Undergraduate Program in Central European Studies

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Environmental Policy in the Central European Context

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

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Lecture 3 - Interventionist solutions to the Externality problem – Marketable pollution permits

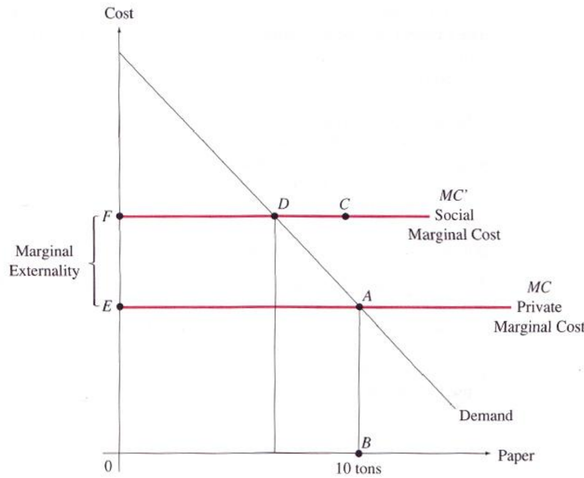
Last week we started to talk about interventionist solutions, starting with Pigovian taxes and standards and charges

1. PIGOUVIAN TAXES

- 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 …
- 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**

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 (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
  - ⇨ 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

  - ⇨ 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**

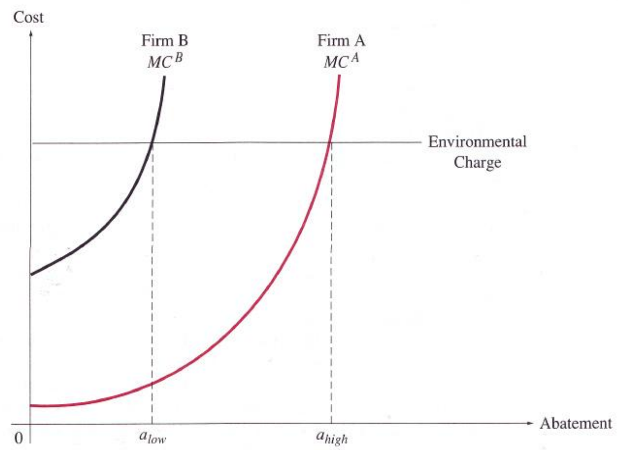
- ⇨ **PROBLEM –** To set the tax, the government needs to know the exact amount of the externality (the cost). The afflicted party, however,
  - o might not be able to estimate accurately
  - o might have incentives to exaggerate (both, the mill and the WTP)

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.
- water-paper society: charge on each gallon of waste to induce the mill to reduce the pollution to the acceptable level
- Ideally, with the charge, the production of waste is at the STANDARD

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!
    - 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)
- **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, don't want the firms to reduce neither too much nor too little)

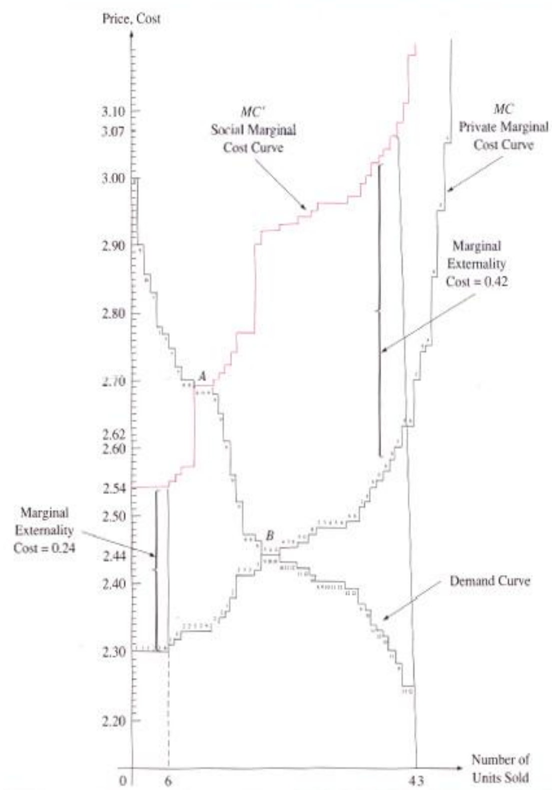
3. MARKETABLE POLLUTION PERMITS … to be discussed today

<u>Experimental Evidence</u> -- Plott, Externalities and Corrective Policies in Experimental Markets

A series of experiments to evaluate how the interventionist solutions work

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.



