AN EMPIRICAL INVESTIGATION OF THE VALIDITY OF THE EHRLICH-COMMONER ENVIRONMENTAL IMPACT IN PAKISTAN

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Abstract

Environmental damage is of serious concern for people of the contemporary world. Pakistan is also suffering from environmental damage. Different consensus existed about of existence of environmental Damage, one of which is Ehrlich-Commoner environmental impact. Therefore, this study aimed to test its validity in Pakistan during 1980-2016. Data is of time series nature, stationerity checking is necessary and ADF is used for stationerity. Mix order of stationarity disclosed by the test. Resultantly, ARDL technique is suitable for estimation. Firstly, bound confirmed the existence of co-integration. In the next step long run and short run parameters are estimated. Results revealed that the variables population growth and consumption per capita are positive and significant to CO2 emission in both long run and short run. Economic growth is found positive but insignificant. Educational Expenditure is found negative to CO2 emission. It is suggested that government may reduce pollution by taking population growth, consumption and education into account.

Keywords: Population Growth, Environmental Impact, Co-Integration, Educational Expenditure.

JEL Classification: Z000

Introduction

Increasing population is one of the important threats to the modern world. To manage and satisfy the needs of increasing population put burden on the use of existing resources and environment. Resource conservation and sustainable development is goal and became the slogan of the contemporary world. Because, the recent race in growth damaged the world's environment. The depletion of resources and high population growth is mostly observed in the developing world. It is argued that the existence in lake of resources is due to mass increase in. Therefore, population increase, resource depletion (surge in utilization population) and environmental degradation are emerged in literature closely to each other.

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Developing countries experienced high population growth during 20th century and the world of the 20th and 21st century witnessed it consequences. One of the consequences is environmental damage. Pakistan is developing country confronting the challenge of enormous growth in population; even their population growth is highest among the developing countries (Afzal, 2009). It is stood at 6th in the world with a population of about 210 million along with growth rate of 1.95% in 2017 (GOP, 2018). The considerable increase in total population every year is a challenge for the policy makers to provide them basic necessities i.e. food and shelter. As population increases the aggregate demand (Increase in consumption) will increase. The additional population demand more for basic necessities which cause increase in land use for agricultural and residential purposes leads to deforestation (Ahmad, *et al*., 2005). Moreover, to achieve higher growth intensive use of technology were experienced. An intensity use of inputs in production leads to increase damage in resource (Ali et al., 2013).

The first theoretical perception about population growth and environmental damage was presented by Malthus (1798). He was of the vision that population growth is a real problem and intensifies the use of existed resources which hurt natural resources (environment). A debate was commenced later on of his writing; both supports and critiques are emerged. In this connection Ehrlich and Commoner portrayed the negative influence of population growth in term of environmental impact:

$$I = P \times F \quad (1)$$

Equation (1) explained that environmental damage is caused by the increase in total population and (P) and Environmental damages (F) per capita. According to Ehrlich and Commoner the F-term is undefined and can be defined in a verity of ways. To avoid complexity in expression (I) they defined the F-term as:

$$F = \int \{c, t, g(t)\} \quad (2)$$

By the addition of F-term to expression, it become as:

$$I = \int \{P, c, t, g(t)\} \quad (3)$$

Where the term 'I' is the Environmental Impact and key factors explaining are percentage rise in total population 'P', average consumption per capita 'c', technology 't' used in the productive environment and economic growth 'g(t)' achieved in time 't'.

Many studies in literature conducted related environmental degradation assumed that there

are several factors which causes of environmental damage but population growth contributed more aggressively in developing countries, even in developed countries (O'Neill *et al.,* 2001; Bongarrts, 1992; Dietz & Rosa, 1994). It contributed directly and indirectly to environmental damage. Along with increase in population growth, human activities like production and consumption cause to increase Carbon dioxide emission (Mir & Storm, 2016). It breakout Greenhouse Gases and as a result world's temperature get warmer and warmer (Watson, *et al*., 1996). Rise in Population increase the use of woods which creates the phenomena of deforestation, in return Carbon consumption reduces (Thomes & Rosa, 1997). Developing countries are considered responsible the disaster of natural resources due to their higher contribution in the world's population.

In this connection Carbon Kuznets Curve concept highlighted that in the start of the growth in per capita income environmental degradation increases with the increase in growth while it declines after some time and with further increase in growth degradation fall with per capita income increase. It means with the increase in growth at beginning CO_2 emission increases (because of intensification in the use of resources and excessive use technology in industrialization) goes to its highest and then starts to fall afterward a thresh hold level of output. Whenever the economy got enough growth and became developed. After satisfaction the needs of the society they start thinking about the sustainability and decrease the CO_2 production (Mir & Storm, 2016).

