Undergraduate Program in Central European Studies

CERGE-EI and the School of Humanities at Charles University
Address: Politických vězňů 7, 110 00 Praha 1
Tel. : +420 224 005 201, +420 224 005 133, Fax : +420 224 005 225
E-mail: upces@cerge-ei.cz
Web: http://www.cerge-ei.cz/abroad

Environmental Policy in the Central European Context

Time: Tuesday 4pm
Location: at CERGE-EI, Room # 9

Professor: Jana Krajcova
email: jana.krajcova@cerge-ei.cz
Reading materials: http://home.cerge-ei.cz/richmanova/TeachingUPCES.html

Lecture 2 – Interventionist solutions to the Externality problem: Pigouvian taxes and standards and charges; also Environmental Kuznets curve, and environmental labeling and incomplete consumer information in laboratory markets

Readings for Lecture 2:

PART I - Interventionist solutions to the Externality problem – Pigouvian taxes and standards and charges
Schotter, Microeconomics, A Modern Approach (2nd edition), Chapter 17, Sections 17.3 & 17.4
Plott, Externalities and Corrective Policies in Experimental Markets

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

PART III – NON-Interventionist solutions -- Environmental labeling and incomplete consumer information in laboratory markets
Cason, Gangadharan, Environmental labelling and incomplete consumer information in laboratory markets

What did we do last time (Lecture 1)

- **introduction** (why do we care about environment, current issues, instruments of environmental protection)
- **externalities** (positive and negative)
- **market failure** (Robinson Crusoe example)
- **public good**, **free-rider problem**, solutions: Lindahl free-market solution that requires truthful revealing of preferences (auctions or demand revealing mechanisms), Coase argument, government provision or subsidies, club goods, supporting public mindedness
- **tragedy of the commons** (too many fishermen)
- in-class experiment on externalities and Coase solution
- use of **experimental methods** and connected problems (selection bias, measurement errors, randomization bias, substitution bias, attrition bias, generalization of the results, publication bias and regulatory bias);
- **contingent valuation**; revealed ("the preferences of consumers can be revealed by their purchasing habits") vs. stated preference ("a survey-based economic technique for the valuation of non-market resource") methods; willingness to pay vs. willingness to accept, real vs. hypothetical surveys

PART I – INTERVENTIONALIST SOLUTIONS TO THE EXTERNALITY PROBLEM

A. Theoretical background

Schotter, Microeconomics, A Modern Approach (Second edition) **Section 17.3**

- problem of externality
- interventionists vs. free market advocates

Interventionist solutions:

1. **Pigouvian Taxes**
2. **Standards and Charges**
3. Marketable Pollution Permits

1. PIGOUVIAN TAXES

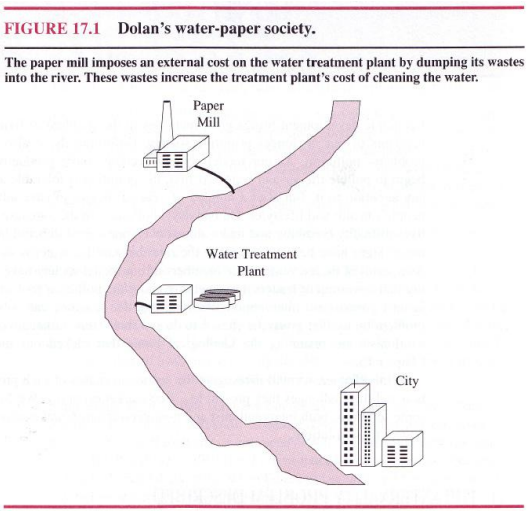


FIGURE 17.1 Dolan's water-paper society.

The paper mill imposes an external cost on the water treatment plant by dumping its wastes into the river. These wastes increase the treatment plant's cost of cleaning the water.

- the society produces paper (paper mill=PM) and clean water (water treatment plant = WTP)
- PM dumps waste into the river and thereby increases the cost of cleaning it => **externality** (as this cost is external to the mill, it is borne by the WTP) => not taken into account when making production decision (in the competitive market price of paper=marginal cost of producing paper)
- Say the **mill** is producing
    - **10 tons of paper** (1 ton=2,000 pounds, 10 tons… **20,000** pounds)
    - with a **(private) MC** (of labor and capital) of **$0.005/pound=$10/ton**.
    - In a competitive market **p=MC**
- **Water treatment plant's MC**
    - when the mill is idle is **$.50/1,000** gallons;
    - when the mill is active, additional cost of **$.05/1,000 gallons for each ton** of paper produced
    - given the current mill's production, the total MC is **$.50 +10(tons)*$.05=$1 per 1,000 gallons**
- In a competitive industry the **price of water will be $1 per 1,000 gallons**. Assume at such price 1 mil. gallons of water is demanded => Society spends $1,000 on water
- **Can we expect the society to produce a PARETO OPTIMAL amounts of water and paper?**
- Intuitively, we might expect the answer to be **NO**.
- The paper mill is imposing an additional cost on the water treatment plant, but there is no mechanism to make the mill accountable for this cost, so it seems unlikely that the outcome for society will be Pareto-optimal. Indeed it is not …

