Carbon leakage and Capacity-Based Allocations. Is the EU right?

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ETS and carbon intensive internationally traded industries

- Leakage and competitiveness issues have led to free allocations in various forms (Hood 2010).
  - Output based in New-zealand, Australia, California;
  - Capacity based in the EU.
- Previous literature only partially addressed the issue.
  - Quirion (2009), Fisher and Fox (2011);
  - Ellerman 2008, Neuhoff 2006, Zhao et al. 2010;
- This paper
  - Introduces a model of capacity decisions under uncertainty;
  - Characterizes the optimal allocation schelme;
  - Applies the analysis to the EU-ETS for cement.

The model (Simplified specification)

- An homogenous good with a variable price function:

$$p(q,\theta) = a + \theta - bq;$$

- Home production:
  - Old plants: $c_h.q_o + \gamma_h q_o^2$
  - New plants: $c_h.q_n + c_k.k$

$$C_h(q,k) = \begin{cases} c_h q & if\ q < k \\ c_h q + 0.5\gamma_h (q-k)^2 & otherwise \end{cases}$$

- Imports:

$$C_f(q_f) = c_f + \gamma_f q_f^2.$$

The Model

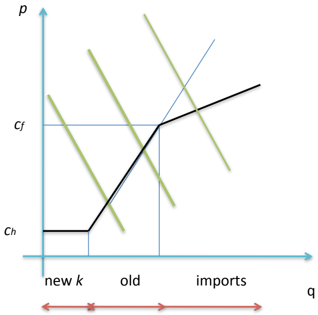

Figure: Supply curve and demand without regulation

The Model

- Environmental damage (σ exogenous):

$$\sigma E = \sigma \left[u_h q_h + u_f q_f \right]$$

- Weflare:

$$W = \int_\theta \left[S(q(\theta), \theta) - C_h(q_h, k) - C_f(q_f) - \sigma E \right] d\theta - c_k k$$

- Policy:
  - Home emissions are taxed σ but imports are not regulated.
  - Production and capacity are subsidized, s_h and s_k.
- Timing:
  1. The regulator fixes s_h and s_k subsidy on production and capacity;
  2. Firms invest in k;
  3. θ is known and firms produce and import.

Direct technology effect

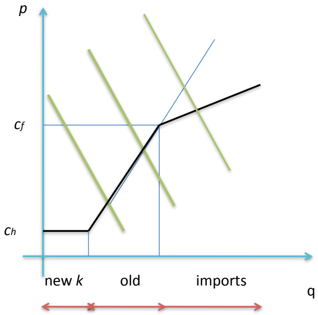

Figure: Without regulation

Direct technology effect

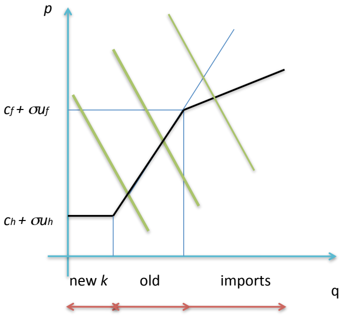

Figure: Uniform carbon price (BTA)

Direct technology effect

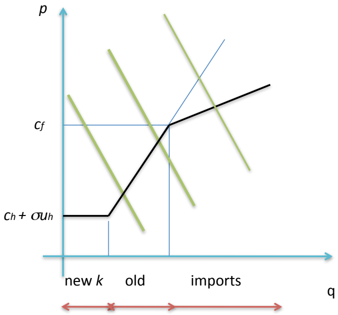

Figure: Unilateral carbon price (auctioning)

Direct technology effect

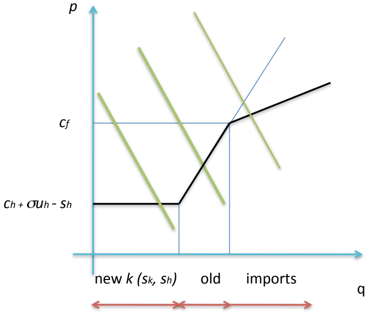

Figure: The subsidy scheme (s_h, s_k)

The optimal Scheme

- Intuition for the results:
  - the first-best would be to tax domestic and foreign emissions (BTA);
  - without uncertainty the second best would be to subsidize home production (OBA);
  - with uncertainty, the regulator would like to set a different subsidy in each demand state;
  - if he cannot do so there is a welfare loss in low demand states;
  - the subdidy on capacity allows to discriminate among demand states.