Developed countries hurt environment more than of the developing countries in the few last decades. Some of the developed countries are the main contributor to CO_2 emission. They got tremendous growth and development on the cost of high environmental degradation. Some of the developing countries are also in the list of high CO_2 emitters countries (Ahmad, 2018). China is on the top of CO_2 emitter developing country and USA is developed CO_2 country. To get higher growth Pakistan also tried a lot in the last few decades. Pakistan got enough growth while not got successful to get consistent growth. All the sectors are operated extensively i.e. Agriculture sector, Industrial sector, and Service sector. Pakistan got enough growth in its services and industrial sector development but agriculture sector not so much successful. The Share of agriculture sector to overall output of the economy falls over time while the shares of services sector and Industrial sector to total output are increased over time. Such diversion from agriculture sector to industrial and services sectors put pressure on environment (Khan & Khattak, 2014).

Sustainable development can be achieved by reducing the harmful effects of industrialization and use of technology in productive environment to minimize the CO_2 emission (Shehbaz et al., 2012). Ehrlich and Holdren (1972) presented a well-known concept by stating that the key determinants of environmental pollution are sizeable population, affluence and implementation technologies. They introduced the IPAT equation, by suggesting association between population, consumption, industrialization, affluence, technologies and environment. Many researchers adopted this equation to analyze the factors affecting environmental degradation in different economies. In this connection present study aimed to investigate IPAT model or hypothesis presented by Ehrlich-Commoner for the

country Pakistan during the period of 180-2016.

Materials and Methods

The foremost emphasis of the present work is to test the legitimacy of Environmental impact (IPAT Model); different studies have been conducted regarding Ehrlich-Commoner environmental impact. Researchers also added various aspects which considerably affect environmental damage. These factors included Population growth, urbanization, migration, and increase in output, energy consumption, and cheap level of technologies, economic growth, industrialization and per capita consumption. They exposed positive association between these factors and degradation of the environment. On the other hand, intensive use of sophisticated technology is reported inversely related to environmental degradation. They used time series and panel data for the estimation purpose. Literature reveals that some of the studies have been employed different models and different techniques relating to Ehrlich-Commoner environmental impact. In regard of environmental degradation mostly researchers have used descriptive techniques and some of them have used different model i.e. OLS, GMM Estimator, STIRPAT Model, Cross Country Analysis and Ridge Regression Method.

Similarly, many of the studies have focused on to elucidate the association between increase in population, average consumption per capita, growth and the intensity of industrialization for productivity with environmental degradation. However, in context of Pakistan, Ehrlich-Commoner environmental impact yet not tested. This study is the first ever study regarding the investigation of IPAT model to Pakistan economy.

To investigate this impact, the model is adopted.

$$I = \alpha + \beta_1 PG_t + \beta_2 CG_t + \beta_3 Y_t + \beta_4 E_t + \mu \quad \text{.....} \quad (4)$$

Where,

I	=	Environmental Impact (Proxy by CO_2Emission).
PG	=	Population Growth
CG	=	Consumption
Y	=	Percentage increase in output.
E	=	Expenditure on Education as % of GDP
μ	=	Normally Distributed Error Term

The data for the variables mentioned in the model are existed over the selected period of time. We deal with time series data; therefore, stationerity testing is necessary. Augmented Dickey Fuller (ADF) test is employed to exposed the order of stationerity. The selection of suitable technique for estimation of the parameters is decided after stationerity checking. ARDL estimation technique is considered for parameters estimation.

If the value lies lower than the lower bound, it indicates that our interested variables are not co-integrated. The null hypothesis will be accepted if F-statistic falls shorter than the upper bound critical value. The hypothesis will be neither accepted nor rejected if F-statistic falls between lower and upper bound and will be rejected if F-statistic falls above the upper bound critical value. Model is of the form:

$$\Delta I = \alpha_0 + \sum \alpha_1 \Delta I_{t-1} + \sum \alpha_2 \Delta X_{t-i} + \infty_1 I_{t-1} + \infty_2 X_{t-1} + \mu_t \quad (5)$$

In the above X_t showed regressor which are already defined as population growth, consumption, real output of the economy and expenditure made on education as % of total output of the country). Long run relation existence is tested with the help of Bound test. Test is grounded on the following assumptions.