Technically, three conditions *must be fulfilled for a perfectly competitive economy to produce* ***Pareto-optimal outcomes****:*

1. ***$MRS_1 = MRS_2$=…*** *the marginal rate of substitution (the ratio of the MU (paper) to the MU (water), which in equilibrium has to be equal to the price ratio of the price of paper and the price of water) of paper for water has to be the same for all consumers. Where* ***$MRS_{w\ for\ p}=MU_p/MU_w=p_p/p_w$****=$0.005/$0.001* ***=5/1*** *=> all consumers maximizing their utility will set their MRSs such that this condition is met*
2. ***$MRTS_p=MRTS_w$*** *- the marginal rates of technical substitution of paper mill and water treatment plant ought to be the same (optimal use of production inputs => optimal production)*
3. ***$MRS_{w\ for\ p}= MRT_{w\ for\ p}= MC_p/MC_w$*** *- the marginal rate of substitution of water for paper must be equal to the marginal rate of transformation of water for paper, which in equilibrium is supposed to be equal to the ratio of the marginal cost of producing paper to the marginal cost of producing clean water*

But … the (private) marginal costs of paper and water are not what their (social) marginal costs, and the marginal utilities are … ***PROBLEM***

- ⇨ *according to condition 3,* ***$MRT_{w\ for\ p}$*** *would have to be* ***5/1****= we must give up 5 gallons of water to obtain 1 more pound of paper.)*

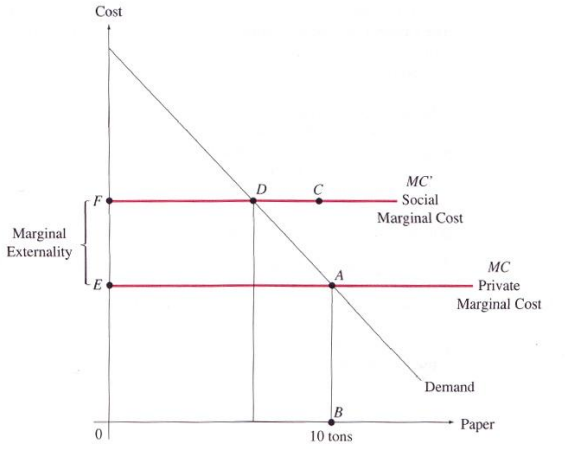
going back to our example…

- take away $1 from production of water (MC_w=$0.001 => **1,000 fewer gallons** are produced) => 999,000 gallons are produced
- give that $1 to the mill ($MC_p$=$0.005 => 200 more pounds of paper can be produced) => so far so good BUT
- extra 200 pounds => 10.1 tons are produced => increase in MC_w (each ton brings extra $0.05 in MC) => 0.1 tons brings about extra $0.005 => MC_w = $1.005 =p => with $999 available on water, the society will only purchase 999/1.005= about 994,000 gallons of water. Thus the society has to give up almost 6,000 gallons, **not 1,000** to obtain 200 more pounds of paper => the **$MRT_{w\ for\ p}$=** 6,000/200=30/1 – "**social marginal rate of transformation**" (accounts for full social costs) rather than 5/1 (**marginal rate of substitution).**
- **$MRS_{w\ for\ p}$** (=5/1)<< **$MRT_{w\ for\ p}$**(=30/1)
- At (competitive) production levels of 10 tons of paper and 1 million gallons of water, the society would be producing too much paper and not enough water => **MARKET FAILURE**

WHY?

FIGURE 17.2 **Pigouvian taxes.**

The imposition of a tax equal to the marginal externality (distance *EF*) equates the private marginal cost *MC* faced by the paper mill with the social marginal cost *MC'* and thereby induces the mill to produce at the optimal level for society (point *D*).



- ⇨ **point A** – the level of production of paper resulting from a competitive market -> Not Pareto Optimal
  - ⇨ assume mill would reduce its production by 200 pounds (0.1 ton). Given the market price that would mean a loss of 200x$.005=$1 in revenues
  - ⇨ cost of producing clean water is now reduced by (200p/2000p)=1/10x$.05=$.005 per 1,000gal. => 1 mil. gallons would be produced at a cost of $995 instead of $1,000 -> $5 saved for the treatment = Pareto Improvement (**HOW COME? We discussed that… WTP can compensate that $1 lost to PM due to reduced production and still have $4 extra… this means that PM is not worse off, while the WTP is better off…)**
  - ⇨ the cost savings of the WT plant are sufficient to allow it to produce more water and to compensate the mill for its lost revenues