- 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?"

4 treatments

1. Market with externality

- benchmark, to see the market solution
- 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
- THE LEAST EFFICIENT OUTCOME

2. **Pigouvian tax policy**
   - 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)
   - 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**
   - only Q_0 permits exist and only licensed unites can be produced, 13 licenses. In the EQ: price of license = MC(of externality); licenses should be held by the low cost sellers
   - 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 (look at 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) – in fact, THE MOST EFFICIENT OUTCOME

4. **Standards policy**
   - limits the amount of admissible pollution such that imposed damage is at optimum volume (so here, number of trades is limited to the first 13 trades)
   - 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

<u>TODAY - MARKETABLE POLLUTION PERMITS</u>

- 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)

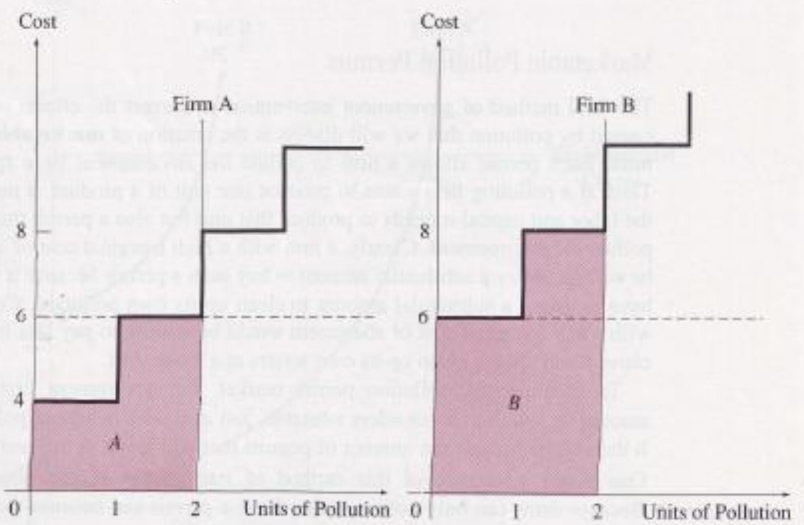
- The government first finds an acceptable level of pollution and then offers for sale the corresponding number of permits

- 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 (and the market takes care of the rest… like the prices of permits and who pollutes how much…)

- 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.



- 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
- 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
- Until when firm A will continue bidding? Firm B?

- in fact, firm B will have permits for $10 (or slightly more). Firm A must cut its level of pollution
- ONLY A MINOR INTERVENTION here – the government simply creates a new additional market

A REAL WORLD 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.**

A specific number of emission allowances is **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 that are listed in the **National Allocation Plan**.

- If the emissions from a given company exceed the limit (the number of allowances it owns), it must buy allowances from another business that has some to spare.
- The fulfillment of the obligation is monitored for a pre-defined period
- For each period, a **National Allocation Plans** are developed that distribute the allowances among the installations' operators.

Emissions trading within EU:

- producers are, within EU Emission trading Scheme, allocated certain amount of EU Allowances (1 Allowance corresponds to 1 ton of **CO2 equivalent** emissions) - **EUA**
- allocation of allowances according to **National Allocation Plans**. NAPs have to be approved by European Commission
- trading of Allowances => new market commodity EUA
- every company that is part of the National Allowance Plan NAP has an account to which its allocated EUAs are automatically credited
- even entities (dealers, brokers, banks…. simply the traders) that are not part of the NAP can trade – they ask NPA for a "personal account" and use it for transactions
- one of the important trading sites is European energy exchange. Data about trades can be found http://www.eex.de/.
- European allowances EUA, valid only in EU are recorded in CITL (Community Independent Transaction Log – independent registry of community transactions), and administered by European Commission (http://ec.europa.eu/environment/climat/emission/citl_en.htm)
- Czech Republic joined EU ETS in 2005-2007. Trading started 1. 1. 2008
- emission reduction goals are set for two **Trading periods:**
  - 1st trading period – 1.1.2005- 31.12.2007
  - further trading periods – 5-year periods, 1.1.2008-31.12.2012,
  - etc…
- data collected in electronic registries on national levels, EU levels and Kyoto levels, all are interconnected

One of such registers is

The European Pollutant Release and Transfer Register (E-PRTR) is the new Europe-wide register that provides key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein and Norway. It replaces and improves upon the previous European Pollutant Emission Register (EPER).

http://prtr.ec.europa.eu/Home.aspx

The new register contains data reported annually by some **24,000 industrial facilities** covering **65 economic activities** across Europe.

