Applied environmental economics |
Economic valuation of environmental damages and analysis of environmental policies

Economic growth and the environment

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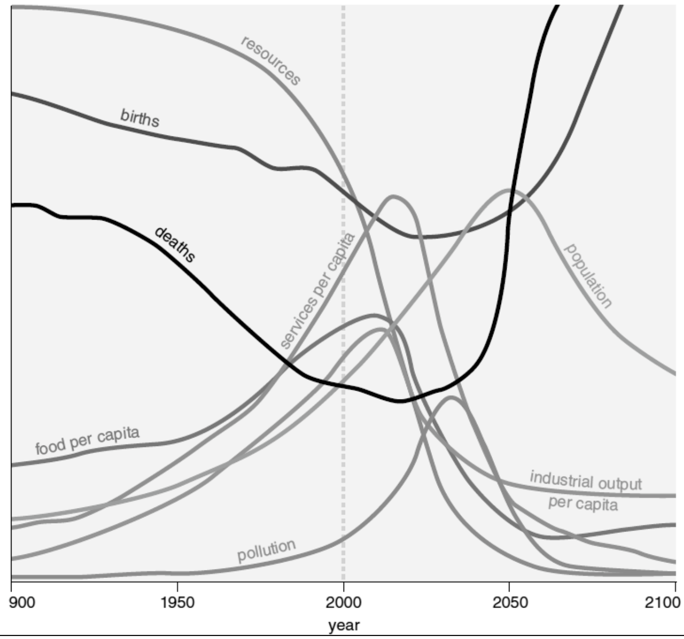
Environment vs growth

1. Limits to growth: for social and **physical** scientists such as Carson (1962), Boulding (1966), Georgescu-Roegen (1971), Meadows et al. (1972), Ehrlich and Holdren (1971,1974): higher levels of economic activity require larger inputs of energy and material, and ultimately generate larger quantities of waste byproducts. Economic growth is limited !
---> **Boudling** (1966): earth is a spaceship vs cowbnoy economy
http://www.panarchy.org/boulding/spaceship.1966.html
---> **Georgescu-Roegen** (1971) : Entropy law

---> **Meadows report** (1972): Club of Rome
---> **Ehrlich et Holdren** (1971) : I=PAT

---> **Odum (2003)** : Prosperous Way Down

Economic growth and the environment – Club of Rome



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Economic growth and the environment – Club of Rome

parameter	predicted	actual
population	6.9 billion	6.7 billion
birth rate per 1,000 people	29	20
death rate per 1,000 people	11	8.3
values vs. 1970 levels (set at 1.0)		
	predicted	**actual**
resources	0.53	
copper		0.5
oil		0.5
soil		0.7
fish		0.3
pollution	3.0	
CO_2		2.1
nitrogen		2
per capita industrial output	1.8	1.9

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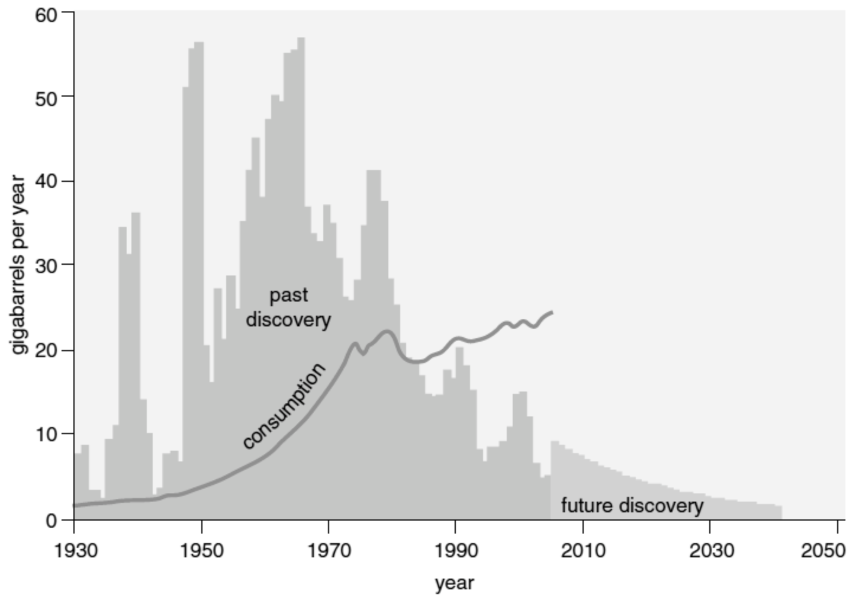
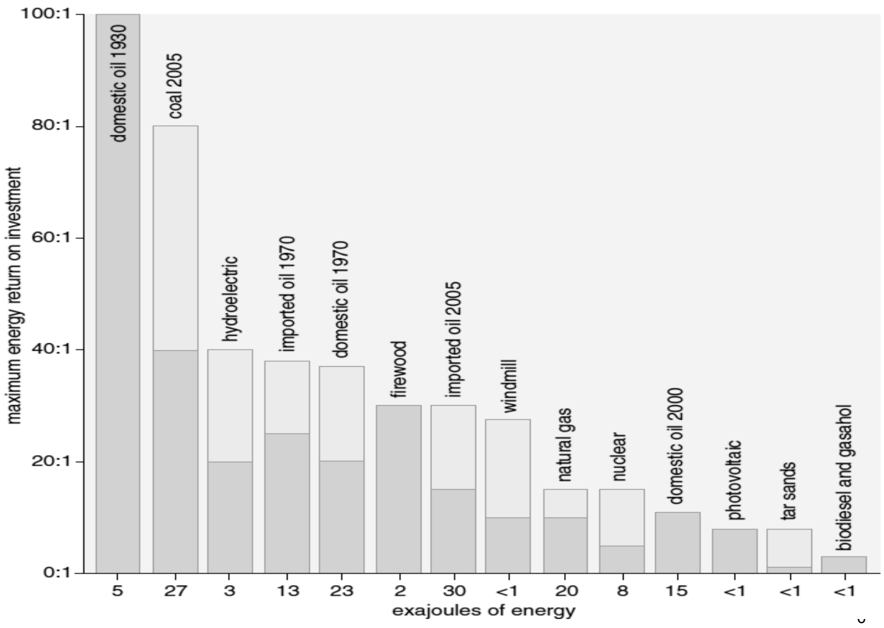
Ressources