PIGOU

- ⇨ the "pollution" cost is external to the mill, so it does not affect the production decision
- ⇨ from the social point of view => Social Marginal cost MC' of the paper production (=production cost + pollution cost)
  - ⇨ point A is not optimal for society – "BC" (social MC)>"BA" (social marginal benefit) => **point D** is the social optimum

Pigou – **TAX on paper**; taxed by the amount of the marginal externality ("EF") in order to internalize the externality and directly affect the mill's paper production => **point D**

- ⇨ **PROBLEM** – To set the tax, the government needs to know the exact amount of the externality (the cost). The afflicted party, however,
  - might not be able to estimate accurately
  - might have incentives to exaggerate (both, the mill and the WTP)

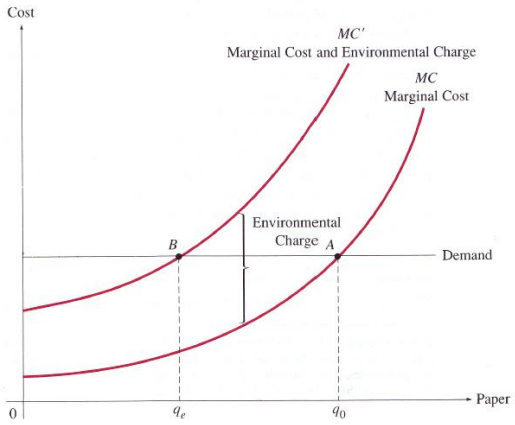
2. STANDARDS AND CHARGES

The government sets the standard – the amount of externality considered acceptable and then charges (per unit of pollution) in order to induce the agents to reduce the externality to the acceptable level.

Single firm

FIGURE 17.3 The effect of an environmental charge on a single firm.

The imposition of an environmental charge equal to the distance between the marginal cost curves *MC* and *MC′* induces the firm to cut back its output from q_0 to q_e.

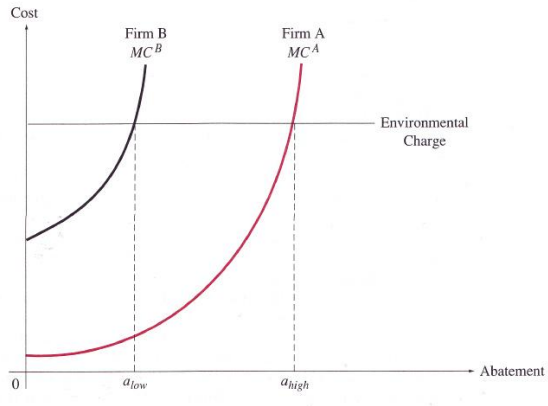


- the government conducts a study to determine how much pollution is acceptable
- charge **on each gallon of waste** to induce the mill to reduce the pollution to the acceptable level
- when the mill's cost is MC => it will produce at point A
- charge=> MC'=> it will produce at point B
- Ideally, with q_c the production of waste is at the STANDARD

Two or more firms

FIGURE 17.4 The effects of an environmental charge on two firms.

The marginal cost of abatement curve for firm A (MC^A) is lower than that for firm B (MC^B). Each firm will choose a level of abatement such that its marginal cost of abatement is equal to the constant environmental charge. Thus, the level of abatement chosen by firm A (a_{high}) will be higher than that chosen by firm B (a_{low}).



- 2 firms: mill A produced 70 gallons of waste a day, mill B 30 gallons. STANDRD= 50 gal.

- an across-the-board 50% cut might not be the most efficient (different MCs for waste reduction=marginal cost of abatement, depending on technology used)
    - A would have to reduce by 35, B by 15 gal. Say A's cost of reducing by additional 1 gal. is $5, B's is $8 => if A's total abatement is 36 gal. and B's is 14 gal. the total abatement is same but the society could save $8-$5=$3.
    - **Firms with lower cost (of abatement) should reduce by more and firms with higher cost by less!**
    - Figure 17.4 – once the environmental charge (per unit of pollution) is set, each firm will reduce by the corresponding amount. $a_{low}+a_{high}=a_{total}$ ($MC^A=MC^B$=charge; STANDARD is induced; note that this is marginal cost of abatement, not of production)
- **PROBLEM** – even more difficult to administer, need to know the exact damage to society to set the STANDARD + the cost of abatement for each firm to be able to set the charge right, so that it induces the desired reduction of pollution (guess and verify, don't want the firms to reduce neither too much nor too little)

Note the difference between the two mechanisms: tax (per unit of paper) vs. charge (per unit of pollution).

3. MARKETABLE POLLUTION PERMITS

- For each unit of produced waste the firm pays not only the cost of labor and capital, but also a permit that will allow to produce that unit. A firm with higher MC of abatement is willing to pay more for the permit that the firm with lower MC of abatement (up to its cost of abatement for the corresponding number of units)
- The government first finds an acceptable level of pollution and then offers for sale the corresponding number of permits
- The firm can only pollute with the permit. The government directly controls the amount of pollution without having to know any specific about the firms' marginal costs of abatement or about the social marginal cost of pollution
- we will talk more about this next week.

