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Investigating the Relationship between CO_2 Emission and Industrial Production of Bangladesh through the Unrestricted Vector Auto Regression Methods.

Ashique Mahmud [1], Ataul Gani Osmani [2]

Abstract

Industrial production units discharge large amounts of CO2 as manufacturing facilities directly use fossil fuels and more electricity than any other sector. Although the per capita emissions in the industrialized countries are typically as much as ten times the average in the developing countries, this study is aimed at analyzing the long-run association between CO2 emissions and industrial production in Bangladesh using an Unrestricted Vector Auto Regression approach. For this purpose, the study uses secondary data for the periods of 1960 to 2016 from world development indicators. The variables of interest are co2 emission and industrial production. In general CO2 data are measured in metric tons per capita and the industrial production index is used as the proxy of industrial production. Other econometric techniques, such as unit root test-ADF, Johanson Co-integration test, and OLS techniques are also applied. Firstly, a descriptive analysis finds that there has been a rapid fall in industrial output and co2 emission in 1971 which can be denoted as an adverse effect of the Independence war of Bangladesh. Despite that, industrial production and co2 emission are intended to increase at a positive slope till 2016. But the increasing rate of industrial production is significantly higher than the increasing rate of co2 emission in Bangladesh. Secondly, the Johanson Co-integration test results reveal that there is no long-run relationship between industrial production and CO2 emission in Bangladesh. But the results from Unrestricted VAR and Ordinary Least Square estimation confirm that CO2 emission one period lag has a negative and significant impact on the industrial production of Bangladesh, where the value of the coefficient is -16.01059. This means that if in the last year, co2 emission increased by 1 metric ton per capita, industrial production will be decreased by 16% in the current period. The study concludes that Bangladesh is running conscious industrial production considering energy conservation policies.

Keywords: Unrestricted Vector Auto Regression model, CO2 emission, Industrial Production, Bangladesh.

Author Affiliation: [1]Department of Economics, Varendra University, Rajshahi, Bangladesh.
[2]Department of Economics, Varendra University, Rajshahi, Bangladesh.

Corresponding Author: Ashique Mahmud.Department of Economics, Varendra University, Rajshahi, Bangladesh.

Email: mahmud.eco.vu@gmail.com

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1.Introduction

Economic growth is recognized as one of the key aspects of economic stabilization ever since the industrial revolution. According to the empirical theory of economic development, the economies are becoming more efficient and stable when they transform to an industrial and service-based economy from a traditional agrarian economy. In that case, developing economies, like Bangladesh, are a great example of economic transformation as the share of industrial production has surpassed the share of agriculture to GDP. [1] The growing demand for industrial commodities is one of the main reasons for increased industrial growth in Bangladesh. As reported by the World Bank the industrial growth rate of Bangladesh in 2019 was 12.67%. Eventually, increased industrial production tends to consume a large portion of fossil fuel to intensify its output growth. The energy demand by any industrial unit heavily depends on its technological advancement, production capacity, surrounding environmental conditions, waste management system, and many more. Therefore, increasing energy consumption is necessary for industrial expansion to meet the growing demand and support rapid urbanization.

On the other side, a growing number of industrial units in Bangladesh tends to intensify the carbon emission which is the major finding objective in this paper.

A study showed that the total CO2 emission in 2011 was estimated to be 57.07 metric tons which is 140.67% higher than that of 1991. [2] As a consequence, extreme heat in summer, excessive flooding in the rainy season, as well as the breakdown of the atmospheric sequence, have been reported in recent years which may or may not be a direct effect of increased CO2 emission in the country. Also considering co2 as a transboundary element there can be a demographic effect on increasing co2 in Bangladesh compared to industrial production that occurs in Bangladesh. Therefore, this study intended to identify the present scenario of industrial production in Bangladesh. The total volume of CO2 emission concerning industrial output growth is also analyzed. Thus, this study also intended to find out the best possible policies, whichcan be recommended for sustainable industrial growth in Bangladesh.

