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THE ENVIRONMENT AND ECONOMIC GROWTH ACCORDING TO THE ENVIRONMENTAL KUZNETS' CURVE **

It is argued that even if economic growth and protection of the environment are not always compatible, they are not necessarily exclusive, which is emphasized by many findings, especially by the hypothesis of Environmental Kuznets' Curve. However, it is not the mechanism of Environmental Kuznets' Curve that automatically reduces the concentration of pollution all over the world. It may be the result of positive changes reflecting microeconomic, macroeconomic and global aspects.

This article concentrates on the mechanisms of the Environmental Kuznets' Curve and its most significant explanations, demonstrates that progressive degradation of the natural environment can be reversed at a certain stage of economic development and presents some findings regarding Polish economy and environment.

Keywords: environmental Kuznets' Curve (EKC), environment, pollution, economic growth, globalization

INTRODUCTION

Economics is a discipline concerned with making choices due to the phenomenon of scarcity. At present, it is generally assumed that one of most important choices is between environment protection and economic growth. Traditionally, the problem of choice has been associated with economic goods, which are scarce, while environmental goods have been perceived as free goods and therefore lying outside the scope of interest of economics. Currently, economic growth has reversed the relations of scarcity – some environmental goods became more scarce than economic goods.

The fact that among environmental goods a decreasing amount of positive free goods and an increasing amount of negative free goods has

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been observed, motivates a growing interest in this issue, especially in the context of globalization. Pollution, which exemplifies negative free goods, is one of the most significant problems of modern society. Several questions arise within this context.

Do we need to sacrifice the natural environment for economic growth? Or, do we have to resist or even halt globalization in order to protect natural resources? We must be aware of the fact that interactions between the economy and environment are multi-dimensional. On the one hand, economic growth is related to the increasing use of materials and the increasing emission of pollutants, which illustrates the impact of economic growth on the environment, but on the other hand, it is limited by stocks of non-renewable resources and the capacity of the natural environment, which depicts the reversed relationship. Many postulate that population and economic growth should be stopped. The opponents of this proposition argue that technological change will make it possible to improve the global efficiency of production and to produce goods that would generate less pollution.

Should the idea of sustainable development be an imperative for policymakers? Or, is this idea contradictory and impossible to implement? Some people mistakenly assume that there is no feedback from environmental damage on economic growth. They are not aware that if pollution is significant enough, it can damage or even destroy production (for instance, we can consider the influence of acid rains resulting from high concentrations of sulphur dioxide in the air). Indeed, the environment and economic growth are interdependent – without appropriate environmental protection, economic growth will fail and without economic growth, environmental protection will be undermined. Therefore, a policy oriented towards economic growth must respect environmental limits and preferably, the conditions of sustainable development, which means meeting the needs of the present generation without undermining the possibility to meet the needs of future generations (World Development Report 1992, p. 8).

Does every country benefit from globalization and global solutions to such problems as pollution? Or maybe, only developed countries can benefit from globalization at the expense of developing countries? Does globalization mean further growth for already developed countries and pollution for the developing ones? These questions are relevant to the phenomenon of the so-called race to the bottom, aimed at attracting investment, which means that each country is susceptible to lower standards and accept more pollution than its neighbour-countries. Nonetheless,

globalization is responsible for world-wide diffusion of standards and, to the extent that environmental standards are stricter in the dominant markets, it may create a trend toward rising standards on a large scale (Panayotou 2000, p. 1). Globalization means proliferation of dangers but at the same time it is the only process that gives us the opportunity to deal with global problems such as global warming.

Is pollution an inevitable consequence of economic growth? Does it deterministically increase with growth? Or is there a mechanism that reverses this trend? Since the beginning of the 1990s one idea reconciling economic growth and environmental protection has become very popular – it is the hypothesis of Environmental Kuznets' Curve (EKC) postulating that pollution rises with income per capita until income exceeds a threshold level and then it starts to decline. This approach seems to be in opposition to the so-called early entropy literature which emphasized that the higher the income level, the greater environmental degradation and therefore questioned both the feasibility and the desirability of economic growth (Georgescu-Roegen 1971, Daly 1977). Furthermore, the complexity of this problem can be also related to the course of the business cycle. In the expansionary phase environmental priorities are more important for policymakers – in this phase more pollution is generated but there are also more incentives to deal with it than in the recessionary phase.