B. Experimental Evidence

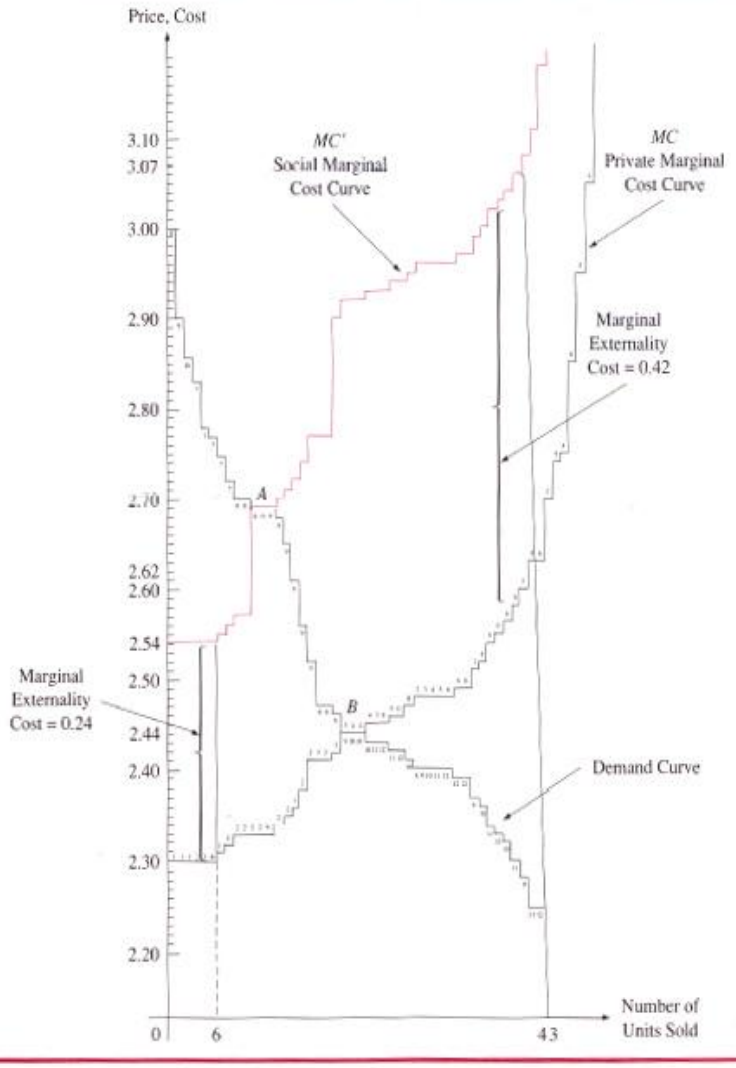
Based on: Plott, Externalities and Corrective Policies in Experimental Markets, also Schotter, Section **17.4**

A series of experiments to evaluate how the interventionist solutions work

- the subjects buy and sell units of a fictitious good using a double oral auction (*In such a **double oral auction** any potential buyer (or, seller) can make a verbal bid (offer) to buy a unit of the good at a specified price. Any seller (buyer) can accept a bid. If a bid is accepted a binding contract is closed for a single unit at the specified price. Any ties are resolved randomly).*
- each buyer is paid a redemption value for every purchased unit according to a predetermined redemption schedule ⇔ induced demand curve
- each seller must pay a premium for each unit he sells according to a predetermined cost schedule ⇔ private marginal cost curve (~induced supply curve)
- every completed transaction imposes an additional cost in all subsequent transactions ; the cost increases with the number of units sold ⇔ externality => social marginal cost curve.

FIGURE 17.6 **Plott's laboratory model of a market with an externality.**

Economic theory predicts that the market, if left alone, will ignore the externality and will reach its equilibrium at point *B*, where the private marginal cost curve *MC* and the demand curve intersect. Point *A*, where the social marginal cost curve *MC'* and the demand curve intersect, is the optimal solution for society.



- Note that after 6 units sold, the marginal externality cost is $.24, after 43 transactions, it is $.42
- Pareto optimal solution -- **point A** (13 units at price $2.69)
- without intervention -> theory predicts the competitive outcome "as with no externality" -> **point B** (24 units at price $2.44)
- Charles Plott:
  - ⇨ "Do markets with externalities behave in accordance with the law of supply and demand?" (thus, will the unregulated market end up in point B?)
  - ⇨ "How do pollution tax, pollution standard and pollution licenses compare as methods for correcting the externality?" (will they help the market to end up in point A?)