2.Literature Review

Concerning the capitalist revelation, the worldwide CO2 emission has gradually increased over time. No matter what extent Bangladesh took protective measures against CO2 emission, because of increasing energy consumption Bangladesh is facing the diverse effects of climate change caused by increasing CO2 in the air. According tothe total CO2 emission has increased around 140.67% in 2011 compared to 1991 in Bangladesh.[1] CO2 is one of the most important elements that cause climate change. Bangladesh is much more vulnerable because of the geographical location and the increasing amount of CO2 is adversely affecting the environment including temperature increase. The fourth assessment report of IPCC predicted that the average temperature of an Asian country like Bangladesh would be above the global average at around 3.3 degrees Celsius. [2] The temperature of Bangladesh is dramatically changing. The greenhouse gas emission has increased over time including carbon dioxide, methane, nitrous oxides, and chlorofluorocarbon because of the increasing use of fossil fuel in the industrial sector as well as in public transportation.The Bangladesh Meteorological Department (BMD) concluded that the average temperature of Bangladesh has increased by around 0.60C over the last 100 years. In addition, Dhaka the capital city of Bangladesh has had an increase of 20C during the same period. [3]

Empirical analysis based on CO2 emission in Bangladesh has shown that technological shift can be a crucial factor in emission reduction. Researchers used a long-term energy system model named MARKAL framework to analyze and evaluate how technological improvement from high fossil fuel-based energy consumption to low carbon energy sources can mitigate CO2 emission in Bangladesh. The result showed that if low carbon-containing alternatives of fossil fuel can be used in the energy sector then the CO2 emission could be reduced up to 30% compared to the base year. [4]

A study based on CO2 emission in Bangladesh stated that almost 50% of total CO2 emission in Bangladesh is generated from the combustion of fossil fuel. As fossil fuel is the major source of energy in Bangladesh, therefore, the growth rate of CO2 emission formulated from it is increasing at a rate of 6.34% y-1. But researcher find it convenient that the increasing use of natural gas as an alternative to coal will reduce CO2 emission. [5] A recent study identified the positive effects of energy consumption for increased CO2 emission in Bangladesh. Therefore, they found a direct impact on energy consumption as well as industrial growth, which is the main reason for intensified CO2 emission in the atmosphere. In addition, researchers identified a unidirectional causal relationship between energy consumption as well as between industrial growth and CO2 emission in Bangladesh. [6]

Structural change of the economy of Bangladesh showed an uprising trend of CO2 emission. While studying the relationship between Per Capita GDP and CO2 emission of Bangladesh, researchers could not find a standard U-shaped Kuznets curve. Therefore, researchers found out that the faster economic transformation of the economy from agrarian to industrialization has a direct impact on increasing CO2 emission in Bangladesh. [7] A study conducted has used an innovative accounting approach to find out the relationship between industrialization and CO2 emission in Bangladesh. [8] The study used a quarter frequency data from the period of 1975-2010 and applied the ARDL bounds testing approach to find out the co-integration in the presence of structural breaks stemming in the series. The results emphasize that electricity consumption has a direct effect on CO2 emission in Bangladesh. In addition, electricity consumption and industrialization granger causes energy pollutants.

The empirical analysis of the Augmented Dickey-Fuller test and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests found data non stationary of the variables industrial output growth, population growth, Foreign Direct Investment and CO2 emission of Bangladesh in the period of 1972–2008. In addition, this study found a net positive feedback effect amongst the variables. [9]

Energy consumption has increased in Bangladesh because of the faster growth of industrialization and energy consumption in different industrial and non-industrial sectors. The energy production of Bangladesh heavily depends on fossil fuel in Bangladesh, which is a major driving factor of CO2 emission in Bangladesh. In a study researcher identified unidirectional causality from energy consumption to CO2 in the short run but feedback causality in the long run. [10]

Empirical theory suggests that increasing economic growth and industrial expansion are necessary for economic development. The increasing economic growth rate is the widely used economic indicator through which development is measured. When one economy shows an increasing growth rate it generally indicates the transformation of the economy through which industrial production will increase and the economy will increase its contribution to the global economy. On the other hand, the increasing growth rate cannot ensure sustainable economic development. The study used time-series data of economic growth, energy consumption, environmental quality of Bangladesh and the ADF test showed data stationary with a result that indicated long-run co-integration amongst variables.[11]Growing economic activity in Bangladesh has also intensified the total amount of CO2 emission in the environment. According tO CO2 emission in Bangladesh has increased by 140% in 2011 compared to the fiscal year 1991.

