Environmental Economics in the Central European Context

Time: Tuesday 4pm – 7pm
Location: at CERGE-EI, Room # 11

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Reading materials: http://home.cerge-ei.cz/richmanova/Teaching.html

Lecture 4 – Noninterventionist solutions: environmental labeling and incomplete consumer information in laboratory markets; Environmental Kuznets curve

Plan for Today:

PART I – NON-interventionist solutions -- Environmental labeling and incomplete consumer information in laboratory markets
Cason, Gangadharan, Environmental labeling and incomplete consumer information in laboratory markets

PART II – Environmental Kuznets curve
Yandle, Vijayaraghavan, Bhattarai, The Environmental Kuznets Curve. A Primer

PART III – In class experiment – Coasian solution for externality problem
Hoyt, Ryan, Houston, The Paper River: A Demonstration of Externalities and Coase's Theorem

Plan for Next week: **STUDENT PRESENTATIONS**

PART I - Environmental labeling and incomplete consumer information in laboratory markets

Product certification

From Wikipedia, the free encyclopedia

Product certification or **product qualification** is the process of certifying that a certain product has passed performance and quality assurance tests or qualification requirements stipulated in regulations such as a building code and nationally accredited test standards, or that it complies with a set of regulations governing quality and minimum performance requirements.

Questions:

Which environmental/quality labels are you aware of?

Do you rely on labels? Are you willing to pay higher price for higher (environmental) quality?

What are the possible problems with certification as a solution to informational asymmetries?

Can you explain what kinds of problems can informational asymmetries constitute here?

Certification of ENVIRONMENTAL QUALITY….

Experimental evidence:

Cason, Gangadharan, Environmental labeling and incomplete consumer information in laboratory markets

Questions:

What is the paper about, what do the authors test?

How much of a problem incomplete information constitutes in this context?

What is the key assumption for price discrimination based on environmental quality?

Do you think it is a reasonable assumption, i.e. does it seem to hold in the real life?

Can we expect the unregulated market to achieve the efficient equilibrium? Explain.

Do the authors offer solutions?

- survey evidence exists suggesting that the consumers care for the environment and are willing to pay a higher price for more environment-friendly products
- they study a market with incomplete information – prior to purchase the consumer is unaware of the product's (environment-related) quality (moral hazard problem)
- no signaling with no reputational concerns typically lead to market failure (under-provision of high-quality products)
- various treatments to remedy the market failure: **cheap talk signals**, **seller reputation**, (**costly**) **certification** ("eco-labeling")

Experimental Design and Implementation

- 21 sessions, 20 periods each (except 1st); 5 sellers+6 buyers, roles randomly assigned
- neutral wording of instructions
- sellers can sell up to 2 units of REGULAR(=low environmental quality) or up to 2 units of SUPER (=high environmental quality) grade in each period
- SUPERs are more expensive to produce than REGULARs: 120 experimental francs (EF) vs. EF 20; this is common knowledge

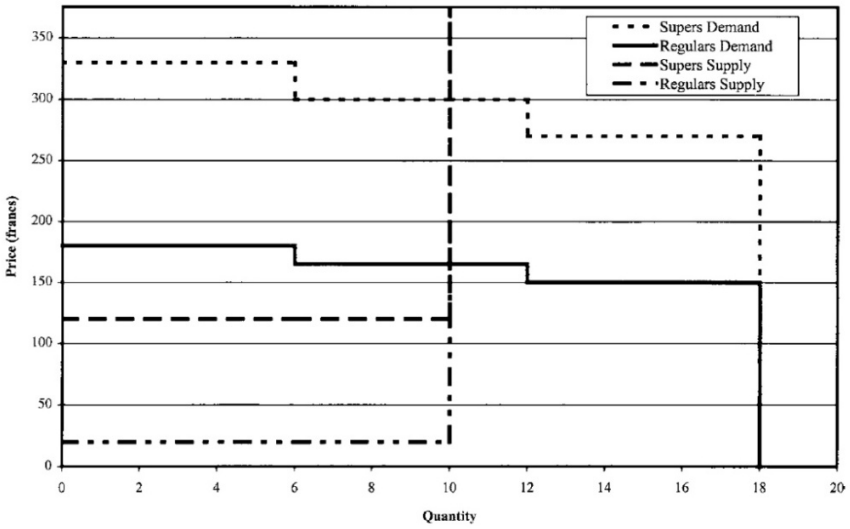
⇨ buyers' resale value of SUPERs > of REGULARs (this means that buyers prefer, and thus are willing to pay a higher price for, SUPERS) which is common knowledge but buyers' specific marginal values are private info (not known to sellers)

