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 2 –Interventionist solutions to the Externality problem: Pigouvian taxes, standards and charges, marketable pollution permits

Next week – shorter class screening of "An Inconvenient Truth," please be on time and please help with organization

Readings for Lecture 2:

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

Marketable pollution permits

Schleich et al., Incentives for energy efficiency in the EU Emissions Trading Scheme

EU ETS factsheet (2013)

Porter et al., The design, testing and implementation of Virginia's NOx allowance auction

A. INTERVENTIONIST SOLUTIONS TO THE EXTERNALITY PROBLEM

- based on Schotter, Microeconomics, A Modern Approach (Second edition) **Section 17.3**
- problem of externality and solutions: interventionist vs. non-interventionist (free market) solutions

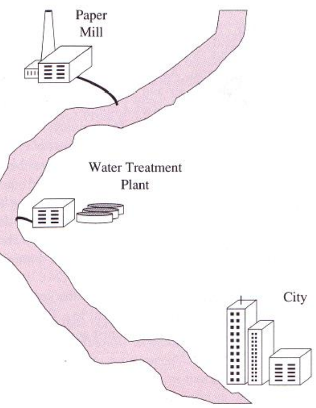
Interventionist solutions:

- Pigouvian Taxes
- Standards and Charges
- Marketable Pollution Permits

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 a competitive market: price of paper=marginal cost of producing paper)

- Say the **mill** is producing
  - **10 tons of paper** (= **20,000** pounds)
  - with a **(private) marginal cost MC** (of labor and capital) of **$0.005/pound = $10/ton**.

  ➔ In a competitive market, price **p=MC**

  ➔ **p=$0.005 per pound of paper**

- **Water treatment plant's MC**
  - when the <u>mill is idle</u> is **$.50/1,000** gallons;
  - when the <u>mill is active</u>, additional cost of **$.05/1,000 gallons for each ton** of paper produced

⇨ given the current mill's production, the total MC is **$.50 +10*$.05 = $1 per 1,000 gallons**

⇨ In a <u>competitive</u> industry the **price of water will be $1 per 1,000 gallons**.

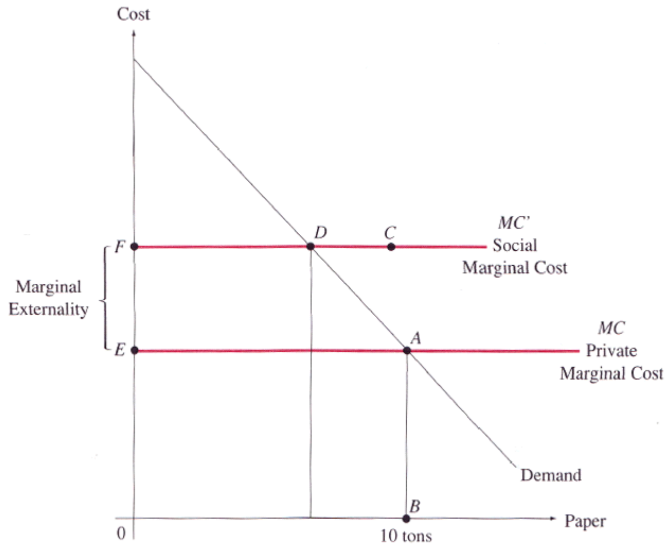
⇨ Assume at such price 1 mil. gallons of water is demanded

⇨ The society spends $1,000 on water

- **Can we expect the society to produce 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,
  - ⇨ it seems unlikely that the outcome for society will be Pareto-optimal
  - ⇨ Indeed it is not …

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
- **Illustration**
  - assume the 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 water treatment** = Pareto Improvement

  - **HOW COME?**

- **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 WTP 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 and thus it does not affect its production decision
- from the social point of view

⇨ Social Marginal cost MC' of the paper production = production cost + pollution cost

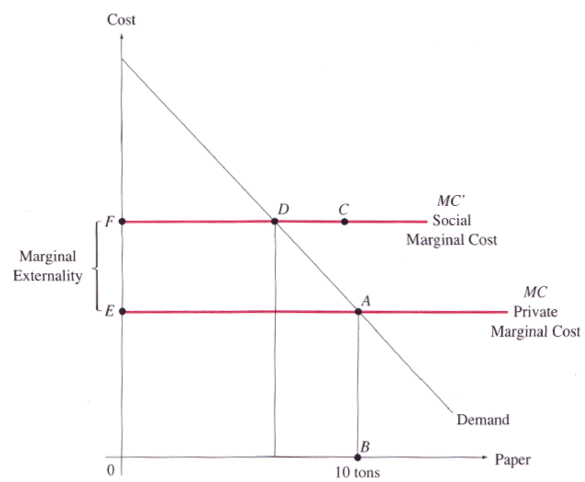
- point A is not optimal for society – "BC" (social MC)>"BA" (social marginal benefit)

⇨ **point D** is the **social optimum**

Pigou – proposed to impose **TAX on paper**; unit of paper produced to be taxed by the amount of the marginal externality ("EF") in order to internalize the externality and directly affect mill's paper production => this would shift our artificial society straightly to **point D, the social optimum**

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*).



Q: Can you think of possible (practical) problems with implementing this solution?

- **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
    - **incentives to innovate???**

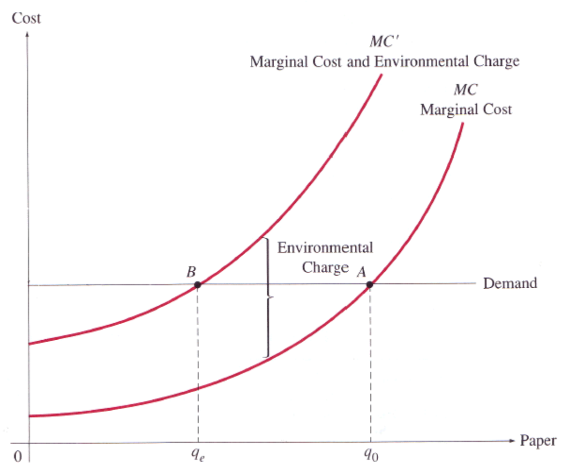
STANDARDS AND CHARGES

- a similar solution as taxes, the mechanism is slightly different, though. Here, 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.
- *NOTE: Some literature does not distinguish and calls this a Pigovian tax too…. here we will distinguish.* ***"Tax" is always per unit of final product, "Charge" per unit of pollution****. Even though the result is the same (in that polluter pays for pollution), the effect through which they work is not. And this has consequences for (proper) applicability of the two.*

Case I: 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.



- **[explain here the difference between the effect of a tax and of a charge, What is MC]**
- 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

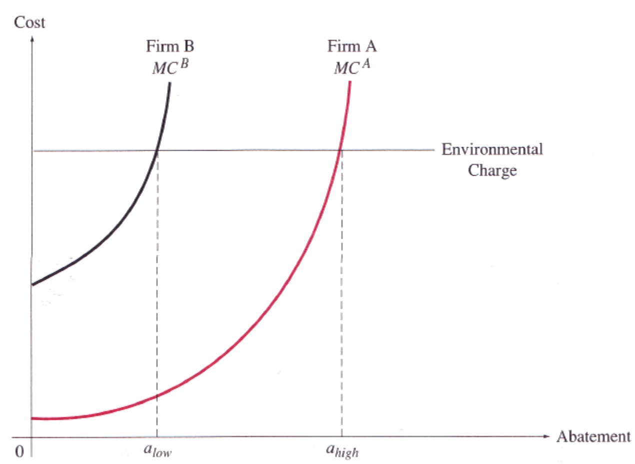
- when the mill's marginal cost (of production) is MC => it will produce at point A
- charge=> MC'=> it will produce at point B
- Ideally, with q_c the production of waste is at the STANDARD

<u>Case II: Two or more firms</u>

- 2 firms: mill A produces 70 gallons of waste a day, mill B 30 gallons. Say the STANDRD is set at 50 gal.
- an across-the-board 50% cut <u>might NOT be the most efficient</u> (different MCs for waste reduction = "*marginal cost of abatement*", depending on technology used by each producer)
  - A would have to reduce by 35 gal.,
  - B would have to reduce 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 instead 36 gal. and B's is 14 gal
  - ⇨ the total abatement is still the same (70)
  - ⇨ but the society could save $8-$5 = **$3**.
- **Firms with lower cost (of abatement) should reduce by more and firms with higher cost (of abatement) by less! [what is abatement and marginal cost of abatement vs. MC of production]**

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}).



