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);

- This paper
  - Introduces a model of capacity decisions under uncertainty;
  - Characterizes the optimal allocation scheme;
  - 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: \( c_h q_n + c_k k \)

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

- 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 ($\sigma$ exogenous): 
  \[
  \sigma E = \sigma [u_h q_h + u_f q_f]
  \]

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

- Policy: 
  - Home emissions are taxed $\sigma$ 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. $\theta$ 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)
Introduction

Direct technology effect

Figure: The subsidy scheme $(s_k, s_h)$
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 subsidy on capacity allows to discriminate among demand states.
The optimal Scheme

Corollary

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

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

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

in which

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

\[
sh = \sigma u_f \frac{b}{b + \gamma_f} \frac{1 - F(\theta^+)}{1 - F(\theta^+) + A} \\
sk = sh \frac{\gamma_h}{b} F(\theta^-),
\]

- 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.
The optimal Scheme

\[ s_h = \sigma u_f \frac{b}{b + \gamma_f} \frac{1 - F(\theta^+)}{1 - F(\theta^+) + A} \]  \hspace{1cm} (4)

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Application to the EU-ETS for the cement industry

- 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)
Introduction

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:

  \[ s_k = 0 \text{ and } \frac{s_h}{\sigma} = u_f \frac{b}{b + \gamma_f} = 0.284t \text{ CO}_2/t. \]

- The EU-ETS policy correspond to:

  \[ s_k = 0 \text{ and } \frac{s_h}{\sigma} = 0.766t \text{ CO}_2/t \text{ and } s_h = 0 \]

  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

<table>
<thead>
<tr>
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<th>No-Policy</th>
<th>Auction</th>
<th>OBA*</th>
<th>EU-ETS</th>
<th>BA*</th>
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<td>Production new plants</td>
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<td>19</td>
<td>11</td>
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<td>146</td>
<td>152</td>
<td>168</td>
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<td><strong>High demand</strong></td>
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<td>20</td>
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<tr>
<td>Production old plants</td>
<td>220</td>
<td>204</td>
<td>213</td>
<td>159</td>
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<tr>
<td>Imports</td>
<td>30</td>
<td>42</td>
<td>39</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>270</td>
<td>246</td>
<td>252</td>
<td>268</td>
<td>241</td>
</tr>
</tbody>
</table>
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

![Graph showing welfare variation compared to No-Policy allocation and different schemes.]

- **Optimal OBA rate**
- **EU clinker benchmark**

Welfare variation compared to No-Policy

Allowance allocation or border adjustment per tonne of clinker

- Auctioning
- NER & EU-ETS
- OBA
- Border adj.
Comparison of schemes: Expected Profits (home)

Expected profit variation compared to No-Policy

-80%  -60%  -40%  -20%  0%  20%  40%  60%

0,1  0,2  0,3  0,4  0,5  0,6  0,7  0,8  0,9  1

Allowance allocation or border adjustment per tonne of clinker

optimal OBA rate
EU clinker benchmark

- Auctioning
- NER
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- Border adj.
- EU ETS

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Capacity-Based Allocations
Comparison of schemes: Leakage

Introduction

Comparison of schemes: Leakage

Leakage-to-reduction ratio

Allowance allocation or border adjustment per tonne of clinker

optimal OBA rate

EU clinker benchmark

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Capacity-Based Allocations

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Comparison of schemes: World emissions

World emissions compared to No-Policy (Mt CO2)

Allowance allocation or border adjustment per tonne of clinker

optimal OBA rate
EU clinker benchmark

Auctioning
NER & EU-ETS
OBA
Border adj.
Comparison of schemes: Expected Clinker Price

Auctioning

NER & EU-ETS

OBA

Border adj.

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Capacity-Based Allocations

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Thank You!