In 1991, the estimated CO2 emission was 33.17 metric tons, which increased to 57.07 metric tons in 2011. [1] The increasing electricity demand in Bangladesh has boosted the initiative to construct more power generation plants. The Bangladesh government has taken initiative to construct and run 30 coal-based power plants, which will be operational within 2031. The report showed that around 115 million tons of carbon dioxide would be generated from those power plants when it will be in the operational phase. [12]

In a study conducted on industrial production, energy consumption and GDP of Bangladesh found significant relation amongst the examined variables. The study used Vector Autoregression approach to find out the relationship in the short run. The study found short run engagement amongst variables and analyzed the appropriateness of Environmental Kuznets Curve (EKC) hypothesis in their study. They emphasized on the short run relationship as they concluded low and insignificant engagement amongst variables in the long-run. [13]

The fossil fuel consumption by different segments of the economy is one of the major factors of CO2 emission in most of the developing countries. In a study conducted based on India, Pakistan and Bangladesh found significant relationship between fossil fuel consumption and CO2 EMISSION. The study used Auto Regressive Distributed Lag model to found out associations amongst examined variables. The study also found that the relationship also fulfilled the properties of environmental Kuznets curve hypothesis. [14]

The power generation industry tend to be the major consumer of fossil fuel and natural gas. Therefore, the indirect CO2 emission by the industry inclines to be much higher paralleled to other manufacturing industries in Bangladesh. According to study result, the natural gas usage is increasing by power generation industry and therefore the projected emission of CO2 can be increased in volume by the sector. Although the CO2 emission from coal powered electricity anticipated to decrease but the increased use of natural gas will be the alternative emitter of CO2 in Bangladesh.[5]

In a study dealing with energy consumption, urbanization and CO2 emission found long run association amongst variables and the Auto Regressive Distributed Lag formation estimated that the long run equilibrium would be adjusted by 77.19%. The study also found the appropriateness of environmental kuznet curve in the context of Bangladesh.[15]The electricity consumption and increased transport demand by the growing industry in Bangladesh is the major deriving force for intensified CO2 emission in the country. The use of fossil fuel by the electricity generating farms and direct fossil fuel consumption by the transportation is the indirect effect of industrialization and urbanization in Bangladesh. In a report published by UK-aid found that because of rapid industrialization the overall CO2 emission tends to be increased by 10% in the period of 2004 to 2016. [16]Energy management efficiency by different industrial sectors plays an important role in energy demand in Bangladesh. The inefficient energy use can be a major factor for overall CO2 emission in Bangladesh. Hence, inefficient use of energy will shift energy demand upward, which will cause more fossil fuel to burn to produce electricity. Study has found inefficient consumption of electricity in the textile industries of Bangladesh.[17]

Industrialization, trade openness, electricity consumption tend to be the major influencer of CO2 emission in Bangladesh. Study has found causal relationship between electricity consumption as well as electricity pollutants and industrial growth. Above all most of the available literature studied and examined electricity production and consumption is the alarming source of CO2 emission in Bangladesh(Muhammad Shahbaz, 2014). [18]

3. Methodology

The purpose of this study is to look at the link between the two variables that were utilized. To achieve the optimum findings, the data for the two variables are collected from secondary authentic sources in this article. Our two variables, CO2 emissions and industrial production in Bangladesh, are used to perform numerous statistical and economic model tests in order to critically assess the current scenario.