The very idea of Environmental Kuznets' Curve is a controversial hypothesis. Nonetheless, it has led to a vivid discussion on the relations between the environment and economic growth as well as the role of the government concerning those issues and contributed to interdisciplinary research in the field of economics, ecology, sozology, environmental economics, environmental statistics, environmetrics and social studies.

Although economic growth and protection of the environment are not always compatible, they are not necessarily exclusive, which is emphasized by many findings, especially the hypothesis of Environmental Kuznets' Curve. However, it is not the mechanism that automatically reduces the concentration of pollution all over the world, but it may be the result of positive changes reflecting microeconomic, macroeconomic and global aspects. Understanding and the eventual verification of the mechanisms underlying the Environmental Kuznets' Curve hypothesis may be crucial in order to cope with the environmental problems adequately both at local and global level.

The major focus of this paper is to:

- describe and explain the mechanism of Environmental Kuznets' Curve, which seems to be missing or marginally treated in Polish literature, except from Żylicz (2004, pp. 154-156), Kukla-Gryz (2004) or Radzikowski and Rybiński (2008, pp. 49-50),
- review the main findings included in numerous foreign publications,
- demonstrate that the progressive degradation of the natural environment can be reversed at a certain stage of economic development, despite the fact that this mechanism is not automatic,
- present some findings regarding Polish economy and environment.

The article provides an overview of the hypothesis of the Environmental Kuznets' Curve, briefly reviews several key explanations of the EKC mechanism and focuses on Poland's case study. Given examples refer mostly to SO_2 (local pollutant responsible for acid rains) and CO_2 (global pollutant responsible for greenhouse effect).

1. PRESENTATION OF THE EKC HYPOTHESIS AND EMPIRICAL OBSERVATIONS

Many scientific disciplines make use of families of inverted-U-shaped curves depicting evidential relationships between different variables. In the field of economics for several years now a vivid discussion has been inspired by an inverted-U-shaped curve regarding both economic and environmental issues. This relationship has been labelled Environmental Kuznets' Curve because of the resemblance to the curve for which Simon Kuznets was awarded the Nobel Prize in economics in 1971. The original Kuznets' Curve depicts the changing relationship between income per capita and income inequality – as income per capita increases, so does income inequality at first, but after a turning point it begins to decline (Yandle et al. 2004, p. 2).

Accordingly, it is hypothesised that at lower levels of income per capita environmental quality deteriorates as income begins to rise, but after having reached a certain threshold it starts to improve as income per capita rises (Yandle et al. 2004, p. 1, Stern 2003, p. 1). As environmental quality is most often measured by various indicators of environmental degradation (such as concentration of sulphur dioxide, nitrogen oxides in the air, that is air pollution and water pollution measures), Environmental Kuznets' Curve is illustrated graphically by an inverted-U-shaped relationship between

income per capita on the horizontal axis and pollution on the vertical axis (Figure 1).

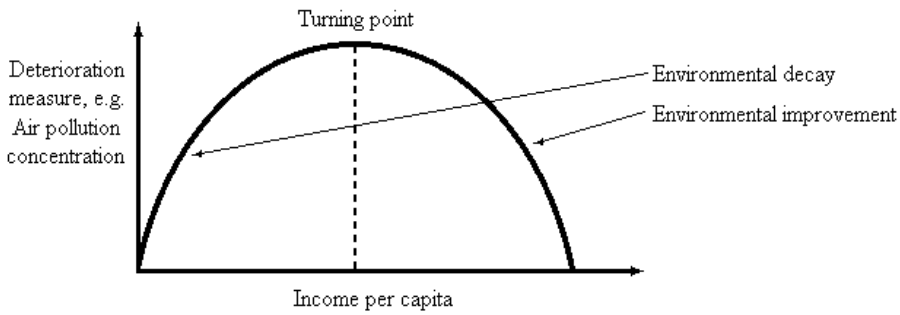

Figure 1. A typical diagram of the Environmental Kuznets' Curve.