- 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); basically each firm is reducing pollution by one additional unit as long as marginal cost of abatement for that particular unit is lower than the environmental charge… because if charge was lower the firm would prefer paying the charge instead of reducing pollution released

  Q: Can you think of possible (practical) problems with implementing this solution?

- **PROBLEM** – even more difficult to administer than taxes, 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 might be the only possibility but changing the parameters too often would not be good for industry and might be administratively expensive, we don't want the firms to reduce neither too much nor too little – **WHY?**)

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 producing that unit. A firm with higher MC of abatement is willing to pay more for the permit than 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
- Each firm can only pollute with the permit.
- Thus the mechanism works similar as with standards and charges (the government sets the standard and issues corresponding number of permits – thereby directly regulating the acceptable amount of pollution), but here we have additional market for permits where firms bid according to their abatement cost

- **Q: Which of the problems above is solved and how exactly?**

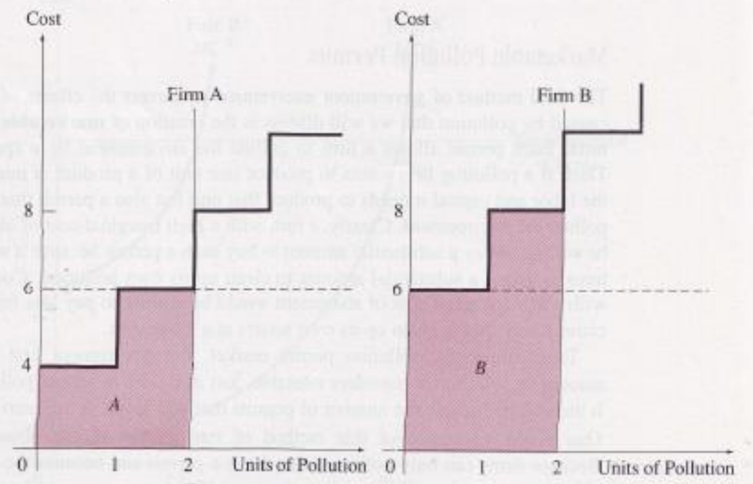
⇨ **Key advantage is that the government does not need to know abatement costs for each firm** like with standards and charges, just needs to set the standard and set up extra market for permits and the market forces will take care of the rest…[analogical to "setting the charge right"]

EXAMPLE

- consider an industry with 2 polluting firms A and B
- the firms have the marginal **pollution-abatement** cost function as on the figure below:

FIGURE 17.5 **A market for pollution permits.**

The cost to clean up two units of pollution is $10 for firm A and $14 for firm B. In a market for permits giving the right to emit two units of pollution, firm A would bid up to $10 and firm B would bid up to $14.



- **Q: Which decisions of the firm might affect the (short-run) shape of these cost functions? How can a firm change these cost functions in the long run?**

- the government decides that pollution should be limited to 2 units and therefore decides to sell permits for 2 units
- each firm, either buys the permits, or pays the cost of cleaning up its own pollution

- **Q: Given the parameters (as in the figure above), what is the (socially) efficient distribution of pollution reduction? I.e. Which firm should buy the permits and pollute, and which one should abate?**

- if firm A does not buy the permits, it will have to pay $4 for cleaning up the first unit of its pollution and $6 for the second unit => $10 altogether
- similarly for firm B => it would have to pay $14 to clean its pollution
- from the social point of view, it is best to reduce pollution to two units for the least amount of money

- Competitive market: it would cost $10 for A to clean, and $14 for B to clean => better if A cleans and B pollutes
- assume auction is held, to sell the permits; bids are to be offered in increments of $.10 and bidding continues until neither firm bids any higher -> at this point permits are awarded to the firm which made the highest bid

- **Q: Until when firm A will continue bidding? Firm B? Which firm will "win" the permits and what will be the price paid?**

- in fact, firm B will have permits for $10 (or slightly more). Firm A must cut its level of pollution (as it is less costly to clean for firm A ➔ **efficiency of distribution**)
- ONLY A MINOR INTERVENTION here – the government simply creates a new additional market

B. Experimental Evidence

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

Questions:

What was the main purpose of Charles Plott's experimental paper?

Was he successful?

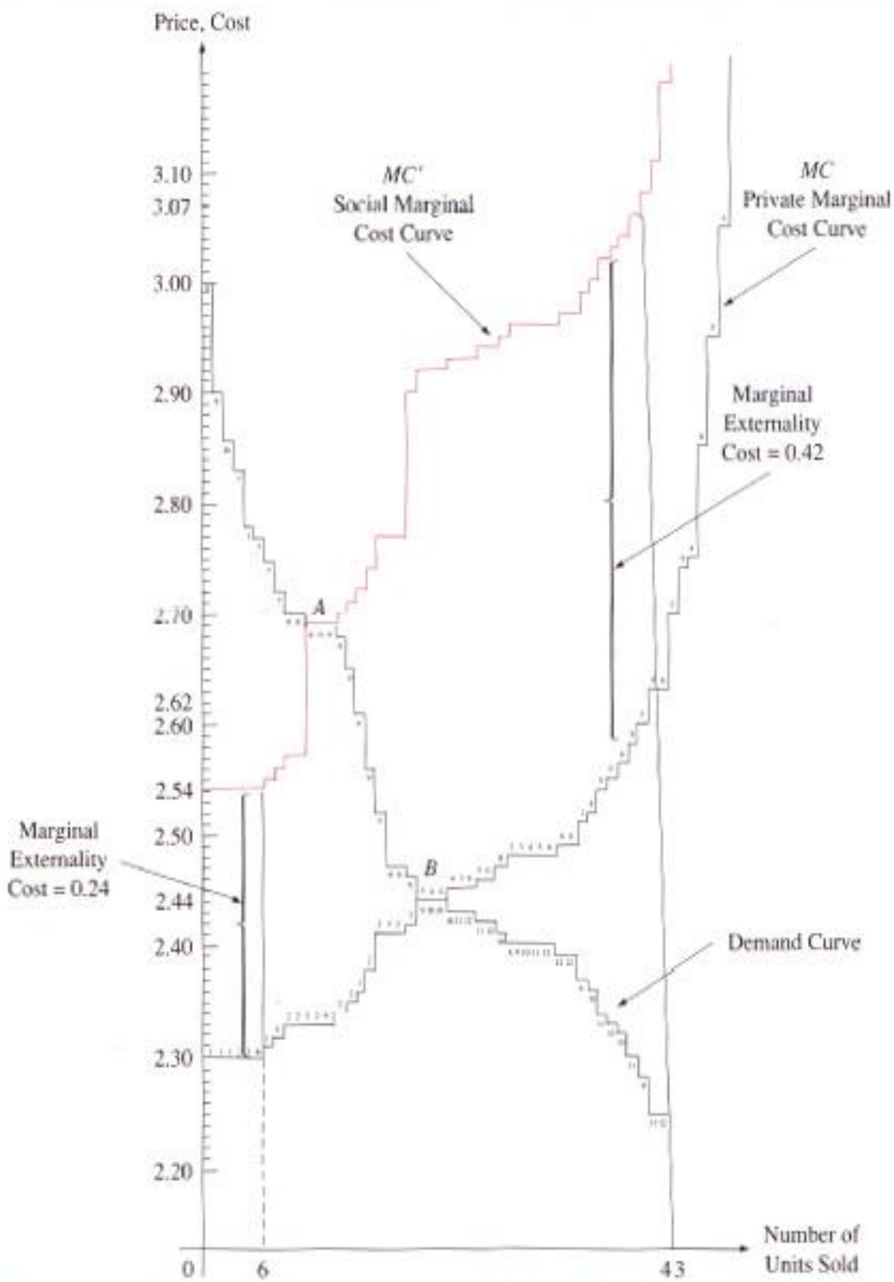
A series of experiments to evaluate how well the interventionist solutions work in practice