Besides the indicators have also been entitled to code names for hazardless use while testing in EViews software for critical analysis. The two variables which are CO2 emission and Industrial Production index have been coded as BDCO2 and BDIPI respectively.

The absence of Unit root is essential in any time series data set to effectively predict future economic events. If a time series data set doesn›t have a unit root it is generally characterized as stationary data with a variance that fluctuates over a constant long-run mean. Therefore while working with time-series data researchers always have to be aware of nonstationary data. Because one study that works with time-series data can only forecast the real scenario of future economic events if the selected data set is stationary. For that case, this study used Augmented Dickey-Fuller (ADF) tests to find data stationery.

To determine the basic and most common relational condition between the two variables, this paper primarily used the ordinary least square (OLS) method. The reason behind OLS estimation is to primarily identify the extent of the relationship between observed variables so that it can be compared with a logarithmic regression model.

3.1 Data Sources

Finding appropriate data for econometric analysis is a crucial factor for any research work. This study is intended to analyze short-run as well as long runrelations between variables, therefore, using relevant time series data set from authentic sources was a prioritized issue. The study has been conducted based on a secondary data set. The data are primarily collected from world development indicators published by the World Bank, covering the period of 1960 to 2016. Moreover, the study also uses different relevant information from published or unpublished books, journals, and government sources.

3.2 Unit Root Test

The first criteria of any time series data are to be tested whether it has a unit root or not. If the result of an ADF or PP test shows the presence of a unit root in time series data it certifies that the data is not stationary and vice versa.

Therefore testing unit root is the fundamental for any time series regression analysis.[19]Despite that, if we observe the presence of unit root in the time series data then we have to develop a more sophisticated model to identify the long-run relationship between variables. Therefore finding the presence or absence of a unit root in any time series regression is the first criterion during time series data analysis. Therefore detecting data stationary or non-stationary is the first step in any time series regression analysis. According to an empirical theory, we know that if a data set of different variables has a unit root that means there has been no short-run causal relation exists between or amongst those variables and more sophisticatedly can be categorized as non-stationary data. On the other hand, if a regressive data set shows no existence of unit root then it can be symbolized as stationary time series data. Empirical theory suggests several econometric models through which we can identify the existence of unit roots in a specific data series. The Augmented Dickey-Fuller (ADF) test has been applied through which we can test data stationary or non-stationary. Also in this study, it has been evaluated how lagged difference terms can be included in the equation of unit root test. In this study, we intended to estimate the unit root where level and intercept have been incorporated. In addition, the test has been done followed by the lag length of 7 in the ADF test that follows the typical Schwarz Information Criterion. Here the ADF test controls the higher-order correlation of dependent variable BDCO2 in the right-hand side of the regression equation. The generalized form of the ADF equation in terms of BDCO2 can be structured as follows.

D (BDCO2t) = μ + αBDCO2 t-1 + β1DCO2t-1 +β2DCO2t-2 + ………..+ βpDCO2t-p + €t

Also the generalize ADF equation for BDIP can be structured as

D (BDIPt) = μ + αBDIP t-1 + β1DBDIPt-1 +β2DBDIPt-2 + ………..+ βpDBDIPt-p + €t

In the above equation, μ is the constant where β represents the coefficient on the time trend in the model along with p representing the lag order of the autoregressive procedure. Here in the model assuming μ = 0 and while assumption of β = 0 indicates a random walk with a drift.

3.3Johanson Co-integration Test

This research also studied the Johnson Co-integration test to see whether an integral relation exists between examined two-time series variables. In general, co-integration tests indicate the number of integral relationships amongst or between variables and in this study, two time series variables have been examined in the analysis.

3.4 Unrestricted Vector Auto Regression Model

The first criteria of any time series data are to be tested whether it has a unit root or not. If the result of the ADF test shows the presence of a unit root in time series data, it certifies that the data is not stationary and vice versa. Therefore testing unit root is the fundamental for any time series regression analysis.

