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Environmental Kuznets curve hypothesis for Bangladesh from the perspective of different environmental degradation indicators: Evidence from ECM Approach

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Abstract: From the perspective of global scenario the human civilization had made splendid alteration to the nature for meeting our needs.As a bydproduct of human activities the earth had been continuously paying up its costs with the negative externalities of climate change.The country Bangladesh is also a part of this impact.It has been seeing a decline in environmental quality, which has caused many people to become concerned about the problem. Growing public concern about the environmental issues has inspired many initiatives to understand the causes of environmental deterioration better. This study discusses how ecological footprint,natural resource rents and carbon emission lead to environmental degradation and tests out the Kuznets curve hypothesis from the perspective of those different environmental degradation indicators with the help of OLS estimation method. To give the estimation results proper validation the Engel-Granger (ECM) or error/eqilibrium correction mechanism is tested to explore the long and short-run causal relationship between the degradation determinants and economic growth measurement. The primary goal of the paper is to achieve new ideas to make sustainable economic growth planning through the abatement of environmental degradation.

Keywords: Environmental Kuznets curve(EKC), GDP per capita, pollutant emission, Natural resource rent (NRR), Ecological footprint (EF), Carbon emission (CO2 emission), Error correction mechanism(ECM).

1. Introduction

Environmental protection and degradation are two of the most significant global issues that are at the top of the political agenda on a worldwide scale. The world's economic climate has deteriorated as a result of excessive heat. The economy, as seen from a global perspective is growing because of an increase in human activity, mobility, labor actions and production of goods and services. Competition for natural resources and sustainability has become threatening over time. This is because carbon dioxide emission (CO2EM) is thought to be the main cause of environmental problems including deterioration. CO2 emission is also influenced by high natural resource rent and ecological footprint.

Bangladesh is a heavily populated country, and the majority of its industries are often located in the middle of residential areas in various localities. Over time, Bangladesh's

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unplanned industrialization has seriously degraded the environment. Bangladesh is currently plagued by all forms of pollution. The rapid rise of industrialization, which is regarded to be the key to a country's development, is achieved by practically every industrial organization exploiting natural resources in various ways. To conserve the limited resource, to minimize resource extraction, and to abate environmental damages, it is necessary to detect the variables associated with resource depletion and environmental degradation acts. To capture the true relation of environmental degraders and economic growth, the help of the Kuznets curve hypothesis framework can be taken. The study has taken carbon emission, ecological footprint and natural resource rent as degrader variables. The paper has also captured to see if there is any significant long-run relationship between the degradation indicators and economic growth.

2. The main objective of the paper is briefly explained below-

High economic growth doesn't necessarily mean it will be sustainable overtime. This study will prove that, the mentioned degrader variables are essential when it comes to measuring environmental degradation acts. Kuznets curve hypothesis will be satisfied with different degrader variables and lastly, there is a significant relation between the degraders and economic growth which will be a necessary finding to make sustainable growth planning.

3. Literature Review

The theory of Kuznets curve:

A theory put forth by economist Simon Kuznets in the 1950s and 1960s is expressed by the Kuznets curve (KC). This theory shows that as an economy grows, market forces first cause the economic inequality to rise, then they eventually cause it to fall.(Kuznets, 1955). Environmental consequences first increase as economies become wealthier but eventually decrease. Despite the fact that richer nations have made progress in reducing some forms of environmental degradation, others have not. Furthermore, the mechanisms that might underlie with the theory are still debatable, and the statistical evidence for the EKC is not strong.(Stern, 2014) .

From the study of (Selden & Song, 1994) it can be said that the EKC hypothesis shows, pollution emissions or environmental quality are linked to economic expansion. The EKC theory satisfies that-from a country's early stages of economic development, till a certain income level, environmental degradation will increase. When this "turning point" threshold is achieved, negative environmental consequence will be low. In some circumstances, an inverted U shaped curve is found. The EKC can also take the form of an N-shaped curve. With the help of regressions which include linear, quadratic and cubic terms, the shapes of EKC can be determined. Study of (Balibey, 2015) shows the theoretical setting where seven possible outcomes can be derived from EKC testing. All the parameter values will be derived from the models which is given below-

$$y = \alpha + \beta_1 x_t + \hat{u}_t$$

$$y = \alpha + \beta_1 x_t + \beta_2 x_t^2 + \hat{u}_t$$

$$y = \alpha + \beta_1 x_t + \beta_2 x_t^2 + \beta_3 x_t^3 + \hat{u}_t$$

if $b_1 = b_2 = b_3 = 0$. There will be no relation between X(economic growth) and Y(environmental degradation indicator).

