generation is a costly and time-consuming process (Steffen, 2020). Thus, to establish the economic viability of renewable energy resources, technological advancement is much needed (Kumar and Majid, 2020). In this pursuit, developing countries can learn from developed nations. For example, in a recent study, Zeqiraj et al. (2020) reported that technological advancement along with wider usage of renewable energy solutions reduced carbon intensity in European countries. Similarly, Malinauskaite et al. (2019) advocated the need for an energy-efficient production process where technological innovations can play a vital role. In other words, the energy-generation processes to be improved so that both energy-generation and waste management could be targeted. In the support of renewable energy usage, Lopez-Menendez et al. (2014) reported that the extended usage of renewable energy solutions improved air quality in European countries. In terms of econometrics treatment, the inclusion of renewable energy pronounced an inverted U-shaped EKC more smoothly. While discussing the role of technological advancement, Fisher-Vanden et al. (2006) ascertained that research & development in the field of energy sector and well-placed property rights might help in achieving energy-efficiency and subsequently a low-carbon economy. By taking the sample of the Southeast Asian region, Kumar (2016) documented that by adopting renewable electricity in Indonesia and Thailand, the level of carbon emissions can be reduced by 81% and 88%, respectively. Further, to reduce carbon intensity, the study recommended the extensive usage of electricity that should be generated by renewable energy resources. However, during the transition from nonrenewable to renewable energy solutions, governments should consider the energy price movements; otherwise, it may lead to inflation in the long run. Contrarily, Sinha et al. (2020) uphold a different view in the case of MENA countries because their results confirmed that technological improvement in the selected countries led to an increase in environmental pollution. Therefore, it cannot be denied that the improvement in technological progress may have a harmful impact on the environment if these changes are not compatible with environmental norms.

After examining the literature, a pertinent question arises whether stock market development in the South Asian region invigorated carbon intensity through production channels. If so, can these nations achieve the low-carbon economy status by increasing the usage of renewable energy solutions and by carrying technological improvements?

3. Research Methodology

3.1. Theoretical underpinning

The growth trajectory of the South Asian countries has been largely pro-growth in nature, while in order to ascertain sustainable development it should have been pro-development. Owing to this phenomenon, these countries are characterized by high carbon emissions (Topcu et al. 2020, Sinha et al. 2021). Now with the rise in economic growth, these countries have attracted investors around the world, and it has led to stock market expansion. This expansion is an indicator of the elevated manufacturing growth in these nations, which has largely been catalyzed by fossil fuel-based energy consumption (Zafar et al. 2019a, Sinha et al. 2020b). In such a scenario, it can be expected that carbon emissions in the ambient atmosphere of these countries will rise. Now, in order to comply with agenda 2030, these nations need to capitalize on their capability to innovate. The rising quantum of innovation in these countries might have an impact on carbon emissions scenario, while reducing the dependence of economic growth trajectory on fossil fuel-based energy solutions (Zafar et al. 2019c, Chen et al. 2021). In this pursuit, it should also be remembered that the rise in technological innovation in the countries also captures the innovations in energy production sector, and these innovations might be reflected in the rising alternate energy solutions, i.e. renewable energy solutions (Sharma et al. 2021, Zafar et al. 2021). With the rise in the diffusion of renewable energy solutions in these nations, it can be expected that carbon emissions might demonstrate a download trend in the coming years.

From this discussion, it can be assumed that the prevailing expansion path attained by these countries might open up avenues for improving their trade relations with the other countries, and this improvement in trade relations might be reflected in their trade expansion pattern. Now, the rise in trade activities might act as a catalyzing agent for manufacturing activities in these countries, and therefore, it might increase fossil fuel-based energy consumption (Destek and Sinha 2020). As a whole, the overall intensification in trade activities might result in a further rise in carbon emissions in these nations. Lastly, the rise in income of citizens in these countries will in turn increase the demand side pressure, and consequently, it will boost manufacturing activities (Shukla et al. 2017). Moreover, betterment in living standards might result in certain increase in energy consumption at the household level. These countries being largely dependent on fossil fuel solutions, it can be expected that the rising demand for energy in household and manufacturing sectors will be catered by these solutions only, which can further increase the level of ambient carbon emissions (Sinha and Bhattacharya 2016, Sinha et al. 2020d).