- 4 treatments, 2 sessions for each, 6 buyers and 6 sellers in each market
- individual demands and costs are assumed to be unknown, only the optimum level of pollution and marginal social cost at the (social) optimum are known for the license and the tax policy

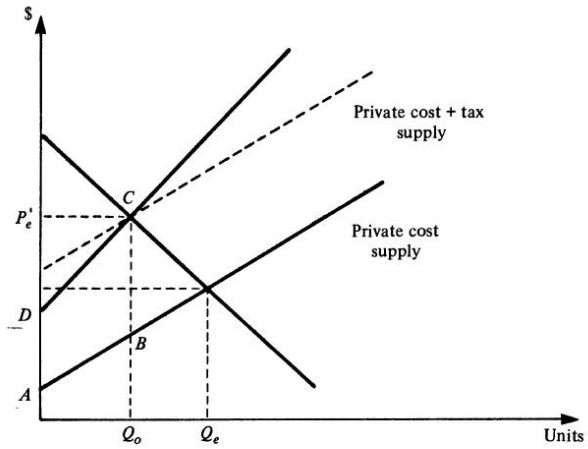


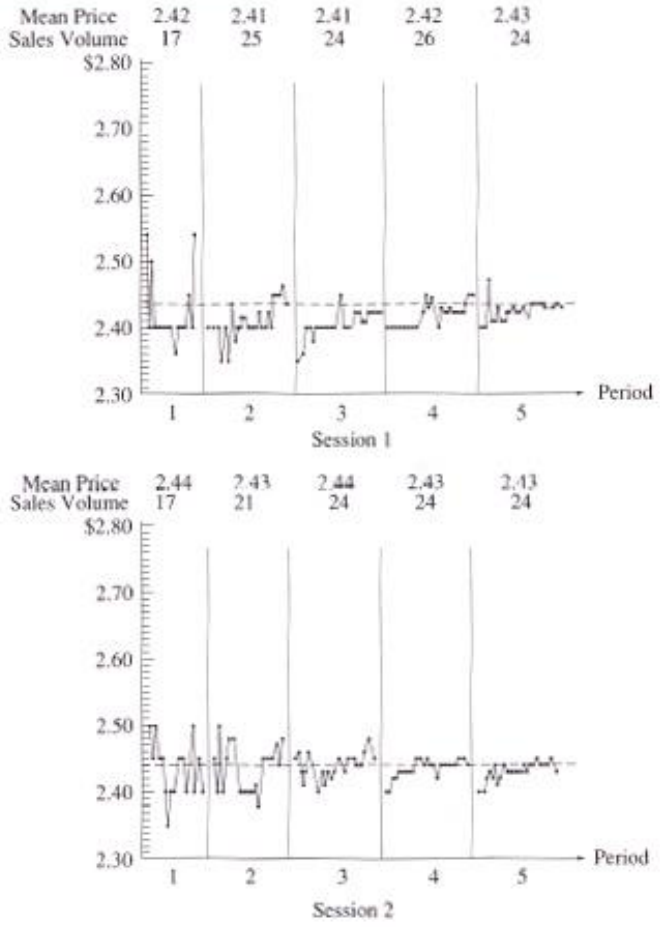
Fig. 2

1. **Market with externality** (no policy, 5 periods in each)
   - benchmark, to see the market solution
2. **Pigouvian Tax policy** (6+7 periods)
   - the amount of marginal social cost is calculated at the optimum quantity Q_0, and is imposed on sellers as a per unit tax. Tax revenues are then redistributed back.
3. **Standards policy** (9+7 periods)
   - the ABCD area is the 'optimum' value of pollution damage => STANDARD limits the amount of admissible pollution such that imposed damage is ABCD (so here, number of trades is limited such that the total environmental damage equals ABCD, 13 units in fact – thus only the first 13 trades)
4. **Permits policy** (10+12 periods)
   - only Q_0 permits exist and only licensed unites can be produced, 13 licenses
   - EQ: price of license = BC; market price of the good = P_e'; quantity = Q_0; licenses should be held by the low cost sellers

1. Market with externality

FIGURE 17.7 **The results of Plott's experiment to investigate the behavior of a market with an externality.**

As economic theory predicts, the prices in the experimental market moved toward the competitive equilibrium price of $2.44 and the quantities sold moved toward the competitive equilibrium volume of 24 units rather than toward the optimal price and volume for society of $2.69 and 13 units.

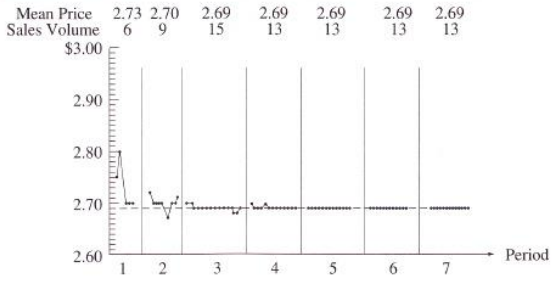


- at the top of each graph, see the mean price and the number of units sold in each period
- in both sessions
  - the volume sold tended to move toward the competitive eq. of 24 units
  - price close to the competitive equilibrium level of $2.44
- **the market failed => the theoretical prediction confirmed:** subjects ignored the externality and arrived to competitive rather than Pareto optimal outcome

2. Pigouvian tax policy

FIGURE 17.8 The results of Plott's experiments to evaluate the interventionist solutions to an externality: The Pigouvian Tax.

