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Research Article

Nexus Between Agriculture, Industrialization, Imports, and Carbon Emissions in Bangladesh

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Abstract
Global warming is a significant worldwide challenge, principally caused by the ongoing increase in carbon dioxide (CO_2) concentrations. Confronting this dilemma necessitates inventive solutions and anticipatory actions to alleviate the consequences. This paper analyzes the influence of Bangladesh's agriculture, industrialization, and imports on CO_2 emissions to inform sustainable development strategies. The dynamic ordinary least squares (DOLS) method was applied by utilizing time-series data from 1971 to 2023. The unit root tests were used to ensure the data stationarity. The results of the DOLS estimation revealed that a 1% increment in the agricultural value added would reduce CO_2 pollution by 0.51% in the long run. However, a 1% increase in industrialization and imports causes higher carbon emissions in Bangladesh by 1.39% and 0.64%, respectively. The research highlights the significance of advancing green manufacturing methods, improving agricultural efficacy, and limiting imports as crucial gauges for reducing CO_2 emissions and attaining ecological longevity in Bangladesh.

Keywords: Climate change; Agriculture; Industry; Imports; CO_2 emissions; Environmental sustainability

Introduction
The ecological damage resulting from CO_2 emissions has emerged as a worldwide issue [1]. In recent years, we have witnessed the consequences of global warming, mostly because of the significant increase in CO_2 emissions. Internationally, the CO_2 levels attained 423.16 ppm, signifying a persistent escalation in greenhouse gas (GHG) rates. The predominant drivers of CO_2 emissions are fossil fuels, and the consumption of these forms of energy is consistently increasing in both emerging and industrialized countries [2]. Nations with developing economies contribute 63% of the annual total CO_2 emissions. Conversely, advanced countries, though generating a lesser share of overall annual pollutants, have traditionally been the predominant polluters. These locations exhibit elevated per capita emissions and have substantially facilitated the formation of GHGs during the previous century. Total emissions from industrialized nations will continue to be a significant contributor to temperature rise. In reaction to this problem, the United Nations launched the Sustainable Development Goals (SDGs) in 2015, with the objective of eliminating poverty, safeguarding

biodiversity, and fostering global growth and stability by 2030 [3]. Nations must strategically formulate revised nationally determined contributions (NDCs) to achieve these objectives. It is essential to attain a 45% decrease in CO_2 releases by 2030 relative to 2010 amounts and to transition to net zero emissions by 2050. CO_2 emissions must reach their apex as soon as feasible to restrict global warming to around 1.5˚C before cutting precipitously. Consequently, regulating CO_2 emissions has emerged as an urgent problem and objective to guarantee the long-term prosperity of low-income nations such as Bangladesh [4]. Concerningly, the nation's CO_2 emissions are escalating significantly on a daily basis.

Attaining elevated revenue generation has historically been a fundamental aspect of Bangladesh's socioeconomic strategies [5]. In the last fifty years, the nation has achieved considerable progress in financial growth. Nevertheless, this advancement has incurred considerable ecological costs, characterized by rising CO_2 emissions, acute contamination, habitat loss, forest destruction, and resource shortages. This environmental issue jeopardizes Bangladesh's long-term prospects [6]. Although Bangladesh accounts for about 0.4% of global GHG emissions, its carbon footprint may escalate due to ongoing economic expansion and a substantial population. Air pollution currently incurs an annual cost of 9% of the country's GDP. Enhanced air quality regulations can bolster well-being and ecological viability. Bangladesh's 2021 NDC aims for a 21.8% decrease in pollutants by 2030, with the possibility of surpassing this goal through robust deployment, technical progress, and shared regional efforts. Bangladesh, in accordance with its NDC, has initiated a green growth trajectory to tackle the critical issue of rising temperatures. The primary goal of this pledge is to decrease GHG pollution by 2030. Bangladesh intends to reduce 12 Mt CO_2 equivalents in the electricity, transportation, and manufacturing industries, signifying a 5% decrease in business-as-usual (BAU) emissions in these areas. Additionally, with global support, this country aims for an additional drop of 24 Mt CO_2 equivalents, resulting in an overall decrease of 10% below business-as-usual pollution by 2030.

