

# ENVIRONMENTAL KUZNETS CURVES: ECONOMIC IMPLICATIONS

## *KUZNETS LĪKŅU VIDE: EKONOMISKĀ IEJAUKŠANĀS*

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**Abstract.** *The results of empirical studies on Kuznets environmental curves are discussed in the article as well as economic implications of findings of these studies. The relationship of economic growth and environmental impact has spurred fierce debates between growth optimists referring to the phenomenon of the environmental Kuznets curve, and pessimists referring to the limits to growth. The article draws some hints from a critical assessment of the literature on the environmental Kuznets curve. In particular it is argued that the optimistic implications of this literature on the sustainability management are not granted. However, environmental Kuznets curves analysis allows clarification of a few basic conditions to achieve pollution reduction with economic growth. These conditions can be met by implementing a systematic and strict environmental policy strategy aimed at shifting Kuznets relations downward.*

**Keywords:** *economic growth, environmental Kuznets curve, environment, sustainable development.*

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### Introduction

Discussions of recent years on the dissociation of previously positive relationship between economic growth and resource utilisation (environmental degradation) are markedly related to research of *environmental Kuznets curves*, where resource degradation will increase initially with per capita income growth and then eventually decline, thus exhibiting the characteristic an inverted U-shaped relationship between income and emissions known as the “*environmental Kuznets curve*”, where emissions initially worsen but ultimately improve with income.

The **research objective** of the article is to analyse the results of empirical studies on Kuznets environmental curves and discuss the economic implications of these studies findings.

**The tasks.** In order to fulfil the objective, the following research tasks had to be accomplished:

- to analyse the essence of environmental Kuznets curves;
- to analyse results and findings of empirical studies on Kuznets environmental curves;
- to define economic implications of the results and findings of empirical studies.

**The methods of the research.** Logic abstraction, which encompasses generalisations on economic and management theories and thoughts, according to the conclusions and reasoning of scientists from other countries, comparison and analysis of Kuznets curves research were used in the article.

### The essence of the environmental Kuznets curve concept

During most of the course of industrial development, economic growth entailed parallel growth in resource consumption and environmental degradation. Though this relationship still holds, experience of the last decades indicates that economic growth and increases in resources consumption and environmental degradation *can* be de-linked to a considerable extent. The path to environmental sustainability lies in maximising this de-linking process. So, the theoretical explanation of the *environmental Kuznets curves* plays a central role for the theoretical foundation of sustainable growth.

Some relative data on environmental quality and natural resources utilisation and income per person, allows us to make a presumption that environmental quality worsens with low-income level. But the situation improves with the increase of income level, which reflects “the pressure of dissociating environment with economic growth” (Simonis, 1989). This relationship – as the income of an economy grows over time, emission level grows first, reaches a peak and then starts declining after a threshold level of income has been crossed – was first suggested in the early 1990s and has thereafter been subject to intensive research. The inverse relationship between pollution and per capita income has been explored for a variety of pollutants, such as nitrogen oxide, sulfur dioxide, suspended particulate matter, carbon monoxide, lead, and for deforestation, biological oxygen demand and others (List, Gallet, 1999; Selden, Song, 1994; Stern, et al. 1996; World Bank, 1992, Panayotou, 1997, Grossman, Krueger, 1995). The empirical literature about *environmental Kuznets curves*, which studies the empirical relationship between per capita income, generally interpreted as a proxy of the stage of development, measured on the horizontal axis, and environmental deterioration, measured on the vertical axis by different indexes: total environmental deterioration, or more often its per capita value or its value per unit of income, extensive critical survey is given in (Stern, et al., 1996; Borghesi, 2001).

This interrelation between the national income per person and the concentration level of industrial waste by P. Dasgupta and K.-G. Maler (1995) is called the *environmental Kuznets curve*, analogous to traditional curve, proposed by Simon Kuznets (1955), which demonstrates a similar relationship between actual income per person and income inequality (Figure 1). (As is well known, S. Kuznets observed that inequality tends to increase during the early stages of growth to decrease later on, describing an inverted-U shaped relationship between per capita income (on the horizontal axis) and income inequality (on the vertical axis). This relationship, called Kuznets curve after the name of the author, was very popular during the 1970s when it was taken as an empirical regularity of the economy).

