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Environment Kuznets Curve for Carbon Emissions: A Cointegration Analysis for Bangladesh

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ABSTRACT: This article investigates the current status of the association between carbon emissions releases, use of energy, openness of trade and overall output of Bangladesh from its independence to 2012. The research outcomes for Bangladesh show that a robust long-run association is present there along with short-run dynamic adjustment among those variables. The research indicates that environmental degradation in Bangladesh may increase because of high economic growth in future and therefore, policies to tackle environmental pollution are imperative where the use of both market and non-market based management tools is important. Finally, this study provides some future research directions which were beyond the scope of this research.

Keywords: Environment; Environmental Economics; Air Pollution.
JEL Classifications: Q5; P42.

1. Introduction

The inverted U-shaped relationship between carbon emissions (CO_2) releases and per capita GDP (Friedl and Getzner, 2003; Stern, 2004) is a dominant analysing instrument in literature (Friedl and Getzner, 2003). Moreover, a variety of recent and emerging line of literature (Ang, 2007, 2008; Shahbaz et al., 2014; Soytas et al., 2007; Ozturk and Uddin, 2012) seems to incorporate both the growth of economy and emissions, as well as use of energy and progress of the economy into a multivariate framework to analyse empirically the dynamic relationships altogether.

Bangladesh is a developing country with 150 million populations. Since the early 1990s the economic growth rate of the country has always been more than 6%. At the same time, pressure of economic growth on environment has been an issue of debate. Because of the industrialisation and rapid urbanisation, the use of coal and oil as the major sources of energy, environmental pollution has been increasing both in urban and rural areas. Given the environmental degradation for economic growth, it is imperative to know the position of Bangladesh within the process of sustainable development.

Among the pollutants, CO_2 is a global pollutant and it is considered as the most important gas that is responsible for greenhouse effect and climate change. Bangladesh's contribution to CO_2 emissions is quite low; per capita CO_2 emissions was only at .03 in 2011; much lower than the OECD average of 12 . Also Bangladesh's share is only 0.14% to the global CO_2 emissions in world emissions (World Energy Council, 2012). Nonetheless, the emissions of CO_2 by Bangladesh is increasing this will continue because of more dependency on coal and oil. Therefore, the pollution level of Bangladesh's economy will be an increasing concern in the future and therefore it warrants additional considerations.

The purpose of this research is to examine the dynamic association among CO_2 discharges, use of energy, output and openness of trade of Bangladesh from its independence to 2012, based on the EKC hypothesis as well as with the help of Johansen (1991) co-integration and the model of vector error-correction. While there are some studies in developing countries and developed countries on the connection among earnings and the environment (for example, Akbostanci et al. 2009; Dasgupta et. Al., 2002; Dinda, 2004; Stern, 2004), there is a dearth of scientific information in Bangladesh on the association among those two variables. This article is an effort in filling this gap.

This study is divided into five sections including introduction and conclusions. Section 2 analyses the econometric specification used in this study. The third section explains the models and data used. Section four consists of the estimation results of the time series data. At last, the fifth section concludes the study.

2. Model Arrangement

This article analyses the association between growth and pollution with particular reference to the emission of CO_2, and growth of economy and energy use in Bangladesh. A single multivariate framework has been used in this study for analysing the dynamic relationship among the chosen variables as previously used by many authors (for example, Ang, 2007, 2008; Shahbaz, Lean and Sabbir, 2010; Soytas et al., 2007). Current literature, some scholars (Halicioglu, 2009; Jalil and Mahmud, 2009) showed foreign trade as an independent factor in their models to examine the impact of foreign trade on environmental pollutants. In our study, we have considered trade policies, like Shahbaz, Lean and Sabbir (2010), to analyse the impact of trade restrictions on environmental pollution. In this study, the relationship between CO_2 emissions, energy use, growth and trade openness of Bangladesh is specified as follows (Eq. 1):

$$CO_2E = f\ (EUSE, GDP, GDP^2, OPEN) \quad (1)$$

Where, CO_2E is the CO_2 emissions per capita, *EUSE* is the energy use per capita, *GDP* is the real *GDP* and GDP^2 is the simple square form of the real GDP. This study also follows Edwards (1994), MacDonald and Ricci (2004), Mkenda (2001), Shahbaz et al. (2010) where the degree of openness of the economy proxies that can allow the exchange and trade controls which is the summation of exports and imports as share of *GDP*. This can be expressed as:

$$OPEN = \frac{(X+M)}{Y}$$

We can now use this degree of openness with Eq. (1) in the following estimable form including the error term, ε :

$$CO_2E_t = \beta_0 + \beta_1 EUSE_t + \beta_2 GDP_t + \beta_3 GDP^2{}_t + \beta_4 OPEN_t + \varepsilon_t \quad (2)$$