Ressources



Environment vs growth

Determinant of emissions

Ehrlich et Holdren (1971) : I=PAT where the impact I of an economy on the environment can be viewed as the product of its population size (P) multiplied by per capita affluence (A) as measured by consumption or GDP, in turn multiplied by a measure of the damage caused by the technologies employed in supplying each unit of consumption or GDP (T).

$$T = f(P),\ A = g(P)\ et\ T = h(PA)$$

$$with$$

$$\frac{dT}{dP} > 0, \frac{dA}{dP} > 0, \frac{dT}{dPA} > 0$$

Environment vs growth

On the other hand, economic growth is not to be limited since **technical progress, future changes in the composition of outputs and the possibilities of substitution between polluting and non-polluting inputs** as well as the **development of abatement activities** might allow to push back the limits to growth indefinitively (see Aghion and Howitt, 1988 and Stokey, 1988).

→ Cole et al. (1973) rerun the Meadow's model and obtain radically different results by postulating increases in resources stocks, through new discoveries and recycling possibilities.
→ backstop technology : provides resources at a constant marginal cost for an indefinitely long time

Overall, the previous debate may be caricaturized by the opposition between optimists who believe in the power of human inventiveness to solve whatever problems are thrown in their way, (…as apparently it has done in the past) and pessimists, who question the success of these technological solutions and fear that future problems may be more intractable (Lecomber, 1975).

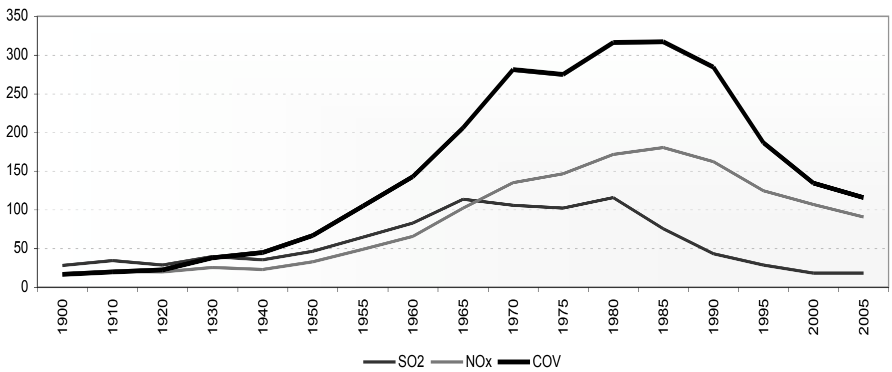
Empirical studies

Baumol et Oates (1979) : Ås …because of growth in population and industrial activity we were convinced that virtually all forms of environmental damage were increasing, and that, in the absence of powerful countermeasures, they would continue to accelerate steadily. However, a more careful and extensive re-examination of the evidence has led us to revise this simplistic view of the course of environmental decay. We have found on closer study that trends in environmental quality run the gamut from steady deterioration to spectacular improvement ».

Basic studies
- Grossman et Krueger (1991), in a NBER working paper as part of a study of the environmental impacts of NAFTA,
- Shafik et Bandyopadhyay (1992) for IBRD's World Development Report 1992;
-Panayotou (1993) in a Development Discussion Paper of the ILO.

GEMS environmental data, http://gems.ecmwf.int/d/products/
GEMS water, http://www.gemswater.org/

Evidences in Switzerland



Empirical studies

Grossman et Krueger (1991), in a NBER working paper as part of a study of the environmental impacts of NAFTA

Using data assembled by the Global Environmental Monitoring System, they examine the reduced-form relationship between various environmental indicators and the level of a country's per capita income.

The study covers four types of indicators: concentrations of urban air pollution; measures of the state of the oxygen regime in river basins; concentrations of fecal contaminants in river basins; and concentrations of heavy metals in river basins.

They find no evidence that environmental quality deteriorates steadily with economic growth. Rather, for most indicators, economic growth brings an initial phase of deterioration followed by a subsequent phase of improvement. The turning points for the different pollutants vary, but in most cases they come before a country reaches a per capita income of $8,000.