$H_0 = \infty_1 = \infty_2 = 0$ (No Co-integrational relationship)

$H_1 = \infty_1 = \infty_2 \neq 0$ (There is Co-integrational relationship)

Decision regarding the existence of long run relationship depends on the value of the F-statistic (Pesaran, 2001). If the value of the F-Statistic is less than the upper bond critical value defined, we accept the null hypothesis and reject alternative hypothesis. Once the long run association existed confirmed, in the next step long run and short run coefficient are estimated. The long run and short run parameters are estimated with the help of the following equations.

$$I = \alpha_0 + \sum \alpha I_{t-i} + \sum \beta_1 PG_{t-i} + \sum \beta_2 CG_{t-i} + \sum \beta_3 Y_{t-i} + \sum \beta_4 T_{t-i} + \mu_t \quad (6)$$

And

$$\Delta I = \alpha + \sum \alpha \Delta I_{t-i} + \sum \beta_1 \Delta PG_{t-i} + \sum \beta_2 \Delta CG_{t-i} + \sum \beta_3 \Delta Y_{t-i} + \sum \beta_4 \Delta T_{t-i} + Ect_{t-1} + \mu_t \quad (7)$$

Data Collection

The time period of the study is from 1980 to 2016. The data for the same purpose are collected from different sources. These sources are Pakistan economic survey, World Bank website and Stat Bank of Pakistan website.

Data Description

The variables which are used in this study are; Environmental degradation (CO_2 emission), economic growth, percentage increase in consumption, population growth and Technology

(Educational expenditures).

- I = CO_2 Emission: the data is defined and measure in metric tons per capita
- PG = Change in Population
- CG = Consumption Per Capita
- Y = GDP (Total real output of the economy)
- E = Educational Expenditure as % GDP used as a proxy for R&D because the data for Research and Development in most of the developing countries are unavailable. The same proxy is already used by Khan and Khattak (2014), Tahir, et al. (2014).

Results

The testing of series relationship and the analysis of co-relationship used a unit root test because the nature of data of our study is time series.

This study used ADF test to check the stationarity on data. Table no. 1 explaining the ADF results to check whether the data is at first difference or at level for the above described variables mentioned in the model (I, PG, CG, Y & E).

Table 1
ADF Test Results

	I(0)			I(1) at 1 %			
Var	**A**	**B**	**C**	**A**	**B**	**C**	**Con**
I	-6.602	-4.241	0.000	---	---	---	I(0)
PG	-2.890	-2.735	0.003	---	---	---	I(0)
C	-5.600	3.715	0.000	---	---	---	I(0)
Y	-3.690	-3.700	0.007	---	---	---	I(0)
E	-2.012	-3.700	0.250	-4.703	-3.640	0.000	I(1)

NOTE: Where Var= Variables and Con= Conclusion, The litters A=Calculated statistic, B=Critical value and C= Probability.

The bird eye view of the above table enables us that all the variables are stationary at level except health expenditure as percentage of GDP. We can conclude from the stationerity testing that we have mix order of stationerity level of the variables at 1% of significance. Therefore, we can proceed with ARDL technique.

Table 2
Long Run Relationship Existence Testing

Bound Test		
	value	**k**
F-Statistic	6.554	4
Significant %	Lower Bound	Upper Bound
10	2.673	3.172
5	2.975	4.015
1	3.801	5.017

The values of the F-Calculated and F-critical are compared in the Table-2. It is clear from the values that there is co-integrational relationship existed. Because, the estimated value of F-statistic i.e. F=6.4435 is greater than the upper class boundary at 1% critical values of significance.

Table 3
Long Run Co-efficient

Variable	**Parameters**	**Std. Error**	**t- Value**	**P- Value**
PG	6.032	1.670	3.611	0.003
CG	0.513	0.930	2.701	0.019
Y	0.351	0.758	0.463	0.651
E	-0.970	2.753	-2.168	0.050
C	-11.801	5.763	-2.047	0.063

Results in Table-3 shows that there is co-integrational relationship between the variables. The positive sign of the coefficient of Population growth shows the positive impact on CO_2 emission in long run having 6.03 co-efficient values which is significant statistically. It is obvious from the above results that 1 percent rises occur in population growth is caused to increase Carbon emission by 60.3%. The variable Consumption growth is significant statistically, while the positive sign if the coefficient shows the positive impact of consumption growth on Carbon Emission having 0.51 coefficient value. It is stated from the results that if consumption increase by 1 percent will leads to increase Carbon emission by 51 percent. The variable Economic growth is insignificant statistically and positive sign show that it is directly correlated with depended variable which having 0.35 of coefficient value. It is obvious from the above results that 1 percent increase in economic growth is caused to increase Carbon emission by 35 percent. The variables Educational Expenditure is significant statistically, while the negative sign of the variable confirms inverse relationship between educational expenditure and CO_2 emission in Pakistan. In the long run the coefficient of educational expenditure is -5.97. It

reflects that if Educational Expenditure increased by 1 percent CO_2 will be reduced by 5.9 percent.