- 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 (or, 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 **=> (induced) social marginal cost curve.**

- **Look at Figure 17.6, how does the author simulate the market? Can you explain the meaning of the curves?**
- **How does he model externality in this artificial market?**

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 **[Can you think of real-life analogy?]**

  Q: Where can you expect the unregulated outcome? The Pareto efficient one? [note]

  - Pareto optimal solution -- **point A** (13 units at price $2.69), where the social marginal cost curve intersects the (induced) demand curve
  - without intervention -> theory predicts the competitive outcome "as with no externality" → **point B** (24 units at price $2.44)
  - Charles Plott:
    1. *"Do markets with externalities behave in accordance with the law of supply and demand?"* (in other words, will the unregulated market end up in point B?)
    2. *"How do pollution tax, pollution standard and pollution licenses compare as methods for correcting the externality?"* (i.e., will they help the market to move to 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

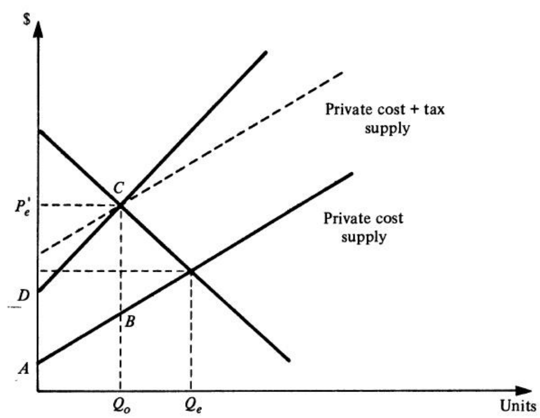


Fig. 2

Q: How are the individual interventionist solutions implemented?

1. **Market with externality** (no policy, 5 periods in each)
   - benchmark, to see the market solution (expected to end up at point B)
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 [**WHY?**].

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 – on the first-come, first-served basis)

4. **Permits policy** (10+12 periods)
   - only Q_0 permits exist and only licensed unites can be produced, 13 licenses are issued (and distributed initially)
   - EQ: price of license = BC; market price of the good = P_e'; quantity = Q_0; licenses should be held by the low-cost sellers

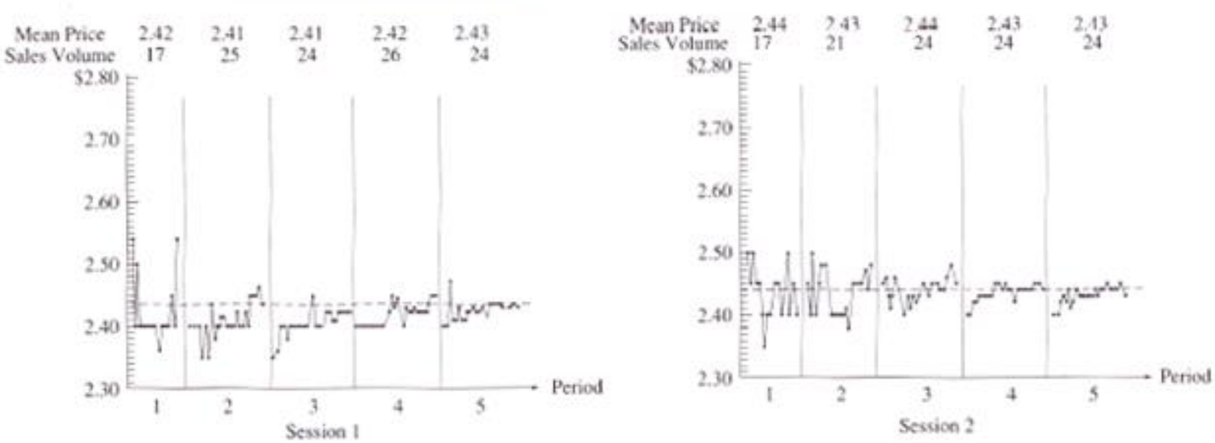
RESULTS

1. Market with externality

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

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.



- **Q: What can you conclude about the results based on the figure above?**

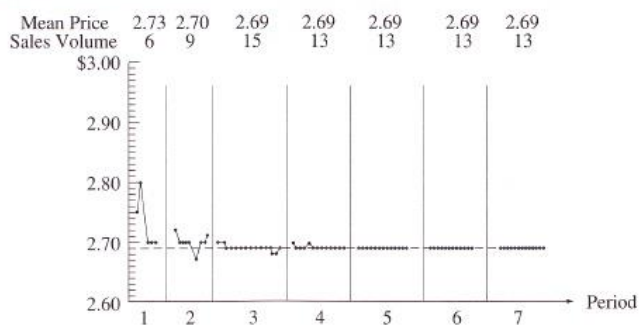
- unregulated market
- in both sessions
  - the volume sold tended to move toward the competitive eq. of 24 units
  - price close to the competitive equilibrium level of $2.44
- **the market failed => the theoretical prediction confirmed:** subjects ignored the externality and arrived to competitive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

2. **Pigouvian tax policy**

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

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.



- **Q: What has changed? What can you conclude from the figure above?**
- marginal social cost, calculated at the optimum quantity Q_0, is imposed on sellers as a per unit tax
- cost schedule is increased by the tax equal to the amount of marginal externality
- the imposition of the tax simply becomes a change in supply
- TAX is effective in pushing the volume down to the Pareto optimal level of 13, and price up to eq. level of 2.69

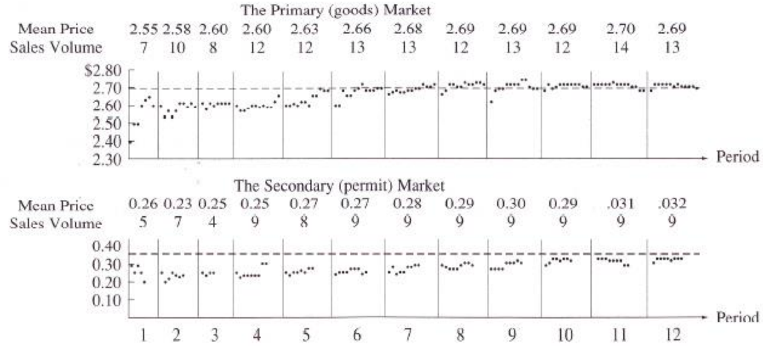
3. **Permits policy**

- at the top of the graph, see the mean price and the number of units sold in each period
- only 13 (= Q_0) permits exist and only licensed unites can be produced, price of license should = marginal externality at Q_0

- 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

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.