For each facility, information is provided concerning the **amounts of pollutant releases** to air, water and land as well as off-site transfers of waste and of pollutants in waste water from a list **of 91 key pollutants** including heavy metals, pesticides, greenhouse gases and dioxins for the year 2007. Some information on releases from diffuse sources is also included.

Most activities falling under the Greenhouse Gas Emission Trading Scheme Directive (Directive 2009/29/EC) are subject to the E-PRTR Regulation. Notable exceptions are combustion of fuels in installation with a total rated thermal input between 20 and 50 MW. In addition, some of the ETS activities descriptions slightly differ from the E-PRTR activities.

Please also note that under E-PRTR there is a facility-based reporting and under EU ETS an installation-based reporting which makes the data not directly comparable.

Which industrial facilities and pollutants are included in The European Pollutant Release and Transfer Register?

The register contains data reported by some 24,000 industrial facilities covering 65 economic activities within the following 9 industrial sectors:

- energy
- production and processing of metals
- mineral industry
- chemical industry
- waste and waste water management
- paper and wood production and processing
- intensive livestock production and aquaculture
- animal and vegetable products from the food and beverage sector, and
- other activities.

Data is provided in the register for 91 pollutants falling under the following 7 groups:

- Greenhouse gases
- Other gases
- Heavy metals
- Pesticides
- Chlorinated organic substances

- Other organic substances
- Inorganic substances.

more info at:
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
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

- 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 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**

> *The* ***European Commission*** *is the executive of the European Union. The body is responsible for proposing legislation, implementing decisions, upholding the Union's treaties and the general day-to-day running of the Union.*[1]
>
> *The Commission operates as a cabinet government, with 27 Commissioners. There is one Commissioner per member state, though Commissioners are bound to represent the interests of the EU as a whole rather than their home state. One of the 27 is the Commission President (currently José Manuel Durão Barroso) appointed by the European Council. The Council then appoints the other 26 Commissioners in agreement with the nominated President, and then the 27 Commissioners as a single body are subject to a vote of approval by the European Parliament.*[2]
>
> *The* ***European Council*** *is the institution of the European Union (EU) responsible for defining the general political direction and priorities of the Union.*[1][1]*. It comprises the heads of state or government of EU member states, along with its President and the President of the Commission. The High Representative takes part in its meetings, which are chaired by its President:*[1] *currently Herman Van Rompuy.*
>
> *While the European Council has no formal legislative power, it is an institution that deals with major issues and any decisions made are "a major impetus in defining the general political guidelines of the European Union". The Council meets at least twice every six months;*[1] *usually in the Justus Lipsius building, the headquarters of the Council of the European Union of Brussels.*

- less allowances => higher prices=> stronger incentives for efficiency
- 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)