Continuous economic growth usually causes more economic activities within the economy, which would lead more energy consumption and regular CO_2 emissions. For this reason, we can expect $\beta_1 > 0$ in Eq. (2). According to the EKC hypothesis the sign of β_2 is expected to be positive, $\beta_2 > 0$, while β_3 is supposed to be negative, $\beta_3 < 0$. However, the sign of β_4 depends on the stage of economic development of a country. Jalil et al. (2009) and Shahbaz et al. (2010) mention that for developed countries where environmental laws are very strict, the sing of β_4 can be negative because of producing less pollution intensive goods within the economy. As these types of countries import such goods from less restrictive environmental laws imposing countries, they can expect $\beta_4 < 0$. On the other hand, Grossman & Krueger (1995) and Halicioglu (2009) argue that developing economies can expect the opposite sign for β_4, which is $\beta_4 > 0$, because of their intention to produce more pollution intensive goods within the economy. Thus, the expected sign for β_4 is mixed in Eq. (2).

3. Assessment Plan

Several techniques can be used for parameters estimation in Eq. (2) and any process from classical regression models to different cointegration-based procedures can be used. This study employs Johansen's (1991) cointegration procedure which has emerged as the most commanding and accepted technique in this area.

The Johansen (1991) approach is popular because it confines the fundamental time series properties of the data. According to Chowdhury (1998), this involves identifying total cointegrating vectors in the system to estimate them. The Johansen procedure starts with a general vector autoregressive model with variables of interest. This is then re-parameterised as a system of error correction model, so that the vector in the auto-regression model consists of lagged first differenced terms and a set of lagged level terms. Applying Ordinary Least Square (OLS) can provide consistent long-run parameter estimations for each equation. Thus, Johansen statistics are able to give a decisive test in cases where other test statistics are border-lined with respect to cointegration (Chowdhury, 1998).

Defining the integration order of the variables of our model is the first issue of this paper; then to detect any long-run association among the variables with the help of cointegration tests. On the basis of the situation of having cointegration in last phase, vector error correction model can be estimated to understand short-run relationship. Tests for residual diagnostic are implemented at the final stage.

Association among the stationary variables is the main dealing issue in classical regression model. But maximum economic variables normally follow a non-stationary trail. According to Gujarati and Porter (2009), unauthentic outcomes will be produced if the dependent variable in a regression remains as a function of a non-stationary progression.

In such case, it may possible to get significant t-ratios and a very high R^2 and the trending variables could be absolutely unconnected. Therefore we need to perform unit root or stationarity tests, following the investigations for cointegration and parameters estimation. The stationarity of the series can be examined in many different ways. The unit root test (Augmented Dickey-Fuller and Dickey-Fuller GLS) and a stationarity check (Kwiatkowski et al., 1992) have been performed in this study. We implement both of these tests in this study to achieve *confirmatory data analysis* (Brooks, 2002).

We need to determine the variables integration order of our model before conducting Johansen (1991) coninteration test. The purpose of the Johansen (1991) cointegration test is to decide the cointegration status of the variables of our model. The basis of Vector Error Correction Model (VECM) condition generates in the presence of a cointegration relation. Next section of this research paper briefly describes the Johansen methodology.