- SUPERs: 1st unit brings EF 330, 2nd unit EF 300, 3rd unit EF 270
- REGULARs: 1st unit brings EF 180, 2nd unit EF 165, 3rd unit EF 150

⇨ all buyers and sellers have identical cost and value schedules

⇨ induced demand and supply curve

FIG. 1. Market supply and demand.



⇨ Efficient equilibrium all (10) SUPERS are produced and traded at EF 300

⇨ Inefficient equilibrium all (10) REGULARS are produced and traded at EF 165

Questions:

How is the baseline treatment set up? What is the outcome?

Can you explain, intuitively, the incentives of market participants and the resulting equilibrium?

What changes in reputations/cheap talk/certification?

To what extent the individual mechanisms improve the information available to the buyers? Do they help – and if yes, how – to increase the market efficiency? How stable any such improvement might be?

Which mechanism(s) help(s) to establish and maintain the efficient equilibrium?

TREATMENTS

- **BASELINE**
  - the sellers are asked to indicate privately the number of units they want to sell, the offer price per unit and the grade of the units at the beginning of each period.
  - the price offers (with no additional info) by the sellers are posted on the board in a random order to hide the seller identity (no reputations)
  - buyers are randomly selected to take turns accepting the offers
  - after all the buyers have an opportunity to purchase, or all the units are sold, the grades of the units are written next to each price offer (in all treatments, grade info of all sellers is revealed publicly at the end of each period)

- in all treatments, sellers must commit to a specific quality level privately to the experimenter at the start of the period.

- **REPUTATIONS ONLY**
  - the same trading procedure as in BASELINE, except that here the first seller's price offer is always written in the first row on the board, the second seller's offer in the second row, etc.
  - allows the buyers to track the sales record of each seller and identify if a particular seller has a history of selling REGULARs or SUPERs

- **THE CHEAP TALK SIGNALLING**
  - Similarly as in REPUTATIONS, prices are written on board in specific order to identify sellers' history
  - sellers have, in addition, the following 2 options:
    1) indicate no grade information to buyers (thus, only the price and the number of units offered for sale appear on the board) – this would be analogical to REPUTATIONS, or
    2) indicate a grade to be shown on the board, although this need not correspond to the actual grade offered
  - the 2nd option represents the unregulated environmental quality claims -> so-called cheap talk (claims made by producers that have not/cannot be verified by a third party)
  - to see whether unregulated claims could by themselves help in increasing the number of SUPERs sold

- **CERTIFICATION**
  - also here, prices are written on the board in the specific order to identify sellers' history
  - sellers have the following 3 options:
    1) indicate no grade information to buyers (thus, only the price and the number of units offered for sale appear on the board)
    2) indicate a grade to be shown on the board, although this need not correspond to the actual grade offered
    3) sellers can pay EF 30 to certify that the product they are offering is a SUPER (thus, the buyers would be sure they are buying a SUPER)
  - the certification is indicated by a ''star'' next to the price offer, and it corresponds to third-party verified environmental labeling schemes
  - the certification is costly (in practice real resources are needed to test products); the cost of certification is set such that it can lead to the efficient equilibrium

Q: Would a seller choose the option of certifying his/her product at extra cost of EF 30?

TABLE I
Experimental Design

Treatment	Features	Number of sessions
Baseline	Seller identification not revealed, no product claims allowed	3 inexperienced (UM1[a], UM3, PU1)
Reputations only	Seller identification revealed, but no product claims allowed	4 inexperienced (PU2, PU3, UM4, UM10) 1 experienced (PU4x)
Cheap talk signaling	Seller identification revealed, unregulated product claims allowed	4 inexperienced (UM7, UM8, PU7, PU8) 1 experienced (UM9x)
Certification	Seller identification revealed, binding ("certified") product claims and unregulated product claims allowed	4 inexperienced (PU5, PU6, UM5, PU9) 1 experienced (UM6x)
Reputations only with outside option	Seller identification revealed, but no product claims allowed; buyers received ten francs for "no-purchase" option	2 inexperienced (PU10, PU11) 1 experienced (PU12)

Note. A PU in the session name denotes Purdue University, and a UM in the session name denotes University of Melbourne. An x in the session name denotes experienced subjects.
[a] Session UM1 lasted 16 periods. All other sessions lasted 20 periods.