Thus, to ascertain the holistic contribution of all stakeholders and institutions, the synergy among economic, environmental, technological, and energy policies is much needed. In this milieu, with the help of the proposed model, we investigated the temporal impact of stock market development on carbon intensity. In terms of econometric representation, equation-1 depicted the proposed relationship:

$$lnCAI_{it} = a_0 + a_1 lnSMC_{it} + a_2 M_{it} + \epsilon_{it} \quad (1)$$

In equation-1, lnCAI depicts carbon intensity, lnSMC is used for stock market capitalization (proxy for stock market development), and other controlled variables are denoted by M where ‘i’ countries are studied against ‘t’ period. Equation-2 represents the matrix of other controlled variables.

$$M = (lnPCI, lnTIN, lnTRE, lnREE) \quad (2)$$

Where, lnPCI, lnTIN, lnTRE, and lnREE are used for per capita income, technological innovations, trade expansion, and renewable energy, respectively. The proposed scheme might allow us to assess carbon intensity in the presence of the given variables. We consider that renewable energy and technological innovations may help to control stock market-driven carbon intensity. Therefore, we developed four distinct models. Model-I and II are employed to examine carbon intensity in the presence of renewable energy. To be specific, Model-I measures the separate influence of stock market and renewable energy on carbon intensity, whereas, in Model-II, the combined impact (interaction effect) of stock market and renewable energy on carbon intensity is also considered. Model-I and Model-II are represented by equation-3 and 4, respectively.

$$lnCAI_{it} = a_0 + a_1 lnSMC_{it} + a_2 lnPCI_{it} + a_3 lnTRE_{it} + a_4 lnREE_{it} + \epsilon_{it} \quad (3)$$

$$ClnAI_{it} = a_0 + a_1 lnSMC_{it} + a_2 lnPCI_{it} + a_3 lnTRE_{it} + a_4 lnREE_{it} + a_5 lnSMC_{it} * lnREE_{it} + \epsilon_{it} \quad (4)$$

Thereafter, in Model-III and IV, we dropped renewable energy and considered technological innovations so that the impact of technological innovations on carbon intensity can be assessed. Similar to previous Models, Model-III measures the separate impact of stock market and technological innovations on carbon intensity, whereas, in Model-IV, the interaction effect of stock market and technological innovations on carbon intensity is also considered. These models are represented by equations-5 and 6, respectively.

$$lnCAI_{it} = \beta_0 + \beta_1 lnSMC_{it} + \beta_2 lnPCI_{it} + \beta_3 lnTRE_{it} + \beta_4 lnTIN_{it} + \epsilon_{it} \quad (5)$$

$$lnCAI_{it} = \beta_0 + \beta_1 lnSMC_{it} + \beta_2 lnPCI_{it} + \beta_3 lnTRE_{it} + \beta_4 lnTIN_{it} + \beta_5 lnSMC * lnTIN_{it}\, \epsilon_{it} \quad (6)$$

Thereafter, to assess the impact of considered independent variables on carbon emissions, the econometric procedures followed in equations 3 to 6 were repeated for the carbon emissions function. The results of the carbon emissions function are reported in Table 3A (see appendix).

3.2. Data definitions and sources

We employed carbon intensity as a proxy to depict low-carbon economy, which is the change in carbon emissions due to the change in the consumption of one unit of energy. To represent stock market development, we carried stock market capitalization (i.e. the number of unsettled stakes multiplied by the stake price times). The incessantly increasing market capitalization in the selected nations motivated us to consider it as proxy for stock market development. Even Ahmad et al. (2016), Zeqiraj et al. (2020), and Sharma and Kautish (2020b) have carried the market capitalization as a proxy for stock market development in their respective studies. The pooling of market capitalization appears just because the currency exchange value across these nations has remained stable. Thereafter, per capita income, trade expansion, renewable energy solutions, and technological innovations are taken as the controlled variables because the literature reported them as the possible drivers of carbon intensity. The official data of the World Bank is used to collect the annual data series of these variables. Thereafter, by converting them into the natural log values, the data uniformity is maintained, which also trimmed down the data sharpness. Table-1 provides the required information about the data series.