Assume a vector:

$X_t = [EUSE, GDP, GDP^2, OPEN]$,

assume that the above vector has a VAR representation in the following way:

$$X_t = z + \sum_{i=1}^{p} \Pi_i X_{t-1} + \varepsilon_t \qquad (3)$$

Where, deterministic variables z has $(n \times 1)$ vector and Π_i is the coefficients of a $(n \times n)$ matrix. For using Johansen cointegration, Eq.3 requires to be transformed into a vector error correction model condition (Brooks, 2002) in the following way:

$$\Delta X_t = z + \sum_{i=1}^{p-1} \mathbf{B}_i \Delta X_{t-i} + \mathbf{\Pi} X_{t-1} + \varepsilon_t \qquad (4)$$

where X_t is a vector of $I(1)$ variables, ΔX_t are all $I(0)$ variables, Δ shows the operator of first difference, coefficient $\mathbf{B}_i$ is a $(n \times n)$ matrix, and Π is a matrix of $(n \times n)$ and its rank defines the amount of cointegrating associations. Brooks (2002) mentions that from an open VAR, Johansen's cointegration test assesses the rank of the Π matrix $(\mathbf{r})$ and investigates the chance of eliminating the limits implied by the reduced rank of Π . If Π is of full rank$(\mathbf{r} = \mathbf{n})$, it advocates level stationary variables and zero rank $(\mathbf{r} = \mathbf{0})$ suggests no cointegration between the variables. However, if Π is of reduced rank$(\mathbf{r} < \mathbf{0})$, it means $(\mathbf{n} \times \mathbf{r})$ matrices α and β:

$$\Pi = \alpha\beta' \qquad (5)$$

Here, α represents the adjustment speed. This actually indicates the response speed of the system because of the deviance from the equilibrium relationship during preceding period. Here, long-run coefficients matrix is β.

We can test the rank of the Π matrix after identifying the appropriate Vector Auto Regressive (VAR) order $(\mathbf{k})$ and the deterministic trend assumption. Johansen cointegration approach has two likelihood ratio (LR) test statistics. First one is the trace $(\lambda_{\mathbf{trace}})$ statistics:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{N} \ln(1 - \hat{\lambda}_i) \qquad (6)$$

And the second one is the maximum eigenvalue (λ_{max}) statistics:

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (7)$$

Here, the total number of cointegrating vectors can be understood by r. Moreover, $\hat{\lambda}_i$ shows the projected value for the i th ordered eigenvalue from the Π matrix in Eq.5. The null hypothesis is examined by the trace statistic and the hypothesis states that the number of cointegrating relations is against the alternate of k cointegrating associations. In this case, number of endogenous variables are represented by k . Brooks (2002) mentions that on each eigenvalue isolated trials are directed by the maximum eigenvalue test. Here, the null hypothesis is that there are cointegrating vectors against an alternative of $r + 1$. Now, the statistics of this trace and maximum eigenvalue test need to compare with the critical values from Osterwald-Lenun to determine the rank of the Π matrix (cited in Takaendesa, 2006). This process delivers a more comprehensive set of critical values for the Johansen cointegration. In case of the both experiments, if the critical values are lower than the test statistics, reject the null hypothesis that there are r cointegrating vectors.

Contradictory results can be obtained from the trace and maximum eigenvalue statistics. Johansen and Juselius (1990) recommend choosing the appropriate estimated cointegrating relations to deal with this problem, based on interpretation capability of those cointegrating associations. But, many researchers argue that the trace test is more robust than the maximum eigenvalue measurement in the determination of cointegrating relationships (Luintel and Khan, 1999).

A VECM (Eq.4) estimation is possible after identifying the number of cointegrating vectors in the model. Takaendesa (2006) appropriately mentions that the VECM is just a restricted VAR intended for using with cointegrated non-stationary series. The specified cointegrating relation in the VECM limits the long-run characteristics of the endogenous variables to meet to their cointegrating relationships. The VECM also represents short-run adjustment dynamics. Because of this procedure, autocorrelation and heteroskedacity of the residuals of VECM checking is necessary after completing the estimation of the parameters.

International Financial Statistics of IMF and different issues of Annual Statistics of Bangladesh Bank is the source of the time series data used for this research. The data used for this study includes per capita CO_2 emissions, energy use, per capita real *GDP* and trade amount for the period of 1972-2012. Domestic currency is used to measure per capita *GDP*. The real *GDP* is measured as nominal *GDP* divided by the *GDP* deflator (2000 = 100). At last, the ratio of total value of exports and imports with nominal *GDP* is defined as trade openness ratio, *OPEN*.

4. Results

Determination of the integration order of the series is the starting step of the Johansen's (1991) technique. In this study we have done the unit root test of all the variables. Augmented Dickey Fuller (ADF) and Dickey Fuller GLS (DF-GLS) tests are implemented. The test results (Table 1) includes both the options 'intercept' and 'intercept and trend'.