The Pigouvian tax intervention pushed prices and quantities toward the optimal levels for society of $2.69 and 13 units.

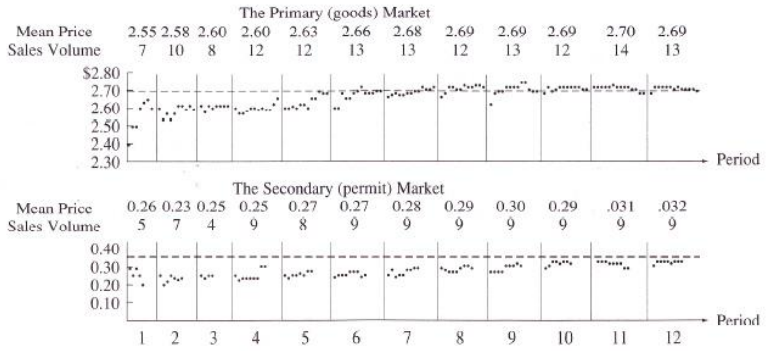


- at the top of the graph, see the mean price and the number of units sold in each period
- cost schedule is increased by a tax equal to the amount of the marginal externality
- the imposition of tax simply becomes a change in supply
- TAX effective in pushing the volume down to the Pareto optimal level of 13, and price up to eq. level of 2.69

3. Permits policy

FIGURE 17.9 The results of Plott's experiments to evaluate the interventionist solutions to an externality: Permits.

Like the Pigouvian tax intervention, the permit intervention succeeded in pushing prices and quantities toward the optimal levels for society. However, the permit intervention was more efficient in terms of the amount of consumer and producer surplus captured.

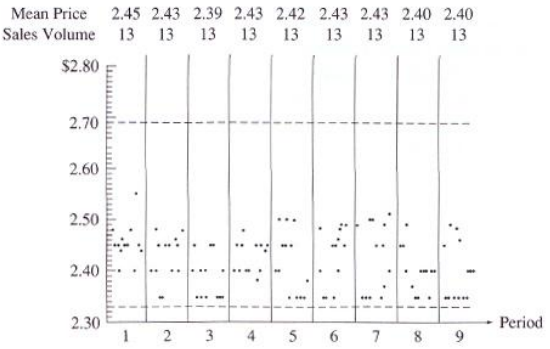


- at the top of the graph, see the mean price and the number of units sold in each period
- secondary market for permits is created: in order to sell 1 unit of the good on the primary market, a seller first had to purchase a permit on the secondary market
- PERMITS effective in pushing the volume down to the Pareto optimal level of 13, and price up to eq. level of 2.69
- ALSO the price per permit converged to the equilibrium level of $.36 (check with the picture in the original paper, p.110)
- more efficient than TAXES in terms of the surplus captured by subjects (efficiency – maximizing the total earnings of subjects)

4. Standards policy

FIGURE 17.10 The results of Plott's experiments to evaluate the interventionist solutions to an externality: Standards.

The standards and charges intervention was the least effective of the three forms of intervention tested by Plott. It led to prices that were not at the optimal level for society.



- at the top of each graph, see the mean price and the number of units sold in each period
- the least efficient way of intervention
- because the total number of permits was limited to 13, the subjects rushed into concluding the deals => dispersed prices, means close to the levels with no intervention

CONCLUSION:

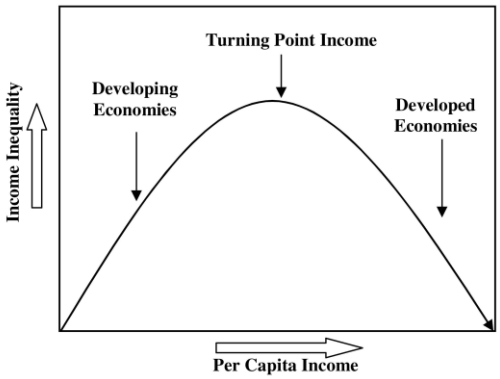
- the LEAST efficient is the unregulated market
- the MOST efficient is the permits policy

PART II - ENVIRONMENTAL KUZNETZ CURVE

Yandle, Vijayaraghavan, Bhattarai, The Environmental Kuznets Curve: A Primer.