Table 4
Error Correction Representation

Dependent Variable: I				
Selected Model: ARDL(3, 3, 3, 3, 2)				
Date: 03/06/18 Time: 19:49				
Sample: 1980-2016				
Var	**Coeff**	**Std. Error**	**t-Value**	**P-value**
D(I(-1))	-0.524	0.308	-1.701	0.114
D(I(-2))	-0.538	0.285	-1.888	0.083
D(I(-3))	-0.339	0.171	-1.976	0.071
D(PG)	0.964	41.542	0.772	0.454
D(PG(-1))	0.624	93.145	2.948	0.012
D(PG(-2))	0.451	36.699	-4.344	0.001
D(CG)	0.641	0.196	3.270	0.006
D(CG(-1))	0.984	0.273	-3.598	0.003
D(CG(-2))	0.661	0.284	-2.321	0.038
D(Y)	0.449	0.433	1.037	0.319
D(Y(-1))	0.492	0.399	-1.233	0.241
D(Y(-2))	0.196	0.440	-0.446	0.663
D(Y(-3))	0.934	0.394	2.366	0.035
D(E)	-0.174	3.431	-2.673	0.020
D(E(-1))	-0.550	3.463	-3.045	0.010
Ect	-0.998	0.306	-3.383	0.005

Co-inteq = I - (6.032*PG + 2.513*CG + 0.351*Y -5.970*E -11.801)

It short run results are given in Table-4. The variable population growth is found positive and significant statistically in the short run. Means that it directly affected environmental degradation with the coefficient value is 0.96, while 0.62 is at 1st lag and 0.45 is at 2nd lag. While the variable consumption growth is significant statistically in short run which has also direct effect on environmental degradation. The coefficient value of CG is 0.64, while 0.98 is at 1st lag and 0.66 is at 2nd lag. In contrast to that coefficient of total output growth represented by 'Y' (economic growth) is found positive but statistically insignificant. Which means that output growth has no contribution to the determination of environmental impact inthe short run? It coefficient value is 0.44, while 0.49 is at

1st lag, 0.19 is at 2nd lag and 0.93 is at 3rd lag. However, the coefficient of educational expenditure is significant statistically and presenting inverse relation with environmental degradations in short run. The coefficient value of E is -0.17 and -0.50 is at 1st lag.

Table 5
LM-Test Serial Correlation

F statistic	2.006
Obs* R2	8.998
Prob. F (2,10)	0.1904
Prob- (2)	0.0081

It is clear from the table-5 given above that the problem of serial correlation not present in the model with the selected variables. The purpose mentioned above Breusch-Godfrey test is used here to diagnose the problem of Auto Correlation.

Cumulative Sum of Recursive Residual and Cumulative Sum of Recursive Residual of Square tests are used to test the stability of the parameters in the model. For the said purpose graphical presentation are given in the following figures at at 5% level showed that the model is stable at 5% level of significance. As, it is clear from the figures that the estimated line falls between the critical bound limits showed in both the figures. Both CUSUM and CUSUMSQ showed that the model is well specified and stable with in the selected period of time.