Source: Yandle et al. 2004, p. 3

It can be also said that a typical Environmental Kuznets' Curve illustrates the transition from poverty to relative affluence, which means that pollution increases monotonically with income in low-income countries, decreases monotonically with income in high-income countries, and in middle-income countries exhibits an inverted-U shape (Deacon and Norman 2004, p. 9).

This systematic relationship between income changes and environmental quality was first reported in 1991 by Grossman and Krueger (1991) who investigated the claim that economic growth accompanying the North American Free Trade Agreement would contribute to environmental degradation. Many people feared that opening markets with Mexico would promote the race to the bottom and companies would try to find the lowest environmental standards possible. However, Grossman and Krueger noted that open economies are more likely to protect the natural environment than highly protected ones and in this case greater access to the large U.S. market and a more liberal trade regime was perceived as likely to generate income growth in Mexico. They found and estimated turning points for SO_2 and dark matter suspended in the air, only the relationship between income and suspended particles seemed to be monotonically increasing. Grossman and Krueger (1994, p. 19) also stated that for a country with an income per capita of $10,000 in 1985 dollars (more than $20,100 in 2008 dollars) the hypothesis that further growth will be associated with a deterioration of the environment can be rejected at the 5 percent level of significance for many pollutants.

Independently, Shafik and Bandyopadhyay in a background paper for the World Development Report (1992) found similar relationships for urban concentrations of particulate matter and sulphur dioxide (Figure 2a), but not for carbon dioxide (Figure 2b) nor for municipal waste per capita. Their researched cross-country samples based on forty three countries for SO_2 and more than one hundred for CO_2.

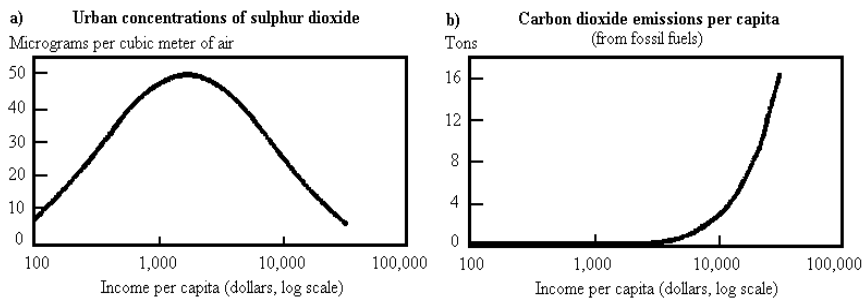

Figure 2. Environmental Kuznets' Curves for a) SO_2 and b) CO_2

Source: World Development Report 1992, p. 11

Since the beginning of the 1990s, the literature concerning Environmental Kuznets' Curve has been proliferating and testing the robustness of early findings or expanding early results to other pollutants. Growing interest in this issue is related to the fact that the behaviour of environmental degradation along a country's development path has critical implications for policy. On the one hand, a monotonic increase of environmental degradation along economic growth requires strict environmental regulations and even limits economic growth. On the other hand, a monotonic decline in environmental degradation would suggest that policies accelerating economic growth also lead to environmental improvement. In such a situation no explicit environmental policy would be needed. It may even be counterproductive, if it slows down economic growth (Panayotou 2000, p. 3). Finally, if we experience an inverted-U shape, a policy oriented towards reaching the turning point of Environmental Kuznets' Curve at the lowest possible level of both income per capita and pollution will be the best solution.

Many researchers have concentrated on cross-country samples. However, the most reliable evidence in favour of the Environmental Kuznets' Curve would be a demonstration that it describes the experience of individual

countries as they grow. Furthermore, a within-country approach minimizes the influence of unobserved factors. This advantage may be illusory, though, if country's attributes change during the observed period, which is the case of Poland (discussed in the third section) where the political system changed (Deacon and Norman 2004, p. 21).