The optimal Scheme

Corollary

With the linear specification, the optimal couple of subsidies satisfies:

$$s_h = \sigma u_f \frac{b}{b+\gamma_f} \frac{1-F(\theta^+)}{1-F(\theta^+)+A} \quad (1)$$

$$s_k = s_h \frac{\gamma_h}{b} F(\theta^-), \quad (2)$$

in which

$$A = \left[\gamma_h + \gamma_f \frac{b}{b+\gamma_f}\right] \left[\frac{F(\theta^-)}{b} + \frac{F(\theta^+)-F(\theta^-)}{b+\gamma_h}\right]. \quad (3)$$

The optimal Scheme

$$s_h = \sigma u_f \frac{b}{b+\gamma_f} \frac{1-F(\theta^+)}{1-F(\theta^+)+A} \tag{4}$$

$$s_k = s_h \frac{\gamma_h}{b} F(\theta^-), \tag{5}$$

- The subsidy on production is the product of three factors:
  - the marginal environmental damage of foreign production;
  - the sensitivity of imports to home production;
  - the ratio between the expected effect of the subsidy on production in high demand states (with imports) and the expected effect in all states.
- The subsidy on capacity is null if capacity is fully used in all states.

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Application to the EU-ETS for the cement industry

- The actual scheme for 2013–2020.
- Some characteristics of cement
  - A carbon intensive internationally traded industry
  - Previous analysis of leakage and competitiveness
  - Demand fluctuations and imports
  - Calibration of the Model (2007 high demand, 2009 low demand)

Comparison of the optimal scheme with the actual scheme

- The optimal (2nd best) scheme is an OBA scheme with a rate of output-based allocations:

$$s_k = 0 \text{ and } \frac{s_h}{\sigma} = u_f \frac{b}{b+\gamma_f} = 0.284\text{t } CO_2/\text{t}.$$

- The EU-ETS policy correspond to:

$$\frac{s_k}{\sigma} = 0.766\text{t } CO_2/\text{t and } s_h = 0$$

  and grandfathering (based on production in years 2005–2008).
- Detailed analysis
  - Welfare
  - Investment in new capacity
  - Leakage
  - Profit
  - Price of cement

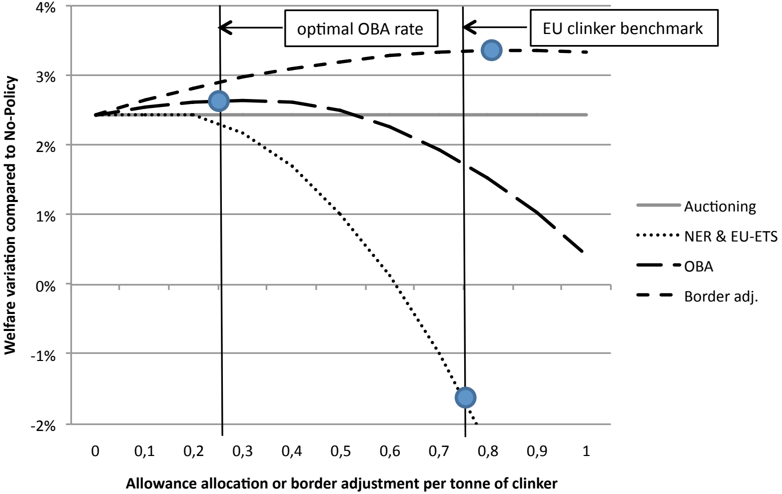
Comparison of schemes: Production

	No-Policy	Auction	OBA*	EU-ETS	BA*
Low demand					
Production new plants	20	0	0	79	0
Production old plants	140	124	133	79	133
Imports	10	22	19	11	7
Total	170	146	152	168	141
High demand					
Production new plants	20	0	0	79	0
Production old plants	220	204	213	159	213
Imports	30	42	39	31	27
Total	270	246	252	268	241

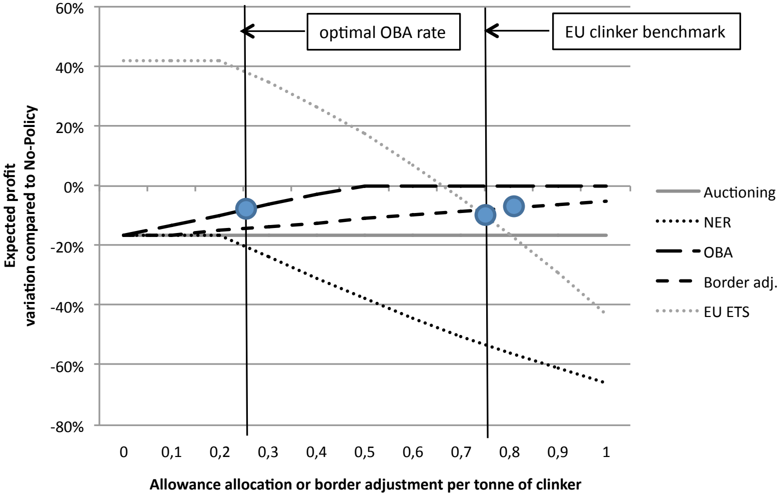
Conclusion

- For both EU ETS and output-based allocation, overall economic welfare is lower with high levels of free allocation.
- Although not justified economically, if it is seen as politically necessary to provide free allocation at the EU benchmark level, providing an output-based allocation has a far smaller negative impact on welfare than EU ETS allocation.
- If the objective is to preserve industry profits, a much lower level of allocation is sufficient (around 0.5 for OBA)
- Welfare–maximising allocation levels (OBA and EU ETS) do NOT prevent leakage. In fact they hardly affect leakage at all.