TESTED MODELS – theoretical predictions:

Lemons Model

When sellers face buyers who cannot distinguish between REGULARs and SUPERs, they will only offer REGULARs. Buyers observe only REGULARs delivered and so they will behave as if they expect only REGULARs. Hence in equilibrium, only REGULARs will be delivered and the price prevailing in the market will be P_R (= EF 165). This equilibrium is particularly likely when sellers cannot establish reputations, as in the BASELINE treatment.

Reputation Model

In the presence of some imperfect information, even in finite period games sellers may establish reputations for delivering SUPERs in sequential equilibrium. According to this model, for some early range of periods some sellers will deliver SUPERs at a price of P_S (EF 300). A buyer who observes a seller delivering a REGULAR will update her beliefs and expect that seller to always deliver REGULARs in the future. Therefore, in later periods more REGULARs will be delivered at P_R.

Signaling Models with Unverifiable Signals

When it is not possible to verify product claims by sellers, then no cost differential exists between adding the ‘‘SUPER’’ signal to SUPERs and to REGULARs. In a ‘‘babbling’’ cheap-talk equilibrium, no seller adheres to her signals, and buyers do not believe that the signals convey any information. Consequently, market outcomes would be unchanged by the introduction of signaling. Signaling could, however, assist sellers in establishing the reputations in early stages.

Signaling Models with Verifiable Signals

When the signaled product claims are verifiable, sellers would find it profitable to deliver certified SUPERs since the certification cost is less than the marginal profit from delivering SUPERs rather than REGULARs at their respective equilibrium prices. Buyers know that if the product is certified, they are guaranteed to receive a SUPER and are thus willing to pay the higher equilibrium price P_S. Hence, when certification is available, outcomes correspond to the full information equilibrium.

RESULTS – What would you expect?

Market performance is measured by frequency of SUPERs delivered to consumers and by the overall market efficiency.

1) ***Allowing seller reputations increases the rate at which SUPERs are traded, but Cheap Talk does not affect the rate at which Supers are traded compared to the treatment with Reputations Only. Certification is sufficient to increase the rate at which SUPERs are traded.***

TABLE II
Treatment Average of Number of Super and Regular Units Sold

	Number of super and regular units sold							
	Baseline		Reputations only		Cheap talk signaling		Certification	
	Reg	Sup	Reg	Sup	Reg	Sup	Reg	Sup
Treatment average (all periods)	6.5	0.9	4.8	3.4	5.7	3.4	2.6	6.2
Treatment average (final 5 periods)	7.1	0.5	5.2	3.2	6.3	3.2	1.8	7.4
Treatment average (final 10 periods)	6.9	0.7	4.9	3.6	5.9	3.5	2.4	6.9

⇨ in the BASELINE, SUPERs account for about 12% of total sales (all periods), whereas in the REPs ONLY it is about 40% (the difference is statistically significant)

⇨ in the CHEAP TALK, about 1/3 are SUPERs (not significantly different from REPs ONLY)

⇨ in the CERTIF., more than 2/3 are SUPERs (significantly more than in REPs ONLY)

⇨ the results also confirmed by econometric analysis

- subjects accumulate evidence from offering SUPERs and REGULARs and update their beliefs about their expected profits
- in REPs ONLY, # of SUPERs rises over time, then drops in final periods

- initial periods of BASELINE are not sign. different than in REPs ONLY, in later periods the # is lower in BASELINE
- early periods of CHEAP TALK – more SUPERs than in REPs ONLY, the difference disappears
- CERTIF. not different in early periods, later on, significantly more SUPERs
- even though SUPERs tend to be delivered in later periods, in the final periods, most units offered are REGULARs except in the CERTIF. (end-game effect – **can you explain why it happens?**)

2) ***Allowing seller reputations marginally increases efficiency, but neither Cheap Talk nor Certification significantly improves efficiency compared to the treatment with Reputations Only.***

