Endogenous Market Power in an Emissions Trading Scheme

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Motivation - Emissions markets

- EU ETS
  - Price far above pre-market expectations in the first phase - signs of price manipulation??
  - There is at least anecdotal evidence of concerns of exercise of market power and price manipulation in permits markets (Klingenfeld, 2007 -interviews with market analysts and investment bankers)
  - In 2010 over 70% of the total emissions came from the combustion sector
- The future US ETS

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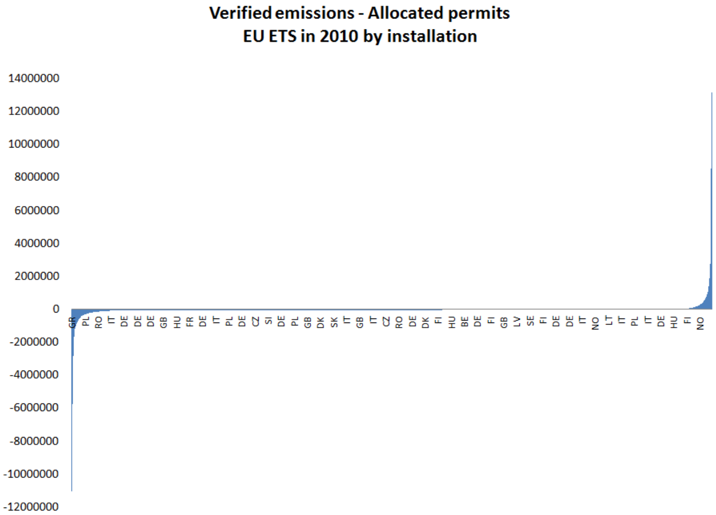

Source: European Commission for Climate Action

Motivation - Theoretical considerations

- Market power exogenously assigned to one or a few players (Cournot) based on some prior beliefs. Why?
- So far...
  - only the effect of free allocation on price manipulation
  - focus on market power in the secondary market only
  - no discussion about the propagation of the anticipation of the market power in the secondary market to the bidding strategies in the primary market

This paper

- Endogenous market power in emissions trading
- Initial allocation: Uniform Price Sealed-bid Auction (UPA)
- Welfare analysis: identifying the direction and the magnitude of the inefficiencies
- Who is gaining from strategic behavior?
- (In which conditions) is the strategic behavior a "good thing"?

Related literature

- Exogenous market power
  - Hahn (QJE, 1984) (seminal paper), Westskog (Energy J, 1996)
    - exogenously assigned market power: dominant firm(s) with a fringe
  - Hintermann (ERE, 2011)
    - links market power in emissions market with that in the output market - raising rivals' costs
  - Maeda (JRE, 2003)
    - derives a threshold for the emergence of the effective market power
  - Montero (CEEPR, 2009) - brings in some discussion on auction
- Endogenous market power
  - Lange (2003), Malueg and Yates (ERE, 2009)
    - endogenous market power, but initial allocation is grandfathering
  - Weretka (2011)
    - a general model of endogenous market power in bilateral trading in an exchange economy with consumption

Setup

- one shot game in complete information
- N players (firms, countries) members of an ETS
- $\overline{E}$ - the absolute cap, which is auctioned off
- e_i - the BaU emissions of player i,
  - with $\bar{e}_N = (\sum_{i=1}^{N} e_i)/N$
  - $e_1 \geq e_2 \geq \cdots \geq e_N$
- D_i - the initial endowment of permits via the auction
- $c(r_i) = \theta r_i^2$ - identical abatement cost
- t_i - trade in the secondary market (> 0 - buyer, < 0 - seller)
- The emissions constraint: $e_i = \underbrace{D_i + t_i}_{\text{permits}} + \underbrace{r_i}_{\text{non-tradeable}}$

Assumptions

For any player i, $e_i \geq \bar{e}_N - \dfrac{\overline{E}}{N} \geq 0$.

Actions

- Stage 1 (The initial allocation): choose $D_i(p_1)$ to minimize the total cost of emissions

$$\min_{D_i(p_1)} C_i = \underbrace{\theta(e_i - D_i - t_i)^2}_{\text{abatement cost}} + \underbrace{p_2 t_i + p_1 D_i}_{\text{permits purchases}}, \tag{1}$$

anticipating t_i from the second stage

p_1=price in the primary market (UPA)
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$\Longrightarrow$ **backward induction**

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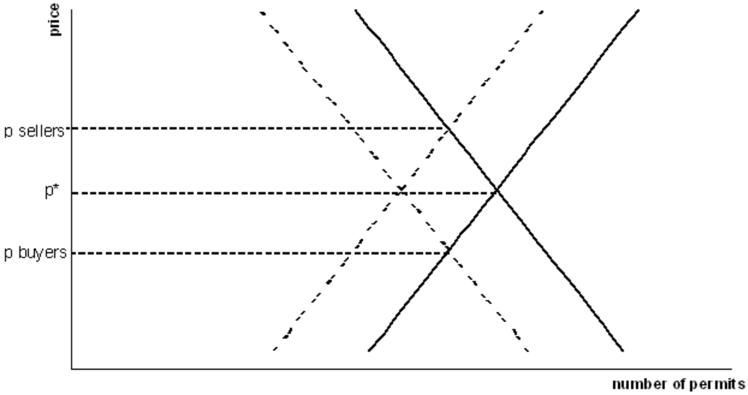
- Nash equilibrium provides the net trade function:

$$t_i^s = \frac{N-1}{N}(e_i - D_i^s) + \frac{1}{N}\left(\bar{e}_N - \frac{\overline{E}}{N}\right) - \frac{1}{2\theta} p_2$$

