STRATEGIC BEHAVIOR AND MARK-UPS IN AN ELECTRICITY MARKET

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Overview

Our main purpose of this study is to observe “mark-ups” in electricity markets such as PJM or Nord Pool, and evaluate their market performances. To address this issue, an oligopoly model is developed to explore the relation between strategic behavior of power generators and spot prices in an electricity market. It is an extent ion of the model presented in Tezuka and Ishii (2011). Other extensions are introduced by Ishii and Tezuka (2008a, b).

The outline of our model is as following. It is assumed that n homogeneous power generating firms are on the selling side of the transaction and the perfectly competitive many retailers are on the buying side. The retailers supply electricity to their customers. All power generating firms are supposed to select and offer exponential supply functions strategically under uncertain demand. Any coalitions among the firms are not assumed in this model. So the model is a non-cooperative game. The unique Nash equilibrium can be derived explicitly.

Then, the optimal strategies yield both the equilibrium spot price formula and the mark up. Based on these results, we assess the impact of strategies by electricity companies on mark-ups. To this end, we use PJM electricity market data to test our mode and to analyze the structure in actual markets.

Methods

We adopt a non-cooperative game to describe an oligopolistic electricity market. For simplicity of the model, we use a one-period model. However, it is easy to extend our idea to a multi-period model. The method is described in Ishii (2007).

In this non-cooperative game, an exponential function is used as the marginal cost function, and all strategies are parallel upper shifts of the marginal cost function. Each generating firm decides its strategy at the beginning of the period.

All consumers' demands are aggregated through the retailers to the market electricity demand. Therefore, the total demand is assumed to realize at the end of the period. On the other hand, all power generating firms can not exactly foresee the total demand, which is a random variable, but know the distribution function at the beginning of the period. Then, the payoff to each firm is set to an alpha-quantile of the future profit distribution. We need only elementally calculus to obtain the unique Nash equilibrium. Using the derived equilibrium spot price formula and statistical models, PJM electricity market data is analyzed.

Expected Results

We derived the unique Nash equilibrium in an explicit form where *n* power generating firms have homogeneous exponential supply functions. The equilibrium spot price is an increasing function of power generators' risk attitude .The relation between the supply function strategies and the spot price process is revealed.

We also calculated the paths of spot prices by using data of PJM and observe mark-ups in the market by comparing the historical (real) data with the numerical computed one (perfect competitive and game theoretic model). After that we briefly evaluate market performances in the market.

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