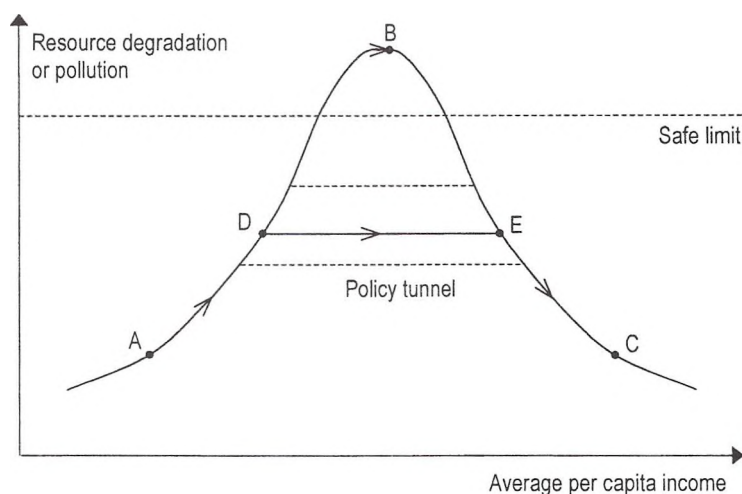


Figure 1. The dependence of environmental quality from income level

Most commonly, the studies of *environmental Kuznets curves* have taken econometric approaches using data based on cross-sections of countries, and sometimes combining this with time series data. Historical approaches to the *environmental Kuznets curve* or other emission patterns, such as studies of individual countries' historical emissions trajectories, have been taken relatively seldom. *Environmental Kuznets curve* studies for single countries most often address developing countries (e.g. Patel et al., 1995; Vincent, 1997). Rare exceptions addressing industrialized countries include (De Bruyn et al., 1998; Friedl, Getzner, 2003). But, as shown by M. Lindmark (2002), historical studies of individual countries offers

an advantage over cross-section approaches in bringing the analyses closer to the dynamics that cause the *environmental Kuznets curve* pattern. An investigation of the time-series data of a single country may be able to account for historic experience such as environmental policy, development of trade relations, and exogenous shocks such as the oil crisis (Stern et al., 1996).

### Results of empirical studies

A number of survey articles (Ekins, 1997; Stern, 1998) prompted several clarifications concerning both the actual development of various pollutants and the methodology used to explain the *environmental Kuznets curve* patterns. The literature has mostly considered *environmental Kuznets curve* as an empirical phenomenon and examined the presence or otherwise of significant statistical association between the level of economic activity and environmental degradation without explicitly discussing the nature of causation between these variables. A principal explanatory factor is *income* based on assumptions of initially high, but falling marginal utility of consumption and initially low, but increasing disutility of emissions as incomes rise (Di Vita, 2004). Thus, it is presumed that the relationship between income and pollution is one of unidirectional causality with income causing environmental changes – viz. a change in the level of economic activity/per capita income causes a consequent change in the environmental quality and not vice versa. Additionally, *technological* and *structural changes*, including *trade patterns*, may also influence an *environmental Kuznets curve* pattern. These changes may in turn interact with *price changes*.

Grossman (1995) plotted Kuznets curves for sulphur dioxide and suspended particulate matter on multi-national basis, and also analysed suspended particulate matter on a multi-national basis, and also analysed suspended particulate matter, airborne lead, sulphur dioxide, carbon monoxide, and nitrogen dioxide on a country basis for the United States. Shafik (1994) developed curves for the following ten environmental parameters: lack of safe water, lack of urban sanitation, annual deforestation, total deforestation, dissolved oxygen in rivers, faecal coliform in rivers, suspended particulate matter, ambient sulphur dioxide, municipal solid waste per capita, and carbon emission per capita.

Environmental Kuznets curves generally exhibit one of three shapes. The first represents an environmental benefit that improves continually with increasing per capita income, as the example in the case of “lack of safe water” (Shafick, 1994). The second shape is showing the continuous increase of pollution (municipal waste per capita, CO<sub>2</sub> emissions) with rising income and can be represented in the form of “N”.