Secondary market equilibrium

secondary market equilibrium price is the same as in the competitive case: $p_2^c = p_2^s$



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$$\min_{p_1}\left(\frac{\theta}{N^2}D_i(p_1)^2-(\alpha_i-p_1)D_i(p_1)\right)\text{ s. t. } D_i(p_1)=\overline{E}-D_{-i}(p_1),$$

where $\alpha_i=\frac{2\theta}{N^2}e_i+\frac{2\theta(\sum_{j=1}^{N}e_j-\overline{E})(N^2-1)}{N^3}$

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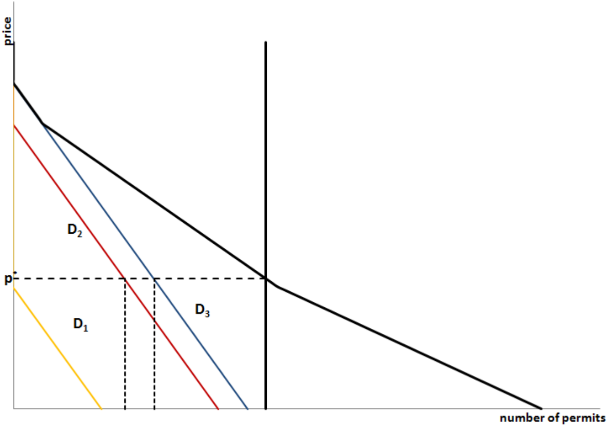
- Focus on linear equilibria with common slope:

$$D_i(p_1) = \begin{cases} \frac{N^2}{2\theta} \frac{N-2}{N-1} (\alpha_i - p_1), & \text{if } \alpha_i > p_1 \\ 0, & \text{if } \alpha_i \leq p_1 \end{cases}$$

Auction Equilibrium



Let $1, 2, \ldots, n$ be the n highest emitters with $e_1 \geq e_2 \geq \cdots \geq e_n$. Then, the auction clearing price is $p_2^s = \frac{1}{n}\left(\sum_{i=1}^{n} \alpha_i - \frac{2\theta}{N^2}\frac{N-1}{N-2}\overline{E}\right)$ and the initial endowment is

$$D_i^s = \begin{cases} \frac{\overline{E}}{n} + \frac{N-2}{N-1}\left(e_i - \frac{\sum_{i=1}^{n} e_i}{n}\right), & \text{for } i \leq n \\ 0, & \text{for } i > n \end{cases} \quad (3)$$

Equilibrium

From

- the definition of the "winners" and "losers" in the auction
- the net-trade position
- the Assumption that $e_i \geq \bar{e}_N - \frac{\overline{E}}{N}$

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Recall:

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Results

- The low emitters (below average) are awarded too many permits in the auction and the high emitters (above average) too few
- The low emitters abate less compared to the efficient solution and the high emitters abate more: $r_i^s = r_i^c + \frac{1}{N(N-1)}(e_i - \bar{e}_N)$
- Trade: $\frac{1}{N}(e_i - \bar{e}_N)$

Proposition 1

With strategic behavior, the secondary market price is unambiguously above the auction clearing price by the positive amount

$$p_2^s - p_1^s = \frac{2\theta\overline{E}}{N^3(N-2)}$$

.

Welfare analysis

- Individual loss from strategic behavior:

$$\Delta C_i = C_i^s - C_i^c = \frac{\theta}{(N-1)^2}(t_i^s)^2 - \frac{2\theta\overline{E}}{N^2(N-1)}t_i^s - \frac{2\theta\overline{E}^2}{(N-2)N^4}$$

- Who is better-off from strategic behavior?
  - all net sellers
  - some net buyers: the net buyers who are low-emitters
- Social loss from strategic behavior $= \frac{\theta}{N(N-1)^2}Var(e) - (\text{price spread})X\overline{E}$
  - increases in the variability of the BaU emissions
  - decreases in the total number of permits in the scheme

Proposition 2

There is a threshold for the fixed supply of permits above which the society is better-off acting strategically.

Conclusions

- Modeled an ETS with an auction as initial allocation method and the possibility for the exercise of market power
- The anticipation of the exercise of market power in the secondary market creates a spread between the prices of the two markets
- Findings
  - High emitters are punished twice in this game
  - Low emitters are over-allocated and under-abate
  - High emitters are under-allocated and over-abate
- Implications
  - Will the electricity producers be the "biggest losers" in the future EU ETS?
  - Justifies the permission of the "outsiders" to bid in the primary market of the EU ETS (EU ETS Auction regulation draft)
- Looking for an interesting numerical application of this model and/or extensions to incomplete info

Thank you for your attention!

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