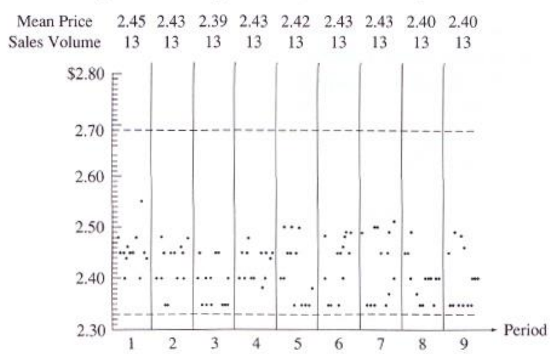
- **Q: What has changed? What can you conclude from the figure above?**
- PERMITS effective in pushing the volume down to the Pareto optimal level of 13, and price up to eq. level of 2.69
- ALSO the price per permit converged to the equilibrium level of $.36 (check with the picture in the original paper, p.110)
- more efficient than TAXES in terms of surplus captured by subjects

4. Standards policy

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

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.



- **Q: What has changed? What can you conclude from the figure above?**
- number of trades is limited to 13; first-come, first-served
- 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:

- with efficiency measured as ratio of total earnings captured by subjects to total earnings possible
    - the LEAST efficient is the unregulated market
    - the MOST efficient is the permits policy
    - theoretical predictions supported by the data

C. MARKETABLE POLLUTION PERMITS: EUROPEAN EXAMPLE:

European Union Emissions Trading Scheme (EU ETS)

- In order to fulfill the commitments ensuing from the **Kyoto Protocol** (more on that to follow later on), the EU has set up its own **European Union Emissions Trading Scheme (EU ETS)** pursuant to **Directive 2003/87/EC**. As an EU member state, the Czech Republic has transposed the Directive into **Act No. 695/2004 Coll.**
- This is the first international cap-and-trade system for CO_2 allowances
- covers around 12,000 large greenhouse gas (**GHG**) emitting installations including power stations and manufacturing plants (combustion installations with over 20MW input capacity, refineries, coke ovens, steel plants, producers of cement clinker, lime, bricks, glass, pulp and paper…) in the 28 EU member states as well as Iceland, Liechtenstein and Norway. Flights within and between most of these countries are also covered
    - covers about 50% of Europe's CO_2 emissions
    - covers about 40% of Europe's total GHG emissions
- a **cap-and-trade system**, where central authority sets a limit (cap) on the amount of pollutant that can be emitted, companies are issued emission allowances and, by the end of the period, must surrender the number of allowances equivalent to the amount of emissions during that period (otherwise they are sanctioned**) [Which assumption does this system rely on?]**
- companies may emit more than their initial allocation of allowances if they purchase extra allowances from other companies; => new market is created
- companies with low cost of abatement may choose to reduce their emissions in order to sell their surplus allowances – those with high cost would buy

=>market => equilibrium price (in the equilibrium, all companies have the same marginal cost of abatement => total abatement cost is minimized – ***STATIC EFFICIENCY***)

=> **allowance price sets monetary incentives to adopt new, more efficient technologies** and services, and to develop fundamentally new or significantly improved solutions) – ***DYNAMIC EFFICIENCY***

- Within EUETS emission reduction goals are set for **trading periods:**
  - 1st trading period – 1.1.2005- 31.12.2007 = PHASE 1
  - further trading periods – 5-year periods, 1.1.2008-31.12.2012 = PHASE 2
  - 2013-2020 = PHASE 3 [with some important changes … more on that later]
- Until 2012, a specific number of emission allowances was **allocated** to every company in the steel and iron sectors, cement and lime production, pulp and paper production, manufacture of glass and ceramics, and refineries and thermal power plants; this was based on the so-called **National Allocation Plan(s).**

National Allocation Plans

- defined the cap (=ET budget = total allowances (**EUA**s) available in each period) => the more stringent the ET budget => the higher the price of EUAs => the stronger the incentives to innovate
- determined how allowances were allocated to individual installations on the national level
- established "how to split the pie" between the EU ETS **trading sectors** and **non-trading** sectors (households, services and transport) to meet the national emission target **[What does this mean?]**
- also determined, to what extent the country relied on **domestic efforts** and to what extent on **Kyoto Mechanisms** (CDM and JI)
  - ➔ **Kyoto mechanisms** Clean Development Mechanism (CDM) and Joint Implementations (JI) are ways to, through green projects (possibly abroad), earn extra certified emission reduction credits which can be counted towards meeting Kyoto targets... more on that later…
  - ➔ the more they relied on Kyoto Mechanisms, the higher the budget for the EU ETS => fewer domestic measures needed to reach the national emission budget, less EUAs needed to be purchased within EU ETS => lower price ... [and also lower the domestic reduction of pollution and weaker the incentives to innovate domestically used technologies!]
  - ➔ all that was also important for **incentives for innovation and long-term investments into carbon/energy efficient technologies**]
- NAPs were prepared for each trading period by the individual governments and consequently they are sent for approval to the European Commission.
- EC evaluated NAPS based on the criteria specified in the Emission Trading Directive and in the NAP guidance (also checks that all NAPs together add up to fulfill the EU-wide commitments)

- every company that was part of the NAP had an account to which its allocated EUAs were automatically credited;
- even entities (dealers, brokers, banks…. simply the traders) that were not part of the NAP could trade – using a "personal account" for transactions
- data was collected in electronic registries on national levels, EU levels and Kyoto levels, all are interconnected (one such register is **The European Pollutant Release and Transfer Register (E-PRTR)** – the Europe-wide register that provides key environmental data from industrial facilities)
- Czech Republic joined EU ETS in 2005-2007. Trading started on January 1, 2008
- due to some inefficiencies, the trading system has introduced some important changes starting from 2013 (phase 3)... more on that to follow...
- among the most important ones is the switch from free allocation of initial package of allowances to auctioning off for certain sectors; auctioning is the main method from now on, free allocation is to be abandoned completely by 2027
    - Since 2013 power generators must buy all their allowances: experience shows that they have been able to pass on the notional cost of allowances to customers even when they received them for free.
    - However, eight of the member states which have joined the EU since 2004 - Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Poland and Romania - have made use of a provision allowing them to continue granting limited numbers of free allowances to existing power plants until 2019. In return they will invest at least as much as the value of the free allowances in modernizing their power sector.

more info:

http://ec.europa.eu/environment/climat/emission/index_en.htm

http://ec.europa.eu/environment/climat/emission/2nd_phase_ep.htm

http://ec.europa.eu/environment/climat/pdf/nap2006/cz_decision_en.pdf

an important trading sits is European energy exchange (trading data here) http://www.eex.de/

Translations of some environmental legislation: http://www.env.cz/ris/vis-legcz-en.nsf/

Schleich et al – Incentives for energy efficiency in the EU Emissions Trading Scheme

Q: What is the main objective of this article?

What kind of methodology is used by the authors?

Explain the difference between the micro and macro incentives in the context of this research.

What is the fundamental relationship between the incentives and the amount of available allowances on the macro level?

- exploring the incentives for energy efficiency induced by the **EU ETS**
- analyzing the 27 National Allocation Plans (**NAPs**) of 27 EU member states, **in phase 2**
- hypothesize that (macro) **incentives for energy and carbon efficiency stronger in phase 2 (2008-12) than in phase 1 (2005-07)**, but only due to reduced number of allowances allocated to member states by the **European Commission**
- intuitively, **less allowances => higher prices=> stronger incentives for efficiency**
- there is also a question of (efficiency of) distribution of pollution reduction between the **trading** and the **non-trading sector**:
    - cuts in allocation to energy and industry sectors => greater reduction in these sectors ->**non-trading** sectors like households, transportation, or services will have to reduce less (in order to fulfill national emission target)
- improvements in the energy and industry sectors might be limited due to use of extra credits from the Kyoto Mechanisms: **Joint Implementation** (JI) or **Clean Development mechanisms** (CDM)

What are the authors interested in?

