Conditions for profit-neutral permit allocations

Jean-Philippe Nicolai [1]

[1]ETH Zurich, Chair of Integrative Risk Management and Economics

The Kyoto Protocol Commitment to reduce all CO_2 emissions (8% with regard to 1990). Countries are free to choose their instrument (price or quantity).

Implementing the Kyoto Protocol in the EU: the EU ETS A cap-and-trade system, that concerns energy-intensive industrial sectors (cement, steel, electricity...) $\Rightarrow$ 50% of total European CO_2 emissions. This market for emission permits first opened in 2005.

A peculiar issue for cap-and-trade: how to distribute permits? Permits may be whether given for free to firms or directly sold to firms or auctioned. A reserve for entrants may be forseen.

First periods(2005-2012):

- More than 95% of permits were given for free.
- Many sectors were not negatively affected by this regulation and the profits increased. (for instance, electricity)Verbruggen, '08; Sijm *et al.*, '06;
- Too many allowances were distributed. (Reilly and Paltsev 2005).

Free allowances and other experiments

- ACES: 80% free
- Australia: 20% free
- EU-ETS post 2013: permits for electricians should be auctioned.

Profits neutrality criterion

Let σ and ε^N be the price of permits and neutral-profits allowances.

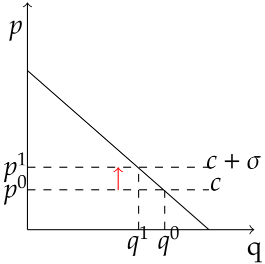
$$\pi_i(\text{After regulation}) + \varepsilon^N \sigma = \pi_i(\text{Before regulation})$$

Consumers and State bear the cost of the environmental policy.
The neutral profits allocations: two main issues in literature

1. Which percentage of permits should be granted for free to compensate firms' losses?
   - Bovenberg & Goulder (2001), Quirion (2003), Smale (2006): in Europe no more than 50% are enough to get profit neutrality.
   - Goulder (2010): giving 20% is enough to neutralize the profits of all US industries.
2. Which is the efficiency cost of avoiding profit losses in various US industries when a CO2 abatement policy is implemented?
   Goulder (2002, 2005, 2007) use the double dividend theory.

Intuitions

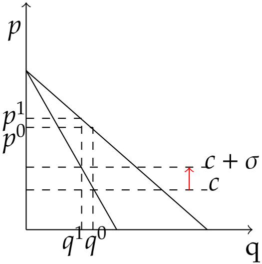
Perfect competition



$\pi(\sigma) = \pi(\sigma = 0) = 0$

No free allowances should be given

Monopoly



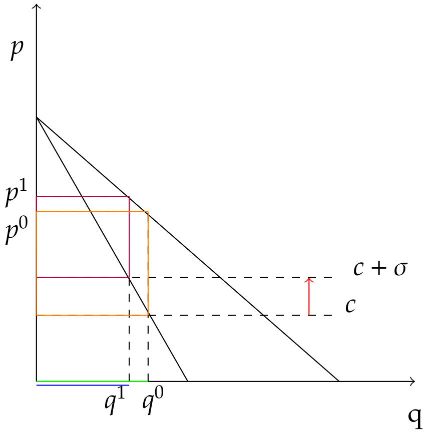
$\frac{\partial \pi}{\partial \sigma} < 0$

Free allowances are recquired

Hepburn, Quah, Ritz (2013):

- Regardless to the market structure, it is always possible to neutralize profits by giving free allowances on the basis of the initial emissions.
- They consider an exogenous permits price.
- They analyze the conditions under which the grand-fathering rate is lower than one. (However, it may correspond to free allowances higher than permits)

Intuitions



The modification of profits

$pi_0 - pi_1$

The gain due to free allowances

Initial emission

Pollution cap

reducing factor$=\frac{q_1}{q_0}$

Firms and consumers

N symmetrical firms competing ”à la Cournot”. Production technology is polluting. One unit of production generates one unit of pollution. No abatement technology.
Firms face an iso-elastic demand function given by:

$$P(Q) = \alpha Q^{-\frac{1}{\beta}} \quad with \quad Q = \Sigma_{i=1}^{n} q_i, \tag{1}$$

β is the elasticity of demand which is constant ($\beta > \frac{1}{n}$) and α is the size of demand.
The goal of the regulator is to reduce emmissions from a factor z, such that

$$Q(\sigma) = zQ^{\varnothing}, \tag{2}$$

where $Q(\sigma)$ is the total production when the price of permits is equal to σ. The total quantity produced when the price of permits is equal to zero $Q^{\varnothing}$ is the initial production.