(1) $b_1 > 0$ and $b_2 = b_3 = 0$.Relation will be positive in an increasing manner.
(2) $b_1 < 0$ and $b_2 = b_3 = 0$. Relation will be negative in a decreasing manner.
(3) $b_1 > 0$, $b_2 < 0$ and $b_3 = 0$. EKC will be inverted U shaped.
(4) $b_1 < 0$, $b_2 > 0$ and $b_3 = 0$. EKC will be U shaped
(5) $b_1 > 0$, $b_2 < 0$ and $b_3 > 0$. EKC will be N-shaped.
(6) $b_1 < 0$, $b_2 > 0$ and $b_3 < 0$.EKC will show opposite pattern of N-shape.

Only for models (1) & (4) the EKC hypothesis will be held. From the slight modification of Simon's Kuznets curve by (Yandle, Bhattarai, & Vijayaraghavan, 2002),a hypothetical plot of Environmental Kuznets Curve can be drawn.

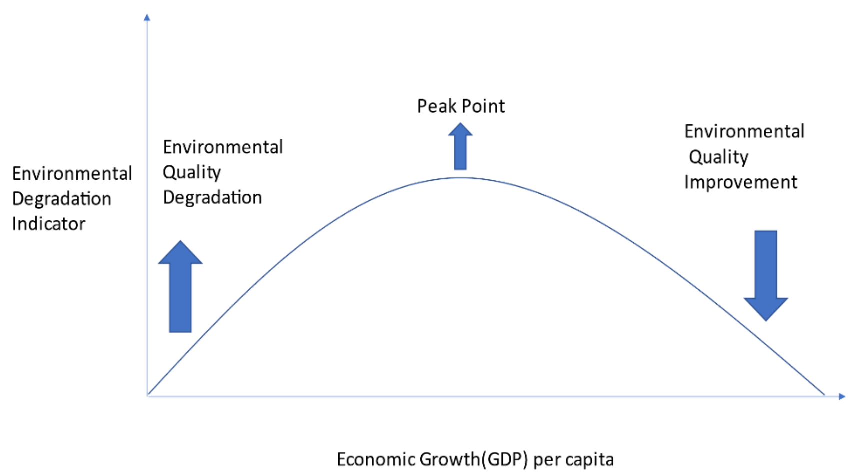

Figure 1:Hypothetical EKC

3.1 The role of carbon emission as an environmental degradation factor

In the study of (Leit˜ao, 2014) it was found out that the carbon emission has positive relation with economic growth. But the long run scenario shows higher level of growth is brought by the reduction of energy usage and the adverse effects of globalization.. The authors from (Chen & Huang, 2013) warn that the cohabitation of high level economic growth and CO2 emission exposes significant difficulties for the environment.

(Selden & Song, 1994) tried to study the impact on environment from the perspective of air quality. They studied the effect of four emission particles. They found inverted u curved relation between the mentioned variables. This basically proves economic growth can only be achieved in the longer run after eliminating all the adverse effect caused by carbon emissions into the air. According to the research on Environmental Impacts of "North American Free Trade Agreement" by (Grossman & Krueger, 1991) it was once again discovered that concentration of pollutant impact on the environment—surge up at low income level, but decline with higher levels of income. Therefore, it is suggested that emission reduction and lessening energy consumption must be the primary goals if the developing nations want to make sustainable growth planning. (Balibey, 2015)

3.2 The role of ecological footprint in EKC studies and its impact on environmental degradation

The paper of (Wackernagel & Rees, 1997) explains the idea of natural capital in detail and argues that in order to offset net losses, investments in natural capital are required. The study of (Siche, Agostinho, Ortega, & Romeiro, 2008) compares EF with determinants related to sustainability. In this regard, it can be told that EF gives the indication of how much consistently available lands can meet up the needs of human consumption (Wackernagel & Rees, 1997).

