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THE ENVIRONMENTAL KUZNETS CURVE IN BULGARIA

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ABSTRACT

This paper carries out an empirical test of the Environmental Kuznets Curve hypothesis with Bulgarian data on pollution and GDP per capita for the years 1970–2008. The existence of such a curve is confirmed in most cases.

Keywords: environment, Environmental Kuznets Curve, pollution, GDP-per-capita

INTRODUCTION

The Environmental Kuznets Curve represents an inverted-U relationship between a certain pollution indicator and GDP per capita. The idea is that at low levels of income, pollution will increase, while at high levels of income pollution decrease. A turning point will be reached, after which pollution diminishes.

Grossman and Krueger (1991) first introduced the Environmental Kuznets Curve (EKC) hypothesis for different environmental indicators such as CO2 emissions. It was well received, especially by international organizations responsible for public policy. The idea that economic growth resolves environmental problems is indeed very appealing: the idea that economic growth is necessary in order for environmental quality to be maintained or improved is an essential part of the sustainable development argument promulgated in the Report of the World Commission on Environment and Development (1987) in *Our Common Future.* It is believed that as society becomes more developed, more resources will be devoted to environmental improvement. Society can and will invest in the environment. Beckerman (1992) maintains that "there is clear evidence that, although economic growth usually leads to environmental

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degradation in the early stages of the process, in the end the best – and probably the only – way to attain a decent environment in most countries is to become rich." (p. 482)

David Stern (2000), however, believes that EKC is mostly an empirical phenomenon backed by poor econometrics; the EKC idea rose to prominence because few paid sufficient attention to econometric diagnostic statistics. Little or no attention has been paid to the statistical properties of the data used, such as serial dependence or stochastic trends in time series, and few tests of model adequacy have been carried out or presented. However, one of the main purposes of doing econometrics is to test which apparent relationships, or "stylized facts", are valid and which are spurious correlations. Studies have been done with panel and time series data. The panel studies may not be very useful in the sense that there is no global EKC valid for all countries. In fact, evidence suggests that the turning point is different for different countries. Single country studies have been employing unit root and cointegration testing to uncover the true relationship between pollution and income series, and to avoid spurious regressions.

Empirical studies have produced mixed results. Multiple country studies employ panel data econometrics, while single country studies employ time series analysis. However, in recent years there has been a concern about unit roots in panel data too with large datasets. Grossman and Krueger (1995) used panel data analysis to confirm the existence of the EKC. Panel data analysis is subject to criticisms in favour of time series analysis of one country. The panel data approach suggests that all countries will follow the same pollution trajectory and there will be a common EKC among countries, which does not appear to be the case. In addition, panels typically use a short time span. The EKC is essentially a long-term phenomenon, since the economy needs time to reach the turning point of the EKC.

Among the time-series studies, Perman and Stern (2003) consider sulphur emissions for many countries both at an individual level, and then at a panel level. Using the Engle-Granger (1987) method, they find that a long-run cointegrating relationship only exists in 35 out of 74 countries. Other studies employ the Pesaran et al. (2001) Autoregressive Distributed Lag bounds testing approach to cointegration allowing both I(1) and I(0) variables in the relationship. Ang (2007) confirms the EKC hypothesis with French CO2 emissions over the period 1960–2000. He reports that there is no one-size-fits-all EKC. The turning points found in different studies are strikingly different, even where EKC is confirmed to exist. This implies that individual country studies are worthwhile. Jalil et al. (2010) suggest that a time series analysis for a single country may provide a better framework to study the relationship.

The unit roots tests typically performed are ones that do not account for structural breaks in the data. In the case of Bulgaria, it is particularly reasonable to expect a structural break, given the change from communism to democracy and the dynamic change in the economic system. Therefore, the Zivot-Andrews unit root test will be employed here; this allows for an unknown one-time structural break in the slope, intercept or both. Bulgaria is also a low-income transition economy.

