Environmental Economics in the Central European Context

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

Instructor: Jana Krajcova
Email: krajcova.janka@gmail.com
Reading materials: http://home.cerge-ei.cz/richmanova/Teaching.html

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

Interventionist solutions:

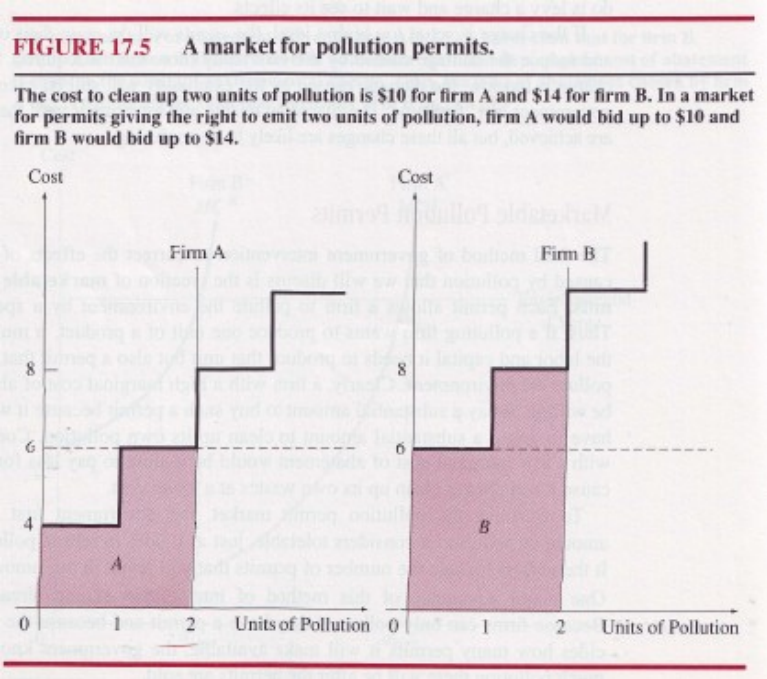
1. **PIGOUVIAN TAXES**
2. **STANDARDS AND CHARGES**
3. **MARKETABLE POLLUTION PERMITS**

Recall the experimental evidence -- Plott, Externalities and Corrective Policies in Experimental Markets, which suggests that permits policy is the most efficient one from the interventionist solutions

THEORETICAL ANALYSIS:

- For each unit of produced waste a 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 (=pollution reduction) 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). **Why?**
- 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 permit(s). The government directly controls the amount of pollution without having to know any specifics about the firms' marginal costs of abatement or about the social marginal cost of pollution (and the market takes care of the rest… => resulting prices of permits and the firm-wise distribution of pollution)
- consider an industry with 2 polluting firms A and B

- the firms have the marginal pollution abatement cost function as on the figure below:



- 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?

- 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

REAL WORLD EXAMPLE: The 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 CO2 allowances, the world's largest emission trading system
- 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 27 EU member states as well as Croatia, Iceland, Liechtenstein and Norway. Flights within and between most of these countries are also covered.
- covers about 50% of Europe's CO2 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)
- 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 abatement costs => overall reduction costs are 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

- 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 on the national level
- 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) [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 is important for **incentives for innovation and long-term investments into carbon/energy efficient technologies**...we will explore why in a bit...]
- NAPs are prepared for each trading period by the individual governments and consequently they are sent for approval to the European Commission. EC evaluates 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 is 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 new Europe-wide register that provides key environmental data from industrial facilities)
- Czech Republic joined EU ETS in 2005-2007. Trading started 1. 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 now, free allocation is to be abandoned completely by 2027
    - From 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 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

one of the important trading sites is European energy exchange; data about trades can be found at 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 to the authors do in order to find answers for their research questions?

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 **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 (macro-level) incentives for efficiency**
- there is also a question 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)

- **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...

Q: What do the authors look at in order to analyze the MACRO incentives?

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 **to see....?**
  - size of the ET budgets in phase 1 **to see....?**
  - projected emissions in 2010 **to see....?**
- 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**

Q: What do the authors look at in order to analyze the MICRO incentives?

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 that the actual 2005 levels (Austria, Greece, Italy, Ireland, Spain and UK) …

Q: 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** (CDM and JI) that companies may transfer and use to cover their emissions (thereby limiting the inflow of extra credits) – **what does that mean?**
- 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 were likely to be stronger in phase 2 than they had been 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 (**think about how 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 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 as 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 efficiency… In other words, **EC's intervention was <u>necessary and successful</u> 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 → again, **what are the incentives under the rules used by the EC as compared to other feasible allocation rules**

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**
  - 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 [which is what is typical for the power sector], 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**:

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

- ***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 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 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 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

- 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 installations – 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 based on their historic production, emission, or consumption levels

    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 CO2 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(=innovation)
    - better than 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
            - 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 loosing allowances, the closure cost are 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?