According to (Bazan, 1997), the land area used in the calculation of EF indicates the total amount of space needed by people for all of their daily activities, which includes farming and industrialization. In a nutshell, EF works as an analytical tool of finding out the biocapacity that is needed for human's sustainable existence. So, EF is considered to be used as an analytical tool to detect environmental sustainability (Sonu, Binod, & Sonika, 2011). According to the study of(Adedoyin, Alola, & Bekun, 2020),high level of EF which is detrimental to the environment is led by economic expansion in the long run. In the reviewed paper(Lin, Wackernagel, Galli, & Kelly, 2015) ,the researchers tried to clarify the misconception of high EF. They believed that the continuous rising per capita footprint in high-income nations was a sign of higher living standards. Because if EF which is representing the biosphere's carrying capacity, someday will exceed the ecological budget in terms of human energy consumption, that situation will ultimately cause environmental degradation as well as poor economic condition. According to the paper of (Siche et al., 2008),it can be presented that higher EF denotes increased environmental harm brought on by human activity and it can be served to illustrate the relationship between EF and the environment. Once again according to the study of (Wackernagel & Rees, 1997) it had been emphasized that compared to European nations the US had the greatest EF per capita indicating that the nation was experiencing an ecological deficit.

Several factors can be liable to affect the EF. Energy consumption, carbon emission, expenditure on RD, nation's debt are likely to be the potential influencers of the EF among them. The study of (Adedoyin et al., 2020) assesses the effects of environmental degradation variable impact on ecological footprint and adds research and development (RD) spending as a new variable to understand the consequence and found out that the panel countries' environmental sustainability is greatly impacted by their RD spending.

According to the paper analysis of (Zafar, Shahbaz, Hou, & Sinha, 2019) higher levels of public spending on research and development (RD), may have over time significantly improved the EU's economic performance. The increasing trend in the EF is due to the concomitant increase in EF, which illustrates the EU's unsustainable economic expansion. The negative trend in growth levels observed from 2008 to 2010 could not be separated from the global economic crisis and the EU debt difficulties. In order to achieve budgetary balance during this time, the EU lowered or maintained present levels of RD spending. From the (Zafar et al., 2019) paper it was emphasized that greater financing for RD, particularly in renewable energy, is what makes this ecologically acceptable transformation to less natural resource consumption possible. From the paper of (Hassan, Xia, Khan, & Shah, 2019) where they collected evidence from Pakistan it was found out that the study confirms - while the use of renewable energy reduces ecological footprint, the use of nonrenewable energy and economic expansion increase carbon emission. Additionally,(Saint Akadiri, Bekun, & Sarkodie, 2019)empirically examined the transition using South Africa as a case study, a nation that reached the ideal turning point in 2011. This study tries to have a different approach to test the EKC from the perspective of consumption and resource availability level. On the paper of olivier Darne(2014) where time series analysis had been conducted it has been found out that consumption-based approach with ecological footprint shows positive result when it is related to economic growth.

3.3 Natural resource rent's function as a driver of environmental deterioration

From the paper of (Chen & Huang, 2013),carbon emission impact is shown from the perspective of different variables. This study would suggest that increased urbanization, financial development, and higher level resource rents are putting on an additional environmental pressure. Short-run estimates from this study show that urbanization, financial development, rent from natural resources, and lagged carbon emission values all have a substantial role in determining the current levels of carbon emissions. Nowadays, there is an increasing tendency of emissions on the economy at a global level due to the increase in human activity, labor, and product creation (Bekun, Alola, & Sarkodie, 2019) .The paper of (Shan, Umar, & Mirza, 2022) explains that less availability of natural resources and fight for sustainability are also related to the environmental degradation. According to the paper of (Huang, Sadiq, & Chien, 2021) it can be said that along with the carbon emission, NRR also plays a critical function in determining the degree of environmental quality and sustainability. NRR is related to ecological footprint and their significant relationship is found in the paper of (Ullah, Ahmed, Raza, & Ali, 2021).

But the paper of (Tufail, Song, Adebayo, Kirikkaleli, & Khan, 2021) examines the opposite case of the existing literature where they showed that reduction of emission enhances NRR and also improves the environment. While testing for the EKC, (Huang et al., 2021) has taken into account of how energy use and NRR impacted China's carbon emissions between 1995 and 2019.

No existing literature within my knowledge tested EKC by taking "natural resource rent" as a degradation determinant directly. So to incorporate NRR in the EKC test, it is necessary to find out how much potential NRR has to be to influence high carbon emission. All the referenced paper given above explained explicitly that NRR has significant contribution toward carbon emission and environmental degradation.