<INSERT TABLE-1 HERE>

3.3. Cross-sectional dependency (CD)

Owing to the possibility of cross-sectional dependency, we need to examine whether the comprised series are associated in the long run. The traditional unit-root tests such as Augmented Dickey-Fuller and Phillips-Perron cannot be employed if the data series are cross-section associated (Liu, 2013). Due to the possibility of social, cultural, and economic cointegration, it is expected that economic transitions might have generated a common pattern in these nations. To confirm this notion, we need to employ the cross-sectional dependence tests developed by Pesaran (2004), and Breusch and Pegan (1980). If the null hypothesizes of these tests are rejected, we can say that economic shocks are common, and traditional unit-root tests are invalid because they may depict series stability when they may be otherwise. In the presence of a smaller study period and a sufficiently large number of countries, the CD test given by Pesaran (2004) is appropriate. Contrarily, the Lagrangian Multiplier (LM) test given by Pesaran is more apt if the time period is large but the country-panel is small. Equation-7 narrates the calculation for the inter-country dependency test (ICD) where RP, NC, pc are used for the research period, number of countries, and pair-wise correlation, respectively.

$$ICD\ test\ value = \frac{\sqrt{2RP}}{NC(NC-1)} \left(\sum_{i=1}^{NC-1} \sum_{q=i+1}^{NC} \mathrm{pc}_{iq}\right) \quad (7)$$

The above-given method to be modified if the sample is unbalanced, which is not a case in our study; therefore, it is not mentioned here.

3.4. Stationarity test in the presence of cross-country dependency

After observing the inter-country association, we need to test whether series are stable in the long run. For doing so, the cross-sectional augmented Dickey-Fuller (i.e. CADF) econometric approach will be followed. This new generation procedure allows us to establish the integration order. Equation-8 exhibits the calculation procedure of this test where ν and z are employed to depict the lag-size and time-based mean interdependency, respectively.

$$\Delta z_{i,t} = \lambda_i + \beta_i z_{i,t-1} + \Phi_i \overline{z_{t-1}} + \sum_{l=0}^{\nu} \gamma_{i,l} \Delta \overline{z_{it-1}} + \sum_{l=0}^{\nu} \zeta_{i,l}\, z_{i,t-1} + \epsilon_{i,t} \quad (8)$$

This procedure, by using the distinct ADF value, generates the t-statistics. Based on the calculated values of this test, the Im-Pesaran-Shin test (CIPS) provides the individually treated values, which are based on the cross-country treatment. The procedure mention in equation-9 generates the Im-Pesaran-Shin test results.

$$CIPS\ test\ value = \left(\frac{1}{NC}\right) \sum_{i=1}^{NC} t_i(NC, RP) \quad (9)$$

3.5. Cointegration in the presence of cross-sectional dependency

By considering the possible cross-sectional dependency, Westerlund (2007) provided a unique solution to establish the long-run association between comprised variables. This test calculates error correction value and generates the four cross-section-based values where the significant values ascertain that the comprised series are cointegrated and apt for the long-run examination, whereas the acceptance of the null hypothesis ascertains that the long-run cointegration among the comprised series is missing. The mathematical treatment given in equation-10 provides the Westerlund test values.

$$\Delta W_{i,t} = \Phi_i k_t + \alpha_i W_{i,t-1} + \lambda_i D_{i,t-1} + \sum_{l=1}^{\nu_i} \alpha_{i,l} \Delta W_{i,t-l} + \sum_{l=-q_i}^{\nu_i} \rho_{i,l}\, D_{i,t-1} + \epsilon_{i,t} \quad (10)$$

In equation-10, k_t, and α_i are positioned to represent the constant term and adjustment speed, respectively. While representing constant term, combinations of constant and trend are also considered. Pesaran (2006) reported a distinct solution to handle mutual dependency, which can help in generating reliable results. The error term given in equation-3 can be calculated by using the unobserved matrix (UFM) of the given factors.

