

# 1 Causal Relationship between Education, Carbon Dioxide (CO<sub>2</sub>) 2 Emission and Economic Growth in Bangladesh

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5 *Received: 10 December 2013 Accepted: 31 December 2013 Published: 15 January 2014*

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## 7 **Abstract**

8 The purpose of this study is to test the relationship among education, environmental pollution  
9 and economic growth in Bangladesh. Perhaps this is the first research done using time series  
10 data for 37 years from 1974-2010. Vector Error Correction Mechanism (VECM) techniques is  
11 applied to establish the long run and short run relationships among the variables in the  
12 model. Using Johansen cointegration method, the empirical findings indicate that there exists  
13 long run cointegration among the variables. Unit root test were performed to test the  
14 statistical properties of the data used in variables. Results show strong positive relationship  
15 among environmental pollution, education expenditure and economic growth. The results of  
16 this study will help the environmental authorities to understand the effects of economic  
17 growth for degrading the environmental quality and manage the environmental pollution by  
18 creating awareness through education.

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20 **Index terms**— environment, education, VECM, GDP, Bangladesh.

## 21 **1 Introduction**

22 Global warming and climate change attracted considerable attention worldwide. The intergovernmental panel on  
23 climate change (IPCC) reported that the global temperatures increase by 1.1 to 6.4 °C and rise in the sea level  
24 of about 16.5 to 53.8 cm by 2100 ??IPCC,2007). This would have tremendous negative impact on the half of  
25 the population of the world live in coastal areas ??Lau et al., 2009). In this circumstance many countries like  
26 Bangladesh will totally submersed by sea water by 2100.

27 Bangladesh is a small developing country in South-east Asia. Its population is above 160 million and the  
28 world's most density of population is situated here. Bangladesh is also recognized worldwide as one of the most  
29 vulnerable countries to the impact of climate change. For the past few decades, Bangladesh government has  
30 been showing concern about environmental pollution. Here with the production and economic activities it emits  
31 huge amount of carbon dioxide every year especially from fossil fuels, gas fuels, liquid fuels and solid fuels. On  
32 the other hand higher economic growth causes environmental degradation threatens the sustainability of the  
33 environment because economic growth is closely related to energy consumption which is responsible for higher  
34 levels of CO<sub>2</sub> emissions. It became the general consensus that higher economic growth should not be pursued  
35 at the expense of the environment and this issue raised the question of how economic growth can be made more  
36 sustainable. Sustainable development defined by ??rundtland (1987) as development that meets the needs of the  
37 present without compromising the ability of future generations to meet their own needs. Some of international  
38 organizations around the world continuously attempt to reduce the adverse impacts of global warming. One such  
39 attempt is the Kyoto Protocol agreement, made in 1997 as an attempt to reduce the adverse impact of global  
40 warming. Among the variety of polluting substances, Carbon Dioxide (CO<sub>2</sub>) is a major one and represents 60  
41 percent of green house gas emission ??World Bank, 2007).

## 8 A) TESTING METHODS OF UNIT ROOTS

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### 42 2 II.

43 Literature Review Grossman and Krueger (1991) and ??uznets (1955) states that in the early stages of economic  
44 growth, environmental quality decreases with an increase in per capita income, but after a certain level  
45 environmental degradation starts decreasing with the increase in the level of per capita income, thus resulting in  
46 an inverted U-shaped curve (i.e. Environmental Kuznets Curve, EKC)

