

Im-perfectly Competitive Contract Markets for Electricity

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Outline of the presentation

- 1 *Objective and motivation*
- 2 *Outcomes*
- 3 *The analytical framework*
- 4 *Strategic behaviors: Cournot and Bertrand models; dominant firm and competitive fringe*
- 5 *Directions for further research*

Do pre-commitments mitigate market power in electricity spot markets?

- IO literature has two drawbacks
 - 1 It is controversial

In favour	Against	Neutral	In between
AV (1993) Bushnell (2008)	Mahenc & Salanie (2004) Gans et al. (1998)	Hughes & Kao (1997) Adilov (2005)	Green (2003) Green (1999) Liski & Montero (2005)

- 2 Several aspects of forward/spot interaction are neglected by traditional settings.
 - Spot and forward markets differ in the demand size, market participants and price sensitivity (DG Competition, 2007)
 - Forward and spot prices are equal at the contract execution date but may diverge before.
 - Cournot and Bertrand behaviors coexist and dominant-fringe market structure are likely too.

Explaining the puzzle...

- The AV framework is unsuitable to model dominant attitudes at the contract stage
- "Inefficiencies and market power in financial arbitrage" (Borenstein et al, *JIE*, 2008):

"[...] two common explanations for the existence of forward-spot price differences even in completely competitive markets, risk aversion and differential trading costs across markets, are not consistent with the data. We then examine explanations in which some firms exercise market power in the arbitraging function."

- Electricity firms market power; market power of arbitrageurs; sellers response to market strategies.
- In our context, we model a "contract market demand" and allow for spot-forward price differences to reflect such potential inefficiencies

- Our setting is a bridge between IO and financial modeling
 - **(Core)** We explicit the demand for contracts (which reacts to the forward price), refuse the "invisible hand" (perfect arbitrage) and assess the likelihood of **strategic behaviors** at each stage
- Our setting is a bridge between IO and empirical findings
 - We consider the case for a dominant firm facing a competitive fringe.
- Our framework is a generalization of AV (determinants of pro and anti-competitive patterns)
 - We use conjectural variations to assess the impact of competition modes, both in the forward and in the spot market

We provide a rationale for the economic contradictions on forward trading (determinants of the dualistic nature), enrich the understanding of existing models (common setting) and is the first attempt to assess the likelihood of dominant attitudes in contract markets (financial modeling)

Outcomes 1/2

- Pre-commitments are neither absolutely for nor exclusively anti-competitive. A critical threshold exists and the effect of trading depends on the position of market players with respect to this level
 - short positions are pro-competitive; long positions are anti competitive.
 - quantity competition is sufficient to have producers selling at equilibrium.

(Intuition) Long-positions: similar to capacity withholding

Outcomes 2/2

- With "strategic arbitrage", forward markets may be used to sustain duopolistic positions in the wholesale market,
 - Quantity competition at the spot stage is no longer sufficient to re-establish pro-competitive effects.
 - Forward market sensitive to market power
- The (binding) perfect arbitrage constraint limits manipulation and strategic behaviors
 - Forward market no longer sensitive to market power
 - No profitable strategies under Bertrand competition
- Sequential interactions
 - "standard settings": followers pre-commit to counterbalance dominant positions in the wholesale market; the leader does not contract (pro-competitive effect)
 - "strategic arbitrage": the leader jumps to short contracts to exploit profit opportunities (anticompetitive effect)

The analytical framework 1/2

- We consider a duopolistic industry producing a homogeneous commodity (energy).
- The good may be traded on either a forward or a spot market which open sequentially.
- In the first period (*contracting stage*) each agent commits on its optimal forward trading volume, while in the second (*production stage*) each participant sets its production decisions.
- Trading positions are binding and observable before the spot market opens.
- Duopolists are profit maximizers, perfectly informed, risk-neutral and rational.

Definition

Let q_k and f_k denote the output and the trading volumes by the k -th firm $k = \{i, j\}$, and $Q = q_i + q_j$ and $F = f_i + f_j$.