$$\epsilon_{it} = \Phi_i UFM_t + \in_{i,t} \quad (11)$$

By using the averages of the mutually dependent factors, the UFM will be calculated, which may efficiently handle the possible inter-dependency. For instance– $\overline{CAI_t} = 1/N \sum_{i=1}^{N} CAI$, other variables are to be treated separately in the same fashion. Equation-12 gives the final regression function where the individual coefficients (ρ_1 to ρ_4) will help in generating the commonly associated effect.

$$CAI_{it} = \beta_0 + \beta_1 SMC_{it} + \beta_2 PCI_{it} + \beta_3 TRE_{it} + \beta_4 REE_{it} + \rho_0 \overline{CAI_{it}} + \rho_1 \overline{SMC_{it}} + \rho_2 \overline{PCI_{it}} + \rho_3 \overline{TRE_{it}} + \rho_4 \overline{REE_{it}} + \epsilon_{it} \quad (12)$$

Similarly, after including TIN and excluding REE from the function, equation-13 provides the individual coefficients.

$$CAI_{it} = \beta_0 + \beta_1 SMC_{it} + \beta_2 PCI_{it} + \beta_3 TRE_{it} + \beta_4 TIN_{it} + \rho_0 \overline{CAI_{it}} + \rho_1 \overline{SMC_{it}} + \rho_2 \overline{PCI_{it}} + \rho_3 \overline{TRE_{it}} + \rho_4 \overline{TIN_{it}} + \epsilon_{it} \quad (13)$$

3.6. CS-ARDL procedure to calculate the common coefficients

The given geographical and cultural proximity may have a common impact on economic activities, which may generate inter-country dependency. If it is the case, we can calculate the common determinants of carbon intensity. However, to calculate the valid results, it is required to address the common-correlated effects. The traditional panel techniques such as the pooled mean group estimation, fully modified ordinary least squares, and dynamic ordinary least squares are weak in the sense that these approaches ignore the cross-sectional dependency. Thus, in the present study, we considered the CS-ARDL estimation which is developed by Chudik et al. (2013). Some inherent advantages of this approach are: (i) provides both types of coefficients (i.e. short run and long run); (ii) circumvents the common-shocks; and (iii) handles the possibility of structural breaks efficiently. The next section allows us to capture the long-run and short-run results.

4. Analysis of empirical results

To begin with, in Table-2, we reported the basic attributes of the comprised data series. As expected, stock market capitalization has depicted more vulnerability because the coefficient of the standard deviation is the largest of all. Contrarily, the carbon intensity series has shown the minimum deviation, which indicates the possible convergence among the selected countries in terms of environmental pollution. The lower panel of Table-2 provided the values of correlation coefficients.

<INSERT TABLE-2 HERE>

The first step is to observe whether series are generating common-shocks in the long run. To about it, we employed the CD tests. The outcomes of CD, LM, and Breusch and Pegan's (1980) tests are mentioned in Table-3.

<INSERT TABLE-3 HERE>

The Pesaran CD and LM test results rejected the null hypothesis. Similarly, Breusch and Pegan's test also rejected the null hypothesis. The rejection of the null hypothesis confirmed that the comprised data series are reinforcing common shocks. In other words, the results reported the presence of cross-country dependency which is not unexpected because the present group of countries shares common economic, cultural, and social attributes. Due to this convergence, the economic and environmental transitions in one country can be easily transferred to other neighboring countries. Therefore, we need to employ advanced stationarity techniques, which can circumvent the common-effect and provide reliable results. Thus, instead of ADF and PP tests, we employed the CADF and CIPS stationarity tests, which are mentioned in Table-4.

<INSERT TABLE-4 HERE>

The stationarity test results exhibited in Table-4 corroborate that the underlying data series are unstable at the level. However, both stationarity tests (i.e. CADF and CIPS) confirmed that the series became stationary after considering the first difference. In the presence of I(0)/I(1) order(s) series, the CS-ARDL approach can be safely employed and results will be reliable. However, before embarking on CS-ARDL estimation, it is required to report whether series are associated in the long run. For examining the cointegration, the traditional panel stationarity tests to be avoided because these tests are unable to handle the possible cross-country dependency. Thus, we employed Westerlund (2007) test, which is a robust panel test as it handles the cross-country dependency. Table-5 reported the results of the cointegration test.