- looking at the **stringency of the cap**, they analyze approved NAPs for phase 2 (of 27 member states) in terms of their incentives for innovation and energy efficiency; in particular
    1. they **compare approved ET budgets for phase 2** with
        a. verified historical emissions in 2005
        b. size of the ET budgets in phase 1
        c. projected emissions in 2010
    2. they also look at how the burden is shared between (EU ETS) **trading and non-trading sectors (cost-efficiency)**
    3. **to what extent the use of Kyoto Mechanisms may crowd out domestic efficiency improvements** in EU (comparing maximum extra credits from CDM or JI that companies are allowed to use and relate it to the above stringency criteria)

⇨ **Looking at incentives for (in)efficiency at MACRO (country-wide) as well as MICRO (for individual installations) level**

OUTCOMES OF THE ANALYSIS:

a. <u>Incentives for efficiency at MACRO level</u>

- in phase 1 and 2 the ETS budgets made up of budgets of individual installations based on combination of **historical emissions** + **growth projections** + **emission savings potentials** and overall **compliance factor**, required to reach the overall ETS budget

<u>Phase 1</u>

only few countries (in their NAPs) allocated to their industrial facilities total number of EUAs lower than the actual 2005 levels (Austria, Greece, Italy, Ireland, Spain and UK) …

Q: Based on this, what are the incentives to reduce emissions in phase 1???

This resulted in a SURPLUS of EUAs on the market

=>**prices plummeted down to zero** towards the end of the first trading period (also, in phase 1, allowances could not be "saved" for the next trading period)

⇨ **little incentives to improve (macro-level) efficiency!!!**

Phase 2

- European Commission (EC) developed own criterion and required budget **cuts in all but 4 initially proposed NAPs** (Denmark, France, UK, Slovenia)
- EC, compared to originally proposed NAPs, **reduced the total cap by 10.4%**, with the highest adjustments for Poland and Germany in absolute terms, and for Latvia, Estonia and Lithuania in percentage terms
- in addition, EC **set a maximum amount of credits from Kyoto Mechanisms**(CDM and JI) that companies may transfer and use to cover their emissions (thereby limiting the inflow of extra credits)
- on average, the ET budgets are about **12.8%** lower than emissions in 2005, **12.9%** lower than budgets in phase 1 and **15.7%** lower than projected emissions in 2010

Q: What does it mean for phase 2 as compared to phase 1 (incentive-wise)?

- ⇨ **MACRO incentives are likely to be stronger in phase 2 than they were in phase 1** (but to be sure that domestic reductions via improved efficiency were achieved, also the credits from Kyoto Mechanisms need to be taken into account)
- ⇨ **BUT** the global financial crisis stroke... overall drop in economic activities... prices of allowances back to zero again in 2010 (**think about why this is different from 2007**)

- **efficient distribution of reduction efforts?** (within both trading and non-trading sectors, those with lower abatement costs should reduce by more) - the authors conclude that adjustments imposed by the EC **also lead to more efficient split of reduction efforts between the trading and the non-trading sector** (and lower overall costs than in the originally proposed NAPs)

  - ⇨ the authors conclude that without the EC's intervention, the notified ET budgets would have resulted in far too little improvement in (macro) efficiency… In other words, **EC's intervention was necessary and successful to improve efficiency at MACRO level**

b. Incentives for efficiency at micro level

- assessing the observed allocation rules for existing and new installations primarily based on economic theory

Initial endowment of allowances

Q: What was the allocation rule used by the EC in the early phases of EU ETS?

What was wrong with such allocation rule?

Why do economists prefer auctioning off rather than free initial endowment of allowances?

- **Auctioning vs. free allocation for existing installations –**typically, **economists prefer auctioning to free allocation**
  - o one of the reasons is that the "**polluter-pays**" principle holds, so the outcome can be perceived as fair
  - o auctioning also addresses "**windfall profits**" – if companies manage to pass the price of allowances on consumers [which is what we see in power sector], extra profits (windfall profits) accrue if those companies had gotten their allowances for free
  - o auction **revenues can be used for R&D**, investment into efficient technologies
  - o Importantly, **facilities' incentives to innovate are stronger with auctioning off**, here is why

Q: Can you recall any of the examples used by the authors to explain why?

- ***Incentives for replacement*** - incentives to replace old installations in the EU ETS are stronger with auctioning rather than with free allocation (because the plant has to purchase allowances at the beginning of the trading period…this enters as extra cost into the cost-benefit analysis of no replacement vs. replacement)
- ***Updating the base period distorts incentives to innovate***– if allowances are allocated for free based on today's emissions – updating the base period distorts incentives to reduce emissions because future allocation will be lower => updating results in reduced incentives to improve efficiency when allocating for free. (with auctioning-off today's emissions do not play a role, there is no base… the government or responsible agencies offer allowances for sale and facilities bid depending on their cost of abatement)
- ***Carbon cost pass through in the power market and demand side incentives* –** if product prices are higher due to higher carbon costs [depends on elasticity of demand, market structure and regulation and then in particular cases might also depend on whether auctioned or for free ... those interested may want to read Schleich et al. p. 10-11] =>stronger incentives for energy efficiency on the demand side when carbon emissions are costly
- ***Diffusion effect***- adoption and diffusion of new technologies reduces emissions and surplus allowances can be sold on the market(or, fewer need to be purchased) => lower demand => lower prices... if allocated for free, the freed-up allowances will generate smaller profit for the investor as the price goes down (something of market value which he got for free, now he sees his profits going down) ... if auctioned off the future cost is lower because of lower allowance price, so in the long run investor benefits....stronger incentives for innovation
- ***Early price signals and planning reliability for investment* –** auctioning off part of the (allowance) budget at the beginning may generate robust early price signals that reflect the scarcity of allowances (bidding behavior reflects marginal abatement cost) –>lower payoff uncertainty for investors, improved planning reliability

- **so, the theory suggests that (micro) incentives to innovate are stronger with auctioning off**

- **Q: Based on the above arguments, which are the two problematic rules used by the EC for initial allocation of allowances in the first two trading periods?**

- **Reality? [until 2012]**
  - the directive **allows** members to auction off **up to 5%** of the ET budget in phase 1 and **up to 10%** in phase 2 [governments to individual facilities]

        - in phase 1, only **4 members chose to auction off** parts of their ET budgets (0.2% of total EU ETS allocation), more members plan to do that in phase 2 (still, only 3.1% of total allocation)
        - **most member states were allocating allowances to installations for free**, based on historical emissions (2005 data)
        - The authors concluded that *"due to low auctioning share it is* ***unlikely that phase 2 would substantially advance as regards improvements in MICRO efficiency"***

- Even in cases when the allowances are distributed for free, it matters to a great extent, on the mechanism by which the allowances are distributed to individual installation – that can affect incentives on individual level…-->
- **Conventional grandfathering vs. benchmarking for existing installations**
    - **Grandfathering Allowances**: allocation method under which the government would give (not sell) allowances to entities <u>based on their historic production, emission or consumption levels</u>

      Q: What is wrong with such scheme (for incentives)?

