Lecture 3 (JK, March 5)

Environmental Policy in the Central European Context

Time: Thursdays 3 p.m. – 6 p.m.
Location: at CERGE-EI, Room # 7

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Undergraduate Program in Central European Studies

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WEEK: TOPICS: DATE: INSTRUCTOR
1 Introduction (history/outline) Feb 19 JK/AO
2 Market failures: externalities, tragedy of the commons, enforcement as public good, also, (rise and fall) of the environmental Kuznets Curve February 26 AO
3 Interventionalist solutions to the Externality problem – Pigouvian taxes and standards and charges, also environmental labeling and incomplete consumer information in laboratory markets March 5 JK
4 Interventionalist solutions to the Externality problem – Marketable pollution permits March 12 AO
5 Non-Interventionalist solutions to the Externality problem – The Coasian solution March 19 JK
6 Non-interventionalist solutions to the Externality problem – Self-regulation March 26 AO
7 *Mid-term exam April 2*
8 Environmental Policy in the Czech Republic – History and current issues April 9 JK
9 Environmental Policy in the EU – History and current problems April 23 (April 16 falls into Semester break and on Easter Holiday) AO
10 Environmental Policy in the world context – History and Current problems April 30 JK/AO
11 Contingent valuation and related issues May 7 AO
12 To be determined by the interests of the class
Final exam: to be determined (according to schedule May 18 – 21)

Readings for Lecture 3:

PART I - Interventionalist 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 labeling and incomplete consumer information in laboratory markets
Cason, Gangadharan, Environmental labelling and incomplete consumer information in laboratory markets

PART I – INTERVENTIONALIST SOLUTIONS TO THE EXTERNALITY PROBLEM

A. Theoretical background

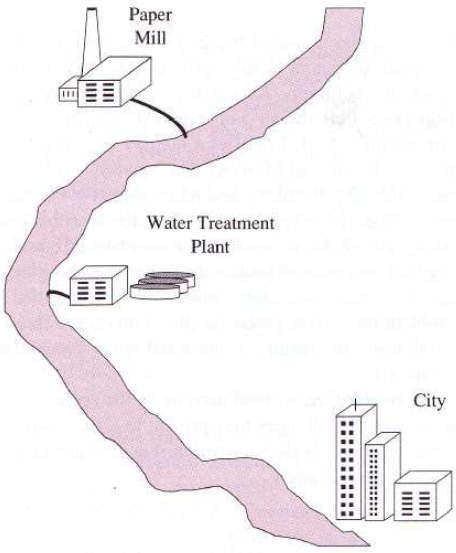
Schotter, Microeconomics, A Modern Approach (Second edition) **Section 17.3**

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

1. PIGOUVIAN TAXES

FIGURE 17.1 **Dolan's water-paper society.**

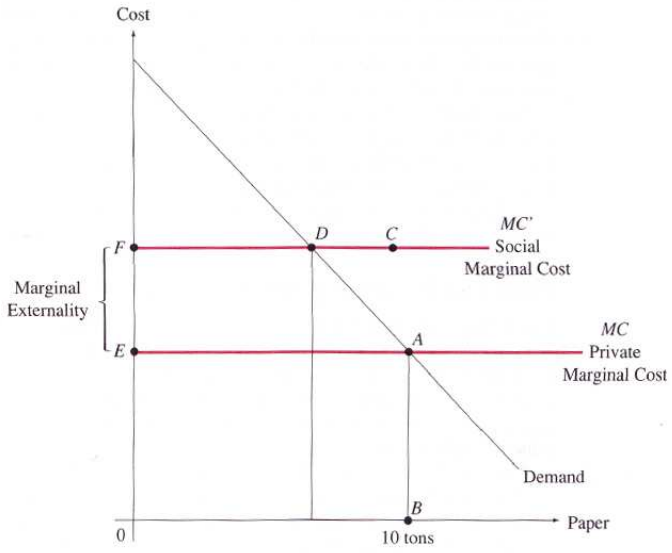
The paper mill imposes an external cost on the water treatment plant by dumping its wastes into the river. These wastes increase the treatment plant's cost of cleaning the water.