The analytical framework 2/2

- The inverse demand function, $P(Q)$, is downward sloping; the cost function, $C(q_k)$, is increasing and convex in its argument.
- Cournot and Bertrand competition, in the spot and the contract market too (*conjectural variations*).

Definition

Agents are selling (buying) forward, or equivalently are taking a short (long) position in the contract market, whenever $f_k \geq 0$ ($f_k < 0$).

- The submission of f_k costs (or pays back), in terms of opportunity costs : $\left[P^f - P(Q) \right] f_k$

Resolution is by backward induction.

Strategic behaviors: Cournot 1/2

Modeling strategic attitudes in the contract market

- The inverse demand for contracts, $P^f(F)$, is downward sloping in forward sales.
- Generators are responsible for convergence between forward and spot prices

The functioning of the wholesale market is the standard one, as in AV

Proposition

(2nd stage) The profit maximizing quantity, q_i^ , is monotonic (non-decreasing) in f_i and (non-increasing) in f_j .*

Corollary

(2nd stage) Aggregate production is monotonic (non-decreasing) in pre-commitments.

What is the optimal trading position of power producers?

Strategic behaviors: Cournot and Bertrand 2/2

If and only if forward contracting is below the AV one, there is a profitable strategy in the forward market such that the spot profit increases.

Lemma

(Price Discrimin.) Short trading is optimal if there is quantity competition in the spot market; spot markets would be illiquid if there is quantity competition in the spot market and Bertrand competition in the forward market.

Lemma

(Excluding PD) Short trading is optimal if there is Cournot competition and there is an opportunity cost of discrimination.

The loss due to price equalization (or opportunity cost) is the Lagrange multiplier associated to the perfect arbitrage constraint.

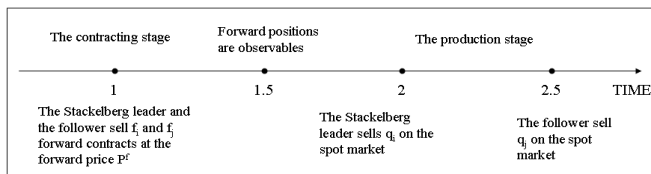
Corollary

Under price competition manipulation of forward market is unprofitable.

Multiple strategic interactions do not exclude that contracts serve as pro-competitive mechanisms and Cournot behaviors may exclude long positions.

Dominant firm 1/3

Assume that firm i is the leader in the production stage while j stands for fringe producers', and asymmetric cost functions



Lemma

(2nd stage) The profit maximizing quantity, q_i^ , is non-decreasing in f_i and non-increasing in f_j . Aggregate output is increasing in forward sales.*

Dominant firm 2/3

Excluding strategic behaviors in the contract market, the fringe is short and the leader does not trade forward.

(Intuition) Contracts are used to counterbalance dominant positions in the wholesale market (forward trading is a substitute of the first mover advantage) as they increase the aggressiveness at the spot stage

With market dominance, forward contracts serve as pro-competitive tools (implementation: no further regulation required)

Dominant firm: strategic behavior 3/3

Modeling strategic attitudes in the contract market

- The inverse demand for contracts, $P^f(F)$, is downward sloping in forward sales.
- Generators are responsible for convergence between forward and spot prices. The functioning of the wholesale market is the one assessed before.

Lemma

(Price Discrimination) Short trading is a dominant strategy (fringe).

Lemma

*(Exc. PD) Short trading **may** be a dominant strategy (fringe).*

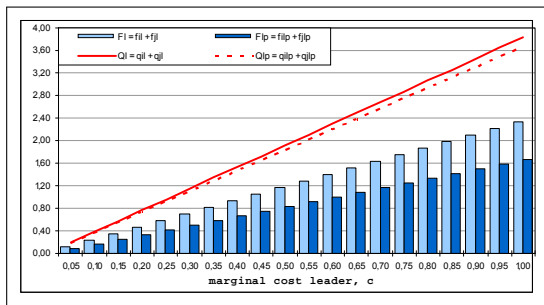
In dominated and strategic contexts, forward contracts **MAY not serve as pro-competitive tools** (further regulation required).