      => Problem: Allocating allowances based on historical emissions in a recent reference period implies that companies which had invested in abatement measures prior to that period would receive fewer allowances than companies which had not invested in such measures (=> **no incentives to innovate**)
    - **Benchmarking**,
        - an approach used to evaluate GHG emissions performance between and amongst similar facilities or operations in the same industrial sector. It uses an objective indicator of efficiency (a benchmark) to compare the facilities or operations to their industry standard or best practice and can therefore recognize and reward facilities that have already invested in achieving emission reductions
        - allocation can be based on specific values per unit of production (e.g., kg of CO_2 per MW hour electricity) for a particular group of products or installations; or on the top x % performers of the EU or of the world.
        - The actual number of allowances can be derived from the specific **benchmark value per unit** of activity multiplied by historical or predicted production levels, utilization rates or the capacity of the individual installations
        - => allocation is NOT based on individual installation's (historical) emissions
    - benchmarking favors carbon-efficient over less-carbon-efficient installations (the latter need to purchase missing allowances on the market, which is costly) and accounts for early action (i.e. **innovation**)
    - better than based on historical emissions:
        - favors low-emission installations -> FAIR

        - allocation is not based on own emissions – limits incentives to behave "strategically" (not lowering current pollution for future allowance allocation)
    - **Reality**
        - several countries use benchmarking, mostly for power installations
            - In the **first phase**, only a few Member States: France, Italy, the Netherlands, and Sweden have applied benchmarking
            - In the **second phase**, Austria, Belgium, Germany, Latvia, Spain and the UK among others also used benchmarking.
        - increased use of benchmarks compared to phase 1 can be expected to accelerate the replacement of old carbon-intensive technologies in phase 2

- Another important factor that affects incentives is how allocation to new installations (started within given trading period) is handled and what happens with allowances of firms that go out of business
- **Allocation rules for new projects**
    - allocating for free to new installations distorts incentives for investing in less-carbon-intensive technologies (**Explain why?**) – should be purchased on the market
    - **Reality**
        - in all member states new projects receive allowances for free from a new entrants' reserve (on a 1st-come-1st-served basis)
- **Allocation rules for closures**
    - if allocation is terminated after closure, companies do not properly account for true opportunity cost of closure **->**because of losing allowances, the closure cost is overestimated and therefore, old plants may continue to be operated for too long and new investments might be postponed
    - **Reality**
        - most member states end the allocation after the closure (of fear that operators might shut down the installations, keep the allowances and open a new business in another country)

European Commission for phase 3 (from 2013 on):

Benchmarks for free allocation

Policy | Documentation | Studies | FAQ

From 2013 onwards the system for allocating emission allowances will significantly change compared to the two previous trading periods (2005-2012). Firstly, emission allowances will be distributed according to fully harmonised and EU-wide rules, meaning that the same rules will apply across all EU Member States. Secondly, auctioning will be the rule for the power sector, which means that the majority of allowances under the EU Emissions Trading System will not anymore be allocated for free.

For industry and heating sectors, allowances will be allocated for free based on ambitious (greenhouse gas performance-based) benchmarks. Installations that meet the benchmarks (and thus are among the most efficient installations in the EU) will in principle receive all allowances they need. Installations that do not meet the benchmark will have a shortage of allowances and the option to either lower their emissions (e.g. through engaging in abatement) or to purchase additional allowances to cover their excess emissions.

In contrast to the most common allocation methods in force since 2005 and until 2012, this new system applying from 2013 onwards will no longer have the perverse effect of providing more free allocation to the highest emitting installations.

The benchmarks are also very important for the achievement of a low-carbon economy. They provide a strong signal for what is possible in terms of low-carbon production. The benchmarks are a milestone to show that the EU is pressing ahead with the implementation of its ambitious climate agenda and that it is serious in striving for a low-carbon economy.

What are benchmarks?

A benchmark does not represent an emission limit or even an emission reduction target but merely a threshold for the level of free allocation of an individual installation. The benchmarks are to be developed per product, to the extent feasible.

Generally speaking a product benchmark is based on a value reflecting the average greenhouse gas performance of the 10 % best performing installations in the EU producing that product. The benchmarks were established on the basis of the principle 'one product = one benchmark', which means that the benchmark methodology does not differentiate by technology or fuel used, nor the size of an installation or its geographical location.

Why free emission allowances?

If other developed countries and other major emitters of greenhouse gases do not take comparable action to reduce their emissions, certain energy-intensive sectors in the EU that are subject to international competition could be put at an economic disadvantage. Therefore, allocating emission allowances free of charge aims at limiting the costs for EU industries in relation to competitors outside of the EU.

At the same time, an absence of comparable action outside of the EU could lead to an increase in greenhouse gas emissions in third countries where industry is not subject to comparable carbon constraints. This would undermine the environmental integrity and benefit of actions by the EU.

To address these issues, industrial sectors that face international competition from industries outside the EU which are not subject to comparable climate legislation will receive a higher share of free allowances than those which are not at the risk of such so-called carbon leakage.

Q: Do you think the new system will be better in terms of incentives? Can you explain?

Q: What is the main argument for allocating the allowances for free to certain sectors? Do you think it makes sense?

Auctioning

Policy | FAQ

The EU Emissions Trading System enables participating installations like factories and power plants in 30 countries to receive emission allowances (a certain amount of greenhouse gases that they can emit) which they can sell to or buy from one another as needed. While auctioning of carbon allowances is limited during the first and second trading period, it will be the main allocation method as of 2013.

During the first trading period (2005 to 2007), Member States have auctioned only very limited quantities of carbon allowances, and also during the second trading period (2008 to 2012) the lion's share of carbon allowances is still allocated for free. From the start of the third trading period in 2013 about half of the allowances are expected to be auctioned. Auctioning is the most transparent allocation method that allows market participants to acquire the allowances concerned at the market price.

Auctioning of allowances becomes rule as of 2013

The revision of the Emission Trading Directive, agreed on 17 December 2008, foresees a fundamental change as from the third trading period starting in 2013. Auctioning of allowances will be the rule rather than the exception. No allowances will be allocated free of charge for electricity production, with only limited and temporary options to derogate from this rule.

Sectors and sub-sectors found to be exposed to a significant risk of carbon leakage will receive allowances for free based on ambitious benchmarks, but for non exposed industry such allocations will be phased out. These rules imply that as from 2013 at least half the total number of allowances is expected to be auctioned.

Q: What is carbon leakage?

Summing-up Schleich et al.

MACRO incentives:

ET budgets for phase 2 are

- about 12.8% lower than historical emissions in 2005,
- 12.9% lower than the budgets in phase 1 (2005-2007),
- 15.7% lower than projected emissions in 2010.

➔ thus, the ET budgets for **phase 2** are **much stricter** than for **phase 1**

➔ and, prices for EUAs early in phase 2 support this view (remember that there were external shocks behind the fall of prices towards the end of phase 2).

➔ **tighter budgets for phase 2 are primarily the outcome of the EC's intervention** (cutting allocation in NAPs) rather than the result of member states' efforts

➔ for **phase 3**,

- NAPs are no longer required
- **Phase 3 is scheduled to last for 8 years** (2013-2020) rather than five, as longer phases **better match companies' investment cycles** and reduce uncertainty about

the profitability of new investments, they are likely to increase the diffusion and development of carbon- and energy-efficient technologies.

- Longer phases, however, also **limit the system's flexibility** to react to unexpected developments, such as technological breakthroughs, sudden changes in climate policy, or improved knowledge about the causes and effects of climate change. … " (p. 16)

⇨ the incentives for carbon and energy efficiency generated through the EU ETS **have significantly improved at the MACRO level**

MICRO incentives

⇨ in phases 1 and 2, **only small share and only in few member states auctioned off => not much of an improvement at the MICRO level between phase 1 and phase 2.**

⇨ use of grandfathering rather than benchmarking

⇨ Phase 3 – introduction of

- harmonized allocation rules in member states, (no NAPs)
- (gradual) switch to auctioning rather than free allocation
- use benchmarking where no auctioning-off
- no free allowances for new power installations,
- same allocation for new as for old non-power installations…

⇨ implies **increased (MICRO) incentives** for carbon and energy efficiency

Reality: Results of EU ETS?