Plotting the Environmental Kuznets' Curve turns out to be a demanding task not only because of problems with data availability and comparability (the EKC relationship depends greatly on time and space attributes), but also due to the choice of measures of economic growth and pollution. A measure of economic growth is most often based on GDP (Gross Domestic Product) per capita. It would be worth considering whether other measures, such as global output, could be adopted. As for measures of pollution, there is no consensus whether to calculate emissions or concentrations of pollutants, in absolute or per capita numbers and whether to distinguish urban and rural areas. Another problem is the choice of the mathematical form of the trend characterizing the observed values. Assuming in advance that Environmental Kuznets' Curve should represent the square, cubic or logarithmic function of income per capita may lead to misleading conclusions. Not every pollutant follows the inverted-U pattern – some of them seem to rise monotonically with income (like CO_2 in most countries), others may follow different patterns (like N-curve, M-curve or inverted-U curve with disturbances near the turning point).

2. THEORETICAL EXPLANATIONS OF THE SHAPE OF THE EKC RELATIONSHIP

Some authors have treated the Environmental Kuznets' Curve only as an empirical phenomenon and emphasized the role of econometrics, others have pointed out that there is nothing inevitable about the shape of the EKC and stressed the role of environmental policy and environmental awareness of the society. A variety of theories have been presented to motivate the empirical work of the Environmental Kuznets' Curve even if most of the observed patterns could have easily occurred by chance (Deacon and Norman 2004, p. 28). The proposed explanations should be considered in a microeconomic, macroeconomic and global context (some them are presented on Figure 3).

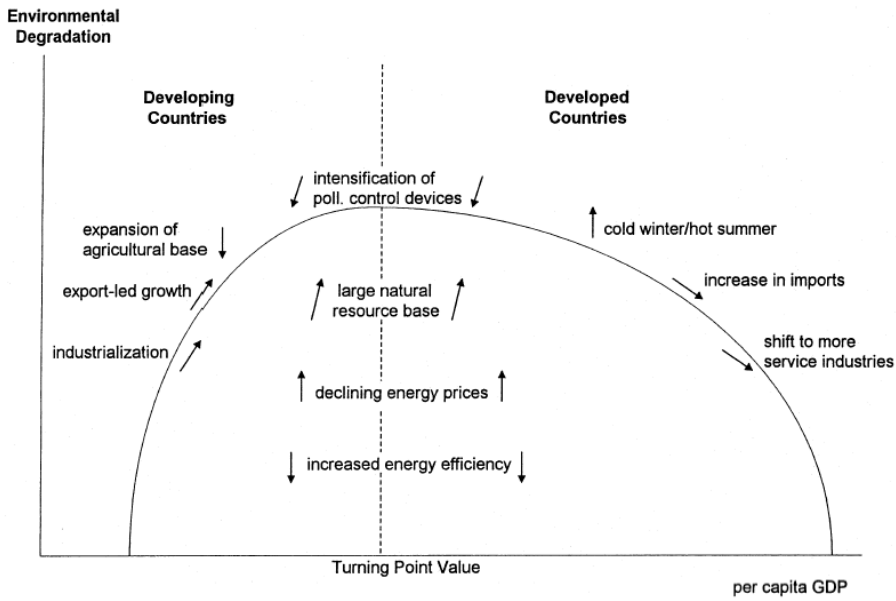

Figure 3. Hypothetical factors shaping the Environmental Kuznets' Curve

Source: Agras and Chapman 1999, p. 275

In the microeconomic context the Environmental Kuznets' Curve is perceived as a consequence of consumers' choice rather than the evolution of economic systems. The consumers' choice between goods with a positive and negative significance in environmental terms (that is between environment-friendly goods and goods contributing to greater pollution), can be analyzed by making use of consumption possibilities frontier (limited by prices of non-environmental goods and by rising prices of scarce environmental goods), indifference curve (reflecting substitution between consumption and pollution, as well as different needs of consumers) and constructing an equilibrium income-pollution path.