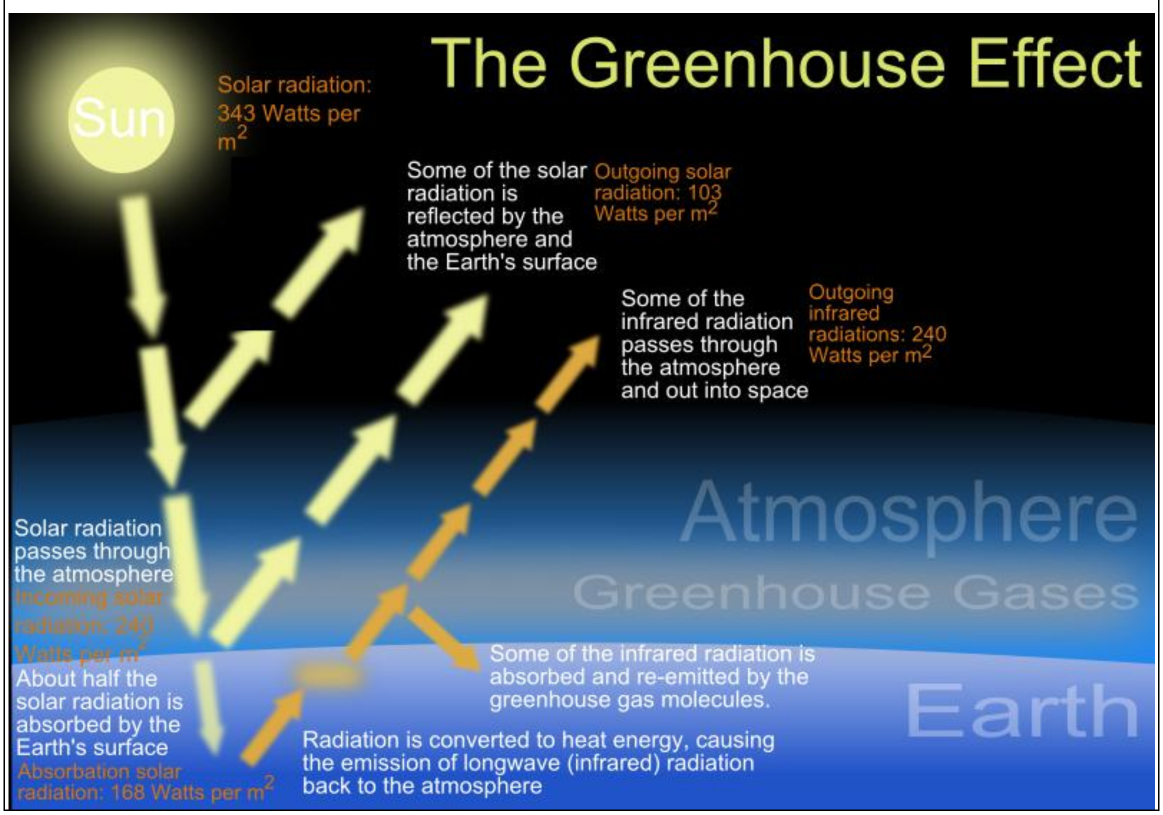
- improvements in the energy and industry sectors might be limited due to use of extra credits from the Kyoto Mechanisms: **Joint Implementation** (JI) or **Clean Development mechanisms** (CDM) that allow countries earning extra credits for participating in emission reduction projects (more on that to follow later on)

Some more details on EU ETS

- EU ETS is the world's largest emission trading system and the first international system for CO2
- a shift from command-and-control to market based instruments launched in Jan 2005
- covers around 12,000 large greenhouse gas (**GHG**) emitting installations in the energy and industry sectors (combustion installations with over 20MW input capacity, refineries, coke ovens, steel plants, producers of cement clinker, lime, bricks, glass, pulp and paper)

Wikipedia

*A **greenhouse gas** (sometimes abbreviated **GHG**) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect.[1] The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. In the Solar System, the atmospheres of Venus, Mars, and Titan also contain gases that cause greenhouse effects. Greenhouse gases greatly affect the temperature of the Earth; without them, Earth's surface would be on average about 33 °C (59 °F) colder than at present.*



- covers about 50% of Europe's CO_2 emissions
- covers about 40% of Europe's total GHG emissions
- 3 trading periods
  - phase 1 = learning phase 2005-07
  - phase 2 – 2008-12
  - phase 3 – 2013-20
- 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 amount of emissions during that period (otherwise they are sanctioned)
- companies may emit more than their initial allocation of allowances if they purchase extra allowances from other companies; -> extra market
- companies with low cost of abatements 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 abatement costs => overall reduction costs are minimized – ***static efficiency***)
- allowances price sets monetary incentives to adopt new, more efficient technologies and services, and to develop fundamentally new or significantly improved solutions) – ***dynamic efficiency***

National Allocation Plans

- define 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
- determine how allowances are allocated to individual installations
- establish "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 => this also determines, to what extent the country relies on **domestic efforts** and to what extent on **Kyoto Mechanisms** (CDM and JI) [again, the more they rely 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 ... all that important for **incentives for innovation and long-term investments into carbon/energy efficient technologies**...]
- all NAPs have to be approved by EC based on the criteria specified in the Emission Trading Directive and in the NAP guidance

