THE ENVIRONMENTAL KUZNETS CURVE (EKC): AN ANALYSIS FOR THE BALKANS

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ABSTRACT

The issue of relations between global climate change and the level of economic activity, lately, has occupied an important role in the field of research. The Environmental Kuznets Curve (EKC) hypothesis postulates an inverted – U – shaped relationship between different pollutants and per capita income. The shape of this curve represents the idea that as incomes rise, the environmental pollution initially increases up to a certain point and then begins to decline. Several studies confirm this behaviour to environmental degradation, but many others say that only some pollutants show the evidence of an EKC. Some countries may represent different shape of the EKC and/or different predicted turning point in income. The article aims to demonstrate, with an econometric model, the EKC for countries in the Balkan region using data from World Bank. As the countries of this region indicate changes in the political, social, economic and biophysics factors, is expected that they exhibit different behaviour of the relationship between environmental pollutants and income. Thus developing countries, applying the standards adopted by developed countries, can bring its environmental policies in accordance with the conditions prevailing in each country.

Keywords: *Economic growth, Environment, Environmental Kuznets Curve (EKC), Pollution, Turning point, Inverted U-shape*
JEL Classification: *Q, E, O*

1. Introduction

There has been a profound debate about the connection of economic growth to environment degradation for a long time. There are two different approaches on this topic. One of them supports the idea that economic growth brings an environmental degradation, whereas the other approach favours the fact that economic growth improves environmental quality.
Economists, in the early'90s, noticed a connection of economic growth to environment degradation, which was known as Environmental Kuznets Curve (EKC) and served as a support for economists further analysis on this field. Grossman and Krueger's first study (1991) proved that there was an interconnection of economic growth to environmental quality and this interconnection follows the inverted-U-shape. The curve shape shows that little attention is given to the economic growth and industrialisation effects on the environment during their first steps. For this reason, the extent use of resources and technology and excessive emission of pollutants increase the environmental pollution, which means its quality reduction. This stage is followed

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by another one that is economic growth which results in income increase and makes the individuals think about their living conditions quality, seeking a cleaner environment. Different studies, which take into account places and various environment polluters favour this curve form EKC, but many others, as Panayotou (1997), state that the relationship of economic growth with polluters is monotonic and positive.

The occurrence of curve different shapes EKC, in a certain way, is expected as far as the countries, taken into consideration, have experienced significant economic, social, political and biophysical changes. Different surveys conducted on EKC demonstrate that there are some factors which affect the shape of EKC. They are:

a) The income elasticity of environment demand

Increase of individuals' living standard through economic and income growth results in a greater environmental quality demand so it encourages structural changes in the economy which brings the decrease of the environmental degradation.

Dinda (2004) states that when income elasticity over environment quality is greater than one, the environmental cleaning and preservation are considered "luxury goods", but the majority of environmental degradation indicators have a linear increase, in which income elasticity is less than one and environmental degradation isn't just an income function.

b) The effect of economic scale, technology and structure

According to Bo (2011), the scale effect is related to the production increase which asks for a greater consumption of resources and energy causing such a pollution that deteriorates the environment quality. Along with the income increase, economic structure tends to alter by enhancing gradually clean-up activities, presenting, in this way, a structural effect. Technological effect is shown when old polluting technology is substituted by a new one which improves environmental quality.

c) International trade

Free trade presents two opposing impacts in the environment. In one hand, the trade between countries leads to the increase of the size of the economy that increases pollution and, on the other hand, the trade enables the transfer of the new and advanced technology through foreign direct investments.

2. Literature review

The first study of the relationship between environmental degradation and economic growth was conducted by Grossman and Krueger in 1991. Their panel data contains 42 countries for sulphur dioxide (SO_2), 19 countries for dark matter and 29 countries for suspended particles. The years of investigation are 1977, 1982 and 1988. The EKC was not confirmed in the case of SO_2 and dark matter which found to follow an N-shape pattern and suspended particles an inverted-U-shape.