TABLE II Efficiency

	Efficiency including surplus loss from certification			
	Baseline	Reputations only	Cheap talk signaling	Certification
	Efficiency	Efficiency	Efficiency	Efficiency
Treatment average (all periods)	0.646	0.787	0.813	0.813
Treatment average (final 5 periods)	0.643	0.812	0.826	0.866
Treatment average (final 10 periods)	0.658	0.806	0.834	0.870

⇨ efficiency measured as the fraction of the maximum possible gains from trade actually realized by subjects

⇨ efficiency goes up from 65% to near 80% when sellers can establish reputation

⇨ the difference between BASELINE and REPs ONLY significant, between REPs only and CHEAP TALK or CERTIFICATION not significant (in CERFTIFICATION efficiency loss due to the cost of certification)

⇨ efficiency tends to rise over time

3) ***Non-certified Super signals are frequently false.***

⇨ about 22% in the CHEAP TALK are false. Non-certified SUPER signals are more rare in the CERTIFICATION, but still 33% of them is false.

⇨ REGULAR signals are much less common in both treatments, they are almost always truthful (**??? What is wrong here?**).

4) ***Given the opportunity in the Certification treatment, sellers frequently certify their units as Super.***

- ⇨ in some sessions nearly all units are certified, e.g. average number of sellers who choose to certify is 4.75 out of 5 in all periods, rises to 5 in both the last 10 and 5 periods; in other sessions the certification rate is 2-4 and tends to increase in time.
- ⇨ many sellers use certification to establish reputation and then, later, use cheap talk to obtain higher prices; buyers, however, often refuse to buy uncertified units for SUPER prices (except of 1 session)

5) ***a) Reputations modestly impact transaction prices in certain conditions;***

   b) signals have an impact on transaction prices in the Cheap Talk treatment; and

   c) certification is necessary for sellers to sell at substantially higher prices in the Certification treatment.

6) ***Sellers who reveal themselves as ''cheaters'' by delivering Regular units at ''Super prices'' can frequently regain a positive reputation quickly – often in the next period. This seems to be due in part to the lack of an explicit outside option for buyers in most of our sessions.***

- ⇨ ''immediate reputation recovery'' -- when a seller is able to sell an uncertified unit at a high price one period after they sold a Regular at a high price
- ⇨ this puzzling high rate of reputation recovery could be due to the fact that buyers' only source of profit is from making purchases in the market.
- ⇨ to test this conjecture, they conducted three additional sessions where buyers could choose not to purchase from any seller and still earn 10 francs, focusing on the REPs ONLY as here the reputation recovery rate was particularly high (70%)
- ⇨ the buyers opt for the no purchase option in exactly one-quarter of the periods
- ⇨ in general, the overall performance in this new treatment is similar to the five sessions with REPs ONLY and no outside option.
- ⇨ Importantly, the reputation recovery rate declines substantially in these new sessions with an outside option, to 33%..
- ⇨ The puzzling high reputation recovery rate in the REPs ONLY without the outside option treatment could hence be explained in part by the inability of the buyers to exit the market profitably.

CONCLUSION

1) Seller reputations increase the number of high-quality goods delivered relative to the no-reputation baseline (=> just some information to the market haleps to improve the outcome substantially)
2) Unverified claims are not sufficient to further improve market outcomes.
3) Although certification is costly, sellers usually opt to certify; consequently, the number of high-quality units increases, even though efficiency does not significantly increase due to

the certification costs. Certification appears sufficient to overcome the moral hazard problem.

4) Seller reputations modestly influence prices in some conditions, and signals and certification have a significant impact on transaction prices.
5) Buyers are willing to forgive sellers quickly who previously delivered Regulars at Supers prices; it is explained at least in part by the absence of a profitable exit from the market.
6) laboratory results suggest that government regulators or non-governmental organizations can improve environmental performance by providing the option of certified green labeling (only a single dimension of the product studied here).