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, they **compare approved ET budgets for phase 2** with
    - verified historical emissions in 2005
    - size of the ET budgets in phase 1
    - projected emissions in 2010
- they also look at how the burden is shared between (EU ETS) **trading and non-trading sectors (cost-efficiency)**
- **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 (in)efficiency at MACRO (country-wide) as well as MICRO (for individual installations) level**

A. Incentives for efficiency at MACRO level

- in phase 1 and 2 the ET 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 ET budget

Phase 1

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

…What are the incentives to reduce emissions in phase 1???

Moreover that 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 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 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

  ⇨ **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)

- efficient distribution of reduction efforts? (within both trading and non-trading sectors, those with lower abatement costs should reduce more) - they 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 as in the originally proposed NAPs)

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

B. <u>Incentives for efficiency at micro level</u>

- assessing the observed allocation rules for existing and new installations primarily based on economic theory
- **Auctioning vs. free allocation for existing installations –** typically, **economists prefer auctioning to free allocation**
    - one of the reasons is that the "**polluter-pays**" principle holds, so the outcome can be perceived as fair
    - auctioning also addresses "**windfall profits**" **–** if companies manage to pass the price of allowances on consumers, extra profits (windfall profits) accrue if allowances are allocated for free
    - auction **revenues can be used for R&D**, investment into efficient technologies
    - Importantly, **facilities' incentives to innovate are stronger with auctioning off**:
        - ***Incentives for replacement*** - incentives to replace old installations in the EU ETS are stronger under auctioning than under 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 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/responsible agency offers 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 Scheicht 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 emission costs (surplus allowances can be sold on the market, or less need to be purchased) => lower demand => lower prices... if allocated for free, the freed-up allowances will generate less 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) – need two-side market where also companies are also allowed to sell otherwise upwards biased price (low-abatement-cost companies cannot sell) – lower payoff uncertainty for investors, improved planning reliability ...

  - ***so this is what the theory suggests***
  - **Reality?**
    - the directive allows members to auction off **up to 5%** of the ET budget in phase 1 and **up to 10%** in phase 2 [countries 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 (only 3.1% of total allocation)
    - **most member states allocate allowances to installations for free**, based on historical emissions (2005 data)
    - due to low auctioning share it is **unlikely that phase 2 would substantially advance as regards improvements in MICRO efficiency**
    - Note that prices in phase 2 are expected to be higher [tighter budgets] -> might lead to **higher demand-side efficiency** (according to Sijm et al. the pass through to electricity prices varies btw,. 60 - 100% in selected countries) – depends on market structure, demand elasticity, country….also… keep in mind that apart from carbon, other factors affect prices of electricity, thus it is hard to make a general conclusion here

- **Conventional grandfathering vs. benchmarking for existing installations**
  - **Grandfathering Allowances**: allocation method under which the government would give (not sell) allowances to entities based on their historic production, emission or consumption levels
  - under **Benchmarking**, allocation is based on specific values per unit of production (e.g., kg of CO2 per MW hour electricity) for a particular group of products or installations – the actual number of allowances is derived from the specific benchmark multiplied by past or predicted installation-specific or standardized activity rates; average benchmarks are computed as activity-weighted average of emission values for particular group
  - with benchmarking, allocation is NOT based on individual installation's 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(=innovation)
  - better the based on historical emissions:
    - favors low-emission installations -> FAIR

  - allocations 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
  - increased use of benchmarks compared to phase 1 can be expected to accelerate the replacement of old carbon-intensive technologies in phase 2

- **Allocation rules for new projects**
  - allocating for free to new installations distorts incentives for investing in less-carbon-intensive technologies – should be purchased on the market
  - **Reality**
    - in all member states new projects receive allowances for free from a new entrants' reserve (on a 1^{st}-come-1^{st}-served basis)

- **Allocation rules for closures**
  - closures of installations should not affect allocations from economic point of view
  - if allocation is terminated after closure companies do not properly account for true opportunity cost of closure **->** because of loosing allowances, the closure cost are higher than optimal 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)