Within this approach consumers' demand for environmental quality seems to be the most important factor determining the shape of the EKC. Increasing income means increasing demand for most goods (which can be somehow associated with the generation of pollution) and for environmental quality which can be treated as a luxury good. Demand for environmental quality appears at a certain income level and rises monotonically (Yandle et al. 2004, p. 6). For example, as pollution has a negative influence on human health, rich people would like to reduce this effect when possible by shifting pollution to other regions or emigrating from the polluted area (and leaving

the problem for others or future generations), so increases in consumers' income can be associated with a decline in exposure to pollution.

For many authors the complexity of the EKC relationship suggests that no simple microeconomic foundations are entirely satisfying and that a broader perspective is needed.

In the macroscale the shape of the Environmental Kuznets' Curve can be perceived as a consequence of structural changes resulting from different stages of economic growth (Panayotou 2003, pp. 2-3):

- agrarian economies are characterized by low levels of income per capita and low levels of pollution,
- industrial economies are marked by increasing income per capita and by increasing pollution, which means that they suffer from environmental damage because of greater use of natural resources, dirty technologies and emissions of pollutants,
- post-industrial (service) economies are characterized by high levels of income per capita and a reduced level of pollution thanks to the ability to protect the natural environment which is possible due to the shift to cleaner technologies and growing significance of services.

This explanation can be formulated differently – when the economy grows, so does its ability to generate pollution and if there were neither change in the structure nor technology in the economy, economic growth would mean a proportional growth of pollution. However, the scale effect is usually accompanied by the effect of technology change which makes it possible to mitigate the former at the third stage of economic growth. For example, pollution may be reduced through the adoption of cleaner energy sources, because pollutants like SO_2 are frequently associated with the production of energy. This argument explains why the turning point for deforestation occurs earlier than for emissions, because it is mainly related to agricultural expansion or the beginning of the industrial stage.

In the macroeconomic context, of crucial importance in reducing pollution are also political factors, such as the role of democracy which is translating the individual demand for environmental quality into policies that restrict pollution (Aldy 2004, p. 4). Democracy associated with greater social cohesion may be enhanced by greater income equality and political conditions including the ability to bring corruption under control. To this extent we can notice a strong similarity to the original Kuznets Curve (Rosser 2005, p. 3).

However, when private markets do not provide incentives for curbing pollution, it is the government or other institutions that should maintain a central role in the area of environmental protection, because the

characteristic shape of the Environmental Kuznets' Curve does not exist in countries with no environmental protection rules. Strong policies and institutions may eliminate or alleviate the situation in which it is the poorest (or the least responsible) who suffer from environmental degradation.

Distinguishing the global context of Environmental Kuznets' Curve mechanism is justified by the existence of global problems, such as the greenhouse effect, and possible impact of international trade on its shape. Besides, global explanations may resemble macroeconomic factors, such as regulatory determinants, the possibility of internalization of externalities and the role of international institutions.

Although there are no clear conclusions concerning the impact of international trade on pollution consistent with Environmental Kuznets' Curve, it can be hypothesized that transferring pollution abroad (at least pollution-intensive production) may play a crucial role in reducing pollution, especially in high-income countries. There is a threat that the race to the top in developed countries can be associated with the race to the bottom in developing countries. And when these countries become developed it may be more difficult for them to reduce pollution, because further externalization will be impossible (Stern 2003, p. 7). This problem is related to the Pollution Haven Hypothesis which suggests that eventually all highly polluting activities will be reallocated to poor countries (Dinda 2004, p. 437).

Another example of an international factor independent of income that may lead to lowering pollution are the European Union environmental policies. Many observations in different countries (not only in present member states but also candidate-states) can be contributed to the process of harmonization of environmental quality standards. It may be very difficult, if not impossible, to separate the effects of European Union policies from the Environmental Kuznets' Curve mechanism (Deacon and Norman 2004, pp. 11-12).