Despite that, if we observe the presence of unit root in the time series data then we have to develop a more sophisticated model to identify the long-run relationship between variables. If the result of the co-integration test shows that there is a long-run relationship among the variables, it is straightforward to develop a Vector Error Correction Model (unrestricted VAR) which has strong empirical properties to critically analyze the long-run relationship between or amongst nonstationary time series variables. However, in the case of variables that have no long-run association, we cannot apply the Vector Error Correction Model (VECM) rather we can use the Unrestricted Vector Auto Regression model (UVAR). Nevertheless, at first, it is essential to make the data series stationary by differencing at one-year lag. In constructing Unrestricted VAR models, we can form the following equations, supposedly by assuming optimum lag 4. We have also considered differencing by one period to make data stationary.

D(BDCO2) = C(1)*D(BDCO2(-1)) + C(2)*D(BDCO2(-2)) + C(3)*D(BDCO2(-3)) + C(4)*D(BDCO2(-4)) + C(5)*D(BDIP(-1)) + C(6)*D(BDIP(-2)) + C(7)*D(BDIP(-3)) + C(8)*D(BDIP(-4)) + C(9)

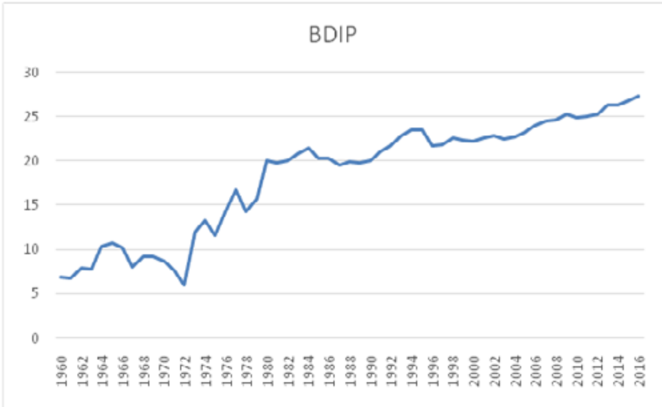
D(BDIP) = C(10)*D(BDCO2(-1)) + C(11)*D(BDCO2(-2)) + C(12)*D(BDCO2(-3)) + C(13)*D(BDCO2(-4)) + C(14)*D(BDIP(-1)) + C(15)*D(BDIP(-2)) + C(16)*D(BDIP(-3)) + C(17)*D(BDIP(-4)) + C(18)

After constructing the above system equation, we can estimate this model by the Ordinary Least Squares (OLS) technique.

4. Results and Discussion

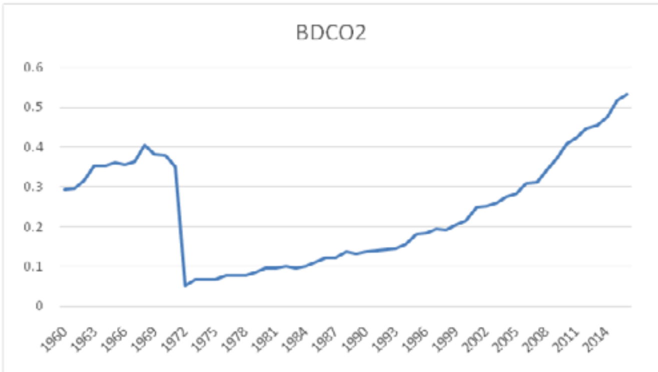
4.1 Trends of Industrial Production

In the first stage of analysis, this research plotted the data value of Industrial production from the period of 1960- 2016. The generalized graph plotted the value of BDIP in the vertical axis and year in the horizontal axis. The following graphical figure indicates upward sloping trends of examined time series variable BDIP. In the preliminary stage of industrial production, the total yearly output was only 6% to 7%, which increased over time with little fluctuation. There has been a rapid fall in industrial output in 1971, whichcan be denoted as an adverse effect of the Independence war of Bangladesh. Despite that, the output production is intended to increase at a positive slope till 2016.