In the modern era, the swift growth of the petroleum industry has markedly heightened the need for oil and energy generation. Since 1985, Bangladesh has experienced a significant increase in CO_2 output nationwide [7]. Bangladesh's manufacturing industries contribution to GDP increased from 6% in 1972 to 35% in 2023 (Figure 1). The overall carbon footprints in Bangladesh from 1971 to 2023 likewise indicate an increased trend (Figure 1). These alarming increases underscore the imperative to analyze industrial activity's influence on CO_2 emissions. Significantly, Bangladesh's farming industry generates around 50 metric tonnes of CO_2 per year, primarily due to activities such as rice cultivation, burning of field residues, and animal maintenance [8]. Agriculture is the main contributor to GHG emissions in Bangladesh, accounting for more than 30% of total emissions. It illustrates the substantial ecological impacts of farming procedures in Bangladesh, a primary aspect to consider in our paper, which focuses on exploring the accomplishments of agricultural value added, industrial value added, and imports to the release of CO_2. Bangladesh is currently one of the top importers in the world. The primary crops brought into the country are staples such as rice and wheat, edible oil, soybeans, raw cotton, dairy goods and milk, spices, sugar, and coconut oil. Cotton, sugar, and gasoline were among the top ten trade items of the country in 2021. Furthermore, this list encompasses various critical commercial assets, including refuse, scrap metal, coal substances, crude oil, medium-grade oils, and fossil fuels. These import patterns may both positively and negatively affect Bangladesh's carbon footprint [9]. Figure 1 shows a decreasing trend in farming output, contrasting with an increasing trend in corporate value-added and a more volatile pattern in imports over time. Different patterns underscore the need for a comprehensive examination of how different industries affect CO_2 emissions, highlighting the requirement for specific measures to mitigate environmental effects while fostering revenue generation.

However, lowering the release of CO_2 is essential for the country's equitable growth. No deep investigation assesses the cumulative impact of manufacturing and cropping industries on CO_2 output in Bangladesh despite several researchers analyzing these sectors individually. This study seeks to comprehensively examine the synergistic effects of industry and agriculture on CO_2 pollution in Bangladesh to address this significant knowledge deficit. The study also examined how imports impact CO_2 emissions by influencing industrialization and reducing crop productivity in Bangladesh. Therefore, our study incorporates an analysis of shipments to enhance our understanding of their function. The investigation seeks to elucidate the roles of agriculture, industrialization, and imports in CO_2 emissions with the objective of informing policy actions that might successfully reduce environmental consequences while fostering prosperity and long-term viability in Bangladesh.