Environmental Kuznets Curves

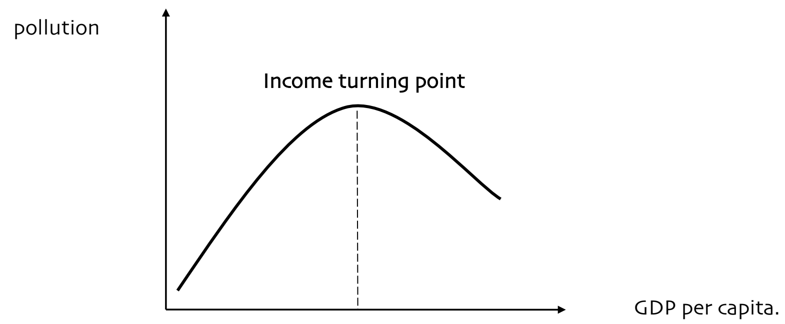
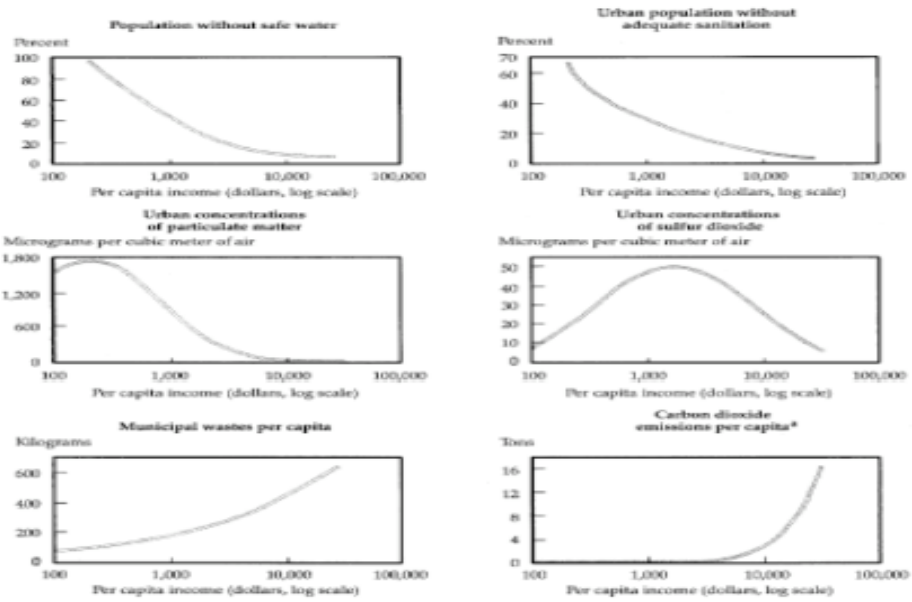


Figure 4 Environmental indicators at different country income levels



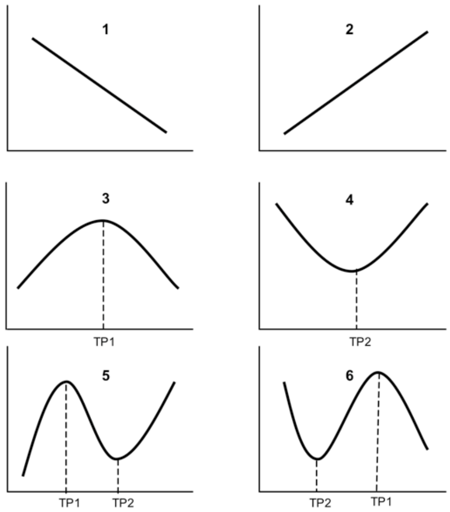
Note: Estimates are based on cross-country regression analysis of data from the 1980s.
a. Emissions are from fossil fuels.
Source: Shafik and Bandyopadhyay, background paper; World Bank data.

Empirical models

$$P_{it} = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it}^{\ 2} + \beta_3 Y_{it}^{\ 3} + \beta_4 X_{it} + \varepsilon_{it}$$

Functional forms	Estimated equations
1. level quadratic	$P_{it} = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \varepsilon_{it}$
2. Logarithmic, quadratic	$\ln(P_{it}) = \alpha + \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{it})^2 + \varepsilon_{it}$
3. level cubic	$P_{it} = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Y_{it}^3 + \varepsilon_{it}$
4. Logarithmic cubic	$\ln(P_{it}) = \alpha + \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{it})^2 + \beta_3 \ln(Y_{it})^3 + \varepsilon_{it}$

Empirical models



Empirical models

	Signs and relative value of the coefficients	Shape of the pollution-income path
1	$\beta_3 = 0$, $\beta_2 = 0$ and $\beta_1 < 0$	linear, downward sloping
2	$\beta_3 = 0$, $\beta_2 = 0$ and $\beta_1 > 0$	linear, upward sloping
3	$\beta_3 = 0$, $\beta_2 < 0$ et $\beta_1 > 0$ and $\lvert\beta_2\rvert << \lvert\beta_1\rvert$	quadratic, inverted-U
4	$\beta_3 = 0$, $\beta_2 > 0$ et $\beta_1 < 0$ and $\lvert\beta_2\rvert << \lvert\beta_1\rvert$	quadratic, normal U
5	$\beta_3 > 0$, $\beta_2 < 0$ et $\beta_1 > 0$ and $\lvert\beta_3\rvert << \lvert\beta_2\rvert << \lvert\beta_1\rvert$	cubic, normal N
6	$\beta_3 < 0$, $\beta_2 > 0$ et $\beta_1 < 0$ and $\lvert\beta_3\rvert << \lvert\beta_2\rvert << \lvert\beta_1\rvert$	cubic, inverted-N

Illustration

- Tab. 1.3 Results from Panayotou et al. (2000)

Dependent variable: (CO_2 emissions per capita)	1	2	3	4
Constant	-26.52 *(-13.87)*	-27.66 *(-12.8)*	-30.36 *(-11)*	-82.86 *(-1.249)*
ln(GDP per capita)	5.38 *(11.5)*	(5.78) *11.5*	6.32 *(10.1)*	7.98 *(15.3)*
ln(GDP per capita) square	-0.25 *(-9.8)*	-0.28 *(-9.58)*	-0.31 *(-8.8)*	-0.42 *(-14.1)*
ln(exportation/GDP)		0.12 *7.8*	-0.22 *(1.2)*	-0.32 *(-1.97)*
ln(exportation/GDP)*ln(GDP per capita)			0.04 *(1.91)*	0.06 *(1.3)*
ln(population density)				0.59 *(9.363)*
EKC	**non***	**oui**	**oui**	**oui**
ITP (in 1990 US-$)	**47099**	**30377**	**26730**	**13360**