Delivering emissions reductions

The EU ETS has proved that putting a price on carbon and trading in it can work. Emissions from installations in the scheme are falling as intended – by around 5% compared to the beginning of phase 3 (2013) (see 2015 figures).

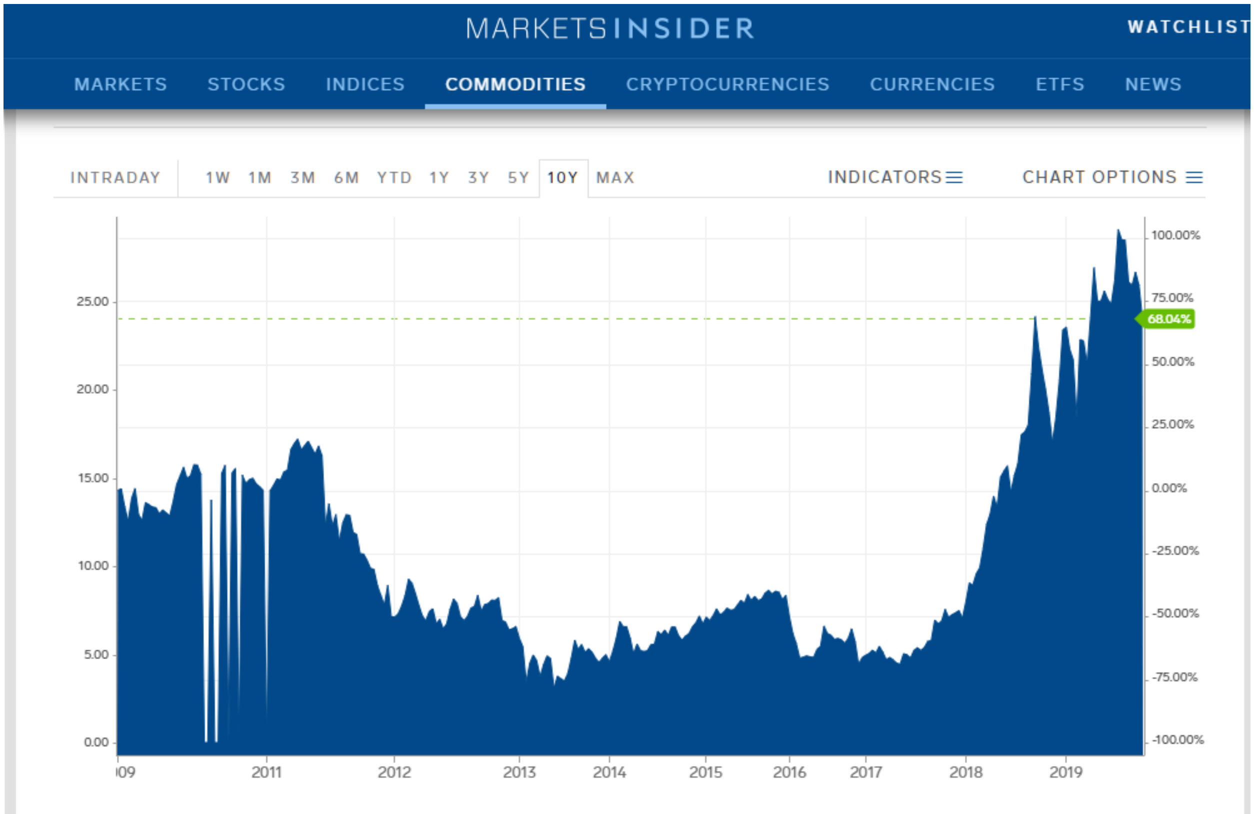
In **2020**, emissions from sectors covered by the system will be **21% lower than in 2005**.

In **2030**, under the Commission's proposal, they would be **43% lower**.

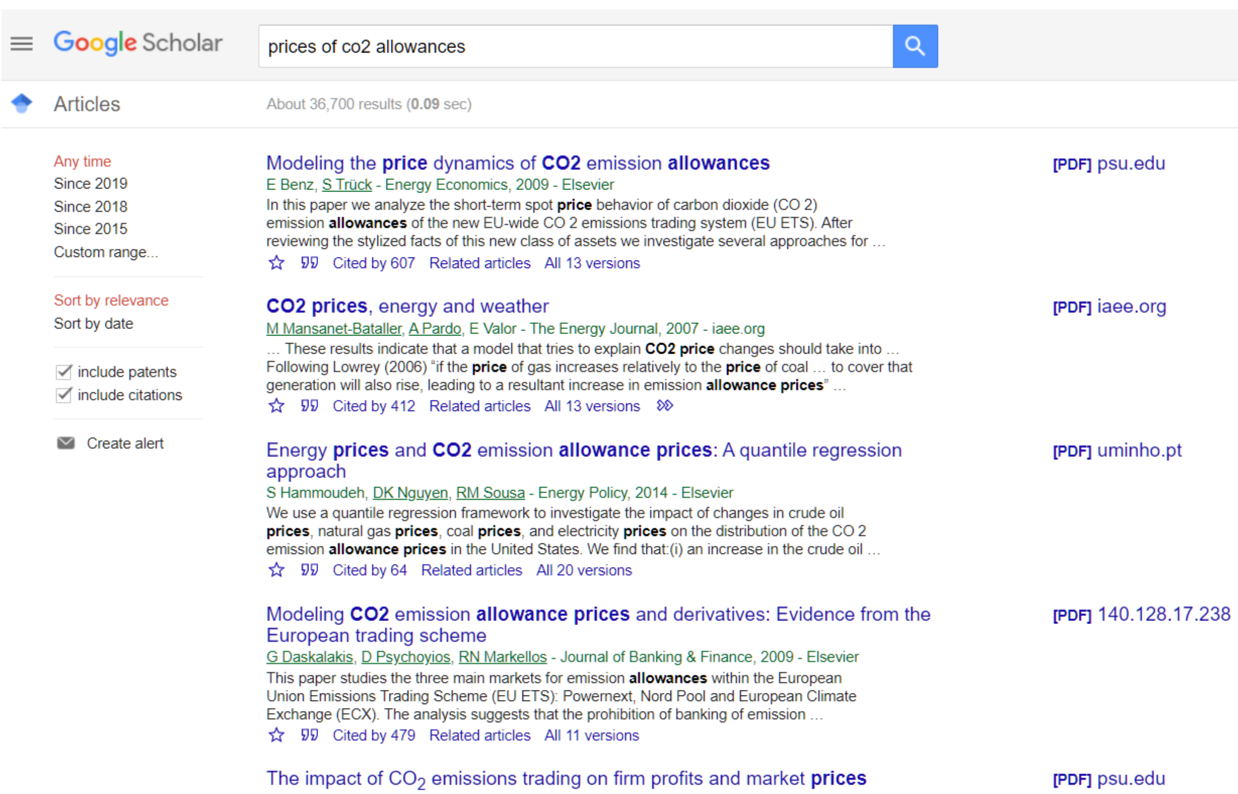
Reports on EU's progress in cutting emissions

Source:http://ec.europa.eu/clima/policies/ets/index_en.htm

And this is what the prices say:



https://markets.businessinsider.com/commodities/co2-emissionsrechte



So now we know that auctioning off is preferable to free allocation. But there are many types of auctions… which one is the best?