4. Methodology

4.1 Sample size-

The GDP of Bangladesh increased significantly from the time period of 1990 to 1999 . At the start of the decade, the agricultural sector provided a major share of GDP; but by the end, that contribution had dropped. The contribution from the service sector went up within the same time period, while that from the industrial sector also increased. The transitional effect from agriculture to industry-centric production was prominent in the 1990s. It is expected that rapid economic growth influenced by high industrialization had contributed to high emission level, natural resource depletion and higher ecological footprint. To incorporate this drastic change that is seen within the decade, in our analysis we are choosing 1990-2018 annual (yearly data set for all the variables under this study.[1]

4.2 Variables under study description:

1. Ecological footprint (consumption per capita): Ecological footprint is measured to give insights on the biocapacity. The determinants of biocapacity that will be taken into consideration to make the comparisons are biologically productive lands like croplands, forests, fishery grounds.[2]
2. Total natural resource rent(% of GDP): Summation of oil ,natural gas, coal, mineral and forest rents derive natural resource rent. NRR is calculated as the difference between commodity price and cost of producing such commodity. Estimation is done by taking a general world price unit of specific commodities and differencing the extraction/harvesting unit cost. These unit rents are then multiplied by a country's quantity of extraction and expressed as share of GDP.
3. CO2 emissions (metric tons per capita) : Carbon emissions per capita are measured as the total amount of carbon dioxide emitted by a country as a consequence of all relevant human (production and consumption) activities and divided by the population of the country.
4. GDP per capita: The economic or final output of a country per person is measured by its GDP per capita.

4.3 Methods and techniques:

This paper will try to test the EKC hypothesis from a multi-model time series analysis. The environmental degradation variables will be treated as dependent variables in each models and the independent variable will be the economic growth. The paper will try to incorporate the independent variables in different functional forms (linear, quadratic and cubic) in each model.

*To test the EKC hypothesis-

While the ecological footprint will be treated as dependent variable-

i. $Ef_t = \alpha + \beta_1 GDPCap_t + \hat{u}_t$*(linear form to see if there is a positive or negative relation)*

ii. $Ef_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \hat{u}_t$ *(quadratic form where the EKC will be tested)*

iii. $Ef_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \beta_3 GDPCap_t^3 + \hat{u}_t$*(cubic form where EKC will be tested)*

\While the natural resource rent (NRR) will be treated as dependent variable-

iv. $NRR_t = \alpha + \beta_1 GDPCap_t + \hat{u}_t$*(linear form to see if there is a positive or negative relation)*

v. $NRR_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \hat{u}_t$*(quadratic form where the EKC will be tested)*

vi. $NRR_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \beta_3 GDPCap_t^3 + \hat{u}_t$*(cubic form where EKC will be tested)*

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[1] https://databank.worldbank.org/source/world-development-indicators

[2] https://www.footprintnetwork.org/

While the CO2 emission (Co2) will be treated as dependent variable-

vii. $Co2_t = \alpha + \beta_1 GDPCap_t + \hat{u}_t$*(linear form to see if there is a positive or negative relation)*

viii. $Co2_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \hat{u}_t$*(quadratic form where the EKC will be tested)*

ix. $Co2_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \beta_3 GDPCap_t^3 + \hat{u}_t$*(cubic form where EKC will be tested)*

The OLS estimation method will be followed for the testing. For further data visualization polynomial regression analysis will be done on the basis of the OLS model plotting. The correct order from the analysis will be detected to give visual proof over the OLS regression result. Due to time series data OLS estimation method will give rise to autocorrelation problem. OLS Estimation will be tested at level form. To provide the validation over the OLS estimation result, Engel-Granger Error correction mechanism (ECM) test will be performed to capture the short and long run causal relationship between the environmental degrader variables and economic growth.

