Initial Allocation Effects in Market Making Oligopoly with Emissions Trading in the Short Run and the Long Run

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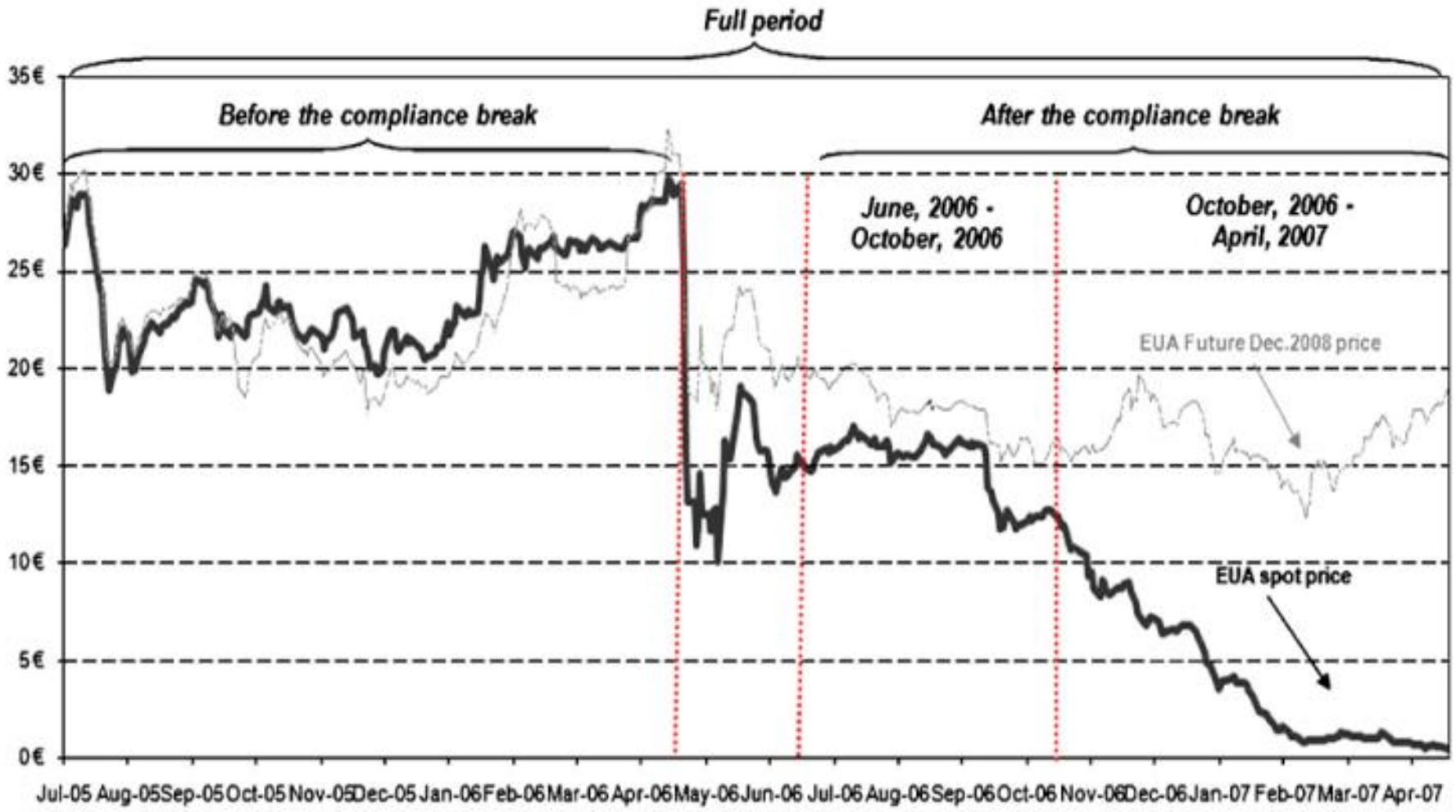
Motivation

EU ETS price development (Alberola et al. 2008):



Outline

Questions:

1. For given technologies, do initial allocation effects derived with Cournot competition carry over to the Bertrand case?
2. Under endogenous technology choice, (a) do the results on the relationship of Bertrand and Cournot outcomes still hold under emissions trading, and (b) what initial allocation effects occur?