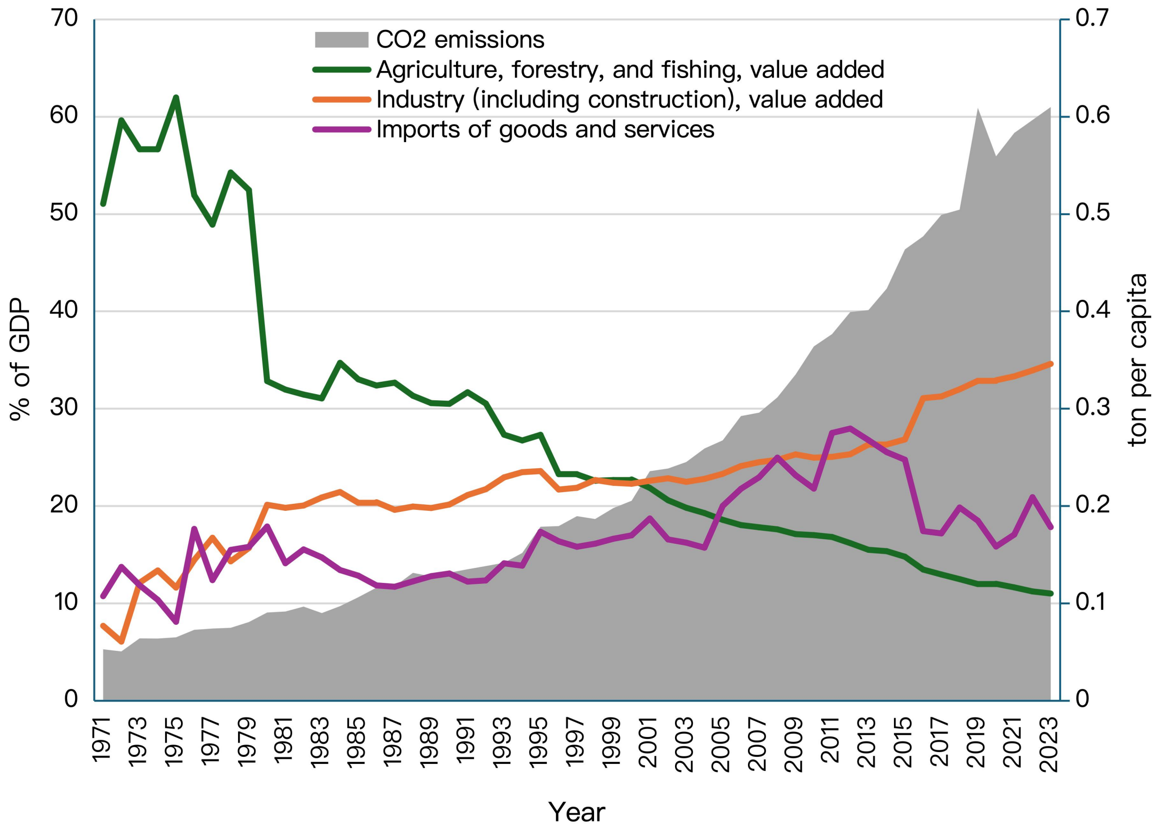

Figure 1. Annual trends of agriculture, industry, imports, and CO_2 emissions in Bangladesh [10,11].

Literature review

The research evaluates the long-term effects of Bangladesh's farming and industrial activities on CO_2 releases. A significant volume of study has been undertaken on the topic of relevance. Furthermore, researchers have conducted additional studies in Bangladesh. Certain studies employ time series data for an individual country, while others use panel data to analyze a collection of states. A unifying aspect across all research is the use of annual data derived from the World Bank database. Researchers have established a universal correlation between agricultural productivity and CO_2 emissions. Khan et al. [13] employed the FMOLS methodology to investigate the impacts of farming on CO_2 emissions in both industrialized and emerging countries. Their data reveal an inverted U-shaped connection between CO_2 emissions and agribusiness.

Doğan [14] examined the long-term relationship between China's agricultural production and the release of CO_2 by adopting the ARDL, FMOLS, CCR, and DOLS methodologies. He illustrates that China's farming industry is a crucial factor in CO_2 emissions. Adebayo et al. [15] employed DOLS, FMOLS, and ARDL to examine the correlation between CO_2 pollution and Indonesian farming practices. The investigation demonstrated a statistically significant and favorable long-term relationship between crop value-added and CO_2 pollution. Phiri et al. [16] assert that there is an encouraging association between agriculture and CO_2 emissions in the near future. Jebli and Youssef [17] posit that the release of CO_2 in Brazil will decline as the value provided by agriculture increases. Moreover, agricultural activity in Saudi Arabia mitigates CO_2 emissions, as stated by Mahmood et al. [18]. Additionally, in Saudi Arabia, Samargandi [19] corroborates the concept that an increase in the agricultural sector may lead to a reduction in CO_2 emissions.