<INSERT TABLE-5 HERE>

We employed the Westerlund test on the two different equations. Firstly, we examined the long-run cointegration in the presence of renewable energy and dropped technological innovations. Thereafter, we dropped the renewable energy series and considered the technological innovations series for the long-run cointegration. The results of Table-5 confirmed the long-run association among the underlying data series, which means, we can safely employ CS-ARDL estimation to compute the long-run and short-run coefficient values.

<INSERT TABLE-6>

The CS-ARDL mechanism provides the speed of adjustment for establishing the automatic equilibrium if due to certain reasons, disequilibrium persists. The significant error correction values with negative signs given in the lower panel revealed that the system is self-corrective with an average speed of 15% (approximately) across all Models. Coming back to upper panel, we observed that the development in market capitalization led to an increase in carbon intensity in the selected four countries. Across all models, the impact of per capita income on carbon intensity is found direct and significant. From these results, it can be contemplated that the increased production activities invigorated carbon intensity in the selected four developing nations in the long run. Thus, it can be inferred that the present production techniques contribute to raising the pollution level, which may be due to the increased usage of fossil fuels across industries. Sinha and Shahbaz (2018), Mirza and Kanwal (2017), and Shahbaz et al. (2014) in their studies reported the direct impact of production on environmental quality in India, Pakistan, and Bangladesh, respectively.

Moving further, the impact of stock market capitalization on carbon intensity is observed direct and significant across all Models. Though stock market development widens the scope for fresh investment, its significant and direct impact on carbon intensity is a matter of concern, as it indicates that not only direct economic channels but also indirect channels may influence environmental quality adversely in the long run. Such a scenario poses a concern to policymakers. From these positive and significant coefficients, it can be inferred that stock markets are involved in pumping financial support to industrial houses but environmental aspects are kept at the bay. Therefore, it can be assumed that stock markets in these nations are yet to achieve the maturity level and the companies listed in stock markets are operating with carbon-intensive energy resources. In order to revert the situation or to ensure the environmentally sustainable contribution of stock market, these nations need to promote environment-friendly investments, techniques, and fresh projects. In doing so, a greater number of renewable energy-based industries could be enlisted in stock markets. Besides, the existing industries should be guided to migrate from fossil fuel-based technology to renewable energy-based technology, for which the funding can be invited through stock markets. The results of Salahuddin et al.'s (2018) and Zeqiraj et al.'s (2020) studies also reported that financial sector development widened environmental pollution in Kuwait and European countries, respectively. In the case of developing nations, Nasir et al.'s (2019) study also reported a direct impact of number of listed companies on carbon emissions in the long run. Similarly, the results of Nguyen et al.'s (2021) study confirmed a direct association between stock market capitalization and carbon emissions in G-6 nations. In contrast, Sinha et al. (2021) reported a negative association between green bonds and carbon emissions in their study. Therefore, the study recommended establishing the environmental accountability of financial markets, so that both economic and environmental goals could be pursued.

Further, we observed that the development in international trade contributed to raising carbon intensity in the given countries. This kind of association between both was expected because to position themselves in international market such nations have increased their international trade. In this process, they might have increased their imports and exports without considering their environmental viability. The positive and significant coefficients of trade openness across all four Models are testimony of the fact that the developing economies of South Asia have intensified their environmental pollution through trade channels. Here it can be argued that, in the beginning years, the developing countries focus on their economic agendas but not on environmental conservation. Gradually, their concern shift towards environmental conservation if economic growth allows them to do so. Presently, the selected four countries appear to be in the first stage where economic interests are more dominant than environmental conservation. Sharma et al. (2020) reported that the incessantly increasing volume of international trade in the South Asian nations has intensified environmental pollution in the long run. Similarly, by using the panel of ASEAN countries, the results of Salman et al.'s (2019) study confirmed that export and import contributed to raising the level of carbon emissions during the study period.