### 47 3 CO

48 emissions in Saudi Arabia. He analyzed that the long run income elasticity of carbon emissions is greater than the  
49 short run income elasticity of carbon emissions. This implies that income leads to greater carbon dioxide emissions  
50 in the long run. Islam, et al., (2012), found that there is a strong positive relationship between international  
51 trade and carbon ( 2 CO ) emissions from the gas fuels of various manufacturing sector of Bangladesh. Bloch,  
52 et al. ??2011) analyzed that the relationship between coal consumption and GDP in China using both a supply  
53 side and a demand side framework. The error correction mechanism (ECM) is used to examine both short  
54 run and long run Granger causality. The results shows that coal prices Granger cause coal consumption, so a  
55 reduction in pollution without restricting economic growth may be possible by withdrawing the current policy  
56 of coal subsidization by the Chinese Government and replacing it with a policy of subsidizing greener energy  
57 sources. Gunter, (2010), analyzed in context of Bangladesh that the lower GDP growth rates imply higher  
58 population growth where the long term impact of low GDP growth on 2 CO emission is actually worse. Higher  
59 GDP growth rates will increase 2 CO emission faster, but it implies that the peak of 2 CO emission reaches  
60 earlier and due to the lower population, at a lower emission level. In other words, development can be considered  
61 to contribute to lower long run 2 CO emissions. Salequzzaman and Davis (2003) found that there are unique  
62 challenges for ecologically sustainable development with a very high population density, a still high population  
63 growth rate and limited natural resources. A significant program of environmental education and development of  
64 local expertise is needed for massive changes in behaviour with respect to the environment. The formal education  
65 system provides a ready framework for reaching a large part of the existing population and can help make future  
66 generations conscious of the importance of environmental conservation. In Bangladesh, NGOs and universities  
67 with environmental education departments can play a significant role in teacher training and providing materials  
68 for formal and non-formal education.

69 Review of literature helps to know the research gap. That is why, a number of literatures have been reviewed to  
70 know the Causal Relationship between Education, 2 CO Emission and Economic Growth and identified research  
71 gap in this field. Environmental pollution education is a new phenomenon in the world and in context of  
72 Bangladesh it is also very recent idea. Most of the study relates this environmental pollution to other things  
73 rather than education. But education is vital elements that create awareness especially among those are the  
74 students, because they are the future of the country. Very few studies are found on the relevant field. Moreover  
75 it is observed that no specific work is done by using empirical model to determination the causality between  
76 education and environmental pollution on this topic in Bangladesh. So the researcher thinks, there prevail an  
77 immense research gap which is the main justification of the research.

### 78 4 III.

### 79 5 Model Specification and Variables

80 The study applied multivariate model analysis techniques to examine the relationships among environmental  
81 pollution i.e.

### 82 6 CO emission, education

83 expenditure and GDP growth in Bangladesh. The study based on the assumption that in GDP production  
84 is driven by high energy consumption that is likely to produce 2 CO emissions that causes environmental  
85 pollution and education expenditure in GDP is driven to create awareness through education among people  
86 about environmental pollution. The basic form of the relationship among the variables can be expressed as:  
87  $t t t GDP Ed Ep ? ? ? + + + = 2 1 (1)$

88 Where, = Ep Environmental pollution i.e. IV.

### 89 7 Empirical Study

90 The empirical study consists of unit root test, the cointegration test and error correction mechanism. These are  
91 discussed below.

### 92 8 a) Testing Methods of Unit Roots

93 Testing for the unit root problem the Augmented Dickey-Fuller test and Phillips-Perron test were used here.

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## 94 9 i. Augmented Dickey-Fuller (ADF) Test

95 The Augmented Dickey-Fuller (ADF) test is used to test for the existence of unit roots and determine the order  
96 of integration of the variables. The ADF test requires the equation as follows:  
97 
$$? + + + = ? ? = ? ? 1 1 2 1 (2)$$

98 Volume XIV Issue VI Version I

## 99 10 = ? ?

100 ) against the alternative  $? < 0$  then  $t y$  contains a unit root. The test we do both with and without a time trend.  
101 SIC method is used to choose the optimal lag length. It can be seen in Table 1 that presence of a unit root which  
102 indicates nonstationarity, cannot be rejected in level form. But in difference form the non stationarity problem  
103 is vanished.

104 ii. Phillips-Perron (P.P) Test Phillips-Perron (1988) test deals with serial correlation and heteroscedasticity.  
105 An important assumption of the DF test is that the error term  $t u$  is independently and identically distributed.  
106 The ADF test adjusts the DF test to take care of possible serial correlation in the error terms by adding the  
107 lagged difference terms of the regressand. Phillips and Perron use non parametric statistical methods to take care  
108 of serial correlation in the terms with adding lagged difference terms. Phillips-Perron test detects the presence  
109 of a unit root in a series. Suppose,  $t y$  is estimating as  $t t u y t y + + + = ? ? 1 * ? ? ? (3)$

110 Where, the P.P test is the  $t$  value associated with the estimated co-efficient of  $?^*$ . The series is stationary if  
111  $?^*$  is negative and significant. The test is performed for all the variables where both the original series and the  
112 difference of the series are tested for stationary.