5. Empirical data analysis

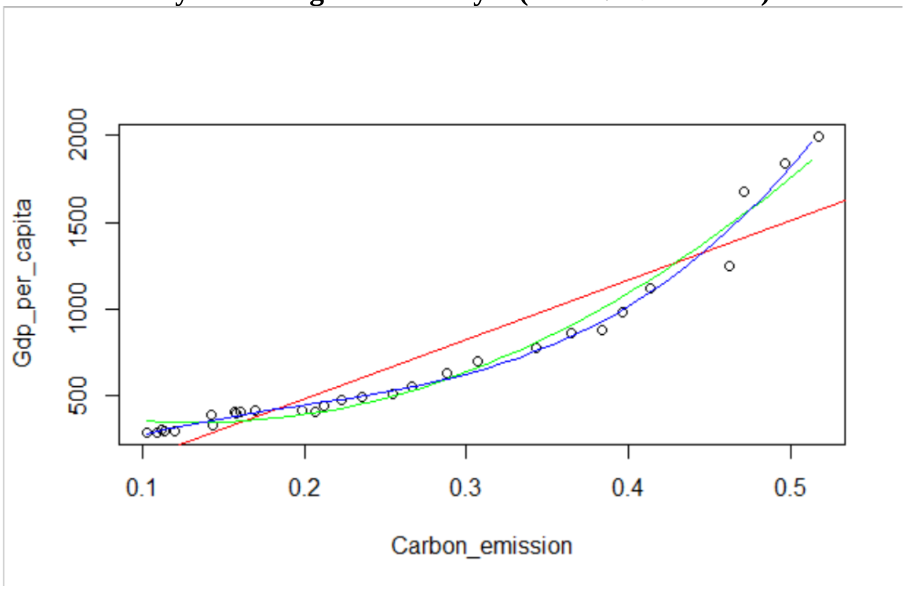
1. For the carbon emission part, linear estimation shows that for 1%increase in GDP per capita the emission goes higher by 4.75%.The result is significant at 5% significance level. For the quadratic function it is seen 1 unit increase in GDP causes the emission to rise by 0.1205 units. Later it goes does down by (1.788×10^{-3}) units. Both the results are significant at 5% level. For cubic function, the emission goes up by.185 units for a unit increase in GDP per capita, at further goes down by (5.379×10^{-3}) units and finally once again goes up by (5.654×10^{-5}).All the parameter values and sign go along with EKC hypothesis. So Kuznets curve is valid significantly in the form of carbon emission.
(see the results at Table 4)

2. Now the result from consumption based approach will be explained. For the Ecological part, linear estimation shows that for 1%increase in GDP per capita the footprint goes higher by 5.21%.The result is significant at 5% significance level. For the quadratic function it is seen 1 unit increase in GDP per capita causes the footprint to rise by 0.142 units. Later it goes does down by (2.168×10^{-3})units. Both the results are significant at 5% level. For cubic function, the footprint goes up by.185 units for a unit increase in GDP per capita, at further goes down by (5.975×10^{-3}) units and finally once again goes up by (5.999×10^{-5}).All the parameter values and sign go along with EKC hypothesis. So Kuznets curve is valid significantly in the form of ecological footprint.
(see the results at Table 5)

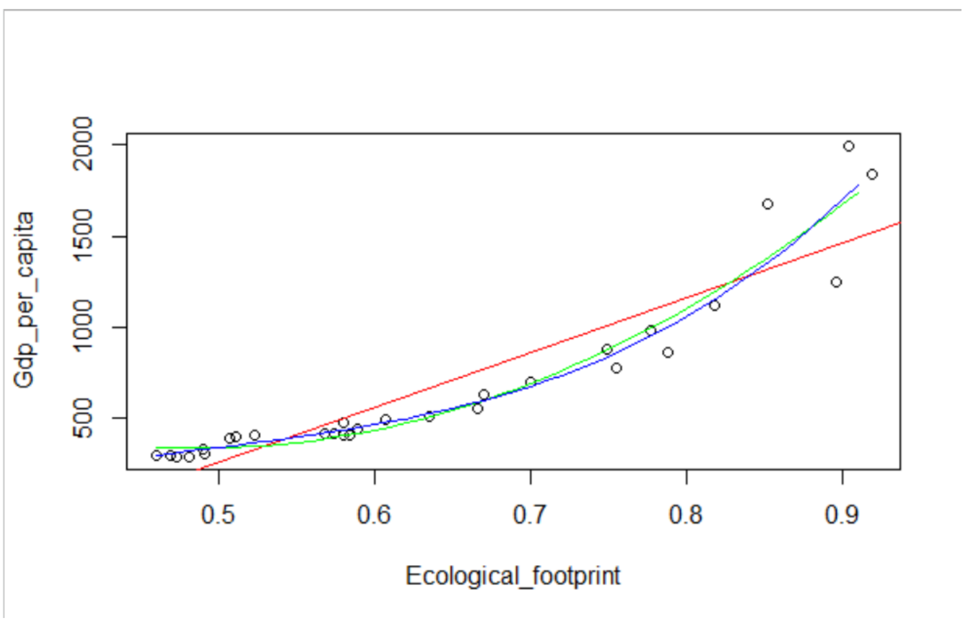
3. Now another result from consumption based approach will be explained from the perspective of natural resource rent. Linear estimation from this case shows that for 1%increase in GDP per capita the rent goes higher by 5.21%.The result is not significant at 5% significance level. For the quadratic function it is seen 1 unit increase in GDP per capita causes the rent to rise by 0.142 units. Later it goes does down by (2.168×10^{-3})units. Both the results are significant at 5% level. For cubic function, the rent goes up by 0.185 units for a unit increase in GDP per capita, at further goes down by (5.975×10^{-3}) units and finally once again goes up by (5.999×10^{-5}) units. Here, only the quadratic and cubic functional parameter values follow the pattern of EKC hypothesis. It is a more significant finding. It can be illustrated on the basis of pecuniary externality (Titenberg et

