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

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Background

* 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

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

$$s.t. e_i \le x_i + \overline{x_i}$$

$$\frac{\partial \prod}{\partial q_i} \to p = \frac{\partial C^i}{\partial q_i}, \frac{\partial \prod}{\partial e_i} \to \sigma = \frac{\partial C^i}{\partial e_i}$$

Familiar FOC results MCP = P, MCA = permit price

σ : Permit Price

x_i : firm i's permit purchases

$\overline{x_i}$: firm i's permit allocation

e_i : firm i's emissions

p : goods market price

q_i : quantity produced by i

Dominant Firm i=1

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

$$s.t. e_i \le x_i + \overline{x_i}$$

$$\frac{\partial \prod}{\partial e_i} \to -\frac{\partial C^i}{\partial e_i} = \sigma(q_1, x_1) + (x_1 - \overline{x_1})\frac{\partial \sigma}{\partial x_1} - \frac{\partial p}{\partial x_1} q_1$$

$$\overline{x_1^*} = x_1 - \frac{\partial p / \partial x_1}{\partial \sigma / \partial x_1} \cdot q_1$$

Optimal Allocation for Firm 1 to achieve socially optimal permit price – ***Less than permit demand***

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What happens when we allow for **Intertemporal trading and banking**

Firms maximise vector of present values of profits:

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

$$\max_{\mathbf{x}_i,\mathbf{X}_i,\mathbf{e}_i} \prod_i^p(\mathbf{x}_i,\mathbf{e}_i) - \boldsymbol{\sigma}\cdot\mathbf{x}_i$$

Kuhn-Tucker conditions:

$$1)\ \frac{\partial \prod_i^p}{\partial e_{it}} - \lambda_{it} = 0$$

$$2)\ \lambda_{i,t+1} - \lambda_{it} + \mu_{it} = 0$$

$$3)\ \frac{\partial \prod_i^p}{\partial x_{it}} - \sigma_t + \lambda_{it} = 0$$

$$4)\ \mu_{it} X_{i,t+1} = 0$$

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

$$1) + 3) \rightarrow \frac{\partial \prod_i^p}{\partial e_{it}} + \frac{\partial \prod_i^p}{\partial x_{it}} = \sigma_t$$

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

$$4) \rightarrow \mu_{it} X_{i,t+1} = 0$$

$$2) \rightarrow \lambda_{i,t+1} - \lambda_{it} = -\mu_{it} = 0$$

$$3) \rightarrow \therefore \sigma_{i,t+1} = \lambda_{i,t+1} = \sigma_{it} = \lambda_{it}$$

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

$$3)\ \&\ 2) \rightarrow \mu_{it} = \sigma_t - \sigma_{t+1} + \frac{\partial \prod_i^p}{\partial x_{i,t+1}} - \frac{\partial \prod_i^p}{\partial x_{it}}$$