Simulation with linear demand and costs 1/2

$c_i = c > c_j = 0$ where i denotes the leader and j the follower; A : intercept of the spot demand function; B : intercept of the forward demand function.

Red thick line: equilibrium quantity with perfect arbitrage; *red dotted line*: equilibrium quantity under strategic behaviors

$$c \in [0.05; 1.00], \quad A = 5.00c \quad \text{and} \quad B = 3.00c$$

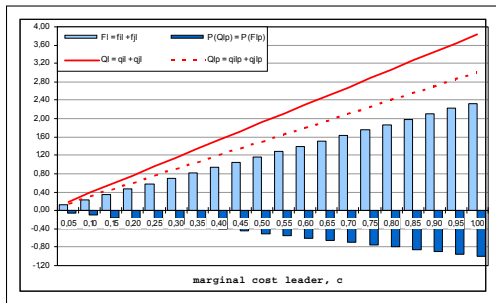


Stackelberg: selling forward.

Simulation with linear demand and costs 2/2

A small difference w.r.t previous schedule with long positions

$$c \in [0.05; 1.00], \quad A = 3.70c \quad \text{and} \quad B = 0.30c$$



Stackelberg: buying forward.

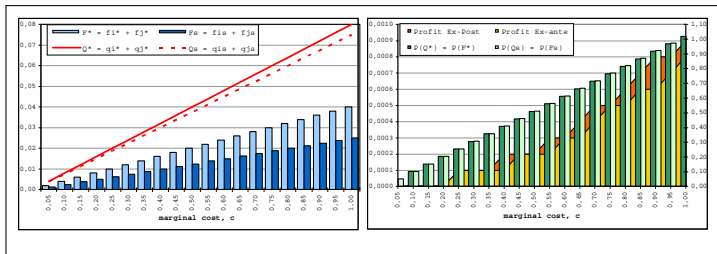
Concluding remarks & directions for further research

- In standard AV settings
 - Cournot behaviour is sufficient to exclude buying forward (anti-competitive);
 - manipulation of forward markets does never verify.
- Moving apart from the "residual demand approach" and perfect arbitrage, the set of anticompetitive strategies amplifies.
- Re-establishing the perfect arbitrage (i.e. excluding price discrimination), even in Cournot settings further regulation may be required to have pro-competitive effects.
- Results are robust to sequential interactions.
- Further research
 - On the endogeneity of forward demand (Powell, 1993 and Green, 2004); Auction behaviors (Fabra et al., 2008); Dynamic interactions (Liski and Montero, 2007).

Simulation with symmetric Cournot duopolists, linear demand and costs 1/2

There is a range of parameter values such that manipulation of forward markets is profitable

$$c \in [0.05; 1.00], A = 1.10c, B = 1.05c$$

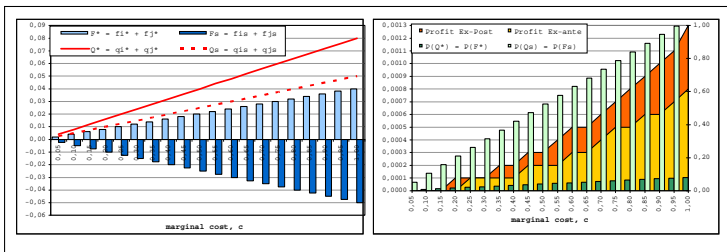


AV versus our setting: selling forward.

Simulation with symmetric Cournot duopolists, linear demand and costs 2/2

A small difference with previous schedule and buying attitudes upsurge

$$c \in [0.05; 1.00], \quad A = 1.10c \quad \text{and} \quad B = c$$



AV versus our setting: buying forward.