On the market for permits

The perfectly competitive permits market clears when supply equals demand, or:

$$Q(\sigma) - \Sigma_{i=1}^{n} \varepsilon_i = zQ(\sigma = 0) - \Sigma_{i=1}^{n} \varepsilon_i \Leftrightarrow Q(\sigma) = zQ(\sigma = 0).$$

The resulting equilibrium price for permits is then:

$$\sigma = (z^{-\frac{1}{\beta}} - 1)c.$$

The profit and the profit factor ($z_\pi = \frac{\pi(\sigma)}{\pi(\sigma=0)}$) are equal to:

$$\pi_i(z) = \left(\frac{1}{n}\right)^{\beta+1} \left(\frac{\alpha}{\beta}\right)^{\beta} (n\beta - 1)^{\beta-1} \left(z^{-\frac{1}{\beta}} c\right)^{1-\beta},$$

$$z_\pi = z^{1-\frac{1}{\beta}}.$$

The implementation of a market for permits is caracterized by:

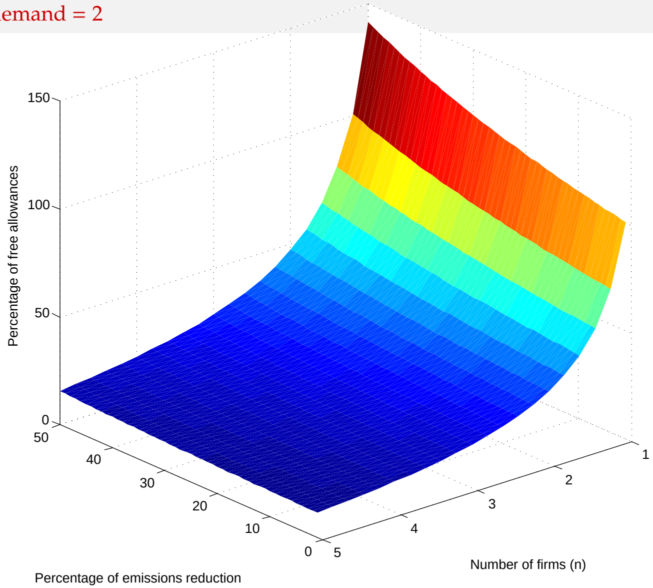
(i) The profit increases when the elasticity of demand is weak (< 1), and it decreases otherwise.

(ii) When the elasticity of demand is high (> 1), the profit 's losses for a firm decreases with the number of firms.

(iii) When the elasticity of demand is high (> 1), the sum of profits' losses decreases with the number of firms.

Percentage of permits

Elasticity of demand = 2



Proposition

Let $\overline{z}(\beta, n)$ be the reducing factor that the regulator can reach giving all permits for free and neutralizing profits. For each (z, β, n), if $z < \overline{z}(\beta, n)$, the offsetting is not possible. The threshold is such that:

(i) $\frac{\partial \overline{z}}{\partial \beta} > 0$ *and* $\frac{\partial \overline{z}}{\partial n} < 0$.

(ii) *When* n=1, $\overline{z}(\beta, 1) > 1$.

(iii) *When* n=2, $0.2 > \overline{z}(\beta, 2) > 0.1$.

(iv) *When* $n > 2$, $\overline{z}(\beta, n) < 0.1$.

Multi-sector regulation

- Two sectors A and B.
- A sector j is characterized by the elasticity β_j, size of demand α_j, marginal cost c_j, number of firms n_j and polluting factor f_j.
- The goal of the regulator is $Q_A(\sigma) + Q_B(\sigma) = z\left(Q_A^{\varnothing} + Q_B^{\varnothing}\right)$.

Implementing a multi-sector market for permits with a reducing factor for the whole economy is equivalent to implement independent markets for permits with individual reducing factors.

$$z_B = ((z_A^{-\frac{1}{\beta_A}} - 1)\frac{c_A f_B}{c_B f_A} + 1)^{-\beta_B}$$

Proposition

When $\beta_A = \beta_B$, $c_A = c_B$ and $f_A = f_B$,

$$\frac{\partial z_A}{\partial \beta_A} < 0, \quad \frac{\partial z_A}{\partial c_A} > 0, \quad \frac{\partial z_A}{\partial f_A} < 0.$$

Parameters

	Electricity	Steel	Cement
market size (α)	3600	200	250
price (p)	47	313	64
unit cost (c)	37	247	46.8
emission rate (f)	0,37	0,88	0,8
ratio (c/f)	100	280	58.5
elasticity (β)	1	2	2
market structure $n = \frac{1}{\beta(1-c/p)}$	5	3	2

Table : Data of the parameters and calibration of the model.

Results

Implementation of the market for permits	
Reduction of total emissions	-5%
Effect on quantities	
Electricity	-3%
Steel	-2%
Cement	-10%
Effect on price (equal to effect on costs)	
Electricity	+3%
Steel	+1%
Cement	+5%
Effect on profits	
Electricity	0%
Steel	-1%
Cement	-5%

Table : Illustration of the effect of the implementation of pollution permits on profits.

Results

Sector-based policy which neutralizes all profits	
Neutral-profits allowances/ initial emissions (%)	
Electricity	0%
Steel	19 %
Cement	31%
Percentage of total allowances given for free	10.38%
Uniform policy which neutralizes all profits	
Grand-fathering rate applied	0.318
Effect on profits	
Electricity	+3.8%
Steel	+0.6%
Cement	0%
Percentage of total allowances given for free	33.47%

Table : Illustration of neutral-profits allowances.

Upper bound?

Do we have to believe in these results? In other words, the percentage of permits found is it an upper bound?

- On the short run? No
- On the middle term? Yes
- With end-of-pipe abatement technology? Yes
- With cleaner production? Yes
- With process-integrated abatement technology? ???