(a)

Figure 1 trends of Industrial Production



(b)

Figure 2. Trends of CO2 Emission

4.3 Unit Root Test

This research has used advanced features of the Augmented Dickey-Fuller (ADF) test to specify lagged difference terms. Therefore, the test of ADF includes level and intercept that employs an automatic lag length of seven. The Akaike information criterion has been used as a standard measurement tool. In addition, the ADF approach controls the higher-order correlation by adding lagged difference terms of the dependent time series variable of Y to the right-hand side of the regression.

4.3.1 Unit Root Test for CO2 Emission at Level

The tested probability value of BDCO2 at level is 0.9264, which is not fulfilling the criteria of being a stationary variable.

4.3.3 Unit Root Test for C02 Emission at First Difference

After testing probability values at the level this study moves toward testing at the first difference to see whether the probability value of BDCO2 is appropriate to standard or not. In the ADF test at the first difference, the estimation reached to standard and can be identified as the BDCO2 variable as stationary at first difference.

4.3.4 Unit Root Test for Industrial Production at Level

The ADF test for BDIP at level could not identify a unit root at level for BDIP.

4.3.6 Unit Root Test for Industrial Production at First Difference

At first difference the ADF test result for BDIP fulfilled the criteria therefore BDIP can be denoted as stationary at first difference.

4.4 Optimum Lag

The optimum lag is 4which has been selected by the information from the entire criterion. We will use this optimum lag in Johanson Co-integration test and in Unrestricted VAR model.

4.5 Johanson Co-Integration Test

As the unit root test suggests that the interesting variables are integrated of the same order 1, that is, the variables are non-stationary at level but stationary after the first difference. This leads to the test of Johanson Co-integration test. Here, the Johanson Co-integration test indicates no co-integrating equation at trace statistics and max-Eigen statistics when the level of significance is 5%. That is, there is no long-run association between industrial production and CO2 emission in Bangladesh.
4.7 Results of Unrestricted Vector Auto Regression Estimation
The results from the Johanson Co-integration test indicate unrestricted VAR estimation as there is no long-run relationship between the interested variables. The results of unrestricted VAR estimation are as follows.

4.8 Ordinary Least Square Estimation

Industrial production of Bangladesh (BDIP) is dependent variable. This indicates that CO2 emission one period lag has a negative and significant impact on the industrial production of Bangladesh, where the value of the coefficient is -16.01059. This means that if in the last year, CO2 emission increased by 1 metric ton, the industrial production will be decreased by 16% in the current period. This result can be tested by the OLS method as well. The results of OLS estimation are as follows.

5. Major Findings

This research primarily studies all the aspects of carbon emission in the industrial sector of Bangladesh. Thus empirical and descriptive analysis of trends and approach of emission in Bangladesh has been critically evaluated based on econometric modeling. The study has been conducted based on the conclusion that there are several studies on carbon emission problems in Bangladesh but rarely a handful of literature is available if thinking about the cause and effect of CO2 emission and industrial production. The secondary data of CO2 emission and industrial production in Bangladesh range from 1960 to 2016 then has been critically analyzed. The trend of CO2 emission and industrial production in Bangladesh indicates increasing characteristics, which are normal in consideration of economic development. In addition, while running several statistical as well as econometrical tests this study found that there has been no long-run relationship between carbon emission and industrial production in Bangladesh. The empirical result indicates that the CO2 emission of one period lag has a negative and significant impact on the industrial production of Bangladesh, where the value of the coefficient is -16.01059. This means that if in the last year, co2 emission increased by 1 metric ton, the industrial production will be decreased by 16% in the current period. Thus, it can be stated that the industrial production of Bangladesh can still increase the growth rate without concerning CO2 emission, as there is no long-run relationship between the two examined variables.

