Trading Beyond Compliance: An Analysis of Electricity Firm Participation in the European Union Emissions Trading Scheme

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Firm participation in an emissions trading scheme (ETS) is not limited to 
compliance trading

Theoretically firms with dual goods and permit
market power have incentives to hold a sub-optimal excess of permits in certain conditions

- Free Allocation
- Low Abatement Target
- Shown in a static framework by Hintermann (2011),
  Calford, Heinzel and Betz (2010) and Eshel (2005)
How Dominant Firms Profit from Excess Holdings: Static Model

Competitive Fringe $i = 2$ to $N$

$$\max_{q,e,x} \prod_i = pq_i - C^i(q_i, e_i) - \sigma(x_i - \bar{x}_i)$$

$s.t. e_i \leq x_i + x_i$

$$\frac{\partial \Pi}{\partial q_i} \rightarrow p = \frac{\partial C^i}{\partial q_i}, \frac{\partial \Pi}{\partial e_i} \rightarrow \sigma = \frac{\partial C^i}{\partial e_i}$$

Familiar FOC results MCP = $P$, MCA = permit price

Dominant Firm $i = 1$

$$\max_{q,e,x} \prod_1 = p(q_1, x_1)q_1 - C^1(q_1, e_1) - (x_1 - \bar{x}_1)\sigma(q_1, x_1) + \lambda(x_1 - e_1)$$

$s.t. e_i \leq x_i + x_i$

$$\frac{\partial \Pi}{\partial e_i} \rightarrow -\frac{\partial C^i}{\partial e_i} = \sigma(q_1, x_1) + (x_1 - \bar{x}_1)\frac{\partial \sigma}{\partial x_1} - \frac{\partial p}{\partial x_1}q_1$$

$$\bar{x}_i = x_1 - \frac{\partial p/\partial x_1}{\partial \sigma/\partial x_1} \cdot q_1$$

Optimal Allocation for Firm 1 to achieve socially optimal permit price – Less than permit demand
What happens when we allow for Intertemporal trading and banking

Firms maximise vector of present values of profits:

\[ \mathbf{p} \cdot \mathbf{q}_i - C(\mathbf{q}_i, \mathbf{e}_i) - \sigma \cdot \mathbf{x}_i \]

\[ \max_{\mathbf{x}_i, \mathbf{x}_i, \mathbf{e}_i} \prod_{i}^p (\mathbf{x}_i, \mathbf{e}_i) - \sigma \cdot \mathbf{x}_i \]

Kuhn-Tucker conditions:

1) \[ \frac{\partial \Pi_i^p}{\partial e_{it}} - \lambda_{it} = 0 \]
2) \[ \lambda_{it, t+1} - \lambda_{it} + \mu_{it} = 0 \]
3) \[ \frac{\partial \Pi_i^p}{\partial x_{it}} - \sigma_t + \lambda_{it} = 0 \]
4) \[ \mu_{it} X_{i, t+1} = 0 \]

\[ X_{i, t+1} \geq 0, \mu_{it} \geq 0 \]

Dominant firm sets Permit price > MAC as second term > 0

Competitive fringe firms will not bank permits when faced with non-increasing permit price

Dominant firms will bank proportionally more permits than an equivalent non-dominant firm given a declining permit price
Theoretical Results

* Only dominant firms have an incentive to bank permits between periods with a declining permit price
* This behaviour drives up the prevailing price of carbon permits
* This increases the marginal cost of production for all electricity firms (even though permits are freely allocated as holding costly permits represents an opportunity cost)
* Specifically we should expect an increase in both the goods and permit market prices
* We should also be able to observe systematic differences in the banking and holding levels between dominant and competitive-fringe firms
Market Power in the Electricity Market

Goods Market Dominance
- Concentration ratios and HHI
- Largest firms in concentrated zones
- Moderate: Spain and Germany
- High: France

Other Factors?
- Ownership structure, would a government owned firm hold excess permits to profit?
# Market Power in the Permit Market (Phase I – First Year)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Firm</th>
<th>Permits Allocated</th>
<th>Total Share</th>
<th>Verified Emissions</th>
<th>Allocation Surplus / Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RWE</td>
<td>145,811,862</td>
<td>6.96%</td>
<td>155,229,304</td>
<td>-9,417,442</td>
</tr>
<tr>
<td>2</td>
<td>Vattenfall</td>
<td>91,689,393</td>
<td>4.37%</td>
<td>87,645,985</td>
<td>4,043,408</td>
</tr>
<tr>
<td>3</td>
<td>E.ON</td>
<td>73,865,224</td>
<td>3.52%</td>
<td>80,578,342</td>
<td>-6,713,118</td>
</tr>
<tr>
<td>4</td>
<td>PGE Polska Grupa Energetyczna</td>
<td>59,754,900</td>
<td>2.85%</td>
<td>58,143,546</td>
<td>1,611,354</td>
</tr>
<tr>
<td>5</td>
<td>Enel</td>
<td>58,329,870</td>
<td>2.78%</td>
<td>68,042,124</td>
<td>-9,712,254</td>
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<tr>
<td>6</td>
<td>EDF</td>
<td>54,989,146</td>
<td>2.62%</td>
<td>59,033,243</td>
<td>-4,044,097</td>
</tr>
<tr>
<td>7</td>
<td>DEI</td>
<td>52,095,606</td>
<td>2.49%</td>
<td>52,587,962</td>
<td>-492,356</td>
</tr>
<tr>
<td>8</td>
<td>GDF SUEZ</td>
<td>48,344,189</td>
<td>2.31%</td>
<td>55,486,479</td>
<td>-7,142,290</td>
</tr>
<tr>
<td>9</td>
<td>CEZ</td>
<td>42,243,211</td>
<td>2.02%</td>
<td>37,494,570</td>
<td>4,748,641</td>
</tr>
<tr>
<td>10</td>
<td>Endesa</td>
<td>40,433,894</td>
<td>1.93%</td>
<td>49,352,656</td>
<td>-8,918,762</td>
</tr>
</tbody>
</table>
Permit Holdings Above Compliance:
4 Largest Electricity Firms
Permit Holdings Above Compliance Relative to Verified Emissions: 4 Largest Electricity Firms
RWE Holdings vs EUA Spot Price
Policy Implications

* Allocation plans must not only consider cap, but also distribution to firms – not previously thought to impact efficiency
* High allocation to electricity firms is supposed to negate output price rises, when in fact it may exacerbate the problem
* Full auction? – transfer of wealth from electricity generators to government
* Empirical Testing
  * Develop a good measure of market power that can be used to test dominant firms compliance levels

* Assess the relation between price movement and holdings for dominant firms
  * Test for example if RWE holding can explain EUA price variation

* Examine the pass though rates in different markets