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The Nexus between Economic Growth, Energy Consumption, and Environmental Pollution in Bangladesh

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Abstract

This research investigates the intricate relationships between globalization, environmental degradation, industrial production, energy consumption, and economic growth in Bangladesh over the period from 1972 to 2019. To examine the long-term relationships among these variables, the study employs the ARDL bound test and the combined cointegration approach. These methodologies are used to predict and confirm the existence of long-run relationships between the variables in question. The empirical findings of this study reveal that globalization, industrial production, and energy consumption contribute positively to environmental degradation. This indicates that as Bangladesh becomes more integrated into the global economy, increases its industrial output, and consumes more energy, environmental degradation intensifies. Conversely, economic growth appears to have a negative effect on environmental degradation in both the long run and the short run. This suggests that as the economy grows, measures are likely being implemented that help reduce the environmental impact, such as improvements in technology and efficiency, stricter environmental regulations, or shifts towards less polluting industries. Moreover, the results indicate a unidirectional causality from environmental degradation and energy consumption to industrial production. This means that changes in environmental degradation and energy consumption directly influence industrial production levels. Specifically, environmental degradation may impact industrial production through regulatory mechanisms or resource constraints, while energy consumption is a direct input for industrial activities, dictating the scale and capacity of production. The policy implications of these findings are significant. Policymakers in Bangladesh might focus on several strategies to manage environmental pollution while sustaining industrial and economic growth. One recommendation is to prioritize the importation of advanced technologies that are more energy-efficient and less polluting. Such technologies can help decouple industrial growth from environmental degradation. Another strategic focus could be on export-led growth, encouraging industries to adopt cleaner production methods to meet international environmental standards, thereby reducing domestic environmental impacts. Additionally, investing in renewable energy sources and enhancing energy efficiency could mitigate the negative environmental impacts of energy consumption. By diversifying the energy mix and improving the efficiency of energy use in industrial processes, Bangladesh can reduce its carbon footprint and other pollutants.

Keywords: Globalization, Industrial Production, Environmental Degradation
JEL Codes: Q56, O13, O44

1. INTRODUCTION

The surge in CO2 emissions worldwide is a concerning trend that has significant implications for environmental sustainability and human well-being. Rapid industrialization and increased production levels, driven by efforts to boost GDP per capita, have contributed to this uptick in emissions. Research over the past few decades has highlighted the consistent upward trajectory of CO2 emissions across various income groups, with notable variations observed between different economic brackets. For instance, lower middle-income countries have experienced a substantial increase in CO2 emissions per capita, rising from 0.58 metric tons to 1.63 metric tons between 1972 and 2015. Similarly, low and middle-income countries have witnessed a significant surge in emissions, jumping from 1.06 metric tons to 3.65 metric tons over the same period. The middle-income group has also seen a notable rise, with CO2 emissions per capita climbing from 1.12 metric tons to 4.05 metric tons during this timeframe. Even in non-OECD high-income countries, where industrialization and development are more advanced, CO2 emissions per capita have continued to grow, albeit at a slower rate. From 1972 to 2015, emissions in this group increased from 12.45 metric tons to 13.73 metric tons. Furthermore, the upper middle-income group experienced a significant escalation in CO2 emissions per capita, soaring from 1.58 metric tons to 6.97 metric tons over the same period.

These trends underscore the urgent need for concerted efforts to address environmental pollution and mitigate the impact of CO2 emissions on climate change. Sustainable development strategies that prioritize energy efficiency, renewable energy sources, and emission reduction measures are crucial for curbing this upward trajectory in CO2 emissions while fostering economic growth and prosperity. Collaboration between governments, industries, and civil society is essential to enact and implement effective policies that promote a cleaner, healthier environment for current and future generations. The regional analysis of CO2 emissions reveals divergent trends that reflect the complex dynamics of carbon emissions on a global scale.