Seldon and Song (1994) analyse a relation, in panel data, between growth and pollution indicators for three different periods of time: 1973-1975, 1979-1981 and 1982-1984. The pollutants are SO_2, nitrogen oxide (NOx), carbon oxide (COx), and suspended particles. Panel data analysis with cross section, fixed and random effects confirm the validity of the EKC hypothesis.

A year after, Seldon and Song (1995) examine the validity of the EKC hypothesis, for 130 countries, between carbon dioxide (CO_2) emissions and Gross Domestic Product (GDP) for the period 1951- 1986. The panel data analysis that they apply allows for fixed and country specific effects.

Shafik (1994) explored the relation between GDP and environmental degradation for 149 countries covering time period from 1960 to 1990. Panel data analysis based on Ordinary Least Square estimates show that from pollution indicators such clean water, urban sanitation, suspended particles, SO_2, dissolved oxygen, faecal coli forms in river, carbon emissions, municipal waste and deforestation, the EKC hypothesis is confirmed only for SO_2 and suspended particles.

The years and time periods in Grossman and Krueger (1995) study are 1977, 1982, 1988 and 1979 – 1990. This study was conducted for the reduced form relationship between per capita income and various environmental indicators such as urban air pollution, the state of the oxygen regime in river basins, faecal contamination of river basins and contamination of river basins by heavy metals. Panel data analysis with random effects confirms the validity of the EKC hypothesis.

Tucker (1995) used a panel data analysis for 137 countries to investigate the EKC hypothesis for the period 1971 – 1991. For the majority of the countries the findings shows that the EKC is confirmed.

In 1997, Moomaw and Unruch used a sample of 16 developed OECD countries for the period 1950 – 1992. They used a structural transition model to examine the relationship between CO_2 emissions and GDP in the panel data. The results confirmed the EKC hypothesis for the period under examination but with inverted-V shapes and not inverted-U shaped curve.

Stern and Common (2001) used an emissions database produced for the US Department of Energy that covers a larger range of income levels and includes more data points than any of the other sulphur EKC studies. In conclusion, the studies that used more globally representative samples of data find that there is a monotonic relationship between sulphur emissions and incomes just as there is between carbon dioxide and income.

We continued our study by describing the data and the methods we use in the analysis and later, with the estimation of panel models.

3. Model specification and data

To determine the nature of the relationship between environmental quality and economic growth in Balkans, the study draws model from both the EKC and the original Kuznets curve literature. The underlying hypothesis is that the relationship between economic growth and environmental quality is not monotonic and may change direction from upward to downward when a country reaches a certain level of income. The earliest EKCs (Grossman and Krueger (1991)) were simple quadratic functions of the levels of income in the following form:

$$\left(E/P\right)_{it} = \beta_0 + \beta_1 y_{it} + \beta_2 y_{it}^2 + u_{it}$$

Where *E/P* denotes the index of environmental pollution per-capita and *y* is per-capita real GDP. Moreover, i denotes countries, t is time, β_0 is constant and β_k is the coefficient of the *k* explanatory variables.

This model provides us to test several forms of environment-economic development/growth relationship:

a) $\beta_1 = \beta_2 = 0$. A flat pattern or no relationship between *(E/P)* and *y*.
b) $\beta_1 > 0, \beta_2 = 0$. A linear relationship between *(E/P)* and *y* with positive slope.
c) $\beta_1 < 0, \beta_2 = 0$. A linear relationship between *(E/P)* and *y* with negative slope.
d) $\beta_1 > 0, \beta_2 > 0$. A monotonically increasing relationship among the variables.
e) $\beta_1 < 0, \beta_2 < 0$. A monotonically decreasing relationship among the variables.
f) $\beta_1 > 0, \beta_2 < 0$. An inverted-U-shaped relationship.
g) $\beta_1 < 0, \beta_2 > 0$. A U-shaped relationship.