- Say the mill is producing 10 tons of paper with a (private) MC (of labor and capital) of $0.005/pound.
- 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
- Given the current mill's production, the total MC is $.50(cost of L and C) +10(tons)*$.05(externality)=$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.
- Social MC of each ton?

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. Why?

- ⇨ assume mill would reduce its production by 200 pounds. 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

⇨ 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 <u>social</u> optimum

⇨ **Pigou** – TAX the mill 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,
- o might not be able to estimate accurately
- o might have incentives to exaggerate

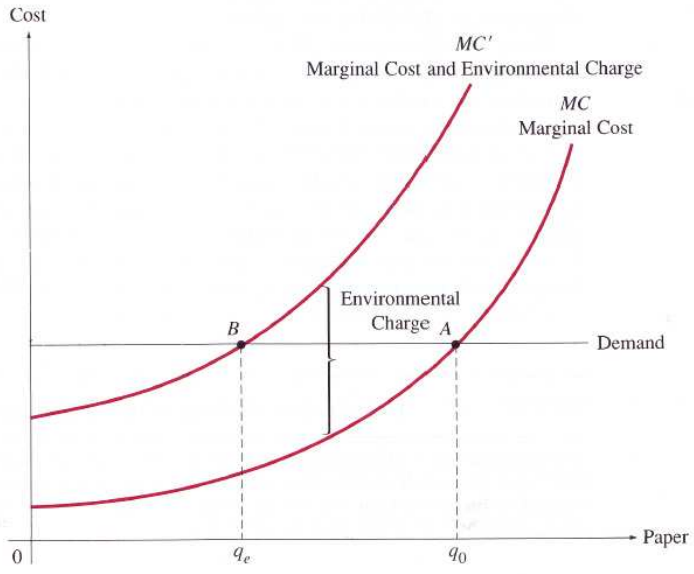
2. STANDARDS AND CHARGES

The government sets the standard – the amount of externality considered acceptable and then charges 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.

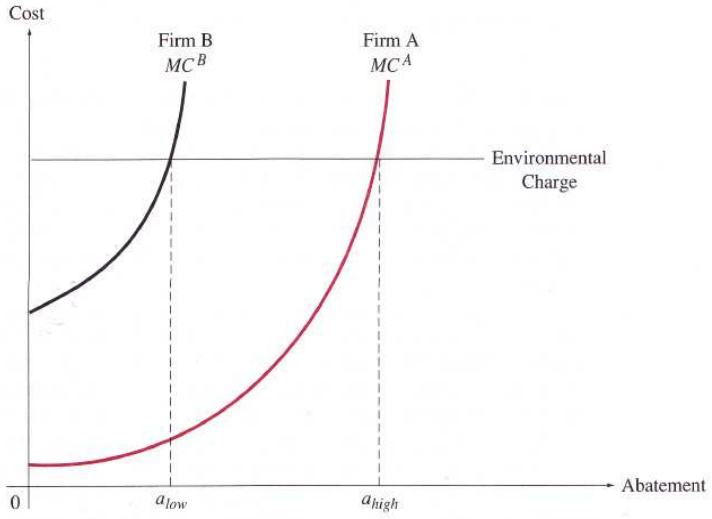


- the government conducts a study to determine how much pollution is acceptable
- charge on each gallon of waste to induce the mill to reduce the pollution to the acceptable level
- when the mill's cost is MC => it will produce at point A
- charge=> MC'=> it will produce at point B
- Ideally, with q_c 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 70 gallons of waste a day, mill B 30 gallons. STANDRD= 50 gal.
- an across-the-board 50% cut not the most efficient (different MCs for waste reduction)
    - 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 should reduce by more and firms with higher cost by less!
    - Figure 17.4 – once the environmental charge is set, each firm will reduce by the corresponding amount. $a_{low}+a_{high}=a_{total}$ ($MC^A=MC^B$=charge; STANDARD is induced)
- **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 (guess and verify)

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.
- 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

- Andreas will talk more about this next week.