The mostly discussed shape of environmental Kuznets curve is inverted “U” shape and has been used to predict air quality as related to economic development. Similar shaped curves have been reported for sulphur dioxide and particulate matter) by several researchers, although they reported different levels of income for the “turning points”. Grossman (1995) calculated that the turning point for both pollutants was approximately 5000 USD; Shafic (1994) placed the top of the curves between 3000 and 4000 USD and Selden and Song (1994) calculated turning points at 10391 USD for sulphur dioxide and 12275 USD for suspended particulate matter. Stern and Common (2001) estimated the turning point at over 100000 USD. Markandya et al (2004) find different turning points for different countries analysed (between 5000 and 140000 USD. Besides that in the same study for all 12 European countries analysed the two turning points were identified (on 7000 USD and 25000 USD). The analysis of implemented environmental regulations performed in the article indicated that all the implemented regulations did shift Kuznets curve down.

Situation with regard of global pollutants (such as CO<sub>2</sub>), which have a limited direct impact on population is quite different (Cole et al., 1997) . CO<sub>2</sub> emissions cause problems on a global scale, and the social costs of global warming accrue both across time and nations. Therefore,

free-rider behavior might lead to a close relationship between carbon emissions and income at all levels of per capita income (Arrow et al., 1995). In line with this argument, a linear relationship for CO<sub>2</sub> emissions and GDP per capita was confirmed in early studies (Shafik, 1994).

But the international nature of global warming is not the only reason that prevents de-linking greenhouse gas emissions from economic growth. The intergenerational nature of the negative impact of greenhouse gas emissions may have also been an important factor preventing the implementation of greenhouse gas abatement measures in the past. For water quality the evidence is more mixed, with studies giving conflicting results on the shape, position and peak of the curve according to the different indicators used. As for the other indicators of environmental degradation, the *environmental Kuznets curve* hypothesis receives very little corroboration. Environmental problems that have a direct and strong impact on the population (such as access to urban sanitation and clean water) tend to improve steadily with the process of development, while environmental problems that can be transferred elsewhere (such as municipal solid wastes) do not exhibit any clear tendency to diminish with development (see Rothman, de Bruyn, 1998).

So, per capita income, in turn, affects inequality and environmental degradation through several channels, as suggested by the literature on the *environmental Kuznets curve*. Although the findings regarding to "*environmental Kuznets curve*" are not conclusive (mentioned survey gives only limited support to the *environmental Kuznets curve* hypothesis), most empirical studies have generated very high income turning points beyond the maximum income level of the data they used in their analysis, and beyond the level of affluence to which most developing countries might realistically achieve in the foreseeable future. For example, Holtz-Eakin and Selden (1995) generate an out-of-sample turning point of \$ 35000 per capita (1986 US\$) that indicates that substantial economic growth would be required before CO<sub>2</sub> emissions begin to decline. De Bruyn (1997) provides a survey of the empirical studies.

Therefore *environmental Kuznets curves* do not explicate on the systems' consequences of environment utilisation, therefore they should not be further used as a proof or a critical argument in grounding the statement that economic growth is sufficient to achieve environmental improvement. Thus, considering all arguments, the *environmental Kuznets curve* should be viewed as *the hypothesis on the interrelation between economic growth and environmental quality*.

It must be mentioned, that recent studies have also tested for a possible third order polynomial relationship between emissions and income (Markandya et al, 2004; Moomaw, Unruh, 1997). However, they conclude that neither the inverted "U" nor an A cubic (i.e. "N"-shaped) relationship between CO<sub>2</sub> emissions and income provide a reliable indication of future behavior. Hence the use of *environmental Kuznets curve* models to forecast future emissions may not be appropriate. From other hand, Jones and Manuelli (1995) using an overlapping generations model shown how the interaction of individual optimal decision making and collective regulation may lead to an *environmental Kuznets curve*, but also a N-shaped curvature is possible. A N-shaped relationship between Austria GDP and CO<sub>2</sub> emissions is found to fit the data most appropriately for the period 1960–1999 in the research, done by (Friedl, Getzner, 2003) too.