Results of Estimations

Table 1 Augmented Dicky-Fuller Test Results

Variables	Level (Prob.)		1st difference (Prob.)		
	C	C & T	C	C & T	Conclusion
BDCO2	0.9264	0.9632	0.0000	0.0000	I(1)
BDIP	0.6295	0.6410	0.0015	0.0074	I(1)

Table 2 Optimum Lag selection

VAR Lag Order Selection Criteria
Endogenous variables: BDCO2 BDIP
Exogenous variables: C
Date: 01/27/21 Time: 01:26
Sample: 1960 2016
Included observations: 49

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-120.9829	NA	0.518906	5.019710	5.096927	5.049006
1	7.132776	240.5437	0.003274	-0.046236	0.185416	0.041653
2	14.06028	12.44124	0.002909	-0.165726	0.220360	-0.019245
3	22.69708	14.80593	0.002413	-0.354983	0.185537	-0.149910
4	31.26783	13.99306*	0.002012*	-0.541544*	0.153410*	-0.277879*
5	33.98686	4.217265	0.002135	-0.489259	0.360129	-0.167003
6	37.77277	5.562976	0.002176	-0.480521	0.523302	-0.099672
7	42.35594	6.360314	0.002156	-0.504324	0.653933	-0.064883
8	44.94266	3.378582	0.002329	-0.446639	0.866052	0.051394

*** indicates lag order selected by the criterion**
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 3 Johanson Co-integration test results

Date: 01/27/21 Time: 01:30
Sample (adjusted): 1965 2016
Included observations: 52 after adjustments
Trend assumption: Linear deterministic trend
Series: BDCO2 BDIP
Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.187155	10.79736	15.49471	0.2243
At most 1	0.000426	0.022173	3.841466	0.8815

Trace test indicates no co-integration at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Table 4 Johanson Co-integration test results

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.187155	10.77519	14.26460	0.1658
At most 1	0.000426	0.022173	3.841466	0.8815

Max-eigenvalue test indicates no co-integration at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**
Unrestricted Co-integrating Coefficients (normalized by b'*S11*b=I):

Table 5 Unrestricted Vector Auto Regression estimation

Vector Auto-regression Estimates
Date: 01/27/21 Time: 02:21
Sample (adjusted): 1965 2016
Included observations: 52 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	D(BDCO2)	D(BDIP)
D(BDCO2(-1))	0.017184	-16.01059
	(0.16310)	(3.54765)
	[0.10536]	[-4.51302]
D(BDCO2(-2))	0.127043	-2.258666
	(0.19084)	(4.15090)
	[0.66572]	[-0.54414]
D(BDCO2(-3))	0.202825	2.008083
	(0.18012)	(3.91777)
	[1.12607]	[0.51256]
D(BDCO2(-4))	-0.109684	-7.568395
	(0.18099)	(3.93670)
	[-0.60603]	[-1.92252]
D(BDIP(-1))	0.006548	0.047820
	(0.00648)	(0.14091)
	[1.01077]	[0.33938]
D(BDIP(-2))	0.004732	-0.259907
	(0.00618)	(0.13449)
	[0.76534]	[-1.93254]
D(BDIP(-3))	0.000921	0.207101
	(0.00599)	(0.13020)
	[0.15379]	[1.59069]
D(BDIP(-4))	-0.001056	0.157925
	(0.00544)	(0.11831)
	[-0.19419]	[1.33479]
C	-0.001331	0.339971
	(0.00830)	(0.18061)
	[-0.16033]	[1.88238]
R-squared	0.070513	0.551754
Adj. R-squared	-0.102415	0.468360
Sum sq. resids	0.095736	45.29417
S.E. equation	0.047185	1.026330
F-statistic	0.407761	6.616188
Log likelihood	89.94760	-70.19510
Akaike AIC	-3.113369	3.045966
Schwarz SC	-2.775654	3.383681
Mean dependent	0.003444	0.325444
S.D. dependent	0.044940	1.407596

Table 6 Ordinary Least Square estimations result

Estimation Method: Least Squares
Date: 01/27/21 Time: 02:53
Sample: 1965 2016
Included observations: 52
Total system (balanced) observations 104