[optional reading: Stern, The Rise and Fall of the Environmental Kuznets Curve not because it is not important but because it is too technical. You might want to read at least the non-technical parts**]**

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



Since 1991 when EKC first reported [Grossman and Krueger's analysis of air quality measures in a cross-section analysis of countries for different years, investigating the claim that economic growth accompanying the NAFTA would foster environmental degradation – they did indeed identify a turning point where higher income started to improve air quality (for two indicators SO2 and dark matter, or smoke)], it has become standard fare in technical conversations about environmental policy. Early estimates showed that some important indicators of environmental quality such as the levels of SO2 and particulates in the air actually improved as income levels and levels of consumption went up(further).

Meadows, Meadows, Randers, & Behrens (1972) – "Club of Rome" study, dire predictions (economic growth is bad, a threat to the environment) (in Stern 2004)

Grossman & Krueger (1991) - impact of NAFTA study, much more optimistic predictions (economic growth may be good); popularized by 1992 World Bank Development Report (IBRD 1992)

the theoretical framework 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 have 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?

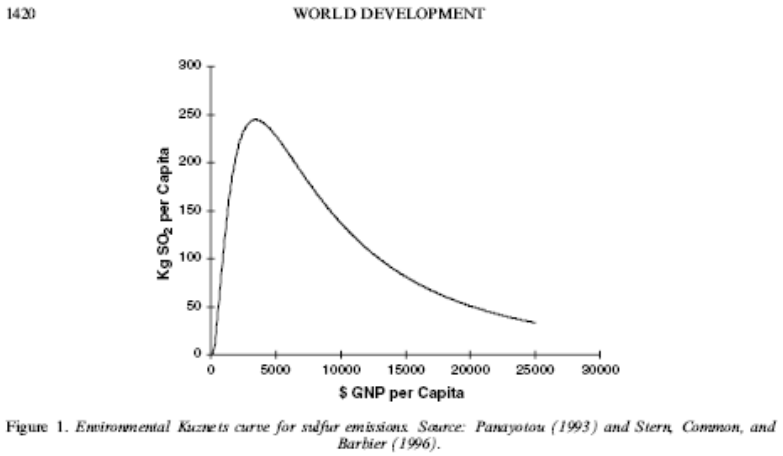


Figure 1. *Environmental Kuznets curve for sulfur emissions. Source: Panayotou (1993) and Stern, Common, and Barbier (1996).*

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?

So what is the intuition?

“At the low levels of per capita income found in pre-industrial and agrarian economies, where most economic activity is subsistence farming, one might expect rather pristine environmental conditions, relatively unaffected by economic activities—at least for those pollutants associated with industrial activity. The EKC statistical relationship suggests that **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, the high priority given to increases in material output, and disregard for—or ignorance of—the environmental consequences of growth. However, **as economic growth continues** and life expectancies increase, **cleaner water, improved air quality, and a generally cleaner habitat become more valuable** as people make choices at the margin about how to spend their incomes. 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. 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**. The movement along an environmental Kuznets curve is also a movement through a well-known set of property rights stations. In primitive societies managed by tradition or tribal rule, part of the resource base may be treated as a commons.** With growing scarcity, however, a time comes when some aspects of the commons become defined as public or private property. **As “propertyness” expands—and private property is the most incentive-enriched form—individuals have a greater incentive to manage, to conserve**, and to accumulate wealth that can be traded or passed on to future generations. … Eventually, **when most aspects of the environment are defined as property, the community moves rapidly in the race to improve environmental life.**”

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

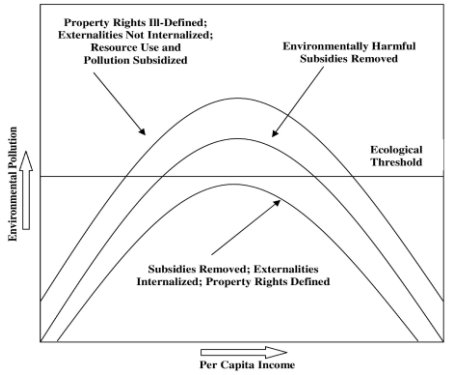
Evidence:

- 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 find 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 environmental improvements as incomes rise and development continues
- Gokany 2001 – "**Open economies improve their environments**" (positive 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 **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 - Stern, The Rise and Fall of the Environmental Kuznets Curve

- 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 perfoming 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…"**
    - … "Satisfying the material needs of people requires the use and disturbance of energy flows and material stocks. Therefore an effort to reduce some environmental impacts may just aggravate other problems."
    - "It seems that emissions of most pollutants and flows of waste are monotonically rising with income", with "income elasticity" being less than 1 and moderated also by other factors ("income independent, **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 and actually hasten output/input mixes, etc.
        - → 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 and recent evidence." (Stern p. 1421)