The outcomes of the Augmented Dickey Fuller tests (Table 1) indicate that with 'intercept and trend' option, data for four variables (CO_2E, *EUSE*, *GDP*) are first difference stationary I(1). On the other hand, GDP^2 is level stationary I(0). With same option, the DF-GLS tests (Table 1) show that all series are I(1). Again, with 'intercept' only option, ADF tests show that all the variables, except only one (*OPEN*), are level stationary I(0).

To confirm the stationarity of CO_2E, *GDP* and GDP^2, we apply a third test, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Augmented Dickey Fuller and DF-GLS methods examine the unit root as its null hypothesis. But, KPSS assumes stationary series as its null. For that reason, after doing ADF and DF_GLS, rejection of null means the series without a unit root. On the other hand, KPSS interprets the outcomes in opposite way. Here, rejection of null means an evidence of non-stationarity, or existence of a unit root in the series.

Table 1. Unit root test

TEST		ADF			DF-GLS			KPSS		
		Level	1st Difference	Order of Integration	Level	1st Difference	Order of Integration	Level	1st Difference	Order of Integration
CO_2E	Intercept	4.525*		I(0)	0.265	-8.544*	I(1)	0.675	0.330*	I(1)
	Trend & Intercept	1.423	-5.143*	I(1)	-2.235	-8.851*	I(1)	0.205*		I(0)
EUSE	Intercept	3.659*		I(0)	3.225*		I(0)	0.715	0.563*	I(1)
	Trend & Intercept	1.270	-7.519*	I(1)	-0.243	-6.705*	I(1)	0.209	0.110*	I(1)
GDP	Intercept	6.685*		I(0)	0.547	-3.227*	I(1)	0.673	0.650*	I(1)
	Trend & Intercept	3.059	-5.532*	I(1)	-1.145	-5.435*	I(1)	0.214	0.227*	I(1)
GDP^2	Intercept	12.584*		I(0)	0.593	-1.042	I(2)	0.642	0.648*	I(1)
	Trend & Intercept	7.169*		I(0)	-1.501	-2.902***	I(1)	0.209	0.204*	I(1)
OPEN	Intercept	0.595	-6.856*	I(1)	0.968	-6.458*	I(1)	0.685	0.262*	I(1)
	Trend & Intercept	-1.738	-7.138*	I(1)	-1.793	-7.319*	I(1)	0.169	0.063*	I(1)

Please note that No Unit Root at 1%, 5% and 10% are indicated by *, ** and *** respectively.

The outcomes of KPSS tests (Table 1) indicate that with 'intercept' option alone, the variables in this research are I(1) and if we consider both option, one variable (CO_2E) is level stationary I(0). While the ADF and DF-GLS show the same variable as first difference stationary I(1), all these tests exhibited that all the variables in this paper are I(1). Before conducting the Johansen (1991) procedure to perform cointegration analysis, we also investigate any possible structural break in the data set.

According to Agung (2009), before obtaining the corresponding time series data of any macroeconomic variables or growth curve, it is important to obtain information regarding any possible breakpoint. We concluded here that there is a possible break point in 1992, when we observed changes in the trends of most of the macroeconomic variables because of the political transition of Bangladesh from dictatorship to elected democratic government. However, in Table (2) we see that based on a p-value = 0.0000, the null hypothesis of 'no breaks at specified breakpoints' (here, 1992) is rejected. On the basis of this, we construct a *DUMMY* variable which assumes value 0 from year 1972 to 1992 and 1 thereafter.

Table 2. Stability test

Chow Breakpoint Test: 1992				
H_0: there are no breaks at specified breakpoints				
Here, all variables are varying regressors.				
Period: 1972- 2012				
F-statistic	21.43739		Prob. F(2,33)	0.0000
Log likelihood ratio	32.75995		Prob. Chi-Square(2)	0.0000
Wald Statistic	43.87577		Prob. Chi-Square(2)	0.0000

Now we run our cointegration analysis, where we also consider the structural break in the data set by considering *DUMMY*. Table (3) shows the cointegration test results for our model.