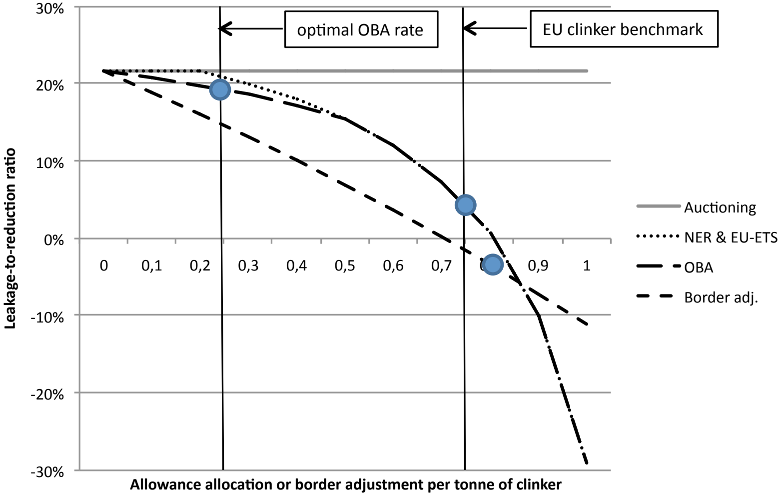
Comparison of schemes: Welfare



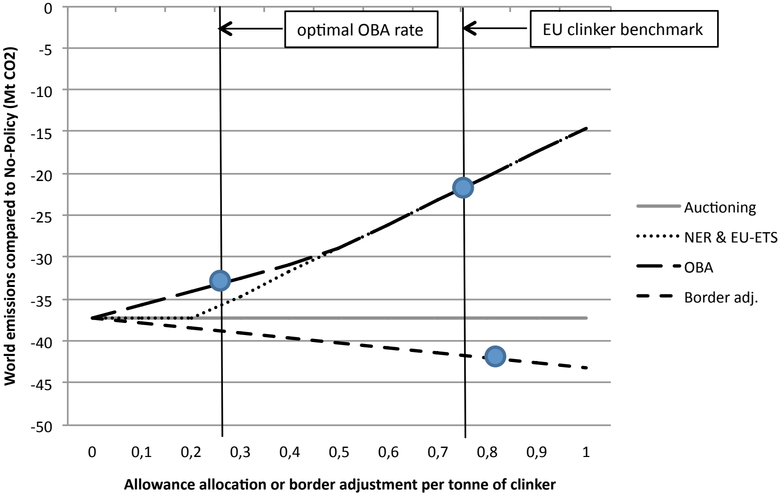
Comparison of schemes: Expected Profits (home)



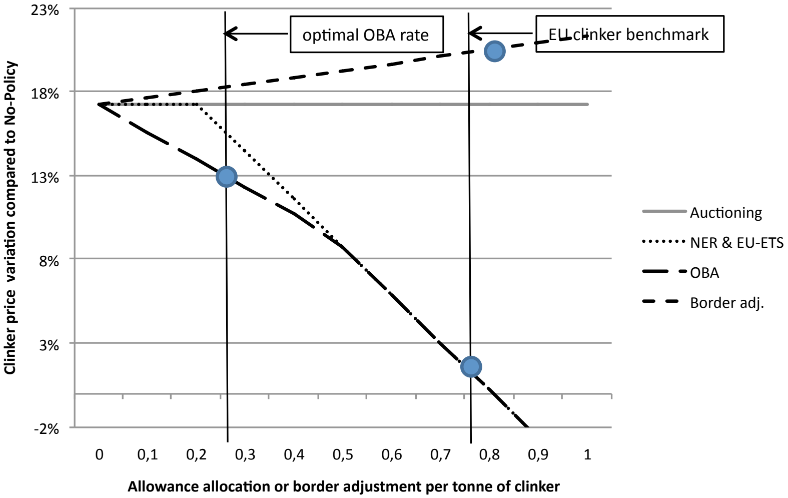
Comparison of schemes: Leakage



Comparison of schemes: World emissions



Comparison of schemes: Expected Clinker Price



Thank You!