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While some regions, such as Central Europe, the Baltics, the Euro area, and the European Union, have shown a reduction in CO_2 emission trends, others, like Arab countries, have experienced an opposite trajectory with an increase in CO_2 emissions. These findings highlight the multifaceted nature of the global carbon emissions landscape, influenced by various factors such as economic development, industrialization, energy policies, and regional dynamics. The reduction in CO_2 emissions observed in certain regions may be attributed to efforts to adopt cleaner energy sources, implement energy efficiency measures, and enact environmental regulations aimed at reducing carbon emissions. Conversely, the increase in CO_2 emissions in Arab countries may be driven by factors such as rapid population growth, urbanization, industrial expansion, and reliance on fossil fuels for energy production. These trends underscore the importance of understanding regional variations and income disparities in addressing the challenges posed by climate change effectively. Policymakers and researchers can draw valuable insights from these regional trends to formulate tailored strategies for mitigating climate change. By acknowledging the unique circumstances and challenges faced by different regions, policymakers can design targeted interventions that promote sustainable development, reduce carbon emissions, and enhance resilience to climate change impacts. Collaboration and knowledge-sharing among countries and regions are essential for fostering global cooperation in tackling climate change and building a more sustainable future for all. The case of Bangladesh presents an intriguing context for examining the relationship between globalization, industrialization, energy consumption, and environmental degradation. As a lower middle-income country in South Asia, Bangladesh has experienced significant economic growth and industrial development over the past few decades. The remarkable increase in Bangladesh's GDP per capita, from $257 to $747 over the period of 1972-2014, reflects the country's progress in economic development. The industrial sector, contributing 17% of GDP in 2014, has been a key driver of this growth, with industrial output expanding substantially from $0.38 billion in 1972 to $45.48 billion in 2014, representing 27% of the GDP in 2014. However, this rapid industrialization and economic growth have come at a cost to the environment, as evidenced by the significant increase in CO_2 emissions. The rise in industrial production and economic activities has led to a surge in energy usage, resulting in higher levels of CO_2 emissions. Bangladesh's per capita CO_2 emissions have increased from 0.05 metric tons to 0.41 metric tons between 1972 and 2015, reflecting the environmental impact of its industrialization efforts.

The case of Bangladesh underscores the complex interplay between economic development, energy consumption, and environmental degradation in the context of globalization. While economic growth and industrialization have contributed to improvements in living standards and poverty reduction, they have also led to environmental challenges, particularly in terms of air pollution and greenhouse gas emissions. Examining the role of globalization in this context requires considering how factors such as trade liberalization, foreign direct investment, and technological advancements have influenced Bangladesh's industrialization and energy consumption patterns. Moreover, it is essential to explore policy measures and strategies that can promote sustainable development and mitigate the adverse environmental effects of economic growth. By understanding the dynamics of globalization, industrialization, and environmental degradation in Bangladesh, policymakers and stakeholders can formulate targeted interventions to promote sustainable and inclusive growth while safeguarding the environment for future generations. This may involve implementing cleaner production technologies, investing in renewable energy sources, enhancing energy efficiency measures, and strengthening environmental regulations to reduce emissions and mitigate climate change impacts. The Environmental Kuznets Curve (EKC) hypothesis has been a focal point in CO_2 emission research, particularly in understanding the relationship between economic development and environmental sustainability. In the context of Bangladesh, several studies have explored the applicability of the EKC hypothesis, investigating how CO_2 emissions evolve with rising income levels. Researchers like Miah et al. (2011), Rabbi et al. (2015), Islam et al. (2013), and Shahbaz et al. (2014) have contributed valuable insights into this complex relationship, highlighting the potential for policy interventions to mitigate carbon emissions as Bangladesh progresses economically.

Moreover, the nexus between economic growth, energy consumption, and CO_2 emissions has garnered significant attention in recent years. Researchers have delved into the intricate relationships between these variables, recognizing the impact of economic activities on energy consumption and subsequent CO_2 emissions. Additionally, studies have incorporated factors such as trade openness, industrialization, and foreign direct investment into the CO_2 emission function, recognizing the influence of globalization on environmental degradation. Bangladesh, with its significant population and growing economy, plays a notable role in global CO_2 emissions. Despite its relatively small contribution to the world's population, Bangladesh accounted for a significant portion of global CO_2 emissions in 2006, according to the World Bank (2007). This underscores the importance of understanding the implications of globalization on environmental quality, as increased trade and investment activities often lead to higher energy consumption and subsequent emissions. Globalization poses both opportunities and challenges for environmental sustainability. While increased economic integration can spur growth and development, it also raises concerns about environmental degradation, particularly in developing countries like Bangladesh. As individuals strive for higher standards of living, they may prioritize consumption over environmental concerns, leading to increased pollution levels. However, as countries progress and achieve higher living standards, there is often a shift towards prioritizing environmental quality, highlighting the importance of incorporating environmental regulations into globalization processes.