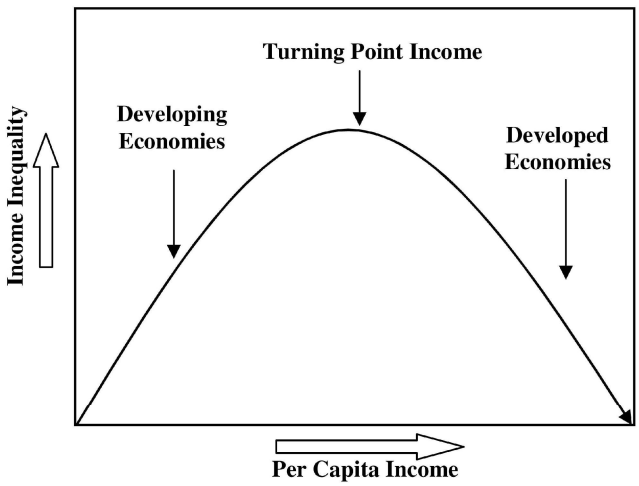
Part II - ENVIRONMENTAL KUZNETZ CURVE

mostly based on: **Yandle, Vijayaraghavan, Bhattarai, The Environmental Kuznets Curve: A Primer.**

[additional reading: **Stern, The Rise and Fall of the Environmental Kuznets Curve** which is quite technical, you might still want to read at least the non-technical parts]

Q: What is the basic relationship claimed? What would it mean if it were true (and as simple as hypothesized)?

Kuznets (1955) hypothesized that income inequality first rises and then falls with economic growth – inverted U shape - hence the name EKC (Environmental Kuznets Curve) for similar pattern in environmental policy



1. EKC first reported in 1991
    - Grossman and Krueger's analysis of air quality measures
        - a cross-section analysis of countries for different years,

- investigating the claim that economic growth accompanying the NAFTA would foster environmental degradation
- the authors identified a turning point beyond which with higher income air quality started to improve (for two indicators: SO2 and dark matter(smoke)),

- ECK has become standard fare in technical conversations about environmental policy
- the theoretical framework is still in early stages (see e.g. Lopez 1994 or Munasinghe 1999, in Yandle et al.)

What is the basic issue?

- Can economic growth be the means to *eventual* environmental improvement?
- Can humankind "have our cake and eat it" – a prospect of achieving sustainability without a significant deviation from business (Rees 1990, p. 435, in Stern)
- Does the following result (of an "inverted U-shaped function of income per capita") generalize to other emissions?

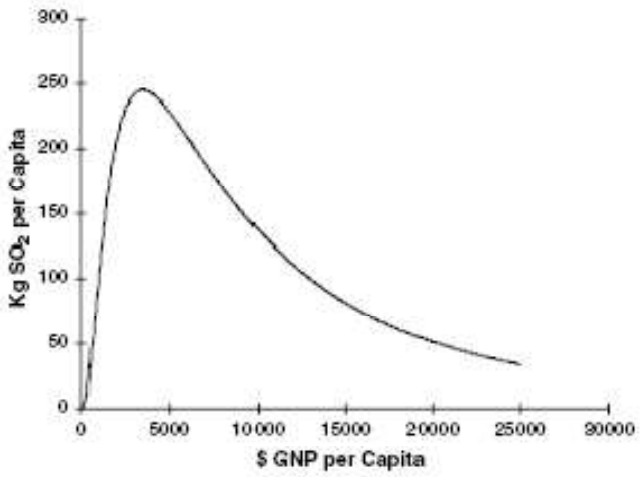


Figure 1. *Environmental Kuznets curve for sulfur emissions. Source: Panayotou (1993) and Stern, Common, and Barbier (1996).*

Yandle et al

- Where did the name "Environmental Kuznets Curve" come from?
- Why Kuznets?
- What have we learned about the statistical relationships between various measures of environmental quality and income?
- Do all aspects of environmental quality deteriorate or improve systematically with economic development?

- Does the degree of property rights and contract enforcement make a difference?

Q: What is the intuitive justification of such U-shaped relationship between growth and pollution?

1. **…[luxury good]**
2. **…[property rights]**
3. **…[trade]**

So what is the intuition?

1. **At the low levels of per capita income**
   - typical for pre-industrial and agrarian economies, not very industrialized
   - rather pristine environmental conditions, relatively unaffected by economic activities (i.e. relatively low "industrial" pollution)
   - **as development and industrialization progress**, **environmental damage increases due to greater use of natural resources, more emission of pollutants, the operation of less efficient and relatively dirty technologies**,
   - also, typically, high priority is given to increases in material output with disregard for the environmental consequences of growth.
2. **As economic growth continues** (and life expectancies increase)
   - cleaner water, improved air quality, and a generally cleaner habitat become more valuable
   - Much later, in the post-industrial stage, **cleaner technologies and a shift to information and service-based activities combine with a growing ability and willingness to enhance environmental quality** (Munasinghe, 1999)."

