"Summary of article by David I. Stern: Progress on the Environmental Kuznets Curve?"

According to the environmental Kuznets curve hypothesis (EKC), an inverted U-curve relationship exists between indicators of environmental degradation and levels of income per capita. This in turn has been taken to imply that economic growth will eventually reduce environmental impacts associated with the early stages of economic development. This paper discusses the theoretical underpinnings of the EKC hypothesis and reviews many of the empirical studies which have used econometric methodology to investigate EKC relationships. The available evidence indicates that a number of other factors affect or modify the income-environment relationship, and that the EKC logic applies only in a limited number of cases.

Theoretical Basis of the EKC

The original Kuznets curve asserted an inverse U-curve relationship between income inequality and income levels.[1] Advocates of the EKC hypothesis argue that as development begins rates of land clearance, resource use, and waste generation proceed rapidly. But at higher levels of development better technology, improved environmental awareness and enforcement, and structural economic change favoring services and information-intensive production techniques lead to improved environmental conditions. According to Beckerman, a strong advocate of this logic, "there is clear evidence that, although economic growth usually leads to environmental degradation in the early stages of the process, in the end the best -- and probably the only -- way to attain a decent environment is to become rich."

Critics of the EKC hypothesis argue that empirical evidence for the relationship is weak and applies only to a subset of indicators. In addition, evidence on existing environmental conditions in poor and rich countries are not good predictors of the dynamic relationships associated with economic growth. And even where EKC-type patterns hold true, global "turning points" towards lower total pollution are decades away.

Theoretical models of economic growth and pollution generate EKC-type relationships under appropriate assumptions about consumer preferences, pollution control policies, and substitutability in production. Empirical evidence is needed to evaluate whether these models are plausible under real-world conditions.

Empirical Evidence on EKC Relationships

The first empirical EKC study, by Grossman and Krueger, estimated EKC's for sulfur dioxide (SO2), smoke, and suspended particulate matter (SPM) as part of a study of the potential impacts of NAFTA. They identified turning points for SO2 and smoke at around $4,000-$5,000 of per capita income using a Purchasing Power Parity measure, and lower turning points for SPM. However, at income levels over $10,000-$15,000, all three pollutant levels appeared to increase again.

A study used in the 1992 World Development Report estimated EKCs for ten different environmental indicators.[2] The results differed for each indicator. Availability of clean water and urban sanitation improved with higher income, while river quality worsened. SO2 and SPM conformed to the EKC pattern, with turning points of $3000-$4000, while municipal waste and carbon emissions per capita increased unambiguously with rising income. Panayotou also found an EKC pattern for SO2, SPM, and nitrogen oxides (NOX), with turning points around $3,000-$5,500 (see Figure 1).

A study by Selden and Song (1994) found EKC relationships to exist for airborne emissions, but with much higher turning points, in the $6,000-$12,000 range. This is significant because it implies that global pollution levels will continue to increase for decades before mean income reaches this range.
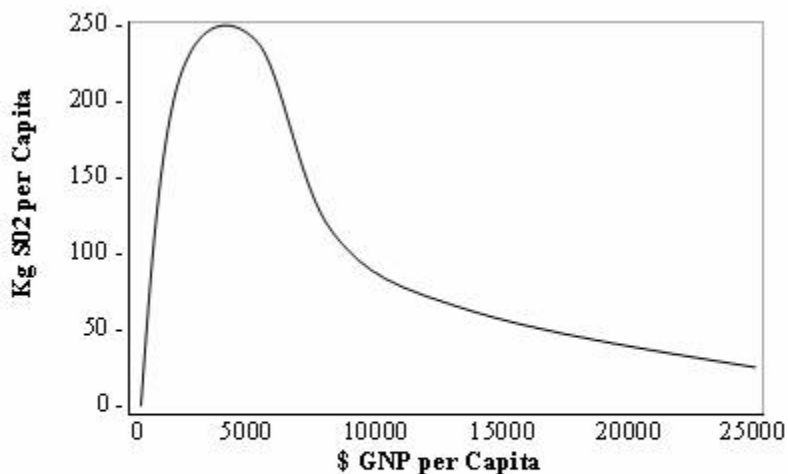

Figure I.5. Environmental Kuznets Curve for Sulfur
Source: Panayotou, T. (1993) "Empirical Tests and Policy Analysis of Environmental Degradation at Different Levels of Development" Geneva: International Labour Office Working Paper WP238.

Critiques of the EKC

Stern et al. (1996) identify seven major problems with the basic EKC hypothesis:

- **Simultaneity and irreversibility.** Environmental damage may not be easily reversible, and the effects of widespread environmental damage may affect economic growth.

- **Trade effects.** Specialization by developing countries in resource-intensive or pollution-intensive production may increase degradation in these countries while reducing it in developed countries. However, when today's developing countries become rich they will not be able to reduce pollution - intensive production by importing such products from poor countries.
- **Econometric problems.** Different functional forms seem to give different EKC results, indicating that the underlying relationship may not be robust.
- **Ambient concentrations versus emissions.** Some of the basic EKC studies measure ambient pollution levels in urban areas. However, even if these levels decline, total emissions may still be increasing, but spread over a wider area.
- **Asymptotic behavior.** Functional forms which imply that pollution levels could go to zero are in conflict with basic principles of thermodynamics, according to which use of resources inevitably implies the production of wastes. For this reason, even if strengthened environmental standards lead to a decline in pollution levels, further increases in consumption will raise levels again. Some of the empirical studies seem to indicate this N-shaped pattern, but the econometric evidence is not conclusive.
- **Mean versus median income.** The turning point estimates for a number of studies are around current world mean per capita income, which at first glance might imply that we can expect a decline in global pollution levels as income grows. However, the world income distribution is heavily skewed, so that there are much larger numbers of people below the mean per capita income than above it. It is the much lower median income which is relevant, implying that global pollution levels will increase for decades to come.
- **Aggravation of other environmental problems.** With economic development, levels of some pollutants decline, but others increase. The mix of effluents typically shifts from sulfur and nitrogen oxides to carbon dioxide and solid waste, but total waste per capita may not decline. Greater energy use per capita, which tends to accompany economic growth, can serve as a proxy for multiple environmental impacts, some of which are monotonically increasing.[3]

Other Determining Factors

Recent studies have identified important factors other than income which serve as determinants of levels of environmental degradation. One of these is trade, which can shift environmental impacts. Rothman suggests that an examination of the environmental impacts generated by consumption within a country, rather than production, shows that impacts increase with higher income levels for all except a few categories of consumption goods.

Other variables which appear significant in affecting environmental quality include degrees of political freedom, spatial intensity of population and economic activity, economic structure, and price effects. Moomaw and Unruh find that the oil price shocks of the 1970s, not income changes, were the triggering factor leading to changes in per capita CO2 emission trends.

Conclusions

"There has been progress in understanding the scope and determinants of the EKC in the last few years and some progress in methods of investigation. Evidence continues to accumulate that the

inverted-U shape relation applies to only a subset of impacts, and that overall impact, perhaps approximated by per capita energy use, rises throughout the relevant income range." (192)   In addition to the importance of structural change, technological progress, and political democracy, there is "increasing evidence that the EKC is partly determined by trade relations.   If this is so, the poorest countries of today will find it more difficult than today's developed countries to reduce their environmental impact as income rises." (192)

Notes

1. This relationship has also been the subject of controversy: see Ackerman et al. eds. (2000).
2. Shafik, N. and S. Bandyopadhyay (1992).
3. See Suri and Chapman (1998).

4