#### **Economic implication of environmental Kuznets curve**

M.Pasche (2002) showed that the sources of an *environmental Kuznets curve* can be summarized into two groups: (a) *the structural change to service and information-based economic activities* which are less pollution intensive than physical production; and (b) *the growing ecological efficiency of production and consumption by means of a "greening"*

*technical progress*. The driving forces behind these two determinants may be a change of preferences favouring environmental goods or at least a sufficiently high income elasticity of demand for environmental goods on the one hand, and regulating activities like e.g. technical standards, legal restraints, environmental taxation on the other hand.

From the other hand, within the extensive body of literature that has been published in recent years concerning the *environmental Kuznets curve*, two main theoretical arguments have been formulated to account for the fact that beyond a particular level of per capita income, the relationship between economic growth and environmental quality becomes a “virtuous” circle (Roca, 2003). Both arguments concern the changes in levels of relative demand that occur as per capita income varies.

The first argument suggests an endogenous change in the demand structure for goods and services. According to this first argument, the sectors that become increasingly important as per capita income increases are those, which have less environmental impact. The evidence that generally underlies this position is the increasing demand directed at the service sectors at the expense of demand directed at the industrial sector. However, much more empirical research needs to be done on the assumptions this argument is based on: some activities that are regarded as services may have as much or more environmental impact (direct and/or indirect) as others involving the industrial sector (consider, for example, long-distance tourism). In any case, this argument would only explain a reduction in environmental pressures per unit of GDP as income increases; it would not explain a reduction of these pressures in absolute terms unless we suppose that the sectors that are most environmentally problematic produce inferior goods. In fact, this is not at all likely (Torrás and Boyce, 1998). In other words, if we apply the distinction made by de Bruyn and Opschoor (1997), the change in demand structure could account for a “delinking” of economic growth and (some) environmental pressures in the “weak (or relative) sense” but not in the “strong (or absolute) sense”.

The second argument, as mentioned by J.Roca (2003), is also based on individual preferences and changes in relative demand that occur as income increases. In this case, however, it is not the changes in the relative demand for different goods and services acquired in the market that are crucial, but those between the consumption of marketable goods and services on the one hand, and environmental quality on the other. According to Lopez (1994), the relation between the level of pollution and the income level then depends on the elasticities of substitution of goods and the risk preference of the households. And a high “income elasticity of demand for environmental quality” could potentially explain the delinking of economic growth and environmental pressures in the “strong sense”.

In other words, under the *environmental Kuznets curve* hypothesis, with growth of income, the status of emission as an item of consumption gradually changes from a *necessary* to an *inferior good* (thus reflecting a clear preference for a cleaner environment at higher levels of living).

In the original definition of sustainable development, suggested by the Brundtland Commission (WCED, 1987): “*sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*”, inequality and environmental deterioration are conceived as equally important and interdependent conditions of sustainability. The recent process of globalisation of international markets has managed to sustain the economic growth of the countries that have actively participated in this process. The available empirical evidence suggests, however, that it has been accompanied by a worldwide increase in environmental degradation and economic inequality. Therefore, there is growing concern that these features of the globalisation process may jeopardise its social and environmental sustainability.

As pointed out in the paper of S.Borghesi and A.Vercelli (2003), environmentally sustainable globalisation requires a policy strategy directed to shift the relationship between *environmental Kuznets curve* relations downwards. Within the process of globalisation it is possible to modify the shape and position of the *environmental Kuznets curves*, thus improving social and ecological conditions. In the case of the environment, public opinion can influence environmental quality not only through the voting system, but also through the market: "greener" consumer demand contributes to a shift in production and technologies towards less polluting activities. Globalisation may increase competition and thus strengthen public opinion pressure for environmental quality. In a more competitive market consumers are likely to have more alternatives to polluting products and thus more chances to express their environmental demand. This positive impact of globalisation on the environment, however, crucially depends on the actual capacity of globalisation to increase competition. If greater market concentration comes together with globalisation (as occurs in some sectors), then the opposite might be true and environmental-friendly consumers might end up with fewer opportunities to express their preferences. S.Borghesi and A.Vercelli (2003) conclude, therefore, that globalisation might contribute to a more sustainable development by enhancing the impact of public opinion pressure on government and market decisions and thus shifting the *environmental Kuznets curve* relations downwards. The implementation of strict environmental policies in developed countries and knowledge and know-how in new technologies sharing with developing world are the main drivers to reduce pollution on global scale.

