Nuclear Production and Market Power in the Nordic Electricity Market

Erik Lundin
Stockholm School of Economics

SUMMARY

In this study we examine hourly aggregate supply- and demand curves from the Nordic electricity spot market to replicate the Cournot- and Cournot output for the three largest nuclear production plants in the system. The plants are all subject to partial cross-ownership by two or three of the dominant producers, and account for 20% of the total production in the market. We find that the incentive for the majority shareholder of each plant to unilaterally reduce output is only marginally affected as a result of cross-ownership. Instead, the observed output corresponds best to a model of collusion. On average, the simulated aggregate- and observed production levels differ only trivially. We conclude that the anticompetitive effects of cross ownership stems from increased possibilities of coordination and profit sharing, rather than through a distortion of the Cournot equilibrium.

It should be stressed that the present study should not be seen as conclusive evidence of collusive behavior in the Nordic power market, but rather as an illustration of how market power could potentially influence nuclear production decisions.

CONTRIBUTION

- It is the first study to test actual bidding data to examine the role of market power in the Nordic electricity spot market.
- It is the first study to quantify the impact of cross ownership on a Cournot equilibrium without relying on parametric assumptions about the shape of the demand function.

INSTITUTIONAL SETTING

We use hourly data on aggregate bidding curves and output from the three largest nuclear plants in the system during 2011-2013. The plants are situated in Sweden, and account for 20% of the total production in the spot market. They are all cross-owned by two or three producers. They have a joint market share on the spot market of around 45%.

- Due to the “Urgent Market Messages” information system we have detailed information on the maintenance decisions in each plant, which determines the available capacity. By taking comparing the available capacity to the actual production, we see that – on average – all available capacity is used for production. Thus, the relevant decision variable is quantity and not price.

METHOD

- We construct a simplified static model of profit maximization, and assume that all non-nuclear production is bid according to marginal cost. The only decision variable is nuclear output. The aggregate supply curve is shifted towards to construct the supply curve net of nuclear production.
- The net supply curve is then subtracted from the aggregate demand curve to construct the residual demand curve for nuclear production. In the model of collusion, nuclear producers choose the optimal point on the residual demand curve jointly. In the Cournot model, a separate residual demand curve is constructed for each plant, and the main owner of each plant unilaterally chooses the optimal point on its residual demand curve taking the production of other nuclear plants as given. The diagram below illustrates how nuclear producers choose their optimal collusive output.
- SupplyB is the supply curve of other production than nuclear. Demand is the demand function, which for illustrative purposes is completely inelastic. Res.demandB is the residual demand function for the nuclear producers. B is the producer surplus from nuclear production. The trapezoid A is the total producer surplus from non-nuclear production.
- α is the nuclear producers’ share of other production than nuclear (which is around 25%).
- MEC is the marginal cost of nuclear, which we take to equal the cost of nuclear fuel (4 EUR/MWh).
- In the diagram, The nuclear producers’ joint profit is maximized at q*
- Given that no maintenance is in fact necessary, a social planner would instead choose to increase output to qMEC to produce at maximum capacity.
- When simulating the Cournot equilibrium, each majority shareholder takes into consideration the effects of cross-ownership when calculating its optimal production levels.
- We do not have data on the producers’ forward positions. However, given that information on maintenance decisions are public, the price of forward contracts should also increase in tandem with the maintenance announcements.
- We assume that the producers meet the system price (i.e. the price where aggregate demand meets aggregate supply). In case of transmission constraints, the producers may meet other prices. However, the Nordic spot market is a zonal market and all nuclear plants lie in the same price zone ("SE3"). The correlation between the price in SE3 and the system price is 0.93. On average, the price in SE3 exceeds the system price by 3%. Data on bidding curves for specific price areas are confidential.

RESULTS

- The average observed load factor differ by only 2% from the collusive output (79% and 77% respectively). The average social planner- and Cournot load factors are 96% and 99% respectively.
- If nuclear output would coincide with the social planner’s optimum, the spot price would decrease by on average 12% (i.e 4 EUR/MWh).
- Market power is not limited to periods of exceptional circumstances like very cold weather, but is present throughout the year.

DISCUSSION

- Although the model that best fits observed output is the model of collusion, we cannot disregard the possibility that maintenance was in fact motivated by safety precautions. Thus, the present study should be seen as an illustration of the incentives to exert market power, rather than as evidence that market power was in fact exercised on a systematic basis.
- In future work, we would like to include ramping constraints as well as individual bidding curves in the model.
- Since a large share of production in Nordpool comes from hydro, we would also like to estimate the dynamic effects on the reservoir levels due to the reductions in nuclear capacity.

CONTACT

Erik Lundin
Stockholm School of Economics
Erik.lundin@phdstudent.hhs.se
+46-707-32 58 47