*"Saying all this **may tempt one to think that higher incomes alone will solve most environmental problems**. **[Do you think this could be true?]** **Unfortunately, life is not that simple**. If it were, transfers of income from richer to poorer societies—through foreign aid, for example—would enable the recipients to avoid environmental destruction."*

3. ***"The movement along an environmental Kuznets curve is also a movement through a well-known set of property right stations!"***
   - In primitive societies managed by tradition or tribal rule, part of the resource base may be treated as commons.
   - With growing scarcity, however, a time comes when some aspects of the commons become defined as public or private property.
   - As "property-ness" expands, individuals have a greater incentive to manage, to conserve, and to accumulate wealth that can be traded or passed on to future generations. …

   "Thus, the Environmental Kuznets Curve is a proxy for a property rights model that begins with a commons and ends with private property rights."

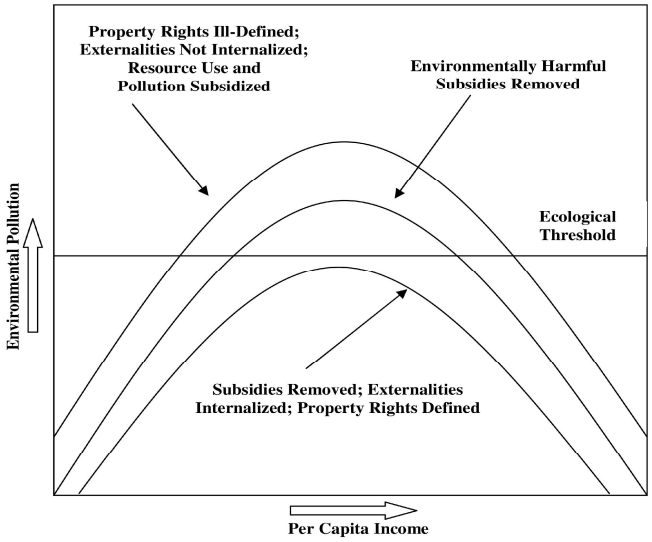
4. ….

Empirical Evidence:

- Grossman and Krueger 1991 – identified the turning point for **SO2** and **dark matter**
- Shafik and Bandopadhay (1992) – for **SO2, suspended particulate matter, fecal coliform** [a bacteria - its aerobic decomposition can reduce dissolved oxygen levels if discharged into rivers or waterways]
- Hettige et al 1992 - using a composed production toxicity intensity index – found EKC for toxic intensity per GDP, not for "per manufacturing output"… Manufacturing, which is just one part of GDP, did not become cleaner or dirtier as income changed. Instead, **manufacturing became smaller relative to services and trade in expanding economies**. … **This could mean that dirty production shifts elsewhere!!!** They found that "toxic intensity in manufacturing has grown much more rapidly in economies that are relatively closed to international trade"
- Suri and Chapman (1998) - focused on energy consumption showed **that as industrialized economies matured, they moved to services and then imported more manufactured goods from developing countries** -> the global diffusion of manufacturing contributes to local environmental improvements as incomes rise and development continues… **another support for trade argument**
- Gokany 2001 – "**Open economies improve their environments**" (**positive (local) impact of international trade?**)
- Cropper and Griffits (1994) – as income increases the rate of **deforestation levels off**
- Panayotou (1995) – finds that the **turning point for deforestations occurs much earlier than for emissions**," because deforestation for either agricultural expansion or logging takes place at an earlier stage of development than heavy industrialization"
- Shafik (1994) – studied four determinants of environmental quality -> **mixed results**
- Grossman and Krueger (1995) – more extensive empirical study, **focusing on water quality , found a turning point for 11 out of 14 selected indicators**
- following up, Selden and Song (1994) – 2 G&K's air pollutants + oxides of nitrogen and carbon monoxide – found EKC for all 4, turning points for pollutants from G&K are significantly higher than G&K's estimates (they use readings from both urban and rural areas, G&K only urban)
- Cole et al – examined a wide range of indicators for different countries

and specifically on **property rights…**

- Panayotou (1997) examining EKC for sulfur dioxide found that faster economic growth and higher population density do increase moderately the environmental price of economic growth, but **better policies such as more secure property rights under a rule of law and better enforcement of contracts and effective environmental regulations can help flatten the EKC and reduce the environmental price of higher economic growth**. Similar results obtained by Qin (1998), and Bhattarai (2000)