All these explanations make it credible that the Environmental Kuznets' Curve follows the inverted-U pattern, but point out that there are several factors and contexts influencing this shape and that the complex link between economic growth and the natural environment should not be illustrated exclusively by the relationship of pollution and income per capita. Another aspect is that some authors argue that the inverted-U shape of the Environmental Kuznets' Curve is not necessarily related to the environment, as it may derive from a general relationship between a desirable good and an undesirable side-effect or any other "good-bad" combinations. For instance, similar results can be obtained for mortality risk associated with driving a vehicle which is highest among middle-income people (Panayotou 2003, p. 11).

3. POLAND'S CASE STUDY

In Poland it is a very important question how to benefit from the process of globalization and how to deal with environmental problems. We can observe economic growth and some improvements related to the state of the natural environment (especially the emissions and concentrations of many air pollutants), but the latter is not necessarily induced by the former.

The Environmental Kuznets' Curves estimated for industrial SO_2 and fossil fuel CO_2 emissions in Poland exhibit significant disturbances near the turning point (Figure 4 and 5), which can be associated with the influence of other (unobserved) factors or with the inaccuracy of estimated data (mainly due to the changes in methodology of GDP calculations in Poland). Only some of the observations follow inverted-U square trends consistent with the EKC hypothesis.

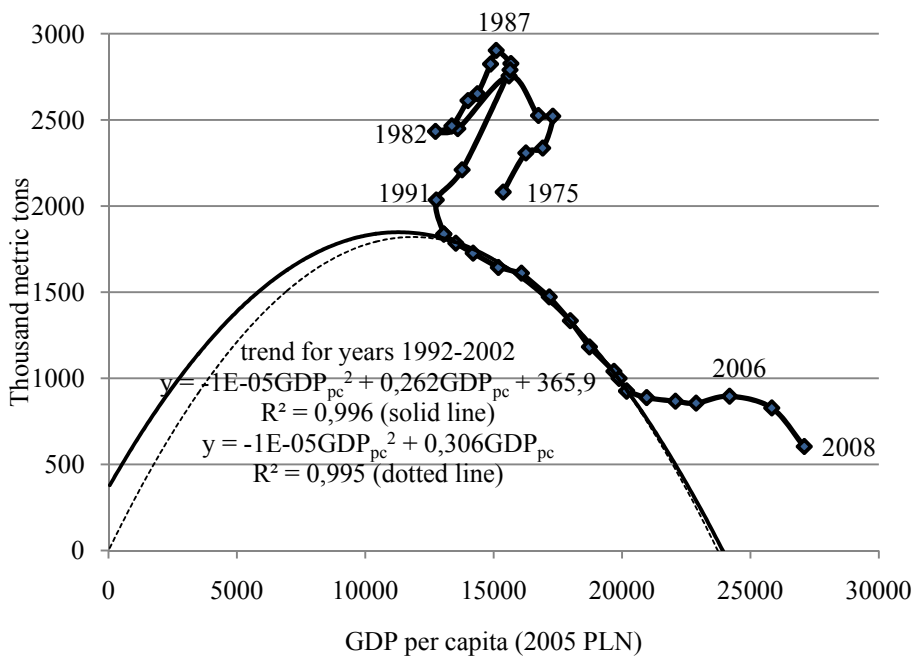

Figure 4. Environmental Kuznets' Curve for total emissions of industrial sulphur dioxide in Poland (1975-2008)

Source: author's calculations based on Statistical Yearbook of the Republic of Poland

The declining trend for selected observations (years 1992-2002) of industrial SO_2 emissions (Figure 4) is consistent with the EKC hypothesis, but because of limited data availability (consistent data on emissions of industrial SO_2 have been available since 1975, total emissions of SO_2 – since 1988 and total emissions of CO_2 – since 1993) and the visible disturbance it is impossible to verify the precise location of its turning point (moreover, the coefficients of trends presented on Figure 4 are statistically insignificant). However, during the next three years this downward tendency slowed down and the year 2006 was the first year in the post-transitional period when the emissions of industrial SO_2 in Poland increased. So far this increase was exceptional (there was a decline in emissions during consecutive two years), but further increases may challenge the hypothesis of Environmental Kuznets' Curve.