Empirical literature : a summary

Pollutants	Observations	EKC	Mean ITP	Decreasing	Increasing	Flat
Energy	11	1	**116411** **22826 ***		10	
CO_2 (or other GHG, except methane)	52	18	**13811** **2666711 ***	1	30	3
CFC	4	2	**14083** **19079 ***		2	
SO_2 and SOx	66	36	**7271** **1949110 ***	5	16	9
SPM	29	17	**7345**	5	4	3
Smoke	8	5	**5516**		2	1
Toxic emissions	12	8	**7737** **18265 ***	1	2	1
CO, VOC, NO_x, NO_2	29	13	**11401** **12203 ***	3	10	3
BOD, COD, DO and nitrates	13	5	**11263** **13960 ***	2	2	4
Coliforms (fecal or total)	5	3	**4155**		1	1
Heavy metals (Pb, Ni, Hg, Cd, As)	5	3	**6140**			2
Access to sanitation and safe water	11	1	**691**	10		
Hazardous waste	8	5	**16758**		3	
Deforestation	28	15	**3566**			13
Biodiversity	5	4	**6219**		1	

Theroethical hypothesis : explanation of EKC

1. A natural progression of economic development from clean agrarian economies to polluting industries to clean service economies.
2. Advanced economies exporting their pollution to less developed countries: pollution heaven hypothesis
3. The internalization of externalities requires relatively advanced and democratic institutions for collective decision-making.
4. Below a threshold level of pollution only the dirtiest technologies will be used.
5. Decreasing costs in pollution abatement.
6. Demand for environmental quality is linked to income level

Any theory of the EKC requires some force to eventually more than fully offset the scale effect of growth. In the income-effect explanation it is primarily a technique effect that does this. At low incomes, pollution initially rises with growth because increased consumption is valued highly relative to environmental quality. As income rises, the willingness to pay for environmental quality rises, and increasingly large sacrifices in consumption are made to provide great environmental benefits.

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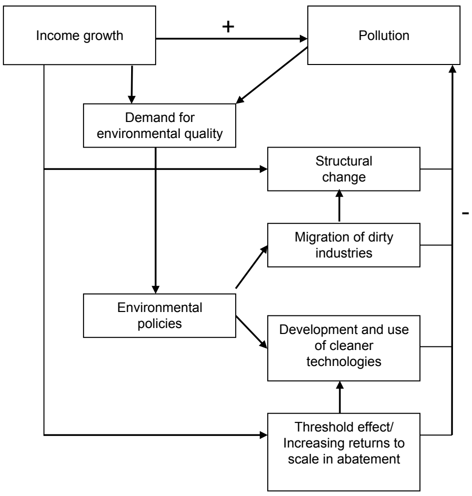
Theorethical analyses



Theoretical analyses

1 .Scale effect, composition effect, technical effect (Grossman and Krueger, 1991)

$$\frac{dE}{E} = \frac{dY}{Y} + \sum_i \frac{e_i s_i}{\sum_i e_i s_i} \cdot \frac{ds_i}{s_i} + \sum_i \frac{e_i s_i}{\sum_i e_i s_i} \cdot \frac{de_i}{e_i}$$

Specific empirical evidence shows that the composition effect (size of the manufacturing sector) remains small and that technological progress (energy intensity of GDP) is much more important for the downturn of emissions
See Cole, 2000; Millimet, 2003; Selden et al., 1999, de Bruyn, 1997.

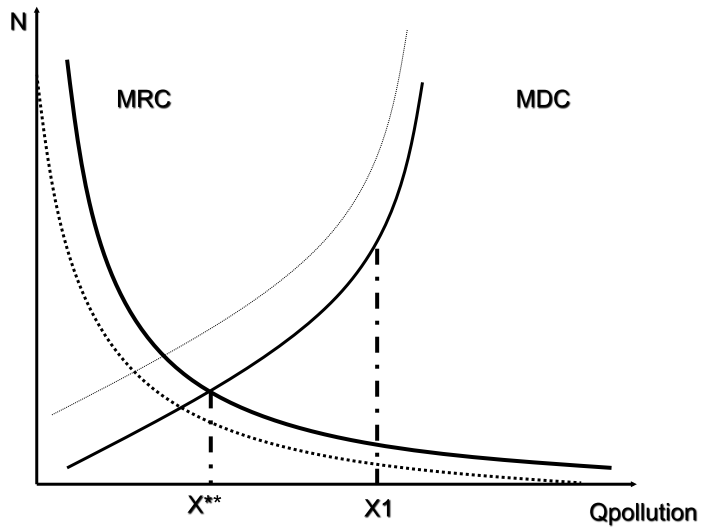
2. Increasing returns to scale in abatement
Andreoni and Levinson (2001) : a larger economy can abate pollution at lower average costs

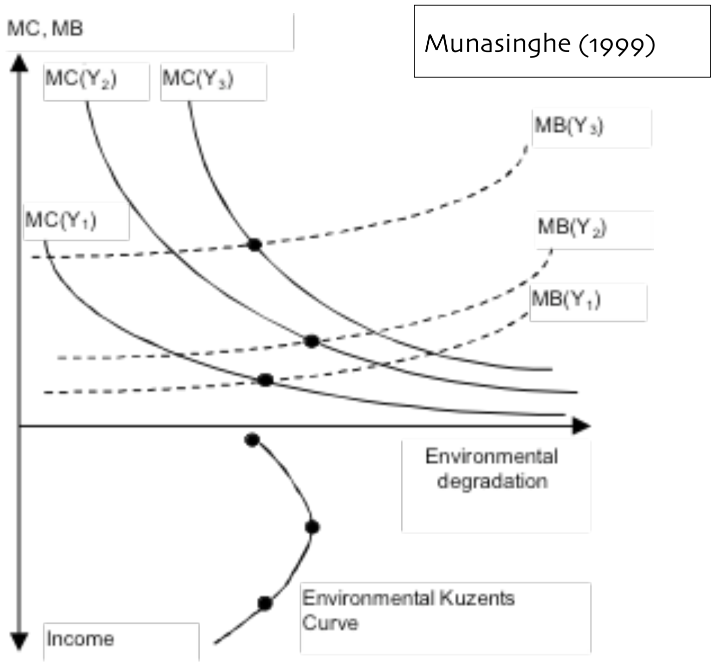
3. Migration of polluting industries and international trade
Copeland and Taylor (1994)