M.Pasche (2002) showed that under reasonable assumptions about technical progress a positive sustainable growth rate fails to exist. The argument is that a growing part of income has to be spent for continuing technical progress in order to compensate the pollution effects of growth. Hence in the long run either the sustainability condition will be violated or the growth rate must decline to zero. Furthermore, in finite time the level of wealth will decrease despite growing income and a constant pollution level, thus further growth is no longer reasonable. Similar arguments also hold for the environmental effects of structural change favoring less pollution-intensive economic activities, when the part of pollution-intensive production can decrease while less pollution-intensive services or information-based production increases. Hence, the level of output can rise with constant or reduced emissions. An evolutionary change of goods and production technology may shift the limits of growth and is hence a prerequisite for a long-run *environmental Kuznets curve*. But the possibilities of a rational sustainability policy seem to be limited.

Several empirical studies of the 1980s and 1990s give a optimistic view: in industrialized countries many pollution indicators decreased despite a growing per capita income, while in less developed countries growth yields increasing pollution. Therefore, economic progress with less impact on the environment seems to be possible. The idea that economic growth is ultimately beneficial for the environment has caused some authors to maintain that only economic growth is necessary, because the surest way to improve the environment is to become rich (Beckerman, 1992). This viewpoint implies that environmental problems are a temporary phenomenon since economic growth and technological innovation will resolve these problems in due time.

But the fact that nations which formerly had or currently have low per capita income are experiencing increasing pollution while industrialized countries are successful in abating emissions does not imply that economic development will solve environmental problems quasi automatically. It is possible to make only one statement: the research results have proved the presumption that economic growth can be conformed to environmental improvement, if accordingly a specific policy is worked out. The key policy conclusion is that even if such a curve characterized past growth, there is no reason for developing countries

passively to accept “historical determinism” along their future development path. In effect, lower-income countries could learn from the experience of wealthier nations and adopt policies that permitted them to “tunnel” DE (Figure 1) through the curve (Munasinghe, 1999). But, in no case can it be expected that public environmental problems will automatically be solved as a result of economic growth, without the need for environmental policy (Arrow et al., 1995). If we deny the need for environmental policy, we are renouncing the mechanism through which higher income could lead in some cases to reduced environmental impact. And some recent studies show that economic and social policy may have a very important role in determining the emergence of the downward sloping part of the *environmental Kuznets curves* (Panayotou, 1995; Grossman, 1995; Torras, Boyce, 1998; Spangenberg et al, 2002; Bosquet, 2000).

### Conclusions

Discussions on dissociation of growth and environmental degradation are based on *environmental Kuznets curves*. Applying critical scientific argumentation, it can be stated that *environmental Kuznets curves* must be viewed as a hypothesis on the interface between economic growth and environmental quality.

A principal explanatory factor of *environmental Kuznets curve* is income. Additionally, technological and structural changes, including trade patterns, may also influence an *environmental Kuznets curves* pattern. These changes may in turn interact with price changes. The process of globalisation may render world development more sustainable simply by pushing the world economy towards the decreasing part of the bell-shaped *environmental Kuznets curves*.

Environmental technical progress and structural change can lead to positive growth rates with a constant or even decreasing level of pollution. Hence the results are compatible with an *environmental Kuznets curves*. But this can only be a temporary phenomenon since in the long term either the condition of a non-increasing emission level is violated (the *environmental Kuznets curves* becomes N-shaped).

It is unrealistic to expect that economic growth per se would reduce environmental pressures. The main drivers turning the inverted “U” curves down in developed countries are strict environmental policies adopted in EU and being considered in the rest of the world, i. e. the EU Thematic Strategy on air pollution COM (2005) 446 final) sets the reduction targets for 2020 to the base year 2000 to reduce SO<sub>2</sub> emissions by 82%, suspended particulates emissions by 59%, NO<sub>x</sub> - by 60% etc., the EU Communication on an energy policy for Europe proposed to cut GHG emissions by at least 20% from 1990 level by 2020.

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