As expected, in Model-I and II, the coefficients of renewable energy are found negative and significant, which indicate that the increased usage of renewable energy solution contributed to reducing carbon intensity in the long run. However, in Model-II, the interaction coefficient of the stock market and renewable energy (SMC*REE) is found insignificant but negative. Here lies the major caveat because the interaction between stock market and renewable energy unable to reduce carbon intensity. Thus, we can infer from the results that the joint impact or synergy between stock market and renewable energy is failed to reducing carbon intensity. In the absence of a concerted effort between targets to achieve a low carbon economy may be difficult because environmental fortification done by renewable energy might be damaged by stock market developments. Stating differently, renewable energy may help in improving environmental quality but stock market development may once again damage it if stock market shocks are stronger than renewable energy shocks. The results of Pham et al.'s (2020) and Sharma et al.' (2021) study also confirmed that the extensive usage of cleaner energy solutions helped to reduce the environmental footprint in the European and South and Southeast Asia countries, respectively.

To understand the role of technological advancement in achieving low carbon economy, we kept the technological innovation coefficients in Model-III and IV, whereas the renewable energy variable is removed from both Models. The results revealed that technological advancement contributed to reducing carbon intensity during the study period because the coefficients of technological innovations are found negative and significant in both Models. Here it can be ascertained that the research and development in the region are helping in conserving environmental quality. However, the insignificant value of the joint coefficient of stock market development and technological innovations (SMC*TIN) indicates that stock market-led carbon intensity is not reduced by technological innovations. In this milieu, it can be inferred that environmental fortification carried by technological innovations might have been spoiled by stock market development because the interaction between both channels did not reduce carbon intensity significantly. In order to reduce stock-market-led carbon intensity, stock market should be attuned to the latest technologies, which are capable of reducing energy consumption and subsequently carbon intensity. In the absence of synergy between stock market and technological innovations, carbon reduction efforts of technological improvements will be offset by stock market development because the improvement in the latter may widen energy consumption and subsequently carbon intensity if the former may not back it. The outcomes of Ding et al.' (2021) study reported a negative association between technological advancement and carbon emissions in the G-7 countries. However, the results of Sinha et al.'s (2021) study revealed that technological advancement led to an increase in carbon emissions in the selected Asia Pacific countries.

Subsequently, the impacts of selected variables on carbon emissions are examined. The computed results indicate that the stock market expansion, per capita income, and trade expansion raised the level of carbon emissions in the South Asian countries, whereas renewable energy solutions and technological advancement helped in navigating carbon emissions in the long run (see Table 3 given in appendix). The convergence between carbon intensity function and carbon emissions function reveals that the selected countries require replacing fossil fuels with environmentally-safer energy solutions.

5. Discussion of Results

Now, if we compile all the threads coming out of the analysis of results, then a wholesome picture of the entire scenario can emerge. It is evident from the results that economic growth trajectory of these nations is pro-growth in nature, and therefore, this growth is attained at the cost of the environment to quality, which is visible from the rise in carbon intensity. Being emerging economies, policymakers have prioritized growth over development, and owing to this fact, the existing production processes in these nations are largely driven by fossil fuel-based energy solutions. As these nations are characterized by high economic growth, they are perceived as profitable investment destinations, and this perception prevailing in the international market has led to the expansion of stock market activities. With the rise in investment, the manufacturing activities in these nations have experienced a surge, and driven by the multiplier effect, fossil fuel-based energy consumption has also gone up. In such a scenario, the expansion of stock market activities might lead to the deterioration of environmental quality, the empirical evidence obtained from the present study substantiates this claim. While attaining this economic growth trajectory, nations try to improve their international relations and enhance their presence in international market, and in this pursuit, the trade activities of these Nations increase. Now, this rise in trade activities is closely associated with a rise in manufacturing activities, and therefore, expansion of trade activities will have an indirect impact on environmental quality, i.e. higher trade expansion catalyzed by higher manufacturing activity will further deteriorate environmental quality. This claim has been substantiated by the outcomes obtained in the present study. When these threads coming out of the discussion are connected together, then it becomes evident that the prevailing economic growth trajectory in these Nations is causing harm to the basis of sustainable development, by enhancing carbon intensity. In such a scenario, it might be difficult for these Nations to accomplish the objectives of SDG 13, main reason behind this phenomenon can be attributed to the non-accomplishment of the objectives of SDG 7 and SDG

8. As these nations need to comply with agenda 2030, treading along this growth trajectory might be a concern for the policymakers.