Ullah et al. [20] use ARDL and NARDL to assess that a portion of agricultural value added to GDP negatively affects CO_2 output in Pakistan. Waheed et al. [21] published a report indicating that farming in Pakistan significantly contributes to CO_2 emissions. Raihan [22] employed various models, including ARDL, VECM, FMOLS, DOLS, and CCR, to assess the influence of Vietnam's agriculture industry on emissions of CO_2. He discovered that a spike in agricultural value added leads to a reduction in CO_2 emissions. Ceesay and Fanneh [23] conducted an inquiry in Bangladesh incorporating the ARDL technique to investigate the impact of the agriculture industry on CO_2 pollution. The farming sector of Bangladesh has an advantageous effect on CO_2 emissions. Ghosh et al. [24] utilized the ARDL and ECM to confirm the findings of Ceesay and Fanneh [23], suggesting that Bangladesh's cropping industry contributes to CO_2 emissions. The findings of the Granger causality test indicate that value added to GDP from farming does not cause CO_2 emissions; nevertheless, CO_2 releases Granger-cause crop production.
Chowdhury et al. [25] examined the link between land use and CO_2 emissions using FMOLS, DOLS, and CCR methodologies. The crop production of Bangladesh has a major positive influence on CO_2 emissions. The outcome of the Granger causality analysis corroborates the findings of Ghosh et al. [24]. Shahbaz et al. [26] assessed the EKC for the impact of industrialization on CO_2 releases in Bangladesh with the ARDL method. The results of the study reveal an EKC linking industrialization with CO_2 emissions. The production sector of Bangladesh exerts a long-term influence on CO_2 pollution. Raihan et al. [6] indicate a beneficial connection between modernization and CO_2 emissions in Bangladesh. Itoo and Ali [27] employed the CCR, FMOLS, ARDL, and DOLS techniques to examine the correlation between industry value addition and the release of CO_2 in India. Each model shows that the correlation between the manufacturing sector and CO_2 emissions is adverse, albeit statistically insignificant.
Khan et al. [28] assert that industrialization does not produce significant effects in either the short- or long-term, as demonstrated by the ARDL model. Raihan et al. [29] warned that ecological damage in could worsen due to rapid economic growth in the future. Patel and Mehta [30] analyzed the effects of industrial growth on CO_2 pollution in India using the NARDL methodology. Researchers have found that industrial development has a short-term detrimental influence on CO_2 outputs, but it also has a long-term beneficial effect. The escalation of economic value diminishes the ecological condition in Europe and Central Asia by elevating CO_2 pollution [31]. Rehman et al. [32] examined data from 1971 to 2019 to investigate the connection between manufacturing production and CO_2 releases in Pakistan. Employing new approaches, like ARDL, DOLS, and FMOLS, they identified that CO_2 emissions adversely affect financial performance in Pakistan.
Ferdousi and Qamruzzaman [33] employed VAR and Granger causality assessments to analyze the influence of imports on CO_2 releases in Bangladesh. They established no causal link between imports and CO_2 emissions. The results of the constrained VAR analysis demonstrate a long-term relationship between carbon emissions and imports. Al-Mulali and Sheau-Ting [34] investigated the correlation among commerce, imports, exports, and CO_2 emissions across six regions. The majority of countries' imports contribute positively to CO_2 emissions, while some countries exert a negative influence. Researchers observed that CO_2 emissions only happen when commerce exceeds 40% of total GDP. Al-Mulali and Ozturk [35] demonstrated a significant and positive correlation between trade transparency and CO_2 releases in fourteen MENA nations. According to Bouznit and Pablo-Romero [36], imports have a significant and long-term positive impact on CO_2 emissions in Algeria. A spatial analysis by Mahmood et al. [37] in North Africa reveals that imports positively influence CO_2 emissions.
This study presents a novel viewpoint on the current knowledge regarding emissions of CO_2 in Bangladesh. We employed the DOLS framework to investigate the impact of agriculture, manufacturing, and imports on the carbon footprint. Multiple investigations in Bangladesh looked at the distinct effects of agriculture, industry, and imports on CO_2 emissions. However, a considerable gap persists in comprehending the interplay of these components. Our research aims to address this deficiency by examining the cumulative impact of farming, manufacturing industry, and commerce on CO_2 emissions. This research tries to elucidate the intricate relationships among these factors by concentrating specifically on Bangladesh. This unique emphasis is to enhance the comprehension of the determinants of CO_2 releases in the nation, thereby aiding in the formulation of appropriate policy measures for long-term prosperity.

Methodology

Data and model

That study in Bangladesh employed an extensive annual time series dataset from 1971 to 2023 to evaluate the impact of various indicators on CO_2 emissions. CO_2 emissions in tons per capita, the value added from industry and agriculture and import percentages to GDP are the parameters incorporated for this analysis. The statistics on CO_2 emissions were obtained from Our World in Data (OWD) [10] whereas the information on agriculture, industry, and imports were adopted from the World Development Indicators (WDI) [11].
Bangladesh's swift economic advancement, predominantly propelled by the agricultural and industrial sectors, has presented advantages and also obstacles. Although these sectors substantially enhance GDP growth, they concurrently escalate CO_2 emissions, causing air pollution and ecological damage. This study seeks to thoroughly examine the correlation between agricultural and industrial revenue generation, imports, and CO_2 releases in Bangladesh, offering a detailed overview of the impact of those aspects on the planet. We commence by delineating a comprehensive model to encapsulate the overarching correlation between CO_2 emissions and the value added by agriculture, industry, and imports to GDP. Equation (1) articulates the empirical framework as follows:

$$CE_t = \tau_0 + \tau_1 AVA_t + \tau_2 IVA_t + \tau_3 IMP_t + \varepsilon_t \quad (1)$$

Where CE_t denotes CO_2 emission in metric tons per capita at time t, AVA_t, IVA_t, and IMP_t indicate the values added to GDP by agriculture, industry, and imports at time t, and εt is the error term encapsulating unaccounted fluctuations.