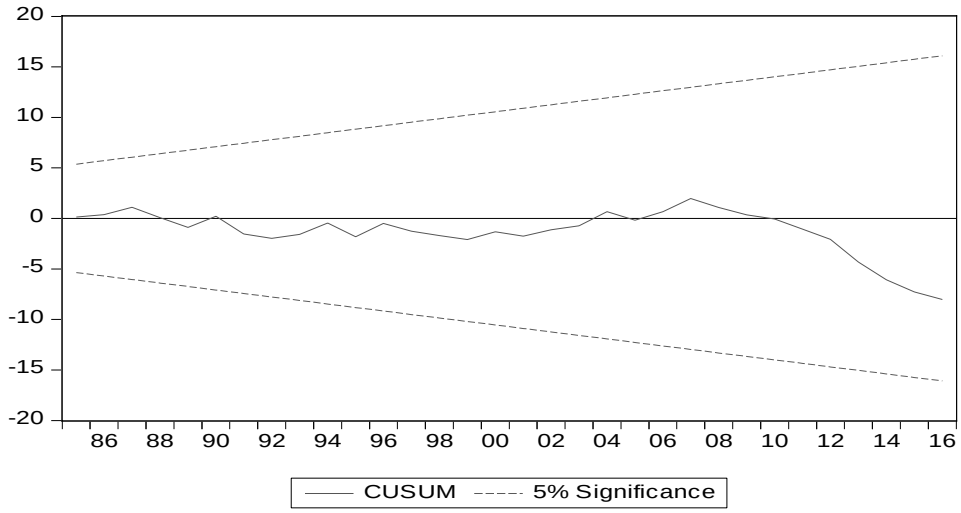

Figure 1: Result of CUSUM

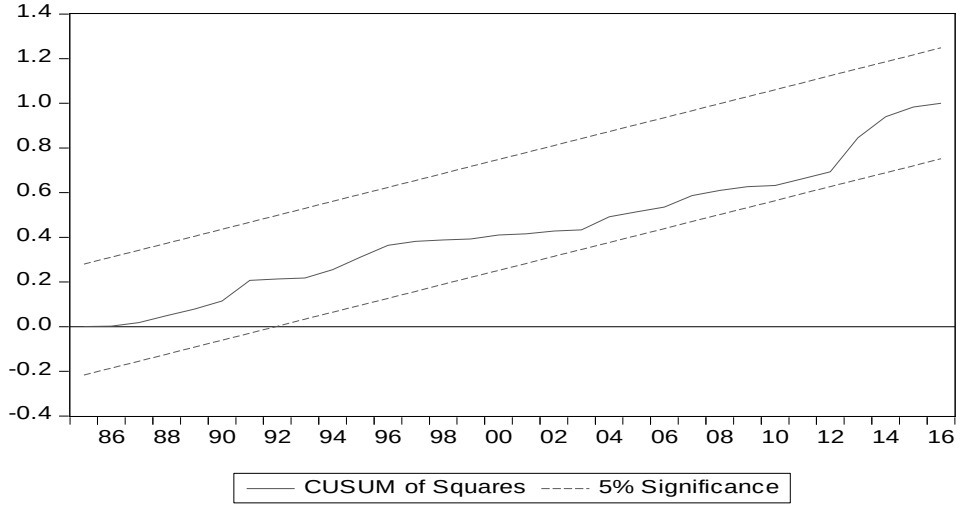

Figure 2: Results of CUSUMSQ

Discussion and Conclusion

The prime aim of the study is to investigation Ehrlich-Commoner environmental impact in Pakistan. The importance of the study is cleared from the previous literature mostly related with IPAT model. Every researcher examined the different views about the impact of Population growth, Domestic Consumption, Economic Growth and Technology on CO_2 emission. Mostly studies agreed on that environmental damage is due to population growth, increase in consumption, economic growth. In this connection, Ehrlich-Commoner impact is investigated for Pakistan which is ignored. In this regard data are got from WDI and Economic survey of Pakistan for the period of 1980-2016.

As the data is of time series nature, stationerity is tested through ADF test. Mixed order of stationerity is reported by the ADF test. Literature suggests ARDL Co-integration technique for estimation purpose. The Bound test result confirms the existence of co-integration. Results declares that population growth is founded positive and significant statistically. The results of the present study supported the outcomes of the studies conducted by Bilsborrow (1992), Birdsall (1992), Commoner (1993), Nagdeve (2002), Pradhan (2004), Neumayer and Cole (2004), Azhar*et al.* (2005) and Bjerke and Rickardsson (2017). The variable consumption is also founded statistically significant with positive sign in both long and short runs. Muhammad *et al.* (2011) and Zhu and Peng (2012) also end with the same findings. They are also of the view that there is positive association between consumption and environmental degradation. The impact of population is found positive but insignificant statistically. Conversely, the variable technology (Education Expenditure) is founded significant statistically

and has indirect relation with environmental impact in both long and short runs. The results of the presented supported the findings regarding educational expenditure and environmental degradation conducted by Jorgenson (1993), Goklany (2009) Ehrlich (2014) and Bjerke and Rickardsson (2017).

Some diagnostic tests are also incorporated to check some of the well-known econometric problems associated with econometric problems. These tests are serial correlation test, CUSUM and CUSUM square. No serious problem is reported by tests.

Some policy suggestions are advised on the basis of the findings of the present study for the survival and preservation of the environment. To overcome the problem of preservation of the environment Government should pay special attention towards population growth control the additional bulk of population every year which put pressure on natural resources and adversely affect environment. People should to spend and invest in those products which have less harmful impact on environment. It may be control through to provide substitute against those products which generate environmental problems. Expenditure on education should be increased in order spread awareness in people to protect the environment.

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