B. Experimental Evidence

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

A series of experiments to evaluate how the interventionist solutions work

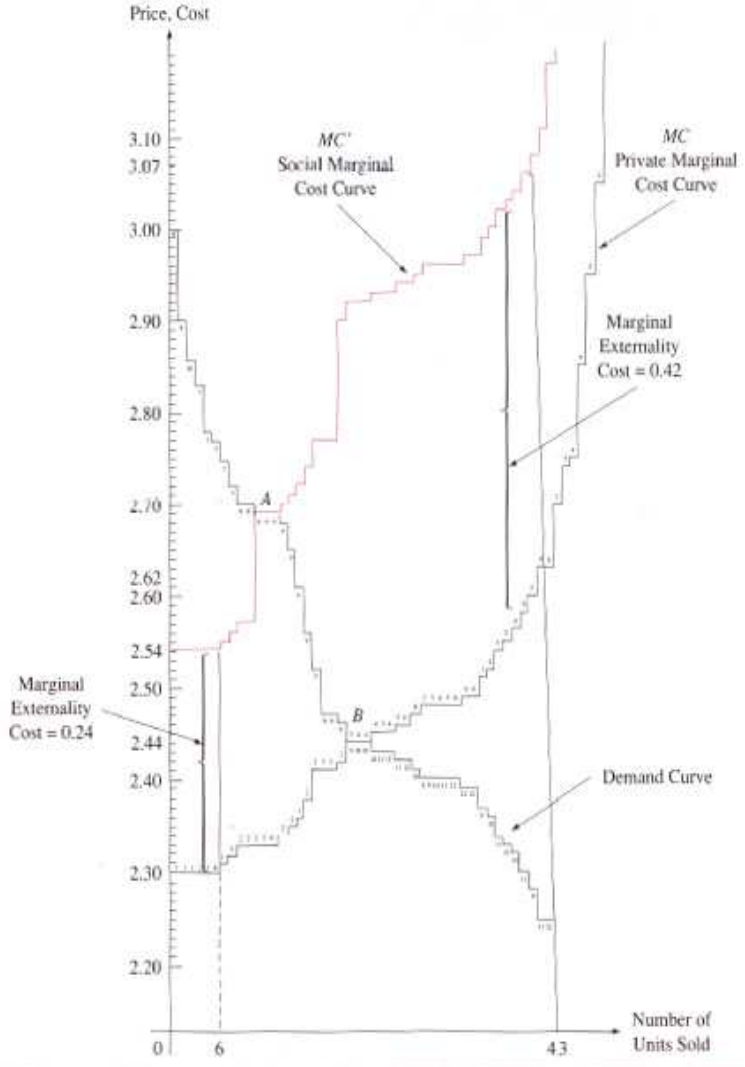
- the subjects buy and sell units of a fictitious good using a double oral auction (*In such a **double oral auction** any potential buyer (or, seller) can make a verbal bid (offer) to buy a unit of the good at a specified price. Any seller (buyer) can accept a bid. If a bid is accepted a binding contract 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
- 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

- 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?”
  - ⇨ “How do pollution tax, pollution standard and pollution licenses compare as methods for correcting the externality?”

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.



