Effect of Suupliers' Risk Appetite on Market Performance in Electricity Markets

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Overview

The main purpose of this study is to develop an oligopoly model to analyze spot prices in electricity markets under uncertainty, to derive the relation among Structure, Conduct and Performance (SCP) in the model, and to figure out effects of demand uncertainty and suppliers' risk appetite on spot prices in real markets. To address these issues, we introduce a non-cooperative game, which describes an oligopolistic competition in an electricity market under uncertainty, and derive a unique Nash equilibrium. At the equilibrium, the mark-up, the difference between the equilibrium price and marginal cost is influenced by both suppliers' risk appetite and market concentration. Regarding the former part, which is determined by the risk appetite, we show that the Arrow and Lind (1970) property holds. Furthermore, we find out relation of the equilibrium price volatility and the risk appetite.

We also notice a remarkable feature of our model. Though our model is a simplified version of the supply function equilibrium model originated from the work of Klemperer and Meyer(1989), it is easier to examine influences of both demand uncertainty and the risk appetite on electricity spot prices with our model.

Methods

We assume an oligopolistic electricity market. Our model has one period: the beginning of the period is called time *zero* and the end of the period is called time *one*. At time *zero*, the spot electricity demand is uncertain and each power producer only has information regarding the probability distribution. Each supplier strategically selects a supply function and submits it. The market operator then aggregates the individual supply functions to construct a market supply function. The demand curve will be realized at time *one* and the spot price is determined which satisfies that supply equals demand. Therefore, going back to time *zero*, each power producer strategically chooses a bid supply curve to maximize an alpha-quantile of its profit distribution given the probability distribution of the random shock on the demand curve. Here, the alpha reflects the risk appetite of the supplier. Under these conditions, we solve the non-cooperative game, and derive the Nash equilibria explicitly. Based on the equilibrium spot price, we manly analyse effects of the risk appetite on the equilibrium spot price.

Results

First, the mark-up can be decomposed into two parts. One is an inevitable part in this market, that is generated to a significant degree by the market power. The other is mainly effected by the risk appetite. In this connection, the Arrow and Lind(1970) property also holds in our model.

Second, effects of the risk appetite on the Nash equilibria are unveiled. Especially, normal random demand shock case is elaborated. For small risk appetite, equilibrium starategy decreases as the volatiltity of the random demand shock increases, and approaches to 0, that is, each supplier bids its marginal cost curve to the market. Then the market performance is same in the perfect competition market. This implies that the market performance of perfect competition is attained even in an oligopoly when the risk appetite of power producer is small and the volatility of the random shock on demand curve is so large.

Third, we investigated effects of the risk appetite on both the expectation and the variance of the equilibrium spot price. The price volatility is an increasing function of the risk appetite. This implies that stochastic volatilites of electricity prices can be caused by changes of the risk appetite.

Conclusions

In this research, we shed light on relations among distribution of demand uncertainty, suppliers' risk appetite, and the market performance. Then, features of spot electricity prices are explained to some extent. Especially, the linkage between the risk appetite and the volatility structure is revealed.

References

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