Manipulate in Nordic Electricity market?

Repeated Sequential Game, Market Power and Collusion

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Motivation

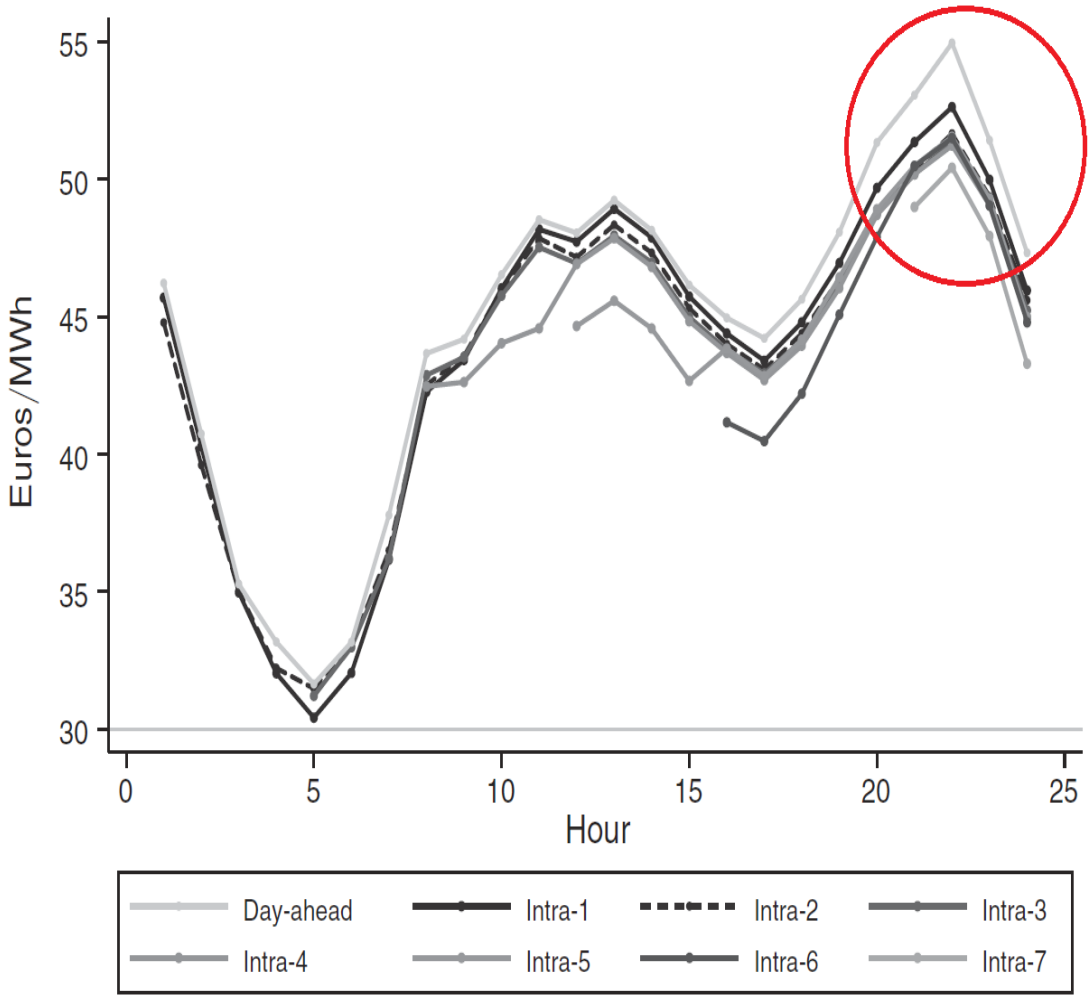

Figure: Day-ahead Market Premium In Iberian Market: Ito and Reguant (2016)

Motivation

- Electricity Market are Particular Subject to Market Power
  - Electricity are hard to storage and the capacity of the power plant is limited during certain period
  - Demand is hard to predict and inelastic to short term price change
- Electricity Market are central to economics activities
- Market Power analysis are important for policy implications

Theoretical Set Up

Sequential Market(Ito and Reguant 2016)

Residual Demand

We set up the demand as residual demand, since there are some supply are fixed, for example the supply from renewable energy market that are guaranteed by the government, nuclear energy:

$$D_1(p_1) = A - b_1 p_1$$
$$D_2(p_2) = (p_1 - p_2) b_2$$

One of the micro foundation of the residual demand is that fringe firm agree to supply electricity as long as the price is higher than marginal cost.

Monopolist Problem

Stage 2

In stage 2: The monopolist try to maximize its profit, which are determined by quantity q_1, q_2, residual demand, D_1, D_2 and costs $C(q_1, q_2)$:

$$\max_{p_2} p_2 q_2 - C(q_1 + q_2)$$

$$s.t.\ q_2 = D_2(p_1, p_2)$$

Stage 1

In stage 1: we use the idea of backward induction to calculate the monopolist maximization problem:

$$\max_{p_1} p_1 q_1 + p_2(p_1) q_2(p_1) - C(q_1 + q_2(p_1))$$

$$s.t.\ q_1 = D_1(p_1)$$

Model Extension

- There are some extensions to the model. First of all, Electricity market is a auction market repeated infinite many times, a typical set up of the repeated game. Using this model, we are able to identify potential collusion and other market manipulate behavior.

Empirical Test

Ito and Reguant (2016) Predicts Froward Market Premium

Under the assumption of monopolist exercise market power. The model predicts that there are premium between the real time market and day-head market.

- We shall use the estimated parameter from our repeated game model, we could simulate the counterfactual, when there is no collusion, and thus no market inefficiency. We are able to see how much welfare loss we encounter.

Empirical Exercise: Welfare Simulation

Procedure

1. Estimating the marginal cost of the plant level firm. We don't directly have the data of the firm's marginal cost at each level of supply, but we could based on the power plant's characteristics to calculate the marginal cost based on the method in Bushnell, Mansur and Saravia (2008).
2. Simulate the best response of Function, and test if there are deviation due to market structure.
3. Use the estimated parameter from our repeated game model, we could simulate the counterfactual, when there is no collusion, and thus no market inefficiency. We are able to see how much welfare loss we encounter.

Data

- Nordic Pool Trading Data - Rich Data Environment
  - Bidding Price and Volume of Each Companies
  - Intradday Data Set and Day-Ahead Data set
- Nordic Authority Estimation Data
  - Data of Demand Estimation of the regulation authority
  - Firm that are
- Plant Level Characteristics Data
  - Ideally we shall have plant level data to estimate capacity and marginal cost for electricity for each company, I am not sure if we do have this data set yet. But professor said that marginal cost data are not difficult to get.

Reference

Ito, Koichiro and Reguant, Mar
Sequential markets, market power, and arbitrage
American Economic Review, 106(7):1921–57, 2016.

Hortaçsu, et.al.
Does Strategic Ability Affect Efficiency? Evidence from Electricity Markets
National Bureau of Economic Research 2017.

Bushnell, James B., Erin T. Mansur, and Celeste Saravia.
"Vertical arrangements, market structure, and competition: An analysis of restructured US electricity markets."
American Economic Review 98, 1 : 237-66 2008