4. The demand for environmental protection (Thalman et al, 20045; Maradan, 2005)

5. Price shocks (energy price) : Unruh and Moomaw (1998)

General model → Munasinghe (1999)





Meta-analysis of the EKC

Empirical analysis of the results of empirical analysis on th EKC

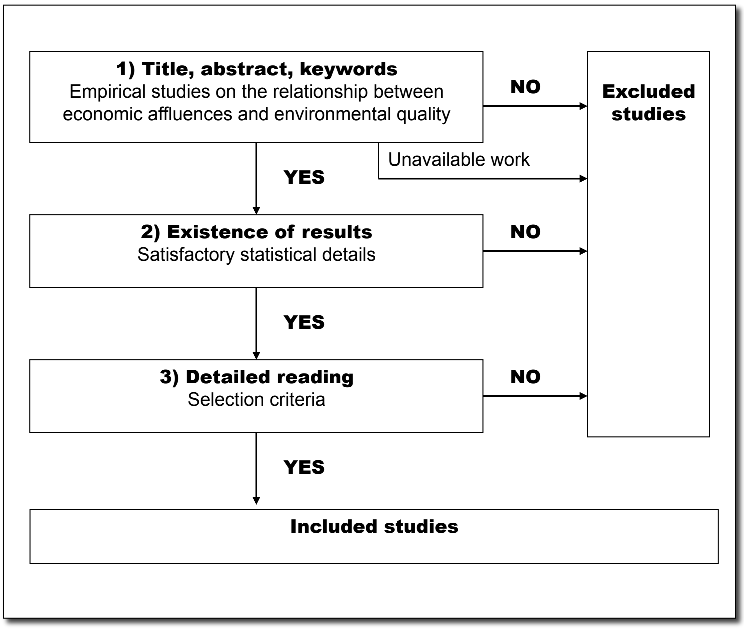
Data : results and the caracteristics of the Ekc studies
- understand the reasons what contradictory results have been found
- are the results depedning on the empricial models used, the data, the countries examined, the quality of the study

Limits:
Publication bias: test and data collection
Heterogeneity among studies: are we examining fruits or only apples?
independence of results : observations may be clustered (a few groups of similar studies)

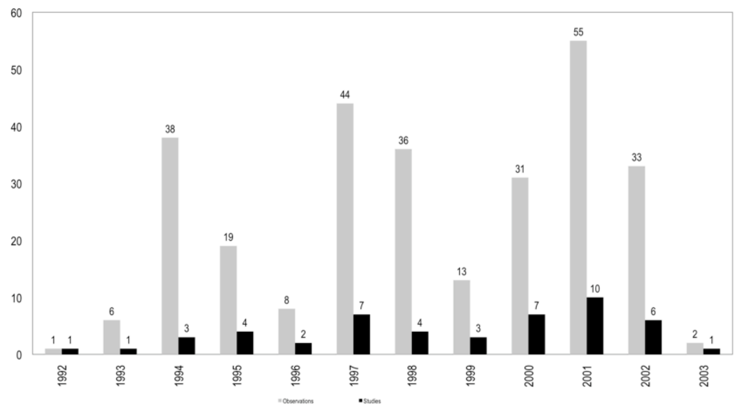
Meta-analysis of the EKC : How to procees

1. Database: data collection and classification
2. What to explain? Selection of the effect size measures
3. Select explanotory variable : test the theorethical hypothesis
4. Run the empirical model

Database : primary studies selection



Database : primary studies selection



Effect size measure : explained variables

Shape of the pollution–income path

4 categories (based only on the statistically significant income parameters, for an EKC, the ITP has to lie inside the income range considered by the study) **:**

I. The observation confirms the existence of an EKC.

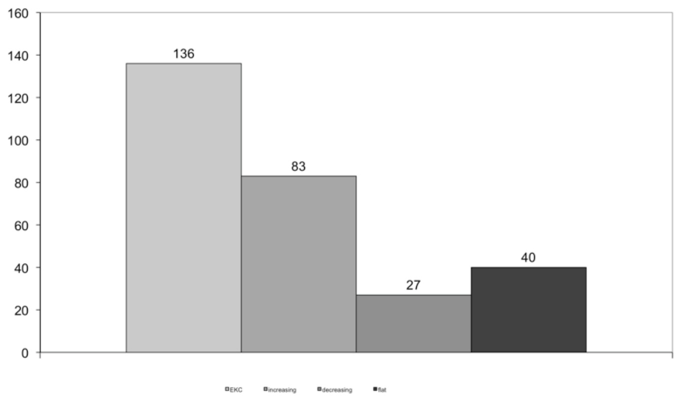
II. The observation does not lead to an EKC but a monotonically decreasing relationship between pollution and income per capita (monotonically decreasing environmental quality).

III. The observation does not lead to an EKC but a monotonically increasing relationship between pollution and income per capita (monotonically increasing environmental quality).