Conclusions

"Our analysis at the macrolevel suggests that, on average, 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), and 15.7% lower than projected emissions in 2010. **Thus the ET budgets for phase 2 are much stricter than for phase 1.** … Prices for EUAs for phase 2 support this view. … The **tighter budgets for phase 2 are primarily the outcome of the EC's decision** to substantially cut the ET budgets in the notified NAPs [a centralized setting of the cap] rather than the result of member states' efforts to curtail greenhouse gas emissions using the EU ETS. … according to the EC's proposal for phase 3, the future EU ETS will no longer require NAPs. Instead, there will be an EU-wide cap which corresponds to a reduction of 21% in 2020 compared to 1990 emission levels (or 14% compared to 2005 levels), … " (p. 15)

“**Phase 3 is scheduled to last for 8 years** (2013-2020) rather than five. … Since 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)

“To sum up, the incentives for carbon and energy efficiency generated through the EU ETS **have significantly improved at the macrolevel, but only slightly at the microlevel between phase 1 and phase 2.** The EC’s proposal for phase 3 (harmonized allocation rules in member states, no free allowances for new power installations, same allocation for new as for old non-power installations…) implies increased incentives for carbon and energy efficiency, in particular at the microlevel. … “ (p. 17)

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

Porter et al. address this question….

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) using a sequential English auction format

*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 (or isomorphic) 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 first-price auction (****the bidder with highest value wins and pays his bid****).*

- 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 …
- auction mechanism designed, tested, implemented by Porter et al.
- brought DEQ/Commonwealth of Virginia $10.5 million, 19 percent above target revenue of $8.8 million
- tight time constraint (from first time Porter et al. were contacted to required delivery time, about two months)
- and all kinds of restrictions on the design:
    - 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 → hence combinatorial clock auction (=bidding for both vintages at once) problematic from the outset; one important complicating factor was the asymmetric substitutability of the two kinds of allowance involved →
- Emitters cannot borrow against future issuances of allowances but … allowances are "bankable", i.e., allowances used in 2004 can be used in 2005 …
- … use of banked allowances subject to restrictions meant to control the rate of their use in a given year (e.g., if region-wide carried-over licenses exceed 10 percent of the total regional budget – the "banking threshold" – then only a fraction of the carried-over licenses may be used, the remainder gets devalued (can be used for cover half of the emission amount in the issue year). See example on p. 192. →
- 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 loose some of their face value)

- **Which auction mechanism / pricing rule to use?**, was the question: "DEQ selected initially a combinatorial clock design, 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." (p. 191) Why?
- Auction Design:
  - Conventional wisdom:
    i. **The design of auctions matters** (Klemperer JEP 2002, What Really Matters in Auction Design; Binmore & Klemperer EJ 2002, The Biggest Auction Ever: The Sale of the British 3G Telecom Licenses).
    ii. **Substitute goods** (such as the 2004 and 2005 allowances) ought to be offered simultaneously… agents submitting bids would be unable to indicate whether they were to accept 2004 allowances in place of 2005 and if so… at which exchange rate… bidders must choose between bidding too conservatively or facing a risk of financial loss
    iii. Auctions ought to be iterative so that the prices discovery process can work its magic.
  - Three auction mechanisms were investigated:
    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, **combinatorial** in that bidding at both vintages, **discriminatory** pricing) **(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 were given "redemption" value for each "product (neutral wording) to simulate the market demand
- tested the three auction mechanisms

Results

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

- revenue measured as revenue in a given round normalized by the maximum possible surplus in that round [so, this is how much government earned compared to the maximum possible revenues… or, percentage of available surplus captured by the auctioneer = the government]
- efficiency measured as sum of values satisfied by the final allocation normalized by the sum of values that would be satisfied by the optimal allocation [this goes back to buyers and their redemption values… how much of maximum possible value (~utility) did they obtain in the end… or, percentage of available social surplus realized by the auction]

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.
3. Differences in competitive equilibrium prices between allowance vintages impact revenue generation in the CEC and SEC but not the CSB (less revenue in complex combinatorial environment => non-trivial impact given expected revenues).
4. High minimum bids (reserve prices) increased revenues, but this was somewhat offset by unallocated units.
5. There was no learning from cycle to cycle.