al.2018) where the external degradation effect is transferred through altered prices. Even though the resource rent doesn't show any positive and linear significant relationship .But as time passes, the economy shows an exponential growth pattern .Consequently, the rent flows along with the trend of EKC. So Kuznets curve is once again valid significantly in the form of natural resource rent.
(see the results at Table 6)

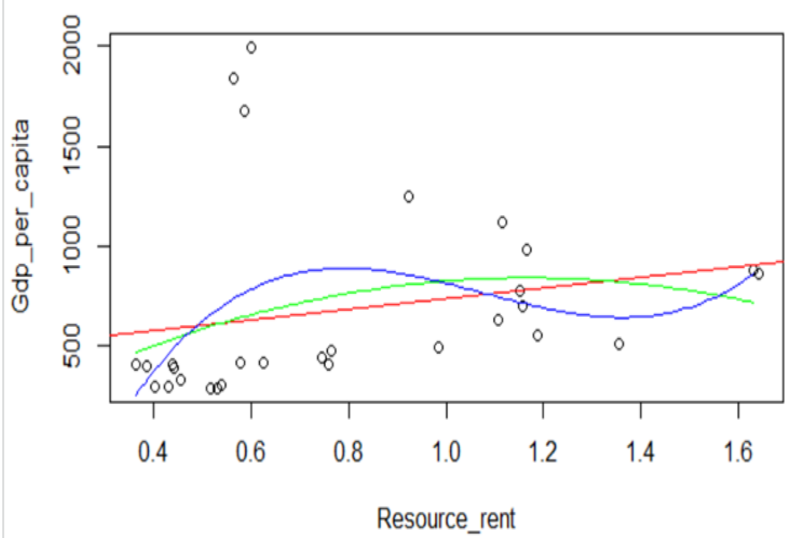
Polynomial regression analysis(Data Visualization)



From first graph all the curves can give possible significant values over the scattered plot. This goes along with the result of our earlier regression analysis. The significant order that can be choosen for carbon emission is 1,2 & 3.So EKC hypothesis once again gets validation on the basis of data visualization.



This second graph gives us the same result as the carbon emission portion. EKC hypothesis will also be significantly tested here. The fitted order will be 1,2 & 3.



From the third graph only 2 of the curves (quadratic and cubic) can give possible significant values over the scattered plot. This goes along with the result of our earlier regression analysis. The significant order that can be chosen for resource rent will be only 2 & 3.So,through this analysis EKC hypothesis once again gets validation on the basis of data visualization.

6. The Cointergration test result

Cointegration is a method to capture the short and long run causal relationship among the mentioned time-series variables. This test is carried out to validate our time series analysis as series analysis sometimes creates the problem of spurious regressions. Analyzing time series without stationarity testing can provide auto correlation problems. To perform the ECM unit root testing is done with ADF method. Unit root test results must show that all the variables are stationary at first differencing with integrated order of 1 or else cointegration test cannot be carried out. The ADF test results are given and explained below for each variables-

Type 3: with drift and trend

	lag	ADF	p.value
[1,]	0	-4.35	0.0105
[2,]	1	-3.63	0.0476
[3,]	2	-2.66	0.3087
[4,]	3	-3.25	0.0981

(Unit-root result for GDP per capita at first differencing)

The table shows that at all the significance levels of the p-values validate significant results. Thus the null hypothesis that GDP per capita has a unit root can be rejected and it will be stationary at first order differencing.

Type 3: with drift and trend

	lag	ADF	p.value
[1,]	0	-6.93	0.0100
[2,]	1	-4.29	0.0126
[3,]	2	-4.27	0.0131
[4,]	3	-4.10	0.0194

(Unit-root result for carbon emission at first differencing)
In this case also the table shows that at all the significance levels of the p-values validate significant results. Thus the null hypothesis that carbon emission has a unit root can be rejected and it will be stationary at first order differencing.