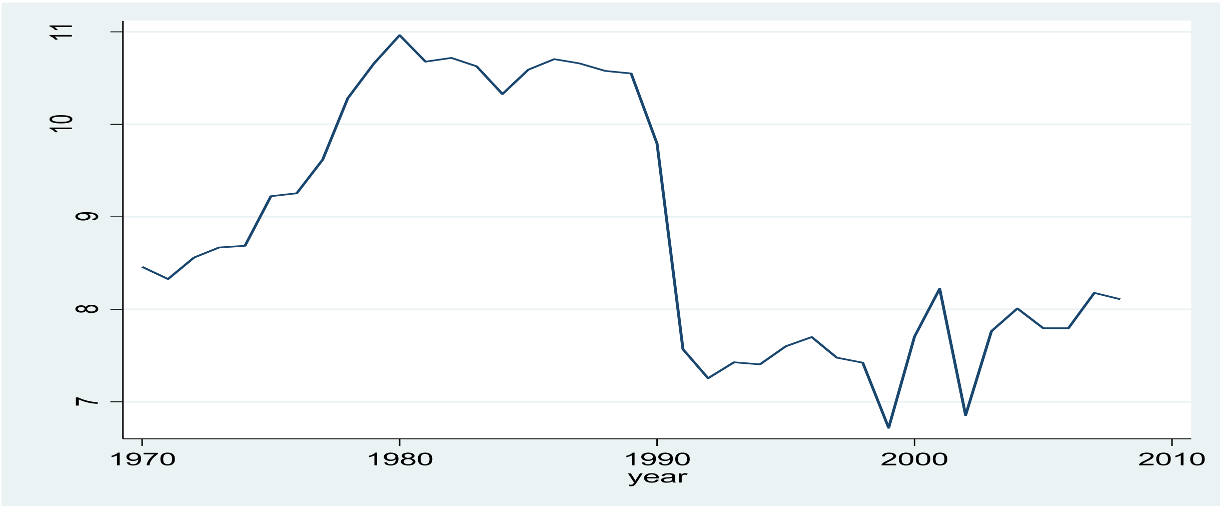
Regressing lnCO2percapita on lnGDPpercapita and its square, it turns out that the residuals have a unit root with a structural break. The variables are not cointegrated in levels and in logs.

DATA AND VARIABLES

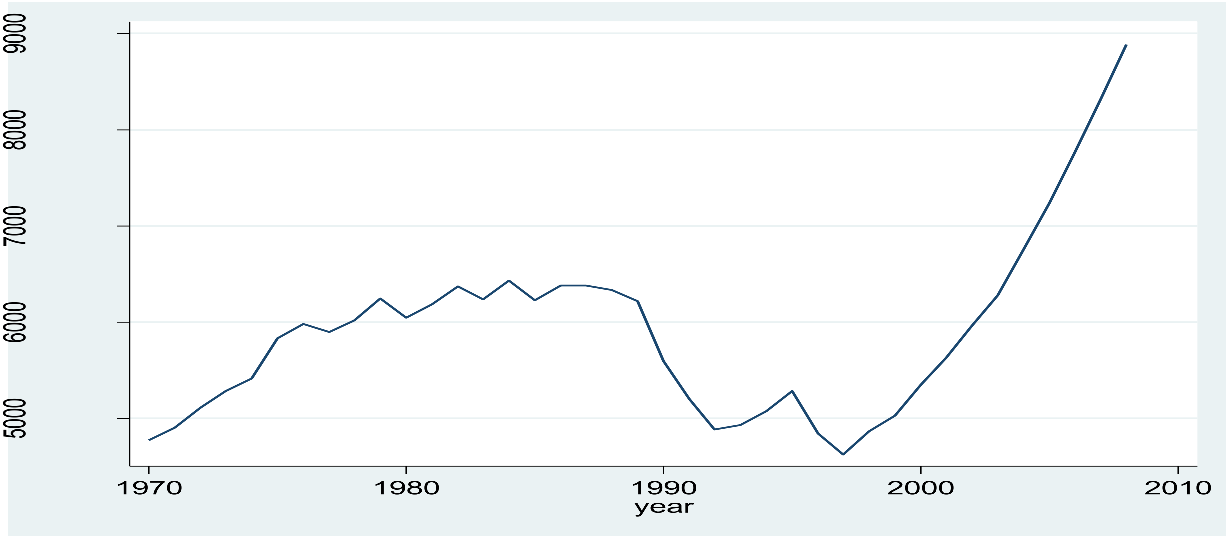
In this study on Bulgaria, we focus on five pollutants: carbon dioxide (CO2), sulphur dioxide (SO2), methane (CH4), ammonia (NH3), and nitrous oxide (N2O). The time-series data cover the period 1970–2008. GDP per capita is measured in International Geary Khamis dollars.