To have a normal distribution for the GDP per capita and N_2O per capita data, we have transformed them in their natural logarithm. For this, the two econometric models are:

$$(CO_2)_{it} = \beta_0 + \beta_1 lny_{it} + \beta_2 (lny_{it})^2 + u_{it}$$
$$(lnN_2O)_{it} = \beta_0 + \beta_1 lny_{it} + \beta_2 (lny_{it})^2 + u_{it}$$

The empirical analysis considers panel data for eight countries of Balkans (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Romania and Slovenia) for the period 1995-2012. The independent variable *lny* represent the natural logarithm of Gross Domestic Product per capita,which is calculated by dividing gross domestic product to mid-year population. Data are in current U.S. dollars. The independent variable *(lny)*^{2} represent a proxy for later stage of economic growth. The dependent variables Carbon Dioxide (CO_2) and Nitrous Oxide (N_2O) emissions per capita are measured in metric tons per capita and represent a proxy for environmental degradation. The variable lnN_2O is the natural logarithm of N_2O emission. The variables are collected from the official website of World Bank.

4. Methods of data analysis and estimation techniques

In the econometrics model the methodology is based on data analysis that includes the selection of fixed or random effect model, unit root test, and co-integration test. All the analysis in the study was conducted using EVIEWS software.

The paper applied the Haussman effect test to check which model is appropriate, the fixed effect or random effect. The Pooled effect model is eliminated because this model suppose the homogeneity of these countries that is not conform to the reality. Table 1 shows the results for fixed and random effect, for both the pollutants.

Table 5: Fixed and Random Effect for CO_2 and lnN_2O

	Fixed Effect CO_2		Fixed Effect lnN_2O		Random Effect CO_2		Random Effect lnN_2O	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	-13.24513	0.0038	5.051735	0.0000	-12.43754	0.0066	5.070351	0.0000
LNY	4.074752	0.0003	0.755826	0.0076	3.832553	0.0007	0.749854	0.0080
LNY2	-0.220915	0.0014	-0.051349	0.0031	-0.203836	0.0028	-0.050910	0.0033

Independent variables *lny* and *(lny)*^{2} are significant for the dependent variables in both models. The coefficient for the variable *lny* is positive and this of variable *(lny)*^{2} is negative.

The Haussman test, with p = 3.48% for CO_2 per capita panel data and p = 56.98% for lnN_2O panel data shows that Fixed Effect Model is better for the first panel data and Random Effect Model is better for the second one.

Table 6: Unit Root Test

	Level			1st difference		
	Intercept	Intercept Trend	None	Intercept	Intercept Trend	None
	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.
CO_2						
Levin, Lin & Chu t*	0.0004	0.7324	0.5046	0.0000	0.0000	0.0000
Breitung t-stat		0.9976			0.0282	
Im, Pesaran and Shin W-stat	0.0349	0.8999		0.0000	0.0000	
ADF - Fisher Chi-square	0.0396	0.3100	0.8642	0.0000	0.0000	0.0000
PP - Fisher Chi-square	0.2086	0.5034	0.8221	0.0000	0.0000	0.0000
lnN_2O						
Levin, Lin & Chu t*	0.2375	0.0013	0.0107	0.0000	0.0000	0.0000
Breitung t-stat		0.7142			0.0000	
Im, Pesaran and Shin W-stat	0.3822	0.0875		0.0000	0.0000	
ADF - Fisher Chi-square	0.2714	0.1119	0.0596	0.0000	0.0000	0.0000
PP - Fisher Chi-square	0.0418	0.2024	0.0046	0.0000	0.0000	0.0000
Lny						
Levin, Lin & Chu t*	0.0000	0.6578	1.0000	0.0000	0.0029	0.0000
Breitung t-stat		0.9989			0.3418	
Im, Pesaran and Shin W-stat	0.2797	0.2125		0.0001	0.5829	
ADF - Fisher Chi-square	0.2494	0.3370	1.0000	0.0004	0.2755	0.0000
PP - Fisher Chi-square	0.7677	0.9542	1.0000	0.0004	0.0701	0.0000
$(lny)^2$						
Levin, Lin & Chu t*	0.0000	0.7626	1.0000	0.0000	0.0101	0.0000
Breitung t-stat		0.9989			0.4335	
Im, Pesaran and Shin W-stat	0.3531	0.2856		0.0002	0.6894	
ADF - Fisher Chi-square	0.3823	0.3913	1.0000	0.0010	0.3835	0.0000
PP - Fisher Chi-square	0.9244	0.9633	1.0000	0.0010	0.1361	0.0000

