Environmental Kuznets curves

Definition: a relationship between environmental quality (emissions) and per capita GDP level

Outline: Does it exist, if so why, and is it policy relevant?

- Initially, an empirical observation.
- Most studies based on cross-country data.
- Different results with time series data.
- Policy significance?
- Structural explanation.

EKC definition

- The EKC hypothesizes that the relation between income per capita and emissions has an inverted U-shape.
- At relatively low income levels, emissions increase with income, but after some “turning point”, emissions decrease with income.

Example

- Typical estimation:

$$\ln(E/P)_{it} = \alpha_i + \delta_t + \beta_1 \ln(GDP/P)_{it} + \beta_2 (\ln(GDP/P))^2_{it} + \varepsilon$$

Turning point is given by $\exp\left(\frac{-\beta_1}{2\beta_2}\right)$

Example

- SO_2

Empirical evidence

- EKC found to hold for some pollutants (sulphur dioxide, particles), but others increase monotonically with income (carbon emissions).
- Differences if study OECD countries or non-OECD countries. No or higher turning point for the latter for CO2 emissions, for example. (Richmond and Kaufman, 2005)

The policy issue?

- EKCs have been used as an argument that economic growth and increased environmental quality go hand in hand.
- They have also been used in support of a do-nothing policy.
- This is not very useful since, if there is a turning point, we would like to know what factors explain it before making assessments of whether environmental policy is necessary or not.

Criticisms of EKC

- A reduced form relationship.
- Policy relevance? Black box.
- The existence of an EKC varies according to the pollutant: carbon emissions is one case in point.
- Income is exogenous: no feedback from environmental damage to income level.
- Econometric issues.

Methodological issues

The first EKC studies were done on cross-section data. Can we infer something about one country's development based on an EKC from cross-section data?

Many functional forms can explain the data (quadratic, other polynomials).

Methodological issues

- Omitted variable bias
- Have to test for stochastic trends in time series.
- It is the median income rather than the mean that matters.

Structural explanations

1) Consumption and production changes with income
2) Preferences for environmental quality
3) Policy/institutions for internalizing externalities
4) Pollution abatement technology (increasing returns to scale)
5) Dynamic models of resource stocks or consumer satiation.

1) Consumption and production changes

- If industry structure changes from relatively clean agrarian economies to polluting industries to tertiary sector, trade and delocalisation plays some role. In a global perspective, there are limits to this phenomenon.
- Scale (GDP), technique (emissions intensity) and composition (output mix) effects.

- The example of CO2 emissions: increased income changes fuel mix, structure of industry.

2) Preferences for environmental quality

- Evidence of increased demand for environmental quality with increased income (positive income elasticity for environmental quality).

- Is environmental quality a normal good or even a luxury good? Kristrom & Riera (1996): income elasticity less than 1.

3) Institutions/policy

- If the demand for environmental quality increases with increased income, then it is this demand that forces an active policy on environment and the creation of institutions to internalize externalities. There is no natural relation explaining the turning point – it is the outcome of a conscious policy choice.

4) Abatement technology

- Is technology sufficient to explain why there can be EKC?
- Even without preferences for environmental quality or externalities and institutions to internalize them, increasing returns to scale in abatement technology can explain the appearance of an EKC (Andreoni and Levinson, 2001).

5) Dynamic modeling

- If environmental quality is seen just as a resource stock then it starts out clean, then degrades until some level of maintenance investment is required.
- The environmental resource constraint only becomes binding when there is a growing population and polluting firms.

Some conclusions

- EKCs may exist for ambient concentration of certain pollutants, but for others, the relationship between income and pollution is monotonically increasing.
- Even if an EKC exists, global pollution may increase, since the fastest economic growth occurs in developing countries with the highest population growth.

Some conclusions

- Even if an EKC exists, no automatic relationship – depends on policy variables.
- Better study those policy variables and how emissions depend on structural changes.

An Incomplete Bibliography

- Andreoni, J. and A. Levinson (2001). The Simple Analytics of the Environmental Kuznets Curve. *Journal of Public Economics* 80 (2): 269-286.
- Arrow, K. et al. (1995). Economic Growth, Carrying Capacity, and the Environment. *Science* 268: 520-521.
- Copeland, B. and Taylor, M.S. (2004). Trade, Growth and the Environment. *Journal of Economic Literature* 42: 7-71.
- Dasgupta, S. et al. (2002). Confronting the Environmental Kuznets Curve. *Journal of Economic Perspectives* 16: 147-168.
- Grossman, G. and A. Krueger (1992). Economic Growth and the Environment. *Quarterly Journal of Economics* 353-377.
- Holtz-Eakin, D. and Selden, T. (1995). Stoking the Fires? CO2 Emissions and Economic Growth. *Journal of Public Economics* 57: 85-101.
- Selden, T. and Song, D. (1994). Environmental Quality and Development: Is There a Kuznets Curve for Pollution? *Journal of Environmental Economics and Management* 27: 147-162.
- Shafik, N. and Bandyopadhyay, S. (1992). Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence. Background Paper for the World Development Report 1992, World Bank, Washington D.C.
- Stern, D. (2004).The Rise and Fall of the Environmental Kuznets Curve. *World Development* 32(8):1419-1439.