On the other hand, in order to internalize the negative environmental externalities exerted by economic growth pattern in the nations, policymakers have started relying on their innovation capabilities, so that their dependence on fossil fuel-based energy can be reduced. The impact of these innovations is expected to be seen on the betterment of environmental quality, and this claim has been substantiated by the study outcomes. With the rise in innovations, it is expected that prevailing production and manufacturing processes will undergo a transformation, which might in turn bring forth a reduction in carbon intensity. Now, when the discussion on innovation comes to pass, the aspect of renewable energy should be prioritized. The majority of the innovations in these nations are carried out towards enhancing energy security, and at the same time, improving environmental quality. Hence, the policy instruments like innovation and renewable energy generation can be the potential drivers in these nations towards accomplishing the agenda 2030. It is also evident from the study outcomes that renewable energy consumption is exerting a positive environmental externality by reducing carbon intensity in these nations. So, when the economic growth trajectory of these nations is putting pressure on environmental quality, the innovation-led growth drivers can not only reduce the pressure on environmental quality, but also can improve them.

Saying this, it is also important to ponder upon the fact that expansion of stock market by virtue of expansion in the manufacturing activities and investment is a major indicator of growth, but not development. Therefore, it might be difficult to synergize the impact of the research and innovation-driven growth drivers with the dynamics of stock market, as the objective of these two aspects might be competing in nature. Making this synergy work might prove to be a challenge for the policymakers, and the evidence of the same can be found from the study outcomes, where impacts of the interaction between stock market expansion and the research and innovation-driven growth drivers on carbon intensity are found to be insignificant. This particular segment of the outcomes might be a concern for the policymakers, as it shows the perceivable inefficiency of stock market to be an ineffective channel for mobilizing innovation. As these economies are lucrative investment destinations in international market, therefore the policy interventions for transforming stock market mechanism into a transformative channel for promoting innovation need to be carried out in a very careful manner. Otherwise, these nations might start losing out on the stream of investments, which can have a negative impact on their economic growth trajectory. A successful maneuver in this regard might help these nations in accomplishing the objectives of SDG 9, and in the long run, the objectives of SDG 8. So, it can be expected that in order to help these Nations to achieve the SDGs or to comply with agenda 2030, a policy realignment is necessary, and present study outcomes have opened several threads of discussion, which converge towards a comprehensive policy framework for these nations.

6. Conclusion and Policy Implications

In the present study, by using the advanced econometric approach, firstly, the impact of stock market intensification on carbon intensity is explored in four South Asian nations. The study outcomes reveal that the prevailing economic growth trajectory in these nations is not environment friendly, while innovation-led economic growth trajectory might bring forth improvement in environmental quality. Discussion of the study outcomes opened several threads for formulating a comprehensive policy framework, which might help these nations in accomplishing the objectives of agenda 2030.

6.1. Central Policy Framework

As the economic growth trajectory of these nations is largely dependent on fossil fuel-based energy solutions, any premature radical transformation in energy sources can cause interruption to the economic growth itself. Hence, the policymakers need to devise the policy framework in a way that the implementation of the policies can be carried out in several stages. During the initial stage, the firms can be endowed with renewable energy solutions against a pro-rata rate fixed by the government, and these solutions can be obtained via financial institutions. Financial institutions might be instructed to set discriminatory lending rates to the firms based on their carbon footprint. This will discourage firms to use fossil fuel-based energy solutions, while encouraging the use of renewable energy solutions. At the same time, financial markets might also be used as a channel to discourage the use of fossil fuel-based solutions. In this pursuit, the listing process of firms might also need to look into carbon footprint of the firms, while firms already listed with stock market might be scrutinized for their prevailing carbon footprint. If the carbon footprint is found to be beyond a certain threshold level set by the policymakers, then the firm might be delisted or might be asked to pay certain penalty. In this way, stock market mechanism can be used to have a check on fossil fuel-based energy usage pattern of public listed firms. On other hand, the listing stringency might be relaxed for firms using renewable energy solutions. This particular process might prove to be useful for encouraging firms to use renewable energy solutions to get listed in the stock market.