Unit root test is to ascertain for stationary of the variables. A variable is said to be stationary if it's mean, variance and auto-covariance remains the same no matter at what point we measure them. A number of tests are available in the literature to check the existence of the unit root problem both in the level of the variables as well as in their first difference. To test the unit root property of the variables, the paper employed different tests: Levin, Lin & Chu t*, Breitung t-stat, Im, Pesaran and Shin W-stat., ADF - Fisher Chi-square, PP - Fisher Chi-square. In all this tests the null hypothesis is that panels contain unit roots and the alternative one is that panels are stationary. Table 2 show that all the variables, at level are not stationary but they became stationary in their first difference, testing in the model with intercept, intercept and trend and no intercept or trend.

The concept of co-integration can be described as a systematic co-movement among the variables over the long-run. One of the most widely used approaches to test for co-integration is Johansen co-integration test. We apply Pedroni method of Johansen co-integration test. Table 3 shows that the variables have a long run balance among them.

Table 7: Johansen Cointegration Test

	Model with CO_2		**Model with lnN_2O**	
	Statistic Prob.	Weighted Statistic Prob.	Statistic Prob.	Weighted Statistic Prob.
	Intercept			
Panel v-Statistic	0.9020	0.9193	0.8307	0.8424
Panel rho-Statistic	0.0005	0.0072	0.0001	0.0001
Panel PP-Statistic	0.0000	0.0000	0.0000	0.0000
Panel ADF-Statistic	0.0000	0.0000	0.0000	0.0000
Group rho-Statistic	0.0742		0.0044	
Group PP-Statistic	0.0000		0.0000	
Group ADF-Statistic	0.0000		0.0000	
	Intercept and Trend			
Panel v-Statistic	0.9985	0.9989	0.9974	0.9975
Panel rho-Statistic	0.0179	0.1010	0.0293	0.0318
Panel PP-Statistic	0.0000	0.0000	0.0000	0.0000
Panel ADF-Statistic	0.0000	0.0000	0.0000	0.0000
Group rho-Statistic	0.3034		0.2153	
Group PP-Statistic	0.0000		0.0000	
Group ADF-Statistic	0.0000		0.0000	
	No Intercept or Trend			
Panel v-Statistic	0.5697	0.6254	0.3897	0.4622
Panel rho-Statistic	0.0000	0.0005	0.0000	0.0000
Panel PP-Statistic	0.0000	0.0000	0.0000	0.0000
Panel ADF-Statistic	0.0000	0.0000	0.0000	0.0000
Group rho-Statistic	0.0021		0.0007	
Group PP-Statistic	0.0000		0.0000	
Group ADF-Statistic	0.0000		0.0000	

5. Conclusions

This study aimed to verify the relationship between environmental degradation and economic growth in Balkan countries by questioning the existence of environmental Kuznets curve. Analyzing the study results that the pollutants carbon dioxide per capita and nitrous oxide per capita have both short-run and long-run balanced relationship with income per capita. The function of both these pollutants is a quadratic one, which shows that an increase in the income levels in a first stage implies a rise in both the pollutants but a decreasing trend for them in a second stage. The outcome is supportive of literature.

On the bases of this finding when other indicators remain constant, the future economic growth in Balkan countries can contribute positively for environmental improvement. To realize this argument the countries should has to sustain the current situation which projects increasing share of service sector in the economy, sustaining the current green economy targeted development policies, sourcing energy from climate resilient green energy and implementing the right environmental governmental and economic policies.

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