This study aims to explore the impact of overall globalization, encompassing social, economic, and political dimensions, on CO_2 emissions in Bangladesh from 1972 to 2015. Unlike previous studies that relied solely on trade openness as a measure of globalization, this research employs the KOF overall globalization index for more accurate and comprehensive results. The study makes several contributions to the existing literature: Firstly, it utilizes the KOF overall globalization index to measure globalization accurately, providing a more nuanced understanding of its impact on environmental degradation in Bangladesh. Secondly, the study examines the combined effects of globalization, industrial production, energy consumption, and economic growth on environmental degradation. By considering these factors collectively, the research offers a comprehensive analysis of the drivers of CO2 emissions. Thirdly, the study adopts the combined cointegration approach introduced by Bayer and Hanck (2013) to assess the long-run relationship between the variables under investigation. This method enhances the robustness of the analysis and allows for a thorough examination of the dynamics between globalization and CO2 emissions. Lastly, the study investigates the causal relationship between the variables using VECM Granger causality and Innovative Accounting Approach (IAA). This approach helps determine the relative strength, direction, and magnitude of causality between globalization, industrial production, energy consumption, economic growth, and CO2 emissions.By employing these methodological advancements, the study aims to provide valuable insights into the complex relationship between globalization and environmental degradation in Bangladesh. The findings can inform policymakers and stakeholders in designing effective strategies to promote sustainable development and mitigate CO2 emissions in the context of globalization.

2. THE MODEL

The three channels through which globalization impacts CO2 emissions and environmental degradation—composition, scale (resource allocation), and technique effects—provide a comprehensive framework for understanding the complex relationship between globalization and environmental outcomes. In the composition effect, trade liberalization and globalization lead to changes in industrial structure, which can increase CO2 emissions. This occurs as countries may specialize in industries with higher pollution levels, leading to an overall increase in industrial pollution. The scale effect, on the other hand, focuses on the efficient allocation of resources facilitated by globalization. While globalization can enhance resource allocation efficiency and increase global production, it may also result in higher industrial pollution due to increased output levels. Lastly, the technique effect involves the transfer of advanced technology and machinery through trade, which can improve production processes and control CO2 emissions. By importing advanced technologies, countries can enhance their productivity while minimizing their environmental footprint.

Grossman and Krueger (1991) suggested that trade openness, often associated with globalization, primarily influences environmental degradation through scale effects. This highlights the importance of considering the overall impact of globalization on resource allocation, industrial structure, and technology transfer in assessing its environmental consequences. By understanding these channels, policymakers and stakeholders can develop targeted strategies to harness the benefits of globalization while mitigating its negative environmental impacts. This holistic approach is essential for promoting sustainable development in an era of increasing globalization. Beyond the three primary channels of composition, scale, and technique effects, globalization amplifies CO2 emissions through additional pathways such as transportation and deforestation. The expansion of transportation networks, particularly road transportation, driven by globalization has led to a notable increase in CO2 emissions. While this growth is evident both domestically and internationally, the rise in emissions within national borders is particularly significant.

Deforestation, while an indirect source of CO2 emissions, is another critical contributor exacerbated by globalization. The process of clearing forests, often for agricultural or industrial purposes, not only reduces the capacity of trees to absorb CO2 but also releases stored carbon into the atmosphere when trees are burned or decompose. This loss of carbon sinks intensifies the volume of CO2 emissions, further exacerbating climate change. Additionally, globalization fosters foreign direct investment (FDI), which fuels economic activities and expands financial markets. While FDI can stimulate economic growth and development, it may also lead to increased energy consumption and CO2 emissions, particularly in sectors like manufacturing and energy production. By recognizing these secondary sources of CO2 emissions exacerbated by globalization, policymakers can better address the environmental challenges posed by economic globalization. Implementing measures to promote sustainable transportation, curb deforestation, and encourage green investment practices are essential steps toward mitigating the environmental impacts of globalization while fostering inclusive and sustainable development.