Setting:

- Oligopolists compete on both an input and an output market, *i.e.*, market making oligopoly (Loertscher 2008, JIE)
- Permits as input, emissions trading scheme with grandfathering
- Short-run model, long-run model

1 Short-Run Model

- Capacity and technology exogenous
- One-period model with two stages:

  Firms purchase permits, then compete in Bertrand competition
- Firms maximise profit:

$$\Pi_i(p_i, x_i) = p_i q_i(p_i) - q_i(p_i) \cdot c_i(q_i(p_i), x_i) - (x_i - x_i^0) \cdot \phi(X)$$

  - p_i output price of firm i, q_i its quantity of output
  - x_i permits holdings of firm i at end of period
  - x_i^0 free initial allocation of permits to firm i at beginning of period
  - $c_i(.)$ non-carbon related marginal costs of production of firm i, with $\frac{\partial c_i(.)}{\partial q_i} > 0$, $\frac{\partial c_i(.)}{\partial x_i} < 0 \ \forall q_i, x_i \in \mathbb{R}_0^+$
  - $\phi(X)$ permit price, with $\frac{\partial \phi(X)}{\partial X} > 0$ and $X \equiv \sum_i x_i$ total amount of permits held by the industry

1 Short-Run Model (cont.)

- Elastic vs. inelastic product demand, *here*: focus on inelastic case
- In Bertrand pricing game, firms price at their carbon-inclusive marginal cost
- First-stage permit choice: distinction of *interior* and *boundary* solution

Boundary solution: $$x_i^* = d_i q_i^*$$

Interior solution: $$\frac{\partial p}{\partial x_i} \cdot q_i - q_i \frac{\partial c_i}{\partial x_i} = \phi(X) + (x_i - x_i^0) \frac{\partial \phi}{\partial x_i}$$

- Note the sign of the derivative:

$$\frac{\partial^2 \Pi_i}{\partial x_i \partial x_i^0} = \frac{\partial \phi}{\partial x_i} > 0 \ ,$$

so that

$$\frac{\partial \phi}{\partial x_i^0} > 0 \ .$$

1 Permit Market Efficiency

- Boundary solution: permit market efficient, only pass-through profits
- Interior solution:

  ***Hahn monopsony* [monopoly] effect**:
  For $(x_i - x_i^0) > [<] 0$, with an increase in the initial allocation to a firm permit market efficiency *increases* [decreases]

  ***Pass-through profits* effect**:
  with an increase in the initial allocation to a firm permit market efficiency decreases

  $\Rightarrow$ For any given emissions cap, there is only one efficient permit market outcome
- The more stringent the target, the more likely boundary solution
- Note: results in elastic case qualitatively the same, which also corresponds to Cournot; higher pass-through profits under Bertrand

2 Long-Run Model

- Technology and capacity endogenous, elastic product demand
- Application of **Kreps and Scheinkman** (1983, BJE): "Quantity Pre-commitment and Bertrand Competition Yield Cournot Outcomes"
  - Bertrand: install capacity – compete over prices;
  - Cournot: compete over quantities
- Here, the firms play either the following game:
  - Choose production technology
  - Install capacity
  - Purchase permits
  - Compete over prices (*Bertrand*)

  Or, equivalently, they play:
  - Choose production technology
  - Compete over quantities (*Cournot*)
  - Purchase permits

2 Long-Run Model: Results

- 'Kreps and Scheinkman' also holds under emissions trading, efficient demand rationing may be realistic
- An increase in the initial allocation of permits to a firm will increase total industry emissions
- Because the size of the emissions cap is unchanged, this represents a change in the distribution of emissions across industries; the effect on sector emissions intensity is ambiguous
- Hahn or pass-through profits effects cannot be distinguished by lack of permit holdings as a direct choice variable

Conclusions

1. Comparison Bertrand – Cournot:
   - *Short run*: Cournot results qualitatively carry over, but Bertrand can also treat inelastic demand and shows higher pass-through profits
   - *Long run*: 'Kreps and Scheinkman' also holds under emissions trading
   - Both Bertrand with inelastic demand in short run, and Kreps-and-Scheinkman framework particularly close to power sector

2. Permit market efficiency depends upon the 'correct' initial allocation of permits, or, eventually, the stringency of the target