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

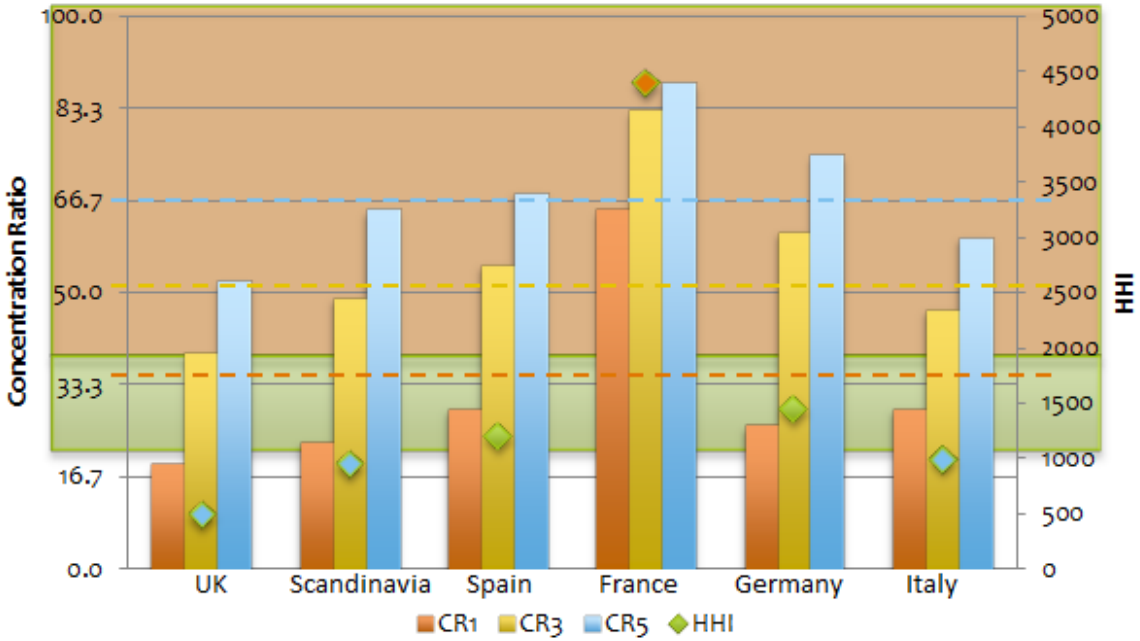
Theoretical Results

* 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



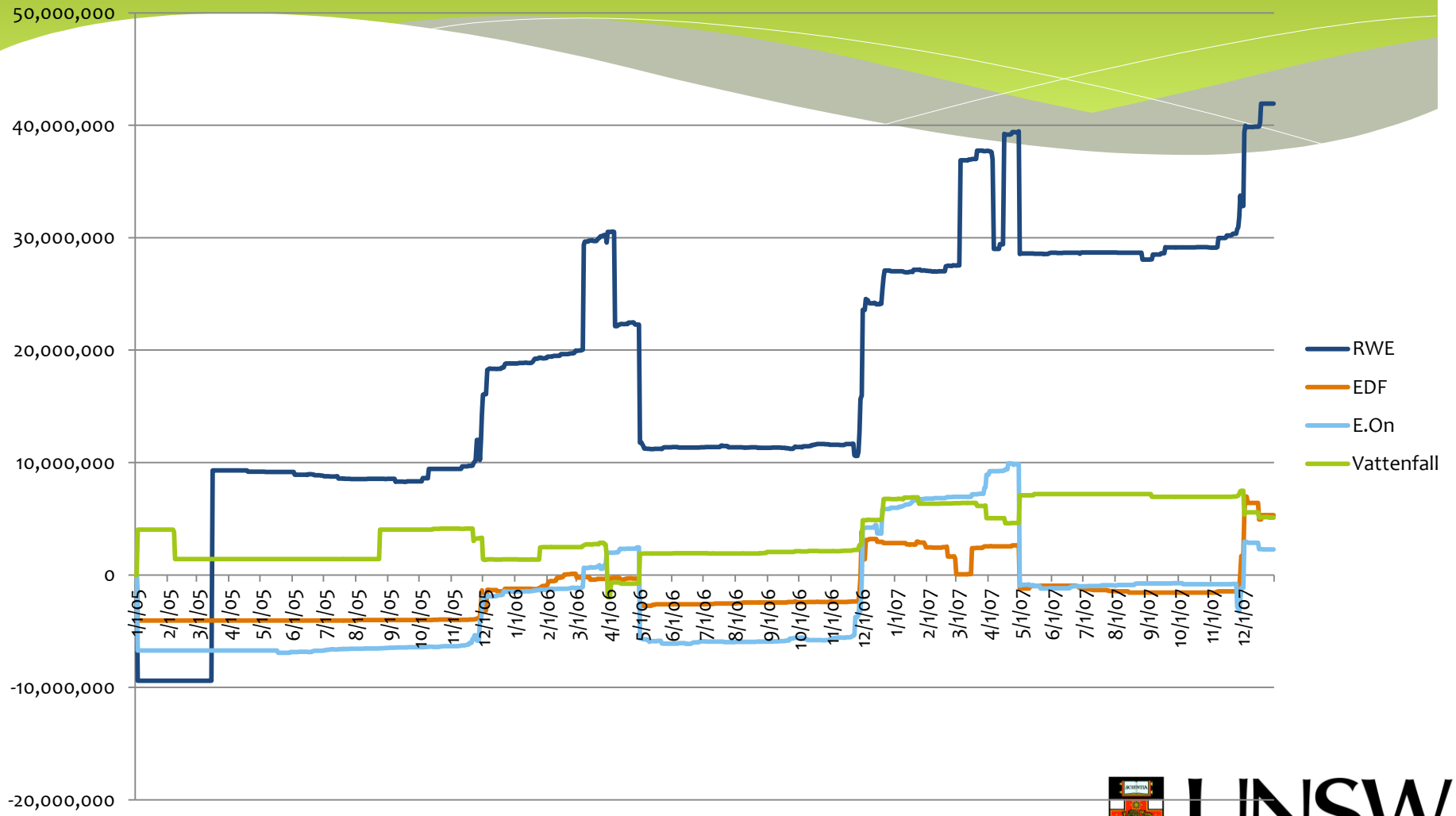
Other Factors?