IV. The observation does not lead to an EKC and no other statistically significant relationship is observed (the pollution income path is flat).

Effect size measure : explained variables

Shape of the pollution–income path



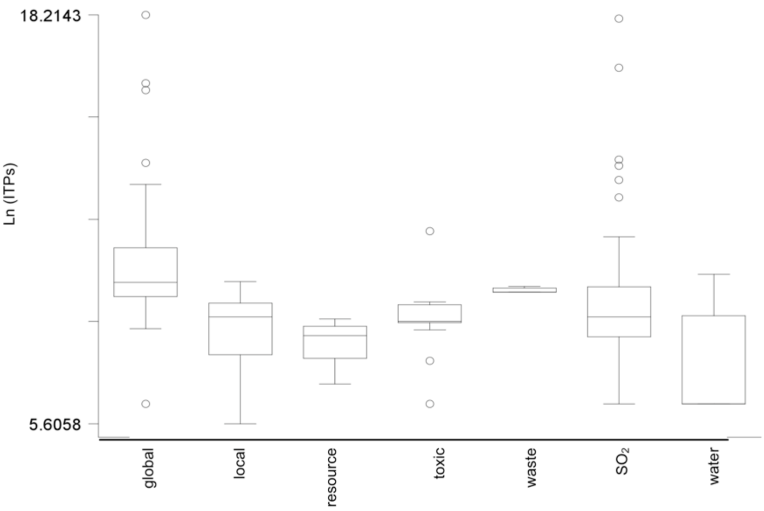
Effect size measure : explained variables

Income turning point

1. In 1985 USD
2. Calculated by differentiation
3. When no income turning point can be calculated, the observation is described as either positive, negative or flat
4. When possible the statistical significance of the ITP is determined

Effect size measure : explained variables

Income turning point by pollutant categories



Explanatory variables

Choice of explanatory variables: graps the difference between the primary studies

- **Empirical methodology and model**
- **Sample size and composition, type of data used**
- **Pollution examined**
- **Publication outcome**

Explanatory variables

sampling variables :
sample size (*size*)
source of the income data used (pwt)
composition of the sample (*dvp* and *ldvp*)

	Sampling variables	Mean (standard error)
size	The natural log of the sample size of the primary study	5.8
pwt	Dummy variable - 1 indicates the study used Penn World Table data, 0 otherwise	0.74
dvp	Dummy variable - 1 indicates the study used developed countries only, 0 otherwise	0.32
ldvp	Dummy variable - 1 indicates the study used developing countries only, 0 otherwise	0.12

Explanatory variables : méthodological variables

	Methodological variables
panel	Dummy variable - 1 indicates the study used panel data, 0 otherwise
re	Dummy variable - 1 indicates the study used a random effect model, 0 otherwise
diff	Dummy variable - 1 indicates the study used a first difference model, 0 otherwise
cub	Dummy variable - 1 indicates the study included a cubic income term, 0 otherwise
log	Dummy variable - 1 indicates the study used the logarithmic specification, 0 otherwise
pop	Dummy variable - 1 indicates the study controlled for population size or population density, 0 otherwise
trade	Dummy variable - 1 indicates the study controlled for trade policy and trade flows, 0 otherwise
pol	Dummy variable - 1 indicates the study controlled for political characteristics (democratic level, quality of institutions and efficiency of political actions), 0 otherwise
educ	Dummy variable - 1 indicates the study controlled for the level of education, 0 otherwise
equ	Dummy variable - 1 indicates the study controlled for equity measures (Gini index), 0 otherwise
eco	Dummy variable - 1 indicates the study controlled for the economic activities of geographical areas, 0 otherwise
price	Dummy variable - 1 indicates the study controlled for the price of goods and behavior closely linked to environmental quality considerations (price of energy, wood), 0 otherwise

Explanatory variables : publication

pub	Dummy variable - 1 indicates the study has been published before June 2003, 0 otherwise	0.72

The likelihood of sampling a study may be correlated with the result it contains = selection bias :

- restrictive sampling over time within a country or a language
- focus on a specific theoretical or modeling approach
- well-known published (and easily accessible) studies present a biased sample of what has been found by researchers.

Empirical model

$$Y_{ij} = \beta_1 c_i + \beta_2 m_i + \beta_3 p_i + e_i$$

Y_{ij} : effect size (relationship or ITP)

c_i : sampling and data characteristics

m_i : methodological characteristics

m_i : pollution characteristics

e_i : error terms, unexplained part of the relationship

Modelling approach

Variables expliquées	Modèles empiriques
Forme de la relation	**Logit multinomial**
Valeur du revenu seuil	**Tobit**
Forme de la relation & valeur du revenu seuil	**Logit emboîté**

Weighting observation: according to the statistical significance of each observations (results of primary studies)

Proxy : sample size of the primary studies /statistical significance of coefficients

Discrete choice multinomial logit model (ML)