Since our prime interest is to examine the impact of globalization on environment degradation by incorporating economic growth, industrial production, and energy consumption. We utilized annual data of Bangladesh over the period of 1972-2015. The functional form of environmental quality function is following:

$$ED_t = f\,(Glob_t, IP_t, EC_t, Y_t)$$

Now we have converted all series into the natural log to get elasticity. The log linear form of environmental degradation function is following:

$$\ln ED_t = \beta_0 + \beta_{Globt}\ln Glob_t, + \beta_{IPt}\ln IP_t + \beta_{ECt}\ln EC_t, + \beta_{Yt}\ln Y_t + \mu_t$$

The econometric framework employed in this study encompasses several key variables and techniques to analyze the relationship between environmental degradation, globalization, industrial production, energy consumption, and economic growth. Environmental degradation, proxied by CO2 emissions per unit of GDP, is represented by the natural logarithm of CO2 emissions measured in kilograms per 2005 US dollars of GDP. Globalization is captured by the natural logarithm of the KOF index of globalization developed by Dreher (2006). Industrial production is proxied by the natural logarithm of industrial value added measured in constant 2005 US dollars, while energy consumption per capita is represented by the natural logarithm of energy consumption. Economic growth is captured by the natural logarithm of real GDP per capita. The error

term, denoted as µt, is assumed to follow a normal distribution with zero mean and constant variance, reflecting the stochastic nature of the model. Data for environmental degradation, industrial production, energy consumption, and economic growth are sourced from the World Bank's World Development Indicators database. The globalization index data is obtained from the KOF website, which comprises measures of social, economic, and political globalization.
To test for cointegration, various techniques from econometric literature are employed. These include methods proposed by Engle and Granger (1987), Phillips and Ouliaris (1990), Boswijk (1994), and Banerjee et al. (1998), as well as F-test and T-test. These techniques are applied to ensure that all series exhibit the same order of integration, either I(0) or I(1). The ARDL bound testing approach developed by Pesaran and Shin (1998) and Pesaran, Shin, and Smith (2001) is particularly flexible regarding the unit root properties of variables. Additionally, the cointegration method proposed by Johansen (1991) is utilized to further analyze the long-run relationship between the variables. The ARDL bound testing approach is suitable for various conditions, including when the variables are integrated of order zero (I(0)), integrated of order one (I(1)), or a combination of both (I(0)/I(1)). However, it's important to ensure that none of the series are integrated at the second difference (I(2)) because the ARDL approach is not applicable in that case. Additionally, the ARDL approach is well-suited for small sample sizes, making it a valuable tool in empirical research, especially when dealing with limited data availability. Its flexibility and robustness make it a popular choice for testing cointegration and estimating long-run relationships in econometric analysis.

3. RESULTS AND DISCUSSION

Table 1: Descriptive Statistics

Variables	ln ED_t	ln $Glob_t$	ln IP_t	ln EC_t	ln Y_t
Mean	-0.8417	3.1850	22.777	4.4884	5.9529
Median	-0.7552	3.1622	22.723	4.8257	5.8534
Maximum	-0.4310	3.7708	24.310	5.4847	6.6599
Minimum	-1.5992	2.5712	21.010	4.4648	5.5491
Std. Dev.	0.3159	0.4117	0.8613	0.2813	0.3209
Skewness	-0.6497	0.0080	0.0675	0.5718	0.7425
Kurtosis	2.2048	1.5031	1.9871	2.2615	2.3625
Jarque-Bera	4.2549	4.1082	1.9141	3.3982	4.7880
Prob.	0.1191	0.1282	0.3840	0.1828	0.0912

Table 2: Unit root Analysis

Variables	ADF Unit Root Test.			Phillips-Perron Unit Root Test.		
	T-statistics "Intercept and Trend	Prob. Value	Decision	T-statistics "Intercept and Trend	Prob. Value	Decision
ln ED_t	-0.9412	0.9413	Not stationary	-2.6950	0.2437	Not stationary
ln $Glob_t$	-2.2784	0.4361	Not stationary	-2.2681	0.4415	Not stationary
ln IP_t	0.3172	0.9981	Not stationary	-1.2276	0.6539	Not stationary
ln EC_t	0.2743	0.9978	Not stationary	0.3154	0.9981	Not stationary
ln Y_t	0.4631	0.9989	Not stationary	1.2457	0.9999	Not stationary
dln ED_t	-11.613*	0.0000	Stationary	-26.026*	0.0000	Stationary
dln $Glob_t$	-7.6111*	0.0000	Stationary	-7.6111*	0.0000	Stationary
dln IP_t	-5.1399*	0.0008	Stationary	-14.378*	0.0000	Stationary
dln EC_t	-9.2629*	0.0000	Stationary	-10.8428*	0.0000	Stationary
dln Y_t	-9.6283*	0.0000	Stationary	-9.7956*	0.0000	Stationary

Note: * shows the significance at 1 percent level of significance.