Porter et al. address this question….maybe even more importantly this has been a very interesting experiment, in which the government really asked experimental economists for advice before deciding on auction mechanism to be employed… also a nice illustration of a difficult way from a simple theoretical recommendation and actual implementation in the real world…

Porter et al. – The design, testing and implementation of Virginia's NOx allowance auctions

- one of the first known cases where emission allowances were auctioned with the explicit intention of maximizing government revenues
- sale of 3710 allowances for emission of nitrogen oxides (NOx) in fiscal years 2004 (1,855) and 2005 (1,855) ultimately using **<u>a sequential English auction</u>** format
- before settling on an auction format, Virgina engaged services of experimental economists to assist in the auction design process => the authors designed, tested and implemented the auction
- auction mechanism designed, tested, implemented by Porter et al.
- 1,855 allowances account for about 8 percent of the annual total allotment. Where do the other allowances go? … to firms in recognition of **their historical "rights to emit**" … the 8 percent were set aside for distribution among new sources of NOx emissions .. originally meant to be handed out for free … but then budget crisis struck …
- part of a cap-and-trade system of pollution allowances that involves Virginia and 18 other states in the eastern U.S.; allowances are freely tradable throughout the 19-state region … there is an active private market …
- brought the Department of Environmental Quality (DEQ) of Virginia **$10.5 million**, 19 percent above target revenue of $8.8 million

> *An **English auction** is a type of auction, whose most typical form is the "open outcry" auction. The auctioneer opens the auction by announcing a Suggested Opening Bid, a starting price or reserve for the item on sale and then accepts increasingly higher bids from the floor consisting of buyers with a possible interest in the item. The highest bidder at any given moment is considered to have the standing bid, which can only be displaced by a higher bid from a competing buyer. If no competing bidder challenges the standing bid within a given time frame, the standing bid becomes the winner, and the item is sold to the highest bidder at a price equal to his or her bid. More generally an auction mechanism is considered "English" if it involves an iterative process of **adjusting the price in a direction that is unfavorable to the bidders** (increasing in price if the item is being sold to competing buyers or decreasing in price*

in a reverse auction with competing sellers).

When the auction involves a single item for sale and each participant has as an independent private value for the item auctioned, the outcome of an English auction is theoretically equivalent to that of the ***Vickrey auction*** *(type of sealed-bid auction, where bidders submit written bids without knowing the bid of the other people in the auction, and in which the highest bidder wins, but the price paid is the second-highest bid). Both, the Vickrey and English auction, although very different procedurally, award the item* ***to the bidder with the highest value at a price equal to the value of the second highest bidder****.*

In contrast, a ***Dutch auction*** *would* ***adjust the price in a direction that favored the bidders****. The auctioneer begins with a high asking price which is lowered until some participant is willing to accept the auctioneer's price, or a predetermined reserve price (the seller's minimum acceptable price) is reached. The winning participant pays the last announced price. This is also known as a "clock auction" or an open-outcry descending-price auction.*

*This type of auction is convenient when it is important to auction goods quickly, since a sale never requires more than one bid. Theoretically, the bidding strategy and results of this auction are equivalent to those in a sealed-bid first-price auction (****the bidder with highest value wins and pays his bid****).*

here the design is quite problematic (a palette of choices is richer) as we are selling more units of two vintages of same product (not only more buyers will end up buying but likely each will purchase different quantities…even the own valuation for each unit may differ for the same buyer as the cost of abatement changes "along the curve")… questions about timing, pricing, etc….

Design restrictions

- tight time constraint (from the first time Porter et al. were contacted to required delivery time, about two months)
- transparency of the pricing rule critical
    - ***option 1*: discriminatory** (or "pay-as-you-bid", every bidder pays the amount he/she bid)
        - ⇨ this poses ex post problem to participants since nearly all participants included in final allocation realize that they could have had the license to pollute for less …"a bidder who wins has paid too much, a bidder who loses has bid too little"
    - ***option 2:* uniform pricing** (market-clearing price is set and everyone biding that or more pays uniform, market-clearing price)
        - ⇨ this might pose a problem to the government because public is likely to find out what bidding prices were and how much the government left on the table – not extracting maximum possible (keeping information secret not an option due to Virginia's Freedom of Information Act)

- **auction mechanism rules had to be simple** since complicated bidding and allocation rules might scare potential buyers off
    - with respect to 2 vintages, they considered two possibilities, **sequential** and **combinatorial** (=bidding for both vintages at once) bidding → combinatorial clock auction is certainly the more complicated one
    - another important complicating factor, in this respect, was the asymmetric substitutability of the two kinds of allowances involved →
        - Emitters cannot borrow against future issuances of allowances but … allowances are "bankable", i.e., 2004 allowances can be used in 2005
        - **use of banked allowances subject to restrictions**; if region-wide carried-over licenses exceed 10 percent of the total regional budget then only a fraction of the carried-over licenses may be used, the remainder gets devalued by 50% (in early March, local exchanges were trading 2004 allowances for about $2,000 and 2005 allowances for about $3,500, reflecting a probability that 2004 allowances may lose some of their face value)

Which auction mechanism / pricing rule to use?:

- Three auction mechanisms were investigated **in laboratory experiment**:
    i. **Sealed bid (first-price auction)** without iteration (participants submit their bids by given deadline and units are allocated to the high bidders on a pay-as-bid basis (**discriminatory** pricing), **combinatorial** in that bidding at both vintages, **(CSB)**
    ii. **Iterative English** (second-price auction, clock quoting successive process and each bidder is required only to indicate his quantity demanded at the standing price, the auction ends when the market clears (total demand=total supply – **uniform pricing,** no info on individual willingness to pay beyond market clearing price)
        1. **simultaneously linked clocks** (for two vintages) ~ Combinatorial English Clock **(CEC)**
        2. **sequential** (takes into account potential substitutability of 2004 and 2005 allowances) ~ Sequential English Clock **(SEC)**
- similarly as in previous experiments, subjects in the lab were given "redemption" value for each "product (neutral wording) to simulate the market demand…

- "DEQ selected initially a combinatorial clock design (based on the results of the experiment), the complexity of the implementation proved prohibitive in the available timeframe, and ultimately a sequential (first one vintage, then the other) clock was implemented instead."

Results

The aim was to estimate revenue and allocative efficiency under the three auction formats

Revenues

1. The **CSB** outperformed both English clock designs in **inelastic** environments (generating more revenue).
2. **Elastic** demand increased revenue in **both English clock** mechanisms, but not in the **CSB**.

=> given sufficiently elastic demand, the **CEC** is the **revenue maximizing mechanism**, but the **CSB** raises more revenue in inelastic demand environments

Efficiency

- Efficiency across mechanisms is comparable irrespective of the environment.

Conclusions

- Experiments are being used (and that is probably for a good reason) to inform public policy decisions
- The Virginia NOx allowance auction had to be implemented on an extremely tight timeline … three important effects:
  a. It forced state administrators to make very quick decisions
  b. It forced selection of an easily implemented auction design that would be attractive and understandable to potential participants
  c. Limited opportunities for involvement of outside parties in the process
- The advantages of test-bedding a new application are:
  a. Exploration of parameter space when there are no empirical guidelines to identify the parameters (e.g., demand elasticity for allowances)
  b. Comparing revenue and efficiency of auction formats makes for better informed decisions.
  c. Increases confidence in process and outcome
  d. Might facilitate the final choice of a contractor to run the auction
  e. All that at relatively low cost (less than 1 percent of the revenue, i.e. about $100,000)