In this cointegration analysis, we consider five variables (*EUSE, GDP,* GDP^2 and *DUMMY*) to see their influence on CO_2E. The trace test rejects the null hypothesis of no cointegrating vector. Here, the test statistic is 129.33 which is greater than the 5% critical value of approximately 93.73. Similarly, it also rejects the null hypothesis that there is at most one cointegrating vector. Thus, the trace test indicates two cointegrating vector at the 5% level of significance. In contrast, the maximum eigenvalue test also rejects the null of no cointegration. However, as the test statistic of approximately 29.61 is less than the 5% critical value of around 31.86, the null hypothesis cannot be rejected. Here, the null is that there is at most one cointegrating vector. Thus, the maximum eigenvalue test shows that there is one cointegrating connection among the variables in our model.

Table 3. Johansen's Cointegration with structural break: Long run estimation

Sample (adjusted): 1974 -2012				
Here, we assume linear deterministic trend				
Series: CO_2E *EUSE GDP* GDP^2 *OPEN DUMMY*				
1 to 1 lags interval (first differences)				
Trace Test				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Probability**
None *	0.789380	129.3311	93.73366	0.0000
At most 1 *	0.583143	76.82164	69.81889	0.0124
At most 2	0.446683	46.19619	47.85613	0.0710
At most 3	0.364665	25.48232	29.79707	0.1449
At most 4	0.176955	9.606203	15.49471	0.3122
At most 5	0.076624	2.790154	3.841466	0.0948
At the 0.05 level this test shows 2 cointegrating eqn(s)				
Rejection of the hypothesis at the 0.05 level is shown by *.				
**MacKinnon-Haug-Michelis (1999) p-values				
Maximum Eigenvalue Test				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Probability**
None *	0.789380	54.51943	40.07757	0.0006
At most 1	0.583143	29.61344	31.86387	0.1164
At most 2	0.446683	20.71387	27.58434	0.2939
At most 3	0.364665	15.87612	21.13162	0.2322
At most 4	0.176955	6.816049	14.26460	0.5111
At most 5	0.076624	2.790154	3.841466	0.0948
At the 0.05 level, this test shows 1 cointegrating eqn(s)				
At the 0.05 level, rejection of null is show by *.				
**MacKinnon-Haug-Michelis (1999) p-values				

However, the value of CO_2E is normalised to one, and after this we get the cointegrating equation (Eq. 8) as follows, with the standard error in parentheses:

$$CO_2E = +0.003\ EUSE + 1.249\ GDP - 0.813\ \mathrm{GDP}^2 - 0.003\ \mathrm{OPEN} + 0.029\ \mathrm{DUMMY} \qquad (8)$$

(0.01) (0.244) (0.138) (0.001) (0.006)

The results in Eq. (8) are statistically significant and also indicate all anticipated signs of the coefficients of explanatory variables. It shows marginal effect of the growth of economy, energy use and openness of trade on CO_2 discharges in the long run. The outcomes show that upsurge in the use energy will escalate the emissions of CO_2. From the Eq. (8) we also see the confirmation of the presence of inverted-U connection between growth of the economy and CO_2 releases. The outcomes show that 1 percent increase in real *GDP* will increase CO_2 releases by 1.25 percent. Moreover, negative sign of GDP^2 appears to support the delinking the discharges of CO_2 and real *GDP* at higher level of income of the society. Thus, this confirmation indicates the increment of CO_2 discharges at the very early period of the growth of an economy and deteriorate after a threshold point. These results are similar like many latest empirical evidences (such as Fodha and Zaghdoud, 2010; Halicioglu, 2009; He, 2008; Lean and Smyth, 2010; Song, Zheng and Tong, 2008).

The coefficient of trade openness (*OPEN*) in our results also shows that it has inverse impact on CO_2 emissions. This outcome is similar like the findings of Antweiler et al., 2001; Copeland and Taylor, 2005; Managiet al., 2008; McCarney and Adamowicz, 2006. The logic behind these findings is that trade openness reduces CO_2 emissions through technological progress in the country. The consideration of structural break also shows statistically significant result.

In the long run, the variables of our model are cointegrated. This is the evidence of the existence of an error correction mechanism. This instrument conveys together the long-run association with its short-run dynamic changes. The estimate of parsimonious dynamic Error Correction Model (Eq. 9) is stated in Table 4. The table also shows different diagnostic tests which are used most commonly in the literature.