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

Efficiency

1. Efficiency across mechanisms is comparable irrespective of the environment.
2. A high minimum bid rule slightly increases efficiency, but is quickly counteracted by unallocated units.
3. Learning occurred only in the SEC treatment.

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 time line … 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 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)

Godby & Shogren, *Caveat emptor (buyer beware)* Kyoto – Comparing buyer and seller liability in carbon emission trading

- Kyoto Protocol requires that leading industrialized countries reduce their GHG emissions by an average of 5 percent below 1990 levels by 2008-12.
- ET allows regulated emitters to buy emission reduction efforts from other emitters
- **The effectiveness of global trading depends on the rules of enforcement and sanctions for nations that shirk on their emission commitments.**
- Domestic trading programs in the United States and elsewhere have relied on strong enforcement and sanctioning frameworks to ensure market compliance but that cannot be

relied on automatically in international contexts (see Phase 2 notified voluntary restrictions within the EU ETS)

- The Kyoto Treaty ignores enforcement (although it really is the main challenge)
- The critical issue: **Who should be held responsible for overselling permits beyond quotas – the seller or the buyer country?**
    - Weak under-compliance penalties and ineffective monitoring methods create the incentive for selling nations to oversell permits (and shirk on their emission reduction commitments)
    - An advantage of seller liability: there is only one price because for the buyer it does not matter where the license to pollute comes from (thus the price does not account for the risk involved).
    - An advantage of buyer liability: buyers would have an incentive to ensure emission compliance through various means (including reputational enforcement, collaterals of various kinds, etc.) Inevitably that would mean that we now talk about different prices because various risk factors would play a role in the determination of the price. (On the positive side, monitoring and enforcement costs could be dramatically reduced.)

  ➔ "The working **hypothesis is that buyer liability leads to greater climate protection**, as markets form to capture the gains from trade and reputations work to police market behavior." (p. 49)
  [Intuitively, with seller's reputation auditing and enforcement becomes crucial – that is costly and often not intensive/efficient enough; with buyers' responsibility reputations work to enhance efficiency – sellers with bad record wouldn't find buyers (or yes, but for a very high price reflecting the risk)… so the buyers being held responsible will replace (at least to some extent) the enforcement agency….

- The authors test experimentally the comparative advantages of three liability rules: seller, buyer, and buyer and refund (seller non-performance inflicts sanctions on buyers only, while sellers forfeit any permit revenues, say by way of escrow accounts.)
- Sneak preview: **They find that "buyer liability under relatively weak international enforcement leads to the worst possible outcome – less climate protection at greater costs**." (p. 49) This result is robust to various robustness checks.

  [Intuitively, it might have been just too complicated… keep in mind that each buyer had to figure out risks connected with particular and reflect that in price…if buyers failed to figure this out properly (setting the right prices for individual sellers) and sellers were not responsible… that is exactly what would have resulted in more shirking]

The experimental details:

- Stylized Kyoto emission market double auction experiment in which liability rules are the treatment
- Each session with eight participants who
    - were told that they represented a firm producing and selling a product at an announced market price, with production costs varying and being private information.
    - were to choose a production level each period (which would materialize somewhat randomly)

- were expected to produce only when they held a permit to do so (but that "it was possible to produce without a permit – but each faced a fixed and known probability of being monitored individually to determine if they held enough permits to cover their production. If found to have produced without enough permits to cover production, individual subjects faced a fixed fine for every unit produced in excess of their permit inventory." (pp. 51 – 53)
- Each session used all three treatments (but in different orders; see Table 3.1. on page 52)

- **Results (somewhat surprising and contradicting intuition, especially as regards the BLR treatment):**
  - "Promoting a *caveat emptor* liability rule backfired in our experiment on both economic and environmental criteria. Holding the subjects that represented high-emission buyer nations responsible for climate shirking rather than holding the relatively poorer low emission seller nation subjects responsible resulted in average emission levels exceeding those observed under seller liability by nearly 34 to 40 percent. The imposition of an escrow-like refund system did not alter this result; and neither did the introduction of tighter enforcement or conditions that could create stronger seller reputations. Our findings support the notion that buyer liability in global emission trading might lead to less climate protection at greater cost." (pp. 73-74)