Conclusion

- there is no single EKC relationship that fits all pollutants for all places and times
- The indicators for which the EKC relationship seems most plausible are local air pollutants such as oxides of nitrogen, sulfur dioxide, and particulate matter.
- there is no evidence to support the EKC hypothesis for gases such as carbon dioxide, which cause no harm locally but may affect the global climate as they accumulate in the atmosphere
- the evidence for water pollution is mixed
- better policies and enforcement can help to flatten ECK and perhaps to achieve an earlier turning point.

A Critique of EKC - <u>Stern, The Rise and Fall of the Environmental Kuznets Curve</u>

- currently, a dispute over methodology and the reality of the EKC – theoretical and econometric critique of EKC literature
    - recent evidence suggests that developing countries are addressing environmental issues, adopting high standards (of developed countries) and sometimes performing better than some wealthy countries
    - "most of the EKC literature is **econometrically weak**" (Stern p. 1420) because it does not account properly for the statistical properties of the data used [serial dependence, stochastic trends] and issues of model adequacy [possibility of omitted variable bias]
    - **"when we … use appropriate techniques, we find that the EKC does not exist"** (Stern p. 1420)

- "e.g., it is clear that **emissions of many pollutants per unit of output have declined** over time in developed countries with increasingly stringent regulations and technical innovations. But the mix of residuals has **shifted** from sulfur and nitrogen oxides to carbon dioxide and solid waste… so that **per capita waste (total) might not have declined…"**
- … "an effort to reduce some environmental impacts may just aggravate other [environmental] problems."
- "It seems that emissions of <u>most</u> pollutants and flows of waste are monotonically rising with income", though the "income elasticity" is less than 1 and is **not a simple function of income alone** -- other factors, income independent or **time related** effects [such **as institutional quality**] reduce environmental impacts in all countries at all levels of income" (Stern p. 1420))
    - → In rapidly growing middle-income countries, **scale effects tend to dominate time effects**
    - → **Pure growth, without change in the structure or technology of an economy, leads to more pollution and other negative environmental impacts (scale effects)**
    - → As economies grow, **output mix changes** – from more pollution intensive to less pollution intensive industries -- input mix changes, emission specific regulations might change
    - → In wealthy countries, time effects can dominate scale effects (partially because growth is slower)
- Arrow et al. (1995) and Stern et al. (1996) argue that EKC relationship (if there were any) might be partly or largely a result of **the effects of trade** in the distribution of polluting industries (developed countries specializing in human capital and manufactured capital intensive activities that might to some extent explain reduction of environmental degradation in those countries)… no consensual answer on the impact of trade in EKC literature

- currently, also a dispute over the appropriate mix of econometrics /statistics and theory, as well as the facts
    - "many environmental economists take the EKC as a stylized fact that needs to be explained by theory." (Stern p. 1421)
    - "**the EKC has never been shown to apply to all pollutants or environmental impacts**" (Stern p. 1421)

- A number of theoretical models have been developed on how preferences and technology interact to result in different time paths of environmental quality. (Stern p. 1422)
    - Most of these studies can generate an inverted U-shape curve of pollution intensity but … but the results are assumption and parameterization sensitive
    - Many studies also include additional explanatory variables,

- intended to model underlying factors such as 'political freedom', or output structure, or trade
- these factors, in general, turn out significant at traditional levels. …
- *"it is not clear what we can infer from this body of work because of potential for omitted variable bias"* (Stern)

- Turning point estimates differ widely (see Table 1, Stern p. 1425):
- **"The only robust conclusions from the EKC literature appear to be that concentrations of pollutants may decline from middle income levels, while emissions tend to be monotonic in income. … "** (Stern p. 1426)
- "It seems unlikely that the EKC is an adequate model of emissions or concentrations. I concur with Copeland and Taylor (JEL 2004), who state that: **"Our review of both the theoretical and empirical work on the EKC leads us to be skeptical about the existence of a simple and predictable relationship between pollution and per capita income."** (Stern p. 1435)

PART III – In-class experiment ...