In Table (4), the error correction coefficient of Eq. (9) indicates that CO_2E has the significant negative coefficient at 5% level and the t-value is -2.12. This suggests that CO_2E equation has the true cointegrating relationship in this vector.

Coefficient of adjustment is a very important parameter to indicate in the estimation of Vector Error Correction models. In this research, this coefficient measures the speed of adjustment in the CO_2E following a shock in economy. Thus, it is for sure that the growth of CO_2 discharges has been significantly impacted by the long run equilibrium deviation and 52 percent adjustment speed per year is definitely high. Alternatively, we can say that it takes about two years to achieve long-run equilibrium whenever here is a deviancy from the long-run steady state. The outcomes are not unexpected given that there is slight control on the growth of CO_2 releases.

Table 4. Error correction model of CO_2E for Bangladesh: 1972–2012

VARIABLES	**Equation- 9** $\Delta\ CO_2E_{t-1}$
ECM_{t-1}	-0.52** (-2.12)
$\Delta EUSE_{t-1}$	4.54 (0.05)
ΔGDP_{t-1}	-2.65** (-2.10)
ΔGDP^2_{t-1}	1.92** (2.14)
$\Delta OPEN_{t-1}$	0.00 (0.29)
Constant	0.02 (-1.39)
DIAGNOSTICS:	
R-squared	0.36
Adj. R-squared	0.20
F-statistic	2.2123
Akaike AIC	-5.6285
Serial Correlation LM	20.34 {0.73}
Normality Test (Jarque-Bera)	36.05 {0.0001}
Heteroskedasticity	202.08 {0.35}

Notes: i) At 1%, 5% and 10% level of significance are indicated by *, ** and *** respectively.
ii) t-statistics are indicated by figures within ( ).
iii) P values for the residual diagnostic checks are the figures within { }.

In addition to the Vector Error Correction results (Table 4), we report some diagnostic checks results. Diagnostic checks are important to measure the efficiency of the model. If there is a problem in the residuals from the estimation of a model, it is a warning regarding the inefficiency of the model and parameter estimation from such a model may be biased. The diagnostic test outcomes (Table 4) indicate that there is no serial correlation as well as the normality of the residual. Here, there is also no sign of heteroskedasticity.

5. Conclusion

This research paper investigates the dynamic relationship between emissions of CO_2, use of energy, output and trade openness of Bangladesh from its independence to 2012, based on the EKC hypothesis as well as by using the Johansen (1991) conintegration and VECM. The empirical outcomes for Bangladesh show the presence of a robust long-run association along with short-run dynamic adjustment between the variables. Emissions of CO_2 is the dependent variable of this long-run relationship of our model. The short-run and long-run elasticities of CO_2 discharges are tested in the model with respect to all other independent variables by this dependent variable. Our research indicates that Bangladesh should adopt new environmental policies to decrease environmental degrading. Outcomes of this study also endorse the presence of inverted-U association between growth of economy and CO_2 discharges.

Certainly, environmental degradation is the result of high economic growth, but on the other hand, decrease in growth can intensify unemployment in a developing country like Bangladesh. Therefore, prioritising different policies to block environmental pollution is important to decrease the preliminary costs and competence of investments for economic development. First of all, Bangladesh should measure the exact scale of industrial environmental pollutants. Identification of these things can help Bangladesh government to issue most relevant rules and regulations for tackling environmental degradation competently. However, introduction of pollutant taxes, which are already implemented in many countries in the world, would reduce the degree of this problem in Bangladesh. Government's incorporation of these environmental policies into macroeconomic framework more rigorously can ensure the pollutant emissions and sustainable growth in Bangladesh.

Analysis in an aggregate level is the main limitation of this research. Energy use differs from industry to industry. Availability of disaggregated data on energy use is very rare. But if such data could be obtained for Bangladesh, that could be a more useful topic for future analysis. Consumption of electricity is used as a proxy for the use of energy in this research and CO_2 emissions as a proxy for environmental degradation. Use of other proxies for consumption of energy and environmental degradation may offer further understanding regarding the link between environmental degradation, energy use and growth. Moreover, examining the contributory association between economic growth, pollution releases and other possible appropriate variables such as automobile use, health expenditure and urbanization would be another direction for further research.

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