## 113 11 b) Cointegration Testing Methods i. Concept of Cointegration

114 The concept of cointegration was introduced by Granger (1983) and the statistical analysis of cointegrated  
115 process was organized by Engle and Granger ??1987). Cointegration means that despite being individually  
116 non-stationary, a linear combination of two or more time series can be stationary (Gujarati, 2011). When a  
117 linear combination of non stationary variables is stationary, the variables are said to be cointegrated and the  
118 vector that is quite possible for a linear combination of integrated variables to be stationary. In this case the  
119 variables are said to be cointegrated. The key point of cointegration is: 1. cointegration refers to a linear  
120 combination of non stationary variables. 2. all the variables must be integrated of the same order. Suppose,  
121 considering the following cointegrated regression equation as  $? 1 \ln( ) ( 1 ? + = ? ? ? = k r i i \text{trace} T r ? ? (5)$   
122 Maximum eigenvalue Statistic:  $? 1 \ln( ) 1 , ( ) 1 \max + ? ? ? = + r T r r ? ? (6)$

123 where  $r$  is the number of cointegrating vectors under the null hypothesis and  $? i$  is the estimated value for  
124 the  $i$ th ordered eigenvalue from the matrix  $?_i$ . The trace statistics tests the null hypothesis that the number of  
125 cointegrating relations is  $r$  against of  $k$  cointegration relations, where  $k$  is the number of endogenous variables.  
126 The maximum eigenvalue test examines the null hypothesis that there are  $r$ -cointegrating vectors against an  
127 alternative of  $r+1$  cointegrating vectors. To determine the rank of matrix  $?_i$ , the test values obtained from the  
128 two test statistics are compared with the critical value from Mackinnon-Haug-Michelis (1999). For both tests, if  
129 the test statistic value is greater than the critical value, the null hypothesis of  $r$  cointegrating vectors is rejected  
130 in favor of the corresponding alternative hypothesis.

131 More specifically, Table 3 shows that at 5 percent level of significance the likelihood ratios (trace statistics)  
132 for the null hypothesis having one ( $r=1$ ) eigenvalue statistics for the null hypothesis having one cointegration  
133 (37.93834) is higher than the critical value (22.29962). Hence, according to the likelihood ratio and maximum  
134 eigenvalue statistics tests-environmental pollution (i.e.

## 136 12 2

137 CO emission), education expenditure and GDP i.e. economic growth are cointegrated. Thus, there is existence  
138 of the long run equilibrium relationship among these variables.

## 139 13 c) Error Correction Modeling (ECM)

140 Granger and Engle (1983) analyzed that if the variables are integrated of order one and cointegrated, then there  
141 exists the Error Correction Term (ECT) and these variables bears the steady state situation or in equilibrium  
142 situation.

143 Considering the following equation which exist each other relationship as:  
144 
$$t t n i t n i t t ETC x y y 1 1 1 1 1 3 1 1 2 1 ? ? ? + ? + ? + ? + = ? = ? ? ? (7)$$
  
145 
$$t t m i t m i t t ECT y x x 2 1 2 1 1 3 1 1 2 1 ? ? ? + ? + ? + ? + = ? = ? ? ? (8)$$

146 Where  $t x$  and  $t y$  denotes the variables,  $1 ? t$  ECT is the error correction term which is the lagged residual  
147 series of the cointegrating vector,  $' ?$  denotes the first difference,  $' ?$  denotes the error correction term. Here  
148 the error correction term capturing the disequilibrium situation. The negative and significant coefficient of error  
149 terms suggests that there is a short run adjustment process working behind the long run equilibrium relationship  
150 among the variables. Coefficient parameters of error correction term are the speed of adjustment for the short run

151 imbalances. In fact, in the vector error correction model all the variables are endogenously determined within the  
152 model. When the variables are cointegrated, there is a systematic and general tendency of the series to return to  
153 their equilibrium situation. This means that the dynamics of adjustment is intrinsically embodied in the theory  
154 of cointegration.

155 The error correction model states the dependence on both  $t x$  and  $t y$  of error correction term. If the error  
156 correction term is not zero, then the model is out of equilibrium. That is  $t y$  lies its equilibrium values and it  
157 starts falling in the next period to correct the equilibrium error.