Using unit root tests like the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests is a common practice in econometric analysis to determine the order of integration of time series data. In this study, we employed both ADF and PP unit root tests to ensure robustness in our analysis. These tests are particularly suitable for our short sample period and have been shown to have good predictive power. The results of the ADF and PP unit root tests, as presented in Table 3, indicate that none of the variables are stationary at the level, suggesting they are integrated of order one (I(1)). However, after taking the first difference, the variables become stationary. This confirms the I(1) integration property of the data series. Following the determination of the order of integration, we proceed to estimate the optimal lag length for the Vector Autoregression (VAR) model. To select the optimal lag length, we employ the Akaike Information Criterion (AIC), which has been shown to provide efficient and consistent results, especially for small sample sizes. Other criteria such as the Final Prediction Error (FPE), Schwarz Information Criterion (SBC), and Hannan Quinn Information Criterion (HQ) were also considered, but AIC emerged as the preferred choice. The results of the AIC criterion indicate that the optimal lag length for our yearly data spanning from 1972 to 2015 for Bangladesh is 2. This lag length selection process ensures that our VAR model captures the dynamic relationships between the variables effectively while minimizing the risk of overfitting or underfitting the data.

The unit root tests conducted on the time series data confirm integration at the first difference, indicating I(1) integration for all variables. Given this unique order of integration, we proceed to employ the Autoregressive Distributed Lag (ARDL) bound testing approach proposed by Pesaran, Shin, and Smith (2001) to investigate cointegration among the variables. However, due to the small dataset, the critical values provided by Pesaran, Shin, and Smith (2001) may not be suitable. Therefore, we use critical values obtained from Narayan (2005) for more appropriate inference. The results of the ARDL bound testing approach, as reported in Table 5, indicate that the calculated F-statistics exceed the upper critical value at the 1 percent level of significance when considering environmental degradation, industrial production, energy consumption, and economic growth as the predictor variables. However, this is not the case for globalization. This finding suggests the existence of four cointegration vectors, confirming a long-run relationship between the underlying variables over the period of 1972-2015 in Bangladesh. Furthermore, sensitivity analyses, including the LM test for serial correlation, examination of the normality of residual terms, and investigation of white heteroscedasticity, reveal no evidence of serial correlation, autoregressive conditional heteroscedasticity, or white heteroscedasticity in the ARDL model of environmental degradation, industrial production, economic growth, and energy consumption. This enhances the robustness of our findings and provides confidence in the validity of the estimated model.

Table 3: ARDL Approach to Cointegration

Bound testing to cointegration			Diagnostic tests			
Estimated Models	Optimal lag length	F-statistics	χ^2_{Normal}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}
ln ED_t	(3, 1, 1, 4, 4)	11.160*	0.5624	[1]: 0.3130	[1]: 0.8063	[5]: 0.1797
ln $Glob_t$	(1, 0, 0, 0, 2)	1.1509	0.0111	[1]: 0.9473	[1]: 0.1201	[1]: 0.4540
ln IP_t	(3, 4, 0, 0, 0)	7.1499*	0.9148	[2]: 0.1572	[1]: 0.9613	[1]: 0.5416
ln EC_t	(1, 3, 0, 0, 2)	6.7872*	0.1944	[1]: 0.7434	[1]: 0.1638	[1]: 0.5510
ln Y_t	(5, 5, 5, 3, 5)	6.6517*	0.3423	[1]: 0.5712	[1]: 0.4798	[1]: 0.3963

The long-run coefficients reported in Table 3 indicate that globalization, industrial production, and energy consumption have a positive and significant impact on environmental degradation in Bangladesh. Specifically, a one percent increase in globalization is associated with a 0.3 percent increase in environmental degradation, while a similar increase in industrial production leads to a 0.52 percent increase in environmental degradation, holding other variables constant. This suggests that policies aimed at promoting trade liberalization and industrial expansion may inadvertently contribute to environmental degradation, especially in the absence of adequate environmental regulations and sustainable practices. Similarly, energy consumption exhibits a positive and significant relationship with CO2 emissions, indicating that the use of energy-intensive processes and fossil fuels contributes to environmental pollution. In response to these challenges, the Bangladesh government has initiated plans focused on fuel switching, renewable energy adoption, and the introduction of energy-efficient technologies to mitigate environmental degradation and promote sustainable development. Interestingly, economic growth shows a negative and significant impact on environmental degradation, suggesting that as the economy grows, there may be improvements in environmental quality due to increased investment in cleaner technologies and environmental management practices. This finding underscores the importance of considering the broader socioeconomic context when analyzing environmental dynamics.