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.017184	0.163102	0.105359	0.9163
C(2)	0.127043	0.190836	0.665721	0.5074
C(3)	0.202825	0.180118	1.126068	0.2633
C(4)	-0.109684	0.180988	-0.606031	0.5461
C(5)	0.006548	0.006478	1.010768	0.3150
C(6)	0.004732	0.006183	0.765340	0.4462
C(7)	0.000921	0.005986	0.153788	0.8781
C(8)	-0.001056	0.005439	-0.194191	0.8465
C(9)	-0.001331	0.008303	-0.160335	0.8730
C(1)	-16.01059	3.547649	-4.513015	0.0000
C(1)	-2.258666	4.150897	-0.544139	0.5878
C(1)	2.008083	3.917768	0.512558	0.6096
C(1)	-7.568395	3.936696	-1.922525	0.0578
C(1)	0.047820	0.140906	0.339376	0.7352
C(1)	-0.259907	0.134490	-1.932539	0.0566
C(1)	0.207101	0.130196	1.590687	0.1153
C(1)	0.157925	0.118314	1.334794	0.1855
C(1)	0.339971	0.180607	1.882382	0.0632

Determinant residual covariance 0.001323

Equation: D(BDCO2) = C(1)*D(BDCO2(-1)) + C(2)*D(BDCO2(-2)) + C(3)
*D(BDCO2(-3)) + C(4)*D(BDCO2(-4)) + C(5)*D(BDIP(-1)) + C(6)
*D(BDIP(-2)) + C(7)*D(BDIP(-3)) + C(8)*D(BDIP(-4)) + C(9)
Observations: 52

R-squared	0.070513	Mean dependent var	0.003444
Adjusted R-squared	-0.102415	S.D. dependent var	0.044940
Durbin-Watson stat	1.977509		

Equation: D(BDIP) = C(10)*D(BDCO2(-1)) + C(11)*D(BDCO2(-2)) + C(12)
*D(BDCO2(-3)) + C(13)*D(BDCO2(-4)) + C(14)*D(BDIP(-1)) + C(15)
*D(BDIP(-2)) + C(16)*D(BDIP(-3)) + C(17)*D(BDIP(-4)) + C(18)
Observations: 52

R-squared	0.551754	Mean dependent var	0.325444
Adjusted R-squared	0.468360	S.D. dependent var	1.407596
Durbin-Watson stat	1.822311		

6. Conclusion

The study report has shown a tremendous effect of CO2 emission with respect to Industrial production of Bangladesh. The adverse effect of CO2 in atmosphere cannot be overlooked in present situation of global warming where local and international continuously arguing for a minimal carbon emission. This study found a positive sign that yet carbon emission by the industrial sector is not that much concerning, as it could not find any long run relation between CO2 emission and industrial production in Bangladesh. Despite of that the production system must adopt sustainable technologies to avoid upcoming risk concerning to the carbon emission as well as other pollution risk factors that could arise in the near future. Also further study should conducted for more reliable results that would be beneficial for policy formulation. The authorized institutions and governing bodies must have to take full and effective monitoring on concerning sectors to avoid future risks on climate. Therefore, it is the high time for Bangladesh to focus on sustainable industrial production system to cut carbon emission. The authorities should also focus on the neighboring countries carbon emission to avoid transboundary effect of CO2 in Bangladesh.

7. Policy Recommendations

According to the findings and evaluation of this study, the following policies can be recommended

1. Restrictions on industrial production because of CO2 emission can be postponed for a specific period to decrease production costs for some prominent sectors.
2. The industry which are struggling with increasing production cost because of compulsory Effluents Treatment Plant (ETP) should be taken into consideration in special cases.
3. The power generation sector of Bangladesh must shift toward renewable energy sources to produce electricity as soon as possible. The expansion of hydroelectricity production capacity, Nuclear power plant can be the best alternative of fossil-fueled power plants.
4. The volume of CO2 emission from the industrial sector in Bangladesh is also affected by the neighboring countries' industrial emissions. Therefore, there should be a joint comprehensive strategic plan where all the countries will contribute to reduce or control CO2 emissions from their industrial output production.
5. Strict policies on the purchase of private vehicles such as the number of private cars for one owner.

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