Many of the reported turning points for different environmental degradation indicators were at a level greater than the current per capita income of most countries (e.g. $4,000–$5,000 in Grossman and Krueger (1991), $8,709 in Selden and Song (1994)).

In Bulgaria, a graph of CO2 per capita pollution looks like this:



A graph of GDP per capita looks like this:



The basic model is:

$$(\ln(CO2/pop)_t = \alpha + \delta_t + \beta_1 \ln(GDP/pop)_t + \beta_2 (\ln (GDP/pop)_t)^2 + \varepsilon_t$$

Where we have CO2 pollution per capita regressed on GDP per capita, (GDP per capita) squared in logarithms and a time trend. To obtain the predicted inverse-U relationship, we need $\beta_1 > 0$ *and* $\beta_2 < 0$. The Breusch-Godfrey test reveals serial correlation. For that reason, we use Newey-West standard errors.

RESULTS

Here are the results from the Newey-West regression using ln(CO2/pop) as a dependent variable:

N=39, F(3,35)=20.58

Ln(CO2capita)	Coefficient	Newey-West std. error	t	P>|t|
Ln(GDPcapita)	29.098	13.159	2.21	0.034
Ln(GDPcapita) squared	-1.635	.750	-2.18	0.036
T	-.008	.002	-3.5	0.001
Constant	-126.979	57.741	-2.2	0.035

For this pollutant, we obtain the desired signs on Ln(GDPcapita) and Ln(GDPcapita) squared; thus, we get the inverse-U relationship between pollution per capita and development. The partial effect of Ln(GDPcapita) on Ln(CO2capita) is equal to 29.098-3.27ln(GDPcapita). Thus the turning point is equal to 7,259.

The results with sulphur dioxide are as follows:
N=32, F(3, 28)=43.77

Ln(SO2capita)	Coefficient	Newey-West std. error	t	P>|t|
Ln(GDPcapita)	-149.192	67.216	-2.22	0.035
Ln(GDPcapita) squared	8.722	3.893	2.24	0.033
T	-012	.004	-3.19	0.003
Constant	635.699	290.149	2.19	0.037

Instead of an inverse-U relationship, we obtain a U-relationship between pollution per capita and GDP per capita. There is increasing SO2 pollution as income increases. This is contrary to the EKC theory.

Next, we have the results for methane:
N=39, F(3,35=8.42

Ln(CH4capita)	Coefficient	Newey-West std. error	t	P>|t|
Ln(GDPcapita)	24.401	11.092	2.20	0.035
Ln(GDPcapita) squared	-1.3995	0.634	-2.21	0.034
T	.01	.002	4.49	0.000
Constant	-109.106	48.557	-2.25	0.031

Here the existence of an inverse-U relationship is confirmed with β_1 being positive and β_2 being negative. The turning point seems to occur at 6063.

The results with ammonia are as follows:

Ln(NH3capita)	Coefficient	Newey-West std. error	t	P>|t|
Ln(GDPcapita)	63.026	30.38	2.07	0.045
Ln(GDPcapita) squared	-3.575	1.74	-2.05	0.047
T	-0.03	.007	-4.56	0
Constant	-281.399	132.66	-2.12	0.041

Here the existence of EKC is confirmed. The turning point occurs at GDP per capita of 6634.

The results with nitrous oxide look like this:

Ln(N2Ocapita)	Coefficient	Newey-West std. error	t	P>|t|
Ln(GDPcapita)	43.047	30.56	1.41	0.168
Ln(GDPcapita) squared	-2.443	1.74	-1.4	0.169
T	-.028	.005	-5.5	0
constant	-194.73	134.17	-1.45	0.156

EKC is confirmed once again. The turning point is around 6634.

CONCLUSION

We observe that for most pollutants, we obtain a relationship resembling an EKC. The only exception is sulphur dioxide. The turning points seems to be rather high, however, at GDP per capita of above 6000. The evidence points towards an inverse-U shaped relationship between pollution per capita and income per capita.

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