All variables in the model are significant at the 1 percent level of significance, indicating the robustness of the estimated relationships. The high R-squared value of 0.977 indicates that 97 percent of the variation in environmental degradation is explained by the independent variables in the model, highlighting the model's explanatory power. Diagnostic tests conducted on the long-run analysis, including tests for serial correlation, white heteroscedasticity, and normal distribution of residuals, indicate that the model is well-specified and does not suffer from major statistical issues. Additionally, stability tests, such as the cumulative sum and cumulative sum of square tests confirm the stability of the long-run parameters over the sample period. These findings provide valuable insights for policymakers and stakeholders aiming to address environmental challenges while promoting sustainable economic growth in Bangladesh.

Table 4 presents comprehensive results from the long-run analysis of the dependent variable ln EDt, including coefficients, standard errors, and diagnostic tests to assess the model's validity and reliability. Beginning with the coefficients, each explanatory variable's impact on ln EDt is evaluated. Notably, ln Globt, ln IPt, ln ECt, and ln Yt exhibit significant coefficients, indicating their influence on ln EDt. Particularly, ln IPt and ln Yt display substantial coefficients, suggesting a robust impact on ln EDt. The overall model fit is evaluated through the R-squared value, demonstrating the model's ability to explain the variation in ln EDt. With an R-squared of 0.9777, the model shows a high degree of explanatory power, implying that the selected independent variables collectively contribute significantly to explaining the variation in ln EDt. Assessment of

autocorrelation in the model's residuals is conducted using the Durbin-Watson statistic, yielding a value of 1.5768, indicating no significant autocorrelation present. This result suggests that the residuals are independent of each other, meeting one of the model's assumptions. Additionally, the F-statistic tests the overall significance of the model, with a large F-value of 428.31 and a low probability value of 0.0000, indicating that the model is statistically significant.
Diagnostic tests further evaluate the model's validity. The Breusch-Godfrey LM test, ARCH test, White Heteroskedasticity test, Ramsey RESET test, and J-B Normality test collectively assess various aspects of the model's performance, such as residual autocorrelation, heteroskedasticity, functional form misspecification, and normality of residuals. These tests provide insights into the reliability of the estimated coefficients and the model's overall goodness of fit. In conclusion, the results from Table 4 suggest that the model adequately explains the behavior of ln EDt, with significant explanatory variables and no significant issues detected through diagnostic tests. This indicates that the model provides a reliable framework for understanding the long-run dynamics of the dependent variable.

Table 4: Long Run Analysis

Dependent variable: ln ED_t

Variables	Coefficient	Std. error	T-statistics
ln $Glob_t$	0.3010*	0.0974	3.0899
ln IP_t	0.5213*	0.0687	7.5814
ln EC_t	1.0626*	0.3434	3.0941
ln Y_t	-1.8300*	0.2327	-7.8645
R-squared	0.9777		
Durbin-Watson	1.5768		
F-statistics	428.31		
Prob.	0.0000		

Table 5: Short Run Analysis

Dependent variable: Δln ED_t

Variables	Coefficient	Std. error	T-statistics
ln $Glob_t$	0.3287***	0.1740	1.8891
ln IP_t	0.3896*	0.0930	4.1860
ln EC_t	1.1788*	0.2942	4.006
ln Y_t	-1.7022*	0.3381	-5.0341
ECM_{t-1}	-0.7599*	0.1605	-4.7327
R-square	0.6442		
Durbin-Watson	2.0494		
F-statistics	13.4003		
Prob.	0.0000		