- 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

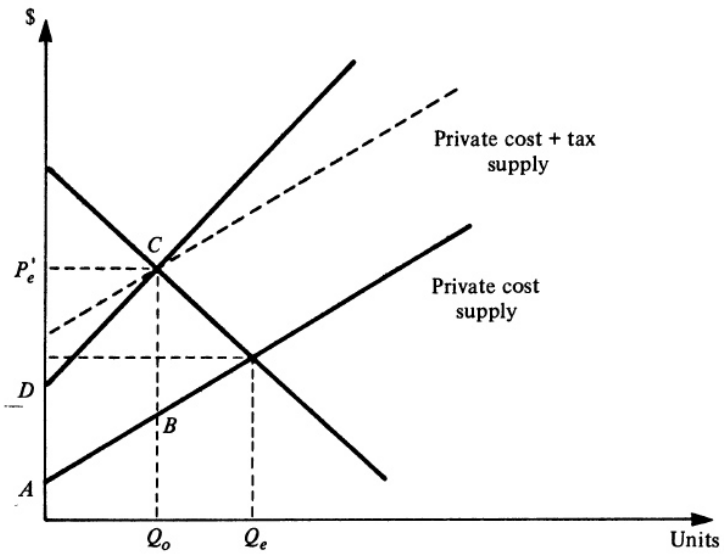


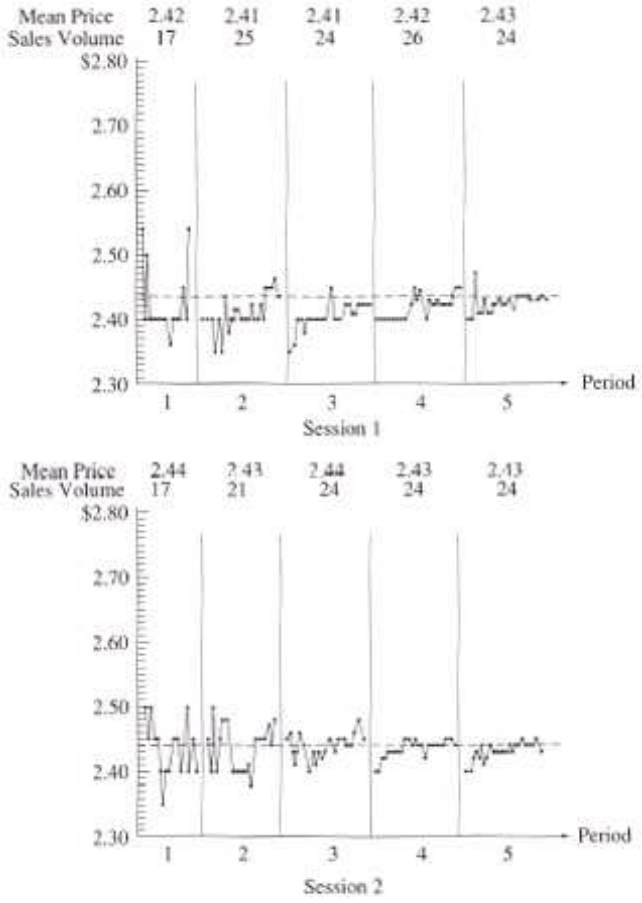
Fig. 2

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
4. **Permits policy** (10+12 periods)
    - only Q_0 permits exist and only licensed unites can be produced
    - 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.

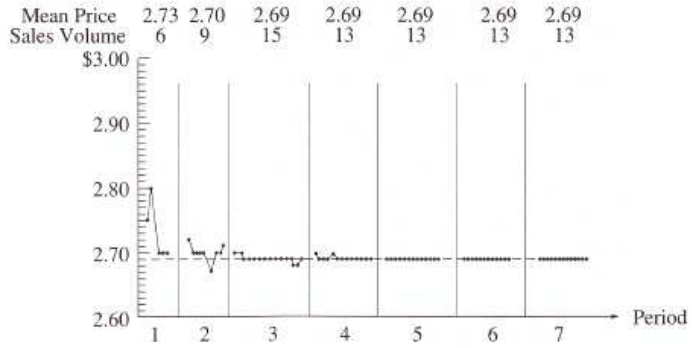


- at the top of each graph, see the mean price and the number of units sold in each period
- in both sessions
    - the volume sold tended to move toward the competitive eq. of 24 units
    - price close to the competitive equilibrium level of $2.44
- the market failed => the theoretical prediction confirmed: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