- A number of theoretical models have been developed of 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 … the assumptions made and the values given to particular parameters make all the difference whether indeed the EKC gets generated.(Stern p. 1422)
- "Many EKC studies have also been published that include additional explanatory variables, intended to model underlying or proximate factors such as 'political freedom' … or output structure … or trade … In general, the included variables turn out to be significant at traditional levels. … it is not clear what we can infer from this body of work [because of potential for omitted variable bias].
- Turning point estimate differ widely (see Table 1, Stern p. 1425, here reproduced in parts only):
- **"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)
- How about the feedback from environmental damage to economic production (typically assumed away by most EKC studies)?
- "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)
- "The true form of the emissions-income relationship is likely a mix of two of the scenarios proposed by Dasgupta et al. (JEP 2002) illustrated in Figure 3. The overall shape is that of their 'new toxics' EKC – a monotonic increase of emissions and income. **But over time this curve shifts down, which is analogous to their 'revised EKC' scenario. [innovations being adopted in high-income countries, and with a short lag in the majority of poorer countries.]"** (Stern p. 1435)

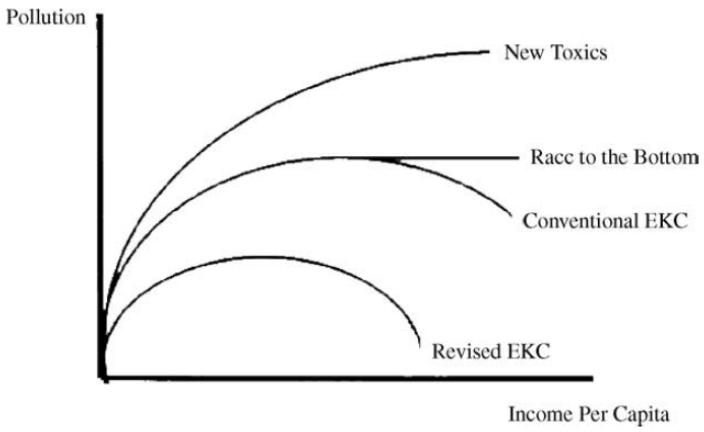


Figure 3. *Environmental Kuznets curve: alternative views. Source: Dasgupta et al. (2002) and Perman and Stern (2003).*

PART III - 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.

Certification of ENVIRONMENTAL QUALITY….

Experimental evidence:

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

- survey evidence exists suggesting that the consumers care for the environment and are willing to pay a higher price for the 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, no reputational concerns => market failure
- various treatments to remedy the market failure: **cheap talk signals**, **seller reputation**, (costly) **certification** ("eco-label")

Experimental Design and Implementation

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

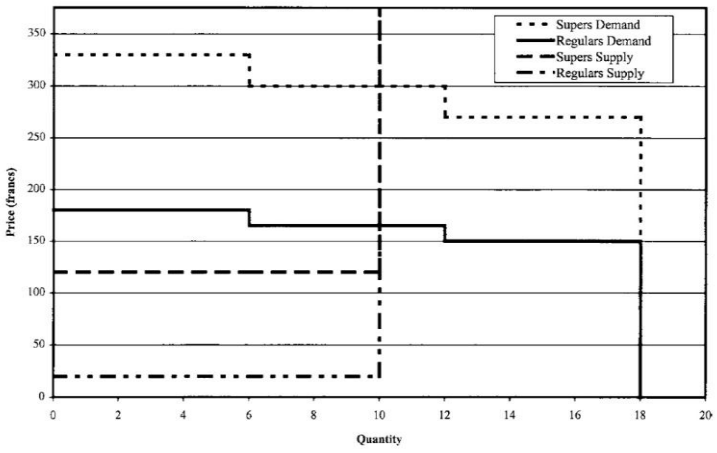
⇨ buyers' resale value of SUPERs > of REGULARs which is common knowledge but buyers' marginal values are private info

  - SUPERs: 1st unit EF 330, 2nd unit EF 300, 3rd unit EF 270
  - REGULARs: 1st unit EF 180, 2nd unit EF 165, 3rd unit EF 150
    - ⇨ buyers prefer to buy SUPERs unless they are by EF 120-150 more expensive than REGULARs
  - Each SUPER costs the seller 120 EF and each REGULAR 20 EF

- 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

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 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**
  - prices written on the board in the specific order to identify sellers' history
  - whether unregulated claims could by themselves help in increasing the number of SUPERs sold
  - sellers have 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)
    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)

- **CERTIFICATION**
  - prices written on the board in the specific order to identify sellers' history
  - would a seller choose the option of certifying his/her product at extra cost of EF 30?
  - 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 30 francs 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

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 (HYPOTHESES)

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.

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 that 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% (significant)

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

⇨ in the CERTIF., more than 2/3 are SUPERs (signif. 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
- 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)

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-ceritfied 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.

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 transactions 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.
2) Unverified claims are not sufficient to 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 deliver Regulars at Supers prices; it is explained at least in part by the absence of a profitably 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).