Table 5 presents the results of the short-run analysis, providing insights into the immediate effects of various factors on environmental degradation (ED). The findings indicate significant relationships between globalization, industrial production, economic growth, and environmental degradation, consistent with existing literature. Globalization and industrial production exhibit positive and statistically significant impacts on environmental degradation at the 10 and 1 percent levels of significance, respectively. This suggests that an increase in globalization by 1 percent leads to a 0.3 percent rise in environmental degradation, while a 1 percent increase in industrial production results in a 0.38 percent increase in environmental degradation in the short run. Conversely, economic growth shows a negative and significant association with environmental degradation at the 1 percent level of significance in the short run. A 1 percent increase in economic growth is linked with a 1.8 percent decrease in environmental degradation, assuming all other factors remain constant. These results align with previous studies by Dogan and Turkekul (2016), Farhani and Ozturk (2015), Ahmed et al. (2015), and Farhani et al. (2014), validating the robustness and consistency of the findings. They highlight the complex interplay between economic activities and environmental outcomes, emphasizing the need for sustainable development policies that consider both economic growth and environmental conservation. The lagged value of the Error Correction Mechanism (ECM) stands at -0.75, signifying its significance at the 1 percent level. ECM(t-1) serves as an indicator of the adjustment speed from short-run disequilibrium to long-run equilibrium. With a coefficient of -0.75, it suggests that approximately 75 percent of the deviation from the equilibrium path is corrected annually. Hence, it would take approximately 1 year and 3 months to return to the equilibrium trajectory. The coefficient of determination (R-squared) is reported as 0.64, indicating that 64 percent of the variability in the dependent variable is accounted for by the independent variables included in the model. This suggests a moderate-to-high level of explanatory power. The F-statistics test, which assesses the overall significance of the model in the short run, confirms its statistical significance. This implies that the model as a whole provides valuable insights into the relationship between the variables under investigation. Furthermore, diagnostic tests conducted on the model residuals reveal no evidence of serial correlation, normality of the residual term, autoregressive conditional heteroscedasticity, or white heteroscedasticity in the short run. This implies that the model assumptions are reasonably met, enhancing the reliability of the estimated coefficients and the validity of the findings.

4. CONCLUSIONS

The study examines the CO2 emission function for Bangladesh spanning from 1972 to 2019. Our empirical analysis reveals the existence of cointegration among variables in the environmental degradation model, which includes industrial production, economic growth, energy consumption, and an overall globalization index. Notably, we utilize an overall globalization index, which combines three key dimensions of globalization: social, political, and economic. Our findings indicate that globalization exerts a positive and significant impact on environmental damages, both in the short run and the long run. This suggests that the process of globalization, characterized by increased international trade, investment, and interconnectedness, contributes to environmental degradation in Bangladesh over the examined period. These results underscore the complex relationship between globalization and environmental sustainability, highlighting the need for policy interventions to mitigate the adverse environmental effects associated with globalization. Policymakers should consider implementing measures to promote sustainable development practices, enhance environmental regulations, and encourage the adoption of clean technologies to address the challenges posed by globalization-induced environmental degradation. The study identifies globalization as a key determinant of CO2 emissions in Bangladesh. Additionally, energy consumption and industrial production are found to exert a positive and significant impact on environmental degradation in both the short and long run. Surprisingly, economic growth exhibits a negative and significant relationship with CO2 emissions in both time frames. Interestingly, while globalization does not directly cause environmental degradation in the short run, it does have a significant impact on environmental quality in the long run. This suggests that the effects of globalization on the environment may manifest gradually over time. Furthermore, the study reveals a unidirectional causality running from environmental degradation and energy consumption to industrial production. This implies that changes in environmental degradation and energy consumption levels influence industrial production in Bangladesh. These findings are consistent with the Porter's Hypothesis, which suggests that as income increases and trade openness expands, developing countries are more likely to adopt stricter environmental regulations and adopt environmentally friendly production practices. Overall, the study highlights the complex interplay between globalization, economic activity, and environmental degradation in Bangladesh, underscoring the importance of sustainable development policies to mitigate environmental impacts. Indeed, the results suggest promising avenues for policymakers to address environmental concerns while promoting economic growth and competitiveness. Importing advanced technology and input goods can facilitate the adoption of cleaner production methods, ultimately leading to a reduction in CO2 emissions. Moreover, embracing an export-led growth strategy can drive economic progress while simultaneously limiting carbon emissions. As Bangladesh's economy progresses to higher stages of development through the adoption of advanced technologies and the promotion of exports, there is a natural inclination to prioritize environmental sustainability. By aligning economic policies with environmental goals, policymakers can foster a virtuous cycle where economic growth is achieved in tandem with environmental preservation. This not only enhances competitiveness on the global stage but also ensures a sustainable and resilient future for Bangladesh.

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