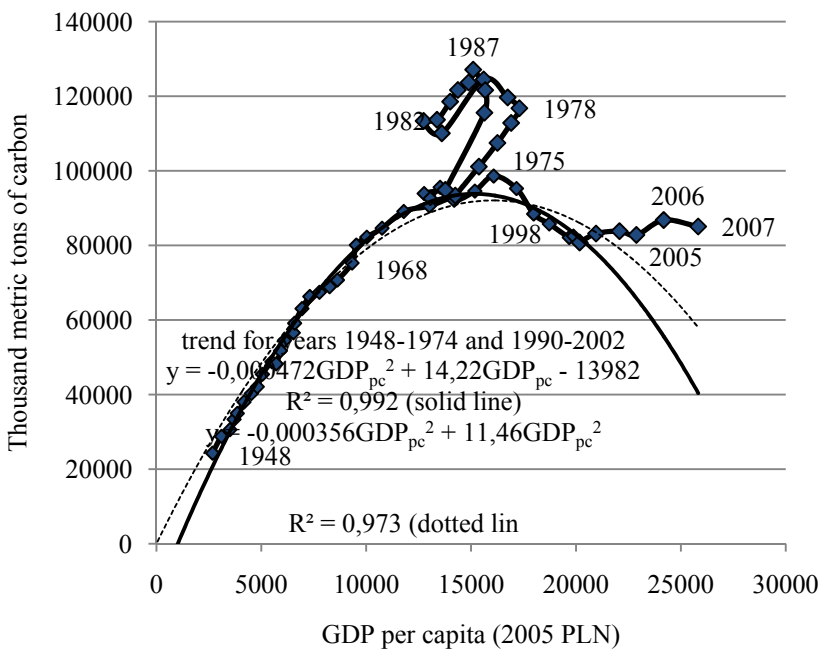

Figure 5. Environmental Kuznets' Curve for total fossil fuel emissions of carbon dioxide in Poland (1948-2007)

Source: author's calculations based on Statistical Yearbook of the Republic of Poland and data from Carbon Dioxide Information Analysis Center

Except for the disturbance near the turning point, the total fossil fuel emissions of CO_2 in Poland seem to confirm the hypothesis of Environmental Kuznets' Curve (estimated coefficients are statistically significant). This inverted-U relationship (presented on Figure 5) is rather unusual, though, as CO_2 tends to follow a monotonically (sometimes even exponentially) increasing trend in most countries. However, increasing values of CO_2 emissions in the year 2003, 2004 and 2006 make it possible that the trend for this pollutant is likely to exhibit a further growth after a temporary decline. In this case, we will observe an N-shaped curve.

Both SO_2 and CO_2 tendencies can be explained as the result of structural changes in the Polish economy. During the last sixty years we could observe the ever diminishing share of agriculture in the structure of GDP accompanied by first growing and now declining share of industry and the growing significance of other sectors, mainly services. After World War II Poland was no longer in the stage of agrarian economy. The turning point for deforestation occurred at a relatively low level of GDP per capita, i.e. lower than PLN 2,500 (Figure 6). The declining trend means expanding forest cover through foresting wasteland and post-agricultural land. It is worth mentioning that the Polish target level of forest cover amounts to 33% in the 2050 (Concise Statistical Yearbook of Poland 2009, p. 329).