158 V.

## 159 14 Empirical Results

### 160 15 a) Results of Unit Root Test

161 We first perform unit root tests on all three series in levels and first difference in order to determine the univariate  
162 properties of the data in the analysis. To investigate the stationary properties of the variables we run the regression  
163 analysis with an intercept term and with intercept term with trend for testing the presence of a unit root. The  
164 Augmented Dickey-Fuller test is used to test for the existence of unit roots and determine the order of integration  
165 of the variables. The tests are done both with and without a time trend. Results show that the variables 2 CO  
166 emission, education expenditure and GDP growth are non stationary in level form because the ADF test statistic  
167 of their level form of the variables are less than their respective critical values. This means that they all have the  
168 unit root problems and hence they suffer from instability problem in the short run.

169 Results of ADF test of the variables in level and difference form are also given in Table 1. which indicates  
170 that the non-stationarity problems vanished after the difference form of the data series, because here the ADF  
171 statistic are greater than their critical values and the null hypothesis of non stationarity are rejected. We have  
172 also applied Phillips Perron non parametric test for checking the non stationarity of the variables. In the level  
173 form, some cases there have the unit root problem in respect of environmental pollution i.e.

## 174 16 2

175 CO emissions, education expenditure and GDP growth. But in difference form both with constant and with  
176 constant and trend, the statistic value is greater than that of critical value at 1%, 5% and 10% levels of significance.  
177 So, the null hypothesis of non-stationarity is rejected, i.e., the data series are stationary at difference form.  
178 Results of Phillips Perron test is shown in Table 2. After checking unit root tests, Johansen maximum likelihood  
179 procedures are used to test for cointegration and to estimate the error correction parameters to confirm that each  
180 series is in I (1) process. Since cointegrating relationship is found among the variables, an Error Correction Model  
181 (ECM) is constructed to determine the direction of causality. The significant lagged ECT coefficient indicates  
182 that the current outcomes are affect by the past equilibrium errors.

183 If the two variables are cointegrated, there must exists an error correction mechanism. This implies that  
184 error correction model is associated with the cointegration test. The long term effects of the variables can be  
185 represented by the estimated cointegration vector. The adjusted coefficient of error correction term shows the  
186 long term effect and the estimated coefficient of lagged variables shows the short term effect. Causality test  
187 among the variables are based on Error Correction Model with first difference. Table ?? shows the Vector Error  
188 Correction Model (VECM).

## 189 17 Conclusion

190 In this study we have used carbon emission data as the environmental pollution indicator, GDP as the economic  
191 growth indicator and education expenditure in GDP as the education indicator. Time series data for 37 years from  
192 1974 to 2010 was used to analyze causal relationship between environmental pollution, education and economic  
193 growth in Bangladesh using VECM based test techniques to establish the short run and long run relationship  
194 among the variables in the model. Result shows that there have the long run linear deterministic relationships  
195 among the variables. From VECM results it is clear that carbon dioxide ( 2 CO ) emission (EM), and education  
196 expenditure (ED) are statistically significant and cointegrated and that is why they effects on each other. It  
197 can be said that more education share in GDP intensify the literacy rate and increase in literacy rate create  
198 awareness among the people that reduces emission, i.e., environmental pollution. The educational attainments  
199 lead to reduce environmental pollution and it also leads to GDP growth, i.e., sustainable development. There  
200 has the unidirectional causality between education expenditure and environmental pollution i.e. education and  
201 sustainable economic growth. These results will help the environmental authorities to understand the effect  
202 of economic growth to the environmental pollution as well as the necessity of environmental awareness through  
203 education in Bangladesh. This results postulates that Bangladesh can obtain higher economic growth with better  
204 environmental pollution management by creating awareness through education.