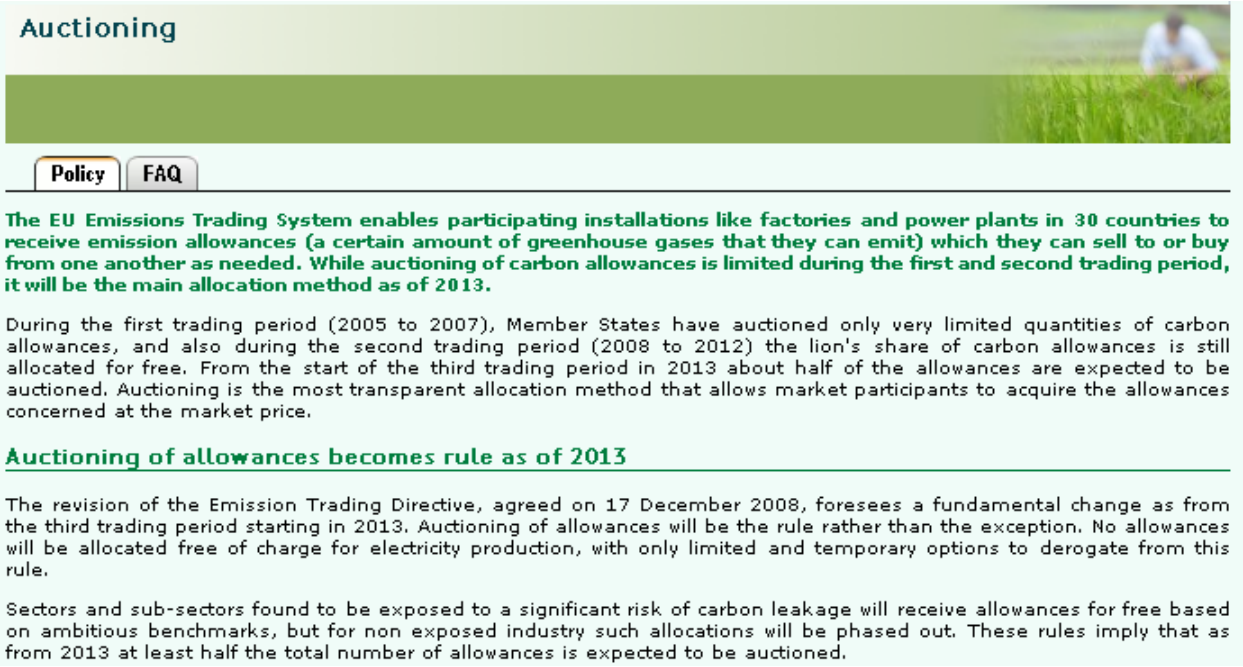
If other developed countries and other major emitters of greenhouse gases do not take comparable action to reduce their emissions, certain energy-intensive sectors in the EU that are subject to international competition could be put at an economic disadvantage. Therefore, allocating emission allowances 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? What is carbon leakage?



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.

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

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 for early years of phase 2 support this view (later on, impacts of the financial crisis)

➔ **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

➔ according to the EC's proposal for **phase 3**,

- the future EU ETS will no longer require NAPs
- 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, 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,
- 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

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

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

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 **a sequential English auction** 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, and 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 (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-bid first-price auction (**the bidder with highest value wins and pays his bid**).*

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 allowance 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?:

- "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."
- 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 (**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 were given "redemption" value for each "product (neutral wording) to simulate the market demand

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 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

- The question of how to ensure compliance is an important one for EU ETS as well... in this context it means monitoring and verifying the emissions and comparing the levels with number of emission allowances...
- these authors ask the question which, the buying or the selling nation, should be held responsible for discovered non-compliance
- As “The effectiveness of global trading depends on the rules of enforcement and sanctions for nations that shirk on their emission commitments.”
- 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

- 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**

- The Kyoto Treaty ignored enforcement for a long time(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.
    - **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.)
        - monitoring and enforcement costs could be dramatically reduced
        - this would mean different prices to reflect various risk factors

- "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)

⇨ 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 of the results: 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.

The experimental details:

- Stylized Kyoto emission market double auction experiment in which liability rules are the treatment
- Each session with eight participants who
    - each 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 "it was possible to produce without a permit – facing a fixed and known probability of being monitored individually; 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)

⇨ A total of 12 sessions, for a total of 96 participants

⇨ Each session took about 2.5 – 3 hours to complete.

⇨ Individual earnings ranged from $27 to $73, with a mean payment of $45.70

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)