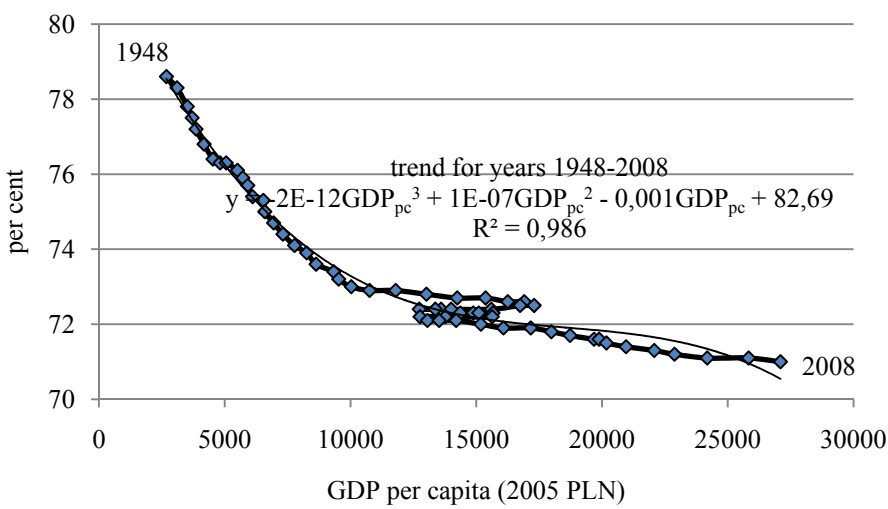

Figure 6. Deforestation in Poland (1948-2008)

Source: author's calculations based on Statistical Yearbook of the Republic of Poland

To recapitulate, in Poland we could observe relations between emissions of SO_2 and CO_2 as well as deforestation and GDP per capita that were at least temporarily consistent with the EKC hypothesis. This fact was related mainly to profound structural changes (e.g. the diminishing role of industry in the post-transition period) and political factors (such as democratization, membership of the European Union, participation in international agreements), as well as income effect illustrating the growing demand for environmental quality and greater environmental awareness.

CONCLUSIONS

Assuming that the inverted-U shape of the Environmental Kuznets' Curve holds for most pollutants, one may be tempted to believe that only economic growth can reverse the trend of environmental degradation and will actually lead to environmental improvement. However, it is obvious that income is not a direct determinant of environmental quality. GDP growth creates the conditions for environmental improvement by raising the demand for improved environmental quality and makes the resources available for supplying it (Yandle et al. 2002, p. 101). But since growing GDP per capita is not the only variable leading to an improvement of environmental quality, it cannot be said that developing countries, like Poland, must follow the Environmental Kuznets' Curve.

There is no unambiguous pattern covering all pollutants, although in many cases it is the inverted-U curve that best approximates the relationship between environmental degradation and economic growth. The forms of pollution that seem to follow the Environmental Kuznets' Curve pattern (e.g. SO_2) are the local ones in their impact, not global. Regulations at national level can bring about the internalization of the relevant externalities, but fail to do so for those with a more global impact, such as CO_2. A global level pollutant must be regulated at global level. The failure to enforce such global level regulations may be an important factor explaining why those pollutants do not exhibit the Environmental Kuznets' Curve pattern in most countries (Rosser 2005, p. 17). Whether the improvements of environmental quality will occur or not, depends mostly on government policies, institutions and markets. Only through effective implementation of environmental regulations can a significant improvement in environmental quality be achieved.

In accordance with the aforementioned arguments it is recommended that:

- the politicians representing governments should not assume that economic growth alone will solve the problem of environmental degradation,
- national and international rules, agreements and environmental regulations should be implemented along with establishing institutions responsible for global problems,
- state should provide better environmental education in public schools and better information of environmental hazards,
- in order to provide credible forecasts and EKC estimations, scientific research and monitoring of natural environment and human activity should be conducted.

We have to stress as well the role of the democratization and the environmental awareness of consumers, which is associated with the support for pollution abatement policies.

Because irreversible damage to the environment and the unsustainability of economic growth may result from the absence of signals of increasing scarcity and rising prices of environmental resources (Panayotou 2003, p. 26), we can assume that in the conflict between globalization and environment the culprit is not globalization but rather the free rider problem. With regard to its impact on the environment we can state that globalization is neither good nor bad. It accelerates structural change, diffuses risks and standards. Globalization proliferates global threats but also presents the only force that can address global problems, such as global warming or ozone layer depletion. However, as this process is vigorous, global institutions may be needed to curb it and to deal with global problems, such as pollution.

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