Now, at the very outset of this policy implementation process, it might not be possible for these nations to create ingenious innovation capability, and therefore, these nations might need to look up to importing the solutions from the developed economies. The financial pressure experienced by the nations can be partially released by means of the interest income earned from the firms with a higher carbon footprint. In such a situation, firms will have an opportunity to realign their import portfolio, i.e. firms will try to import innovative technological solutions, so that the energy efficiency of their existing production processes can be improved and their carbon footprint can be reduced. This will help the trade activities to reduce or internalize the negative environment externally exerted by them, as the manufacturing processes will be more innovation-driven. During this phase of implementation, the government might utilize the collected penalty from the stock market for boosting the research and development process within the nation. This process is necessary to build the domestic innovation capability, as dependence on the imported technologies might not be a viable long-term solution. Once this capability is built, such nations will be able to develop renewable energy and energy-efficient solutions domestically. This will help these nations to ensure an energy-secured future, and thereby, proceeding towards the accomplishment of SDG 7. Now, with all the innovation capabilities in place showing the sign of growth, these nations will be able to sustain the industrial growth by means of innovation, and it will assist them in proceeding towards the accomplishment of SDG 9. While the energy security of these nations is achieved and financialization of innovation processes is carried out via the channel of financial markets, these nations might experience opening up of new ventures, based on the newly developed innovation capabilities. These developments might in turn increase job opportunities, and it might directly impact the state of livelihood of the citizens. Treading on this path, these nations might proceed towards the accomplishment of SDG 8. Lastly, shifting of energy sources from fossil fuel to re-enable energy solutions and development of domestic innovation capabilities will help these nations in improving environmental quality, and thereby, preceding towards the accomplishment of SDG 13.

6.2. Tangential Policy Framework

Central policy framework requires a support mechanism, which will help the staining policy framework. This support mechanism might be referred to as a tangential policy framework, which might be derived by extrapolating the results obtained in this study. In order to sustain and ensure the growth in the innovation capabilities the policymakers need to reach the grassroots level, so that the future generation of the labor force might be well acquainted with the latest technological development. For achieving this, the policymakers might need to introduce certain amendments in educational curriculums. Another aim of this particular policy move is to enhance the environmental awareness of the citizens, so that environmental quality can be retained. Moreover, the policymakers need to encourage people-public-private partnerships for diffusing the newly formed innovative energy solutions. This particular policy move might open up even further avenues for green jobs.

6.3. Policy Caveats

While stating the policy frameworks, it is also needed to remember that this policy framework is made by assuming certain conditions, which might be considered as policy caveats. Non-adherence to these caveats might restrict these policies from reaching their full potential. First, the red herring prospectus might be revised to include the clause of carbon footprint, so that the effectiveness of stock market channel to reduce carbon emissions can be institutionalized. Second, a separate regulatory body should be formed to check the status of carbon footprint of firms, on behalf of financial institutions. Third, existing ecological safety legislation should be made more stringent, so that public property rights could be retained. Fourth, policymakers need to make sure that the bureaucratic process should be free from the rent-seeking mechanism, so that the entrepreneurship ventures can be boosted smoothly.

6.4. Limitations and Projections

While the policy frameworks are discussed and deliberated, it is also required to remember that this policy framework has been designed by considering certain policy instruments, and hence, this framework is not all-inclusive. Saying this, it should also be understood that this policy framework can serve as a baseline approach for the other emerging economies, which are also facing similar kinds of issues. The advantage of this framework is that it can be tailor-made in keeping with the specific issue of the countries, and there lies the contribution of this baseline approach. By considering the sample of high, middle, and low-income countries, future studies may explore the impact of green investments, eco-innovation, and environmental regulation on carbon emissions. Besides, studies in the future can explore the impact of stock market development on carbon emissions by using the sample of high carbon emitter and low carbon emitter countries; and the large size of stock market and small size of stock market. While carrying such kinds of samples, future studies may also consider the possibility of structural breaks. As the structural discontinuity in financial sector may have a significant impact on other sectors of an economy and subsequently on environmental quality in the long run.

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