Econometric methods

Employing a unit root examination is essential for avoiding flawed regression analysis. This method isolates the parameters in a regression to assure their stationarity, utilizing only stationary procedures to calculate the formula of concern. To fully comprehend cointegration across factors, empirical research emphasizes the necessity of first articulating the order of integration. Studies show that because unit root tests work differently depending on the size of the sample, it is important to use more than one when looking at the integration sequence of the series [38]. The Augmented Dickey-Fuller (ADF) [39], the Dickey-Fuller generalized least squares (DF-GLS) [40], and the Phillips-Perron (P-P) [41] tests were applied to detect the autoregressive unit root. Unit root assessments have been carried out to make sure that no variables deviated from the amalgamation pattern and to support the DOLS system above traditional cointegration frameworks.
The DOLS technique [42] was employed to assess the time series statistics. The DOLS cointegration process combines descriptive parameters and the leads and lags of the initial variance phase into the error covariance matrix, which then aligns endogeneity with the standard deviation calculations. The incorporation of the initial and final terms from the various parts demonstrates the orthogonalization of the error term. The DOLS estimator's standard deviations have a normal asymptotic distribution, making it an accurate proxy for testing statistical validity. Moreover, it can accurately approximate the endogenous factor on exemplary elements at different levels, leads, and lags when there is a mixed integration order. This makes it easier to include certain factors in the cointegrated framework. Several additional factors in the regression were I(1) factors, representing the leads (p) and lags (-p) of the initial variance, while other variables remained I(0) parameters with a constant term. This inquiry ignores issues of small-sample bias, endogeneity, and autocorrelation by aggregating both leads and lags across representative variables [43]. Subsequently, the researcher deployed Equation (3) to calculate the long-run coefficient utilizing the DOLS procedure.

$$\Delta CE_t = \tau_0 + \tau_1 CE_{t-1} + \tau_2 AVA_{t-1} + \tau_3 IVA_{t-1} + \tau_3 IMP_{t-1} + \sum_{i=1}^{q} \gamma_1 \Delta CE_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta AVA_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta IVA_{t-i} + \sum_{i=1}^{q} \gamma_4 \Delta IMP_{t-i} + \varepsilon_t \quad (2)$$

Results and discussion

Table 1 highlights the statistical description of the parameters for the time span 1971–2023. Skewness projections near 0 demonstrate that the parameters have a normal distribution. Additionally, the kurtosis data indicates that each dataset is platykurtic, with values below 3. Also, the Jarque-Bera probability evaluations suggest that each factor exhibits a normal distribution.

Table 1. Descriptive statistics.

Variables	CE	AVA	IVA	IMP
Mean	0.24	27.67	22.40	16.92
Median	0.22	23.25	22.47	16.23
Maximum	0.55	61.95	34.59	27.95
Minimum	-0.15	11.00	6.06	8.10
Std. dev.	0.16	14.29	6.22	4.66
Skewness	-0.09	0.09	-0.22	0.38
Kurtosis	2.01	2.92	2.41	2.86
Jarque-Bera	0.08	3.21	0.82	4.14
Probability	0.96	0.16	0.66	0.13
Observations	53	53	53	53

Note: CE = CO_2 emissions, AVA = agricultural value added, IVA = industrial value added, IMP = imports.

Before the preceding DOLS estimation, it is crucial to verify the stationarity of the time series data. Each element must exhibit stationarity at first difference I(1) or at level I(0) prior to the use of the DOLS paradigm. The null hypothesis for these analyses asserts that the series possesses a unit root. We conducted unit root assessments to illustrate the superiority of the DOLS approximation framework over mere cointegration, ensuring that no component exceeds the assimilation process. Table 2 showcases the outcome of unit root analysis with the ADF, DF-GLS, and P-P examinations. It demonstrates that all factors are non-stationary at I(0) but attain stationarity at I(1).