Tab. 2.5 Multinomial logit model

	Multinomial logit (reference category: EKC) Increasing	Decreasing	Flat
size	0.311*	0.149	0.291
	1.87	*0.36*	*1.40*
pwt	1.502**	-3.498***	2.154**
	2.28	*-3.35*	*2.29*
dvp	-0.528	-1.619	-0.094
	-0.99	*-1.43*	*-0.12*
ldvp	1.423	-3.344	2.488***
	1.58	*0.01*	*3.02*
pub	1.588**	0.486	0.341
	2.40	*0.40*	*0.45*
panel	-0.927*	-2.290**	-1.341*
	-1.71	*-2.41*	*-1.78*
re	0.070	-0.189	-0.459
	0.14	*-0.21*	*-0.66*
diff	1.374	-3.098	0.572
	1.44	*-0.00*	*0.39*
conc	-0.237***	0.785	0.976
	-2.32	*0.88*	*1.32*
cub	-0.812	-0.181	0.391
	-1.35	*-0.14*	*0.51*
log	0.907*	-0.688	0.448
	1.88	*-0.62*	*0.71*
pop	1.021*	0.394	-1.310*
	1.78	*0.47*	*-1.87*
trade	2.116**	-1.426	-0.554
	0.83	*-0.79*	*-0.64*
pol	-2.810***	-1.529	0.011
	-2.72	*-1.17*	*0.01*
educ	3.620***	-4.045	2.294**
	2.93	*0.03*	*2.30*
equ	-3.086**	0.543	0.587
	-2.46	*0.41*	*0.68*
eco	-0.282	0.309	0.613
	-0.32	*0.31*	*0.83*
price	-5.829***	-3.522	-1.557
	-2.84	*-0.01*	*-1.13*
tox	-1.219	-6.207***	0.298
	-0.85	*-2.91*	*0.27*
res	-2.981**	-4.819	0.897
	-1.96	*0.02*	*0.87*
local	0.725	-2.270**	-0.329
	0.83	*-2.18*	*-0.38*
so2	-0.705	-3.854***	-0.203
	-1.78	*-3.04*	*-0.24*
glob	3.070***	-5.038***	0.359
	2.92	*-2.99*	*0.29*
waste	1.756**	-4.489	-3.780
	1.96	*0.01*	*0.00*
Constant	-5.103***	5.391*	-5.131***
	-3.28	*1.80*	*-3.15*
R2	0.3818		
Obs.	286		
Log likelihood	-215.17251		

Weighted Least Square

VARIABLES	WLS	t-STAT	OLS robust	t-STAT	t-STAT with clustering
size	0.178*	*1.81*	0.186*	*1.7*	*1.3*
pwt	0.467	*1.51*	0.354	*1.06*	*0.9*
dvp	-0.886***	*-2.89*	-0.972**	*-2.41*	*-2.05*
ldvp	-1.031**	*-2.1*	-1.069*	*-1.75*	*-1.42*
pub	0.662**	*2.08*	0.816**	*2.36*	*2.17*
panel	1.161***	*3.25*	1.121***	*2.92*	*2.3*
re	0.567*	*1.87*	0.598*	*1.84*	*2.28*
diff	0.682	*1.08*	0.494	*0.63*	*0.59*
conc	-0.773**	*-2.11*	-0.931*	*-1.77*	*-1.36*
cub	-0.755**	*-2.13*	-0.683**	*-2.06*	*-1.73*
log	0.362	*-1.3*	0.559**	*-2.03*	*-1.96*
pop	-0.143	*-0.46*	-0.197	*-0.72*	*-0.64*
trade	-0.042	-0.12	-0.12	-0.38	-0.3
pol	0.808*	*1.97*	0.993*	*1.67*	*1.59*
educ	0.459	*0.72*	0.356	*0.59*	*0.49*
equ	-0.848*	*-1.81*	-0.936**	*-2.11*	*-2.41*
eco	-0.519	*-1.49*	-0.45	*-1.4*	*-1.08*
price	0.054	*-0.08*	-0.316	*-0.42*	*-0.32*
tox	2.188***	*3.4*	1.764***	*2.92*	*2.03*
res	1.888***	*3.06*	1.696***	*2.69*	*2.01*
local	1.364***	*3.19*	1.368**	*2.33*	*1.68*
so2	1.466***	*3.56*	1.442**	*2.42*	*1.79*
glob	3.039***	*-6.37*	2.944***	*-4.63*	*-3.5*
waste	3.721***	*4.26*	3.489***	*6.12*	*4.47*
C	5.167***	*7.96*	5.167***	*7.1*	*5.3*
Obs	203			203	
Adj.R2	0.5			0.49	
F(B1and B2=0)	4.51			3.86	
restr.-unrestr. chi2(6)	36.06			36.06	

Weighted Tobit

Tab. 2.7 Weighted Tobit model

VARIABLES	Tobit (1/lnn)	t-STAT	Tobit robust	t-STAT	t-STAT with clustering
size	0.150*	*1.66*	0.098	*1.23*	*1.87*
pwt	1.366***	*4.69*	1.223***	*4.45*	*3.76*
dvp	-0.043**	*-2.15*	-0.14**	*-2.5*	*-1.83*
ldvp	0.679	*1.45*	0.442	*0.86*	*0.91*
pub	0.368	*1.22*	0.421	*1.38*	*1.19*
panel	0.101	*0.33*	0.156	*0.46*	*0.31*
re	0.076	*0.26*	0.128	*0.49*	*0.49*
diff	1.046*	*1.7*	0.946*	*1.68*	*1.16*
conc	-0.372	*-1.55*	-0.262	*-1.63*	*-1.45*
cub	-0.184	*-0.57*	-0.222	*-0.81*	*-0.6*
log	-0.023	*0.09*	0.078	*0.31*	*0.24*
pop	0.262	*0.9*	0.22	*0.74*	*0.74*
trade	0.519*	*1.67*	0.424	*1.35*	*0.97*
pol	-0.362	*-0.92*	-0.223	*-0.5*	*-0.43*
educ	2.005***	*3.86*	1.845***	*3.39*	*2.62*
equ	-1.225***	*-2.61*	-1.261***	*-2.62*	*-2.56*
eco	-0.168	*-0.52*	-0.219	*-0.76*	*-0.55*
price	-0.477	*-0.67*	-0.754	*-1.21*	*-0.9*
tox	1.732***	*2.75*	1.089	*1.63*	*1.14*
res	0.497	*0.81*	0.369	*0.54*	*0.47*
local	1.564***	*3.68*	1.350**	*2.43*	*1.81*
so2	1.442***	*3.48*	1.282**	*2.53*	*1.92*
glob	3.148***	*6.9*	3.015***	*5.78*	*4.73*
waste	3.657***	*5.63*	3.255***	*6.09*	*4.63*
C	5.486***	*8.38*	6.020***	*9.37*	*6.85*
obs	244		244		244
cens	21		21		21
F Chi2(17)	21.37		42.5		37.64
r-unr Chi2(6)	62.30		52.92		