<sup>1</sup> <sup>2</sup>

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<sup>2</sup>CO Emission: A case study for Bangladesh until



Figure 1: =

should be effective to reduce or mitigate the environment pressures and simultaneously maintain economic development. Odhiambo, (2011), examined that the unidirectional causal flow from economic growth to  $2\text{CO}$  emissions in South Africa without a feedback. The results also show that energy consumption Granger-causes  $2\text{CO}$  emissions and economic growth. Alkhathlan, (2012), found that the positive and significant relationship between GDP and  $2\text{CO}$  emissions declines at initial level of economic growth then reaches a turning point and increases with the higher level of economic growth. Ahmed et al. (2012) claimed that there is a strong positive relationship between environmental pollution and economic growth. Granger Casualty Test indicates changes in GDP per capita Granger-cause Emission. Ru, et al., (2012), analyzed that the relationship between economic development and the factors causing the environmental pressures is the basic premise of formulating and adjusting the environmental policy. A sound environmental policy

Figure 2:

equilibrium relationship between the series y and x. The term  $t u$ , indicates the deviation from the long run equilibrium path of  $t y$  and  $t x$ . A time series data ( $t y$ ) is said to be integrated of order one and that can be denoted as  $I(1)$ . If the original non stationary series has to be differenced 'd' times for stationary process, the original series is integrated of order 'd' that can be denoted by  $I(d)$ . Consistency in ECM requires all of terms to be integrated of order zero,  $I(0)$ . This is possible only if y and x are cointegrated in a linear form, that is

$$y_t = \beta_0 + \beta_1 x_t + u_t \quad (4)$$

In this series  $t y$  and  $t x$  are  $I(1)$  and the error term  $t u$  is  $I(0)$ . Then the coefficient measures the

Figure 3:

1

Variable	Statistics With intercept	Critical Values			Statistics With and intercept	Cr
		1%	5%	10%		
<b>Level Form</b>						
2 CO <sub>2</sub> emission	3.138912(2)	-3.626784	-2.945842*	-2.611531*		-0.989891(2) -4.234972
Education expenditure in GDP	2.928958(2)	-3.632900	-2.948404	-2.612874*		2.638842(2) -4.243644
GDP Difference Form	1.750733(2)				-3.626784 -2.945842 -2.611531	-1.099151(2) -4.234972
2 CO <sub>2</sub> emission	-4.681470(2)	-3.632900*	-2.948404*	-2.612874* -6.739015(2) -4.262735* -3.552973* -3.209642*		
Education expenditure in GDP	2.631175(2)	-3.632900			-2.948404 -2.612874*	-6.022913(2) -4.252879*
GDP	-5.201792(2)	-3.632900*	-2.948404*	-2.612874* -6.033745(2) -4.243644* -3.544284* -3.204699*		
Note:						

[Note: b) Phillips-Perron Test]

Figure 4: Table 1 :

## 17 CONCLUSION

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2

Variable	Statistics With intercept	Critical Values			Statistics With trendl% and intercept	Critical Values	
		1%	5%	10%		5%	
<b>Level Form</b>							
2 CO emission	6.132033(2)	-3.626784*	2.611531*	-	-0.655198	-4.234972	-
				2.945842*		3.202445	3.540
Education	13.38117(2)	-3.626784*		-	12.53238	-4.234972*	-
expenditure			2.611531*			3.202445*	
GDP	1.839900(2)	-3.626784		-	-1.054326	-4.234972	-
				2.945842			3.540
<b>Difference Form</b>							
2 CO emission	-4.818463(2)	-3.632900*	2.612874*	-	-9.851673(2)	-4.243644*	-
				2.948404*		3.204699*	3.544
Education	3.873066(2)	-3.632900*		-	-	-4.252879*	-
expenditure			2.612874*			6.022913(2)	3.207094*
in GDP							
GDP	-5.209039(2)	-3.632900*		-		-4.243644*	-
			2.612874*			6.056790(2)	3.204699*

Note: The test is conducted using Eviews 7.1

[Note: 2]

Figure 5: Table 2 :

3

		2 CO Emission i.e. Environmental Pollution and Total GDP.				
H0	H1	Trace Statistics	5% Critical value	Max. Eigen value	5% critical value	Hypothesis
H 0 : r=0	H 1: r=1	57.33895	35.19275	37.93834	22.29962	None**
H 1: r=1	H 1: r=2	19.40061	20.26184	11.99227	15.89210	

Note : The test is conducted using Eviews 7.1

d) Results of Error Correction Model (ECM)

Figure 6: Table 3 :

4

GDP

Figure 7: Table 4 :

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Figure 8:

2

Figure 9:



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205 [ Bangladesh Development Research Working Paper Series] , [www.bangladeshstudies.org/wps/  
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