Table 2. Results of unit root test.

Variables	ADF		DF-GLS		P-P	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
CE	-0.84	-6.31***	-0.81	-5.24***	-0.84	-6.13***
AVA	-0.52	-5.73***	-0.44	-5.32***	-0.54	-5.59***
IVA	-0.47	-4.78***	-0.38	-4.20***	-0.41	-4.98***
IMP	-0.69	-5.51***	-0.62	-4.94***	-0.67	-5.64***

Note: ADF = Augmented Dickey-Fuller, DF-GLS = Dickey-Fuller generalized least squares, P-P = Phillips-Perron, CE = CO_2 emissions, AVA = agricultural value added, IVA = industrial value added, IMP = imports. ***$p<0.01$

Table 3 illustrates the long-term consequences of the DOLS structure. The findings indicate a negative over-time connection between CO_2 emissions and agricultural value added, implying a link between lower CO_2 emissions and enhanced agricultural output. The findings indicated that a 1% rise in agricultural value added would lead to a 0.51% cut in CO_2 pollution over the long run. Conversely, manufacturing growth and CO_2 emissions have a positive and strong correlation, as do over-time imports of products and services and CO_2 output. Projections indicate that CO_2 emissions will rise by 1.39% and 0.64% for each 1% rise in industrial production and imports, respectively.

Table 3. DOLS test results.

Variables	Coefficient	Standard error	t-statistic	p-value
AVA	-0.51***		-3.63	0.00
IVA	1.39***		7.51	0.00
IMP	0.64***		3.79	0.00
C	7.55		1.42	0.11
R^2	0.94			
Adjusted R^2	0.93			
F-statistic	91.05			0.00
Root mean square error (RMSE)	0.06			
Mean Absolute Error (MAE)	0.05			

Note: AVA = agricultural value added, IVA = industrial value added, IMP = imports. ***p<0.01

Moreover, the patterns of the projected coefficients are coherent from both a conceptual and a practical perspective. Additionally, multiple diagnostic methods were utilized to evaluate the adequacy of the calculated simulation. The regression model that was created fits the data well, with $R^2 = 0.94$ and modified $R^2 = 0.93$. This means that the explanatory parameters explain 93% of the variation in the predictor factors. Both the endogenous and exogenous parameters confirm the DOLS paradigm, as demonstrated by the F-value. The regression model is statistically significant, with an F-test p-value of 0.00. The RMSE and MAE were effectively utilized to determine the precision of the model's predictions. The DOLS procedure delivered outcomes that closely align with the statistics, as evidenced by the RMSE and MAE values being almost zero and non-negative.

To assess the adequacy of the DOLS model, we conducted the Breusch–Godfrey LM test for serial correlation, the Breusch–Pagan–Godfrey evaluation for heteroscedasticity, the Jarque–Bera test for the normality of residuals, and the Ramsey RESET test for model specification, outlined in Table 4. The marginal probability values for all the tests exceed 0.10. Diagnostic tests indicate a thorough distribution of residuals and the lack of problems such as serial correlation and heteroskedasticity in our estimation.

Table 4. Results of diagnostic test.

Diagnostic tests	Coefficient	p-value	Decision
Breusch-Godfrey LM test	1.29	0.38	No serial correlation
Breusch-Pagan-Godfrey test	1.17	0.32	No heteroscedasticity
Jarque-Bera test	1.84	0.26	Normal residual distribution
Ramsey RESET test	1.58	0.54	The model is properly specified

The DOLS model offers a valuable overview of the link between the monetary output and CO_2 releases. The results indicate an opposite connection between agricultural value added (AVA) and the release of CO_2. The finding aligns with previous investigations that frequently suggest farming's role in reducing CO_2 pollution. Over the past century, Bangladesh has had rapid growth in GDP, with an average yearly increase of 6% from 2000 to 2023. Furthermore, the economy predominantly relies on its manufacturing industry, and our discoveries demonstrate that Bangladesh's manufacturing industry is accountable for its long-term carbon footprint. This conclusion coincides with prior studies indicating that industrial activity favorably affects CO_2 emissions in Bangladesh and other economies. This observation contradicts several past studies [27,28,44].