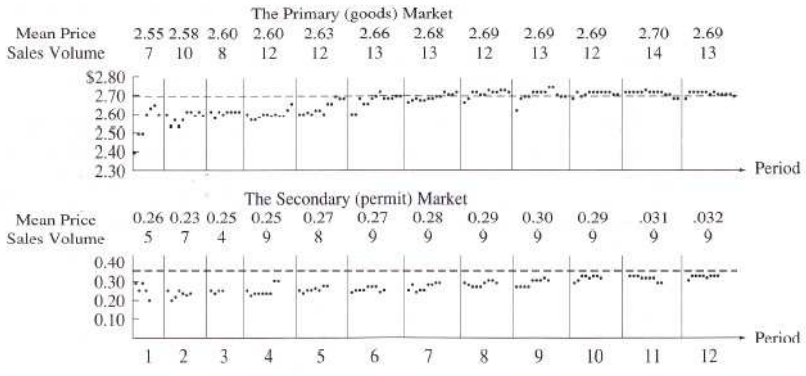


- at the top of the graph, see the mean price and the number of units sold in each period
- cost schedule is increased by a tax equal to the amount of the marginal externality
- TAX effective in pushing the volume down to the Pareto optimal level of 13, and price up to eq. level of 2.69
- Session 4 cleaner results than session 3, faster convergence

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.



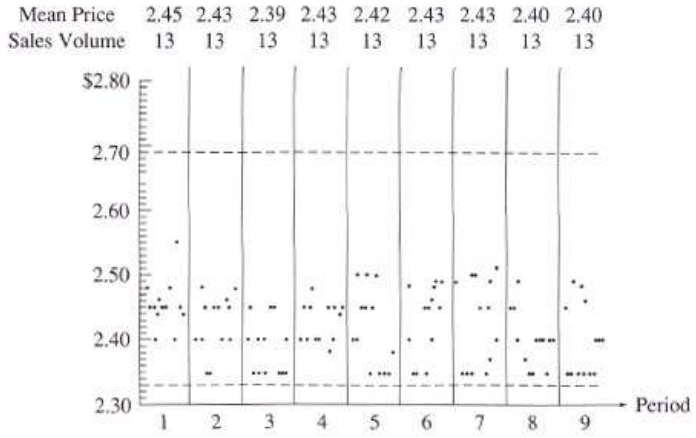
- at the top of the graph, see the mean price and the number of units sold in each period

- 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
- Session 8 convergence more obvious, session 7 series more stable, close to eq. levels
- more efficient than TAXES in terms of the surplus captured by 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 labeling and incomplete consumer information in laboratory markets

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 (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, each: 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 (common knowledge)

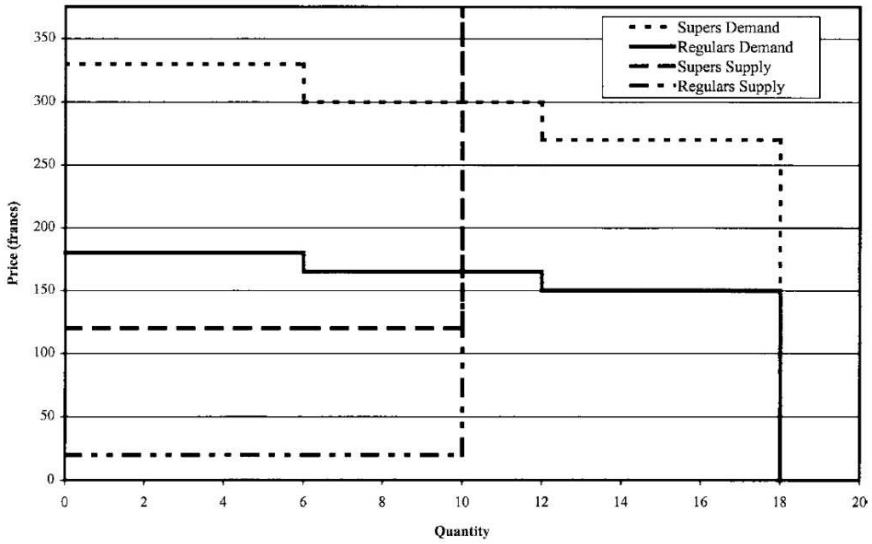
⇨ buyers' marginal values (private info)

  - 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 EF 120-150 more expensive than REGULARs

- all buyers and sellers have identical cost and value schedules

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 sellers choose the option of certifying their 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

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, signif. 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 improve 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
- ⇨ 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)