Type 2: with drift no trend

	lag	ADF	p.value
[1,]	0	-6.52	0.0100
[2,]	1	-4.38	0.0100
[3,]	2	-4.10	0.0100
[4,]	3	-3.58	0.0157

(Unit-root result for ecological footprint at first differencing)
In this case also the table shows that at all the significance levels of the p-values validate significant results. Thus the null hypothesis that ecological footprint has a unit root can be rejected and it will be stationary at first order differencing.

Type 1: no drift no trend

	lag	ADF	p.value
[1,]	0	-3.77	0.0100
[2,]	1	-3.62	0.0100
[3,]	2	-1.90	0.0572
[4,]	3	-2.11	0.0370

(Unit-root result for Natural resource rent at first differencing)
In this case also the table shows that at all the significance levels of the p-values validate significant results. Thus the null hypothesis that ecological footprint has a unit root can be rejected and it will be stationary at first order differencing.
However, as it is found out that all the variables are stationary at first differencing now ECM can be performed and lagged term can be obtained to understand whether the variables will converge to equilibrium in the long run or not.
The cointegration model can be written as-

$$Y_t = \alpha + \beta_1 GDPCap_t + \beta_2 GDPCap_t^2 + \beta_3 GDPCap_t^3 + \beta_4 ECT_{t-1} + \hat{u}_t$$

Here, the ECT(error correction term) shows the long run and short run causal relationship. The parameter 'β_4' which is associated with the error correction term is by default negative which implies a correction of short term error that will be adjusted in the long run. The error correction/cointegration term and coefficients are given and explained below-

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDPER)	-0.014466	0.031667	-0.456807	0.6521
CointEq(-1)*	-0.944515	0.203724	-4.636243	0.0001
R-squared	0.587507	Mean dependent var		0.001087

(Table-1)

Firstly we see from (Table-1) that whether the result of carbon emission having a long run equilibrium relationship over GDP per capita. The result shows carbon emission adjusts to GDP with a lag of about 94% and the term is significant. So even though having a high correction magnitude, still the discrepancy will be corrected eventually and will reach a balanced path.

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-1.281322	0.190524	-6.725249	0.0000
R-squared	0.634924	Mean dependent var		0.000780

(Table-2)

From table-2 we happen to see that ecological footprint adjusts to GDP with a lag of about 128% discrepancy. It is quite a high value. The error correction term is supposed to have stay between the value of 0 to -2 and very strictly between 0 to -1.However higher Error correction term value means oscillatory convergence to equilibrium. It means that equilibrium level will be reached but it will take a long time to be corrected. Still this paper's main implication was to find out if there is a significant relationship between the cointegrated variables and the results shown above provide significant causal long term relationship between the mentioned variables.

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NRR(-1))	-0.738394	0.096021	-7.689887	0.0000
D(GDPER)	-0.658134	0.439804	-1.496426	0.1519
D(GDPER(-1))	-0.969160	0.478609	-2.024951	0.0580
D(GDPER(-2))	-1.890102	0.537719	-3.515039	0.0025
CointEq(-1)*	-0.238090	0.097631	-2.438665	0.0253
R-squared	0.850383	Mean dependent var		0.024179

(Table-3)

Table-3 shows that in case of natural resource rent the discrepancy is about 23% which will be corrected and as the value is negative and significant so, eventually the variables have long term causal relationship with each other and will reach to convergence with a lag.

This discrepancies are corrected to be on a convergent path. They are all significant at 5% significance level. This result shows all the degradation variables have significant causal impact on GDP per capita on the long run. It shows that the degradation indicators are indeed potential factors to affect the long term GDP per capita. So using them under the framework of EKC is valid which is already proven with least square method.

The ECM model is chosen to give proper validation on the estimated parameters done by the least square method. Time series analysis might give out autocorrelation results. This is why ECM method is run to capture the long run causal relationship among the variables and justified with the significant results. ARDL(Auto regressive distributive lag)method is also another robust method for time series analysis which requires an extra F-statistic testing to the ECM. Due to representation of the degradation variable impact on the economic growth individually, ECM is chosen. Also all the variables mentioned above are found to be stationary at first differencing and least square method is done to prove EKC. Both the methods are basically derivative of each other. ECM is just a dynamic derivation of ARDL. So justifying the validity of least square parameters with ECM will clear out the spurious regression problem. Already it was shown through the mechanism that ECM creates valid results that are significant and also indicates a causal long run equilibrium relationship.

7. Limitations And recommendations

This study tried to represent environmental quality from different degradation indicators and tried to capture their impact on economic growth individually. The framework which is used to show the relationship was EKC hypothesis. If possible more variables associated with environmental degradation should be detected to make proper environmental valuation and more projections on the environmental scenario can also be made trough more different approaches of analysis.