- Ownership structure, would a government owned firm hold excess permits to profit?

Market Power in the Permit Market (Phase I – First Year)

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

Permit Holdings Above Compliance : 4 Largest Electricity Firms



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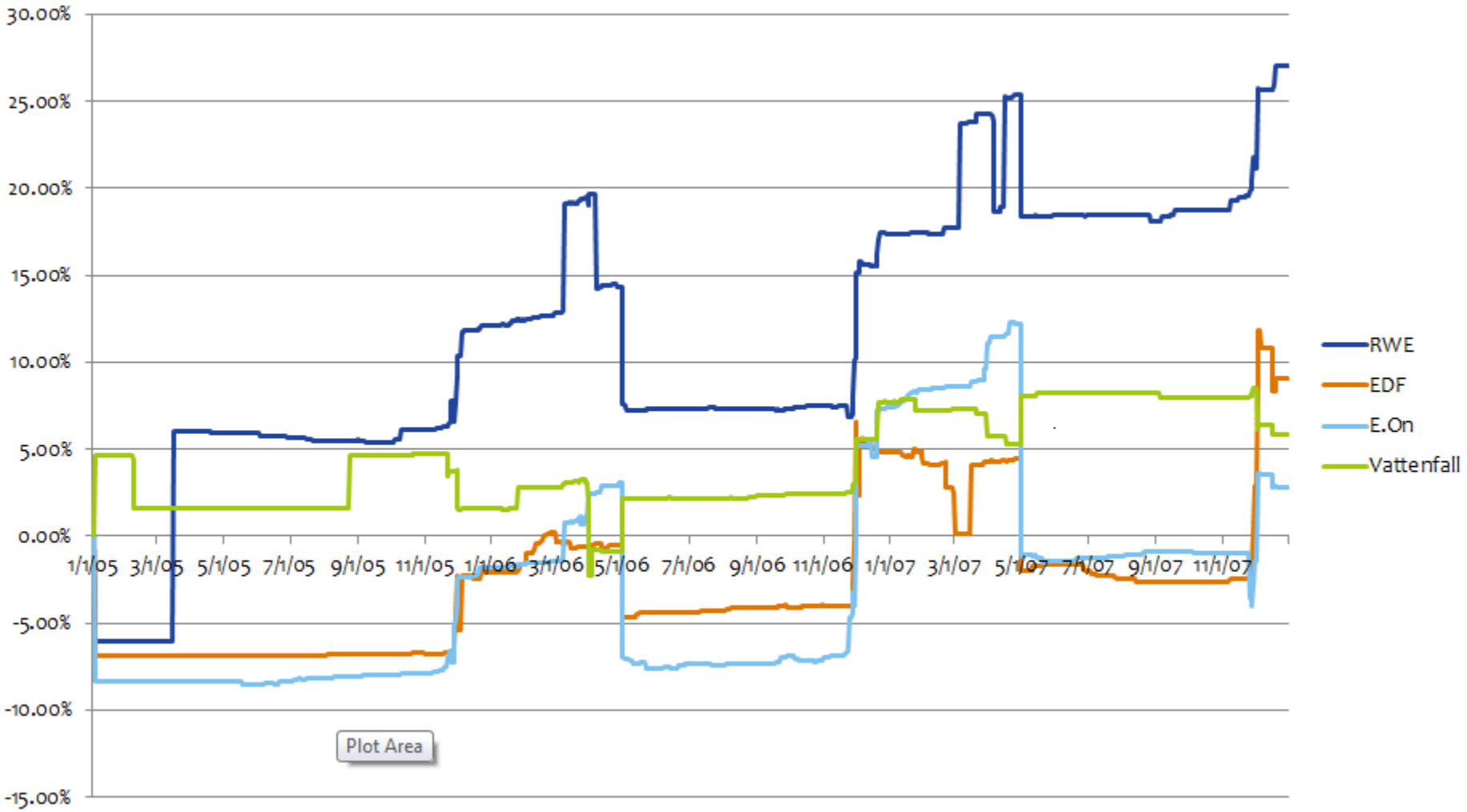
Permit Holdings Above Compliance Relative to Verified Emissions : 4 Largest Electricity Firms



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RWE Holdings vs EUA Spot Price

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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

Future Work

* 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