Furthermore, the DOLS calculations indicate an encouraging and significant correlation between imports and CO_2 pollution. This suggests that, over time, a rise in imports correlates with a surge in CO_2 pollution. This study indicates that the imported goods and services in Bangladesh might be carbon-intensive or that the rise in imports results in higher GDP and, subsequently, elevated pollution. This outcome aligns with other research [36,37] demonstrating that imports positively influence carbon emissions.

Our study reveals several substantial strategies for Bangladesh. It highlights the detrimental effect of farm operations on CO_2 emissions, indicating that the promotion of green farming methods could further alleviate environmental problems without substantially influencing emissions. Secondly, the notable positive correlation between industrialization and CO_2 emissions underscores the pressing necessity for rigorous regulatory frameworks and technical innovations to mitigate industrial CO_2. Thirdly, governments ought to emphasize the promotion of low-carbon import practices and the cultivation of local sectors that conform to the SDGs. These insights necessitate focused policies that harmonize revenue generation with ecological responsibility, ensuring Bangladesh progresses toward a more resilient and sustainable future.

Conclusions and policy recommendations

This study article delves into the intricate relationship between CO_2 emissions in Bangladesh's agricultural and manufacturing sectors and its import patterns. We verified the stationarity of the dataset by executing the ADF, DF-GLS, and P-P unit root evaluations. The DOLS model's conclusions observe significant linkages. The outcomes indicate that agricultural output exerts a substantial, long-term inverse influence on CO_2 emissions, demonstrating agriculture's involvement in reducing CO_2 levels. Additionally, the paper demonstrates that the manufacturing industry causes more CO_2 emissions over the long run. It illustrates the positive implications of imports for the release of CO_2. Our results provide substantial knowledge of the intricate linkages between socioeconomic domains and CO_2 emissions in Bangladesh, offering in-depth knowledge crucial for enlightened policy creation and sustainable endeavors. Moreover, the country's economy is predominantly reliant on agriculture; however, this reliance has progressively diminished in the recent past. In wealthy countries, the trend of environmental damage from agricultural activities is significant, whereas in Bangladesh, it is markedly low. This investigation underscores the farming sector's potential to significantly contribute to a sustained decrease in CO_2 emissions.

Government authorities and legislators must prioritize programs to enhance the Bangladeshi farming industry, emphasizing equitable growth. Therefore, authorities ought to advocate alternative agricultural techniques, like organic cultivation, climate-smart agriculture, and solar-powered irrigation methods, which might improve the sector's ecological efficacy in the near future. Considering that the production methods significantly contribute to carbon emissions, the government ought to implement more stringent limits on emissions from factories and promote the utilization of greener technologies. Enacting carbon and green taxes can alleviate ecosystem damage while preserving manufacturing output. Moreover, the import sector's upward relationship with CO_2 emissions advocates for the advancement of sustainable operations and the trade of eco-friendly products. Moreover, funding for research, awareness campaigns, and involvement from lawmakers is essential to cultivating thorough knowledge and endorsement of these activities. The coordinated initiatives are essential for Bangladesh to meet its ambitious objectives outlined in the revised NDCs, which seek to decrease GHG emissions by 22% by 2030.

While major discoveries have been made, there are also drawbacks. The study's limitation lies in its focus on only four variables: CO_2 emissions, agriculture, industry, and imports, despite the presence of numerous other socioeconomic factors that clearly influence CO_2 pollution. Future research could expand by incorporating more variables and comparative analyses to enhance the study's applicability to other nations. These are crucial variables in developing countries and could provide a more comprehensive picture of the factors impacting CO_2 emissions. Future studies may investigate the environmental impacts of urbanization, trade, financial development, foreign direct investments, tourism, technological innovation, ICT, globalization, natural resources rents, agricultural land, and forest area. The study's findings are highly specific to Bangladesh, which may limit their applicability to other developing countries with different socioeconomic and environmental conditions. Future studies should include a comparative analysis with similar economies to improve the generalizability of its findings, making the results more valuable for broader applications across other developing countries facing similar environmental challenges. Furthermore, future research might conduct a more detailed analysis of each sector's role in CO_2 emissions. For instance, the effects of different agricultural practices or types of imported goods could provide insights into specific actions for reducing emissions. A more granular analysis could reveal sector-specific strategies that go beyond general recommendations, thereby offering more targeted policy guidance.

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