NESTED LOGIT MODEL

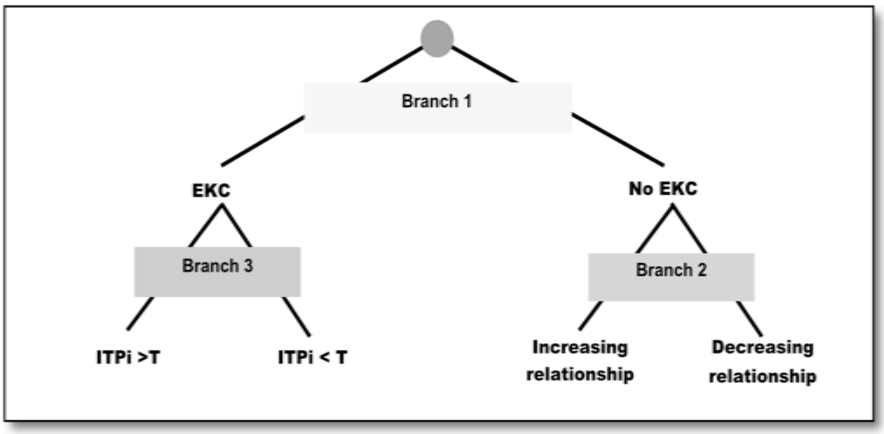
The ML, WLS and WT models are unfortunately limited:

•The multinomial logit model just examines the shape of the pollution-income path and does not offer evidence on the value of the ITPs.

•The weighted least squares and weighted tobit models focus on the value of the ITPs. However, as monotonically increasing and decreasing relationships are included, they don't allow us to formulate conclusions on the variation of ITPs when a well-defined EKC is found.

We rather would like to know, on the one hand, which elements favor the apparition of the EKC and, on the other hand, what influences the value of the ITP when the EKC exists.

NESTED LOGIT MODEL



NESTED LOGIT MODEL

VARIABLES	EKC Branch 1	t-Stat	Increasing Branch 2	t-Stat	ITP > T Branch 3	t-Stat
size	-0.11	*-0.78*	1.01	*1.31*	0.55*	*1.92*
pwt	0.24	*0.51*	5.81**	*2.19*	0.59	*0.63*
dvp	1.14**	*2.52*	4.15**	*2.28*	0.34	*0.30*
ldvp	-1.12	*-1.41*	#		-3.21*	*-1.89*
pub	-1.58***	*-3.07*	-2.03	*-1.09*	0.32	*0.32*
panel	1.04**	*2.11*	3.61*	*1.72*	0.82	*0.75*
re	0.41	*0.93*	-0.95	*-0.61*	2.05**	*2.01*
diff	-0.68	*-0.76*	#		#	
conc	0.95*	*1.64*	-3.84**	*-2.09*	-1.68*	*-1.94*
cub	0.58	*1.17*	-5.83*	*-1.89*	-0.10	*-0.10*
log	-0.16	*-0.40*	0.01*	*1.81*	-0.11	*-0.13*
pop	-1.04**	*-2.15*	-0.27	*-0.14*	-1.23	*-1.40*
trade	-1.15**	*-2.13*	5.82**	*2.35*	0.72	*0.81*
pol	1.18*	*1.81*	-1.65	*-0.85*	0.08	*0.07*
educ	-1.38	*-1.48*	#		-0.43	*-0.30*
equ	1.38*	*1.69*	1.77	*0.62*	-3.51**	*-2.21*
eco	0.39	*0.70*	7.52**	*2.36*	-3.98***	*-2.92*
price	1.36	*0.86*	#		-1.79	*-0.46*
tox	4.87***	*3.78*	5.64*	*1.65*	-0.41	*-0.38*
res	5.60***	*4.18*	-2.52	*-0.85*	##	
local	1.43***	*2.07*	2.19	*1.24*	0.32	*0.29*
so2	1.95*	*2.83*	0.53	*0.23*	-1.48	*-1.37*
glob	0.40	*0.49*	8.63**	*2.45*	1.15**	*2.67*
waste	1.38	*1.22*	4.5 **	*1.98*	#	
C	-1.06	*-0.93*	-11.98**	*-2.27*	-2.08	*-1.18*
Log likelihood (starting value)		-337.21				
Log likelihood (final value)		-198.84				
Obs.		244				

Results

What are the main determinants of the pollution-Income path?

Pollutants

Units of measurement of pollution

Sample composition

Additionnal variables considered (with GDP per capita)

Publication: published studies are less likely to conclude to an EKC

Conclusion

- No systematic and universal pollution-income path
- Pollutants categories matters
- The context seems to be important (… values are contingent)
- No analysis explains with precision why EKC did sometimes appear (legislation, price shock, sectoral change, technological change)
- A possible hypothesis links education (human capital), income, environmental information to better environmental quality. The previous elements may be linked to a technological opportunity.
- ITP may not be predicted.
- No strategy (public policy) maybe based on the EKC.

Conclusion

Theorethical model of growth, human capital and environmental quality (endogeneous growth model, Lucas type)

Data: new data, control their origin (some regress contructed data)

Test with time series analysis, country specific analysis