8. Conclusion

Bangladesh is exposed to only a little percentage of carbon emission. So there is no way the country should fight alone to combat the climate crisis. Underdeveloped nations like Bangladesh are calling for help from developed countries who possess a major share of emission. Finally we can agree with the findings that Carbon emission is a major driving factor of environmental deterioration. Therefore, despite improving life quality, economic growth causes environmental deterioration and resource depletion. This conclusions have a big impact on environmental policies. Therefore, it is required to determine how much capacity there is for EF to affect the decline of environmental quality for including EF in the EKC test. Already the analysis above made it clear that EF significantly contributes to the economy’s unsustainable expansion. Ultimately it can be stated that also the higher natural resource rents bring the indication of environmental quality degradation which leads the economic growth path to be hampered and unsustainable in the long run.

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Appendix

Table 4(Co2)

Linear

Estimate		SD value	Error t value	Pr(>|t|)
(Intercept)	8.349e-02	1.536e-02	5.436	9.47e-06
$Gdpcap_t$	2.568e-04	1.852e-05	13.863	8.53e-14
R^2	0.877			
F Statistic	192.192			

Quadratic

Estimate		SDvalue	Error t value	Pr(>|t|)
(Intercept)	-5.966e-02	1.253e-02	-4.763	6.29e-05
$Gdpcap_t$	6.579e-04	3.193e-05	20.604	< 2e-16
$Gdpcap_t^2$	-1.920e-07	1.492e-08	-12.871	8.73e-13
R^2	0.983			
F Statistic	765.007			

Cubic

Estimate		SD value	Error t value	Pr(>|t|)
(Intercept)	-1.409e-01	2.319e-02	-6.077	2.38e-06
$Gdpcap_t$	9.999e-04	9.157e-05	10.920	5.27e-11
$Gdpcap_t^2$	-5.775e-07	9.980e-08	-5.787	4.95e-06
$Gdpcap_t^3$	1.208e-10	3.105e-11	3.891	0.00065
R^2	0.990			
F Statistic	792.432			

Table 5
(Ecological footprint)

Linear

Estimate		SD value	Error t value	Pr(>|t|)
(Intercept)	4.487e-01	1.915e-02	23.43	< 2e-16
$Gdpcap_t$	2.819e-04	2.309e-05	12.21	1.68e-12
R^2:	0.8466			
F-statistic:	149			

Quadratic

Estimate		SDvalue	Error t value	Pr(>|t|)
(Intercept)	2.752e-01	1.812e-02	15.19	1.93e-14
$Gdpcap_t$	7.683e-04	4.620e-05	16.63	2.25e-15

$Gdpcap_t^2$	-2.328e-07	2.158e-08	-10.79	4.27e-11
R^2	0.972			
F Statistic	451.021			

Cubic

	Estimate	SDvalue	Error t value	Pr(>|t|)
(Intercept)	1.891e-01	3.796e-02	4.980	3.92e-05
$Gdpcap_t$	1.131e-03	1.499e-04	7.543	6.75e-08
$Gdpcap_t^2$	-6.414e-07	1.634e-07	-3.926	0.0006
$Gdpcap_t^3$	1.280e-10	5.083e-11	2.519	0.0185
R^2	0.978			
F Statistic	364.608			

Table 6 (Natural Resource Rent)

Linear

	Estimate	SD value	Error t value	Pr(>|t|)
(Intercept)	0.6846588	0.1240903	5.517	7.61e-06
Gdpcapt	0.0001653	0.0001496	1.105	0.279

Quadratic

	Estimate	SD value	Error t value	Pr(>|t|)
(Intercept)	-3.092e-01	1.653e-01	-1.871	0.0726 .
$Gdpcap_t$	2.951e-03	4.213e-04	7.004	1.95e-07
$Gdpcap_t^2$	-1.333e-06	1.968e-07	-6.774	3.45e-07
R^2	0.654			
F Statistic	24.565			

Cubic

	Estimate	SD value	Error t value	Pr(>|t|)
(Intercept)	-1.245e+00	3.272e-01	-3.806	0.000815
$Gdpcap_t$	6.890e-03	1.292e-03	5.333	1.58e-05
$Gdpcap_t^2$	-5.774e-06	1.408e-06	-4.100	0.000383
$Gdpcap_t^3$	1.392e-09	4.381e-10	3.177	0.003935
R^2	0.753			
F Statistic	25.467			