TRANSMISSION CONGESTION AND SWITCHING SUPPLY FUNCTIONS

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Overview

The design of electricity markets, including the rules governing the physical day-ahead markets, aims at delivering prices and quantities comparable to a competitive market outcome. A number of empirical studies of the NordPool spot market conclude that the market outcome, on average, is close to the competitive outcome. However, congested transmission lines between markets creates opportunities for exercising market power locally and for limited time periods.

Mirza and Bergland (2015) find price behavior in the NordPool day-ahead market consistent with strategic bidding behavior for producers where the realized prices are higher in periods with transmission congestion than what is expected. Furthermore, Bergland, Mirza and Love (2014) estimate a switching regression model and find clear evidence that producers in the aggregate are bidding higher in the day-ahead market when they anticipate the bidding area to be import congested.

Theoretically this behavior is consistent with a supply function equilibrium (Baldick, Grant and Kahn, 2004) where producers are strategically bidding in the day-ahead market conditional upon their beliefs (predictions) about the size of the market in the different hours. Data with individual bid information is not available for the NordPool market, and the evidence of strategic behavior presented in the above papers relies on aggregate market data. In this paper we use individual bid data from the Italian electricity market to test empirically for switching behavior in the bidding. Both NordPool and the Italian electricity market are using bidding areas and market splitting to manage transmission congestion. The Italian market provides an alternative market to test explicit the hypothesis of supply function bidding conditional upon beliefs about the size of the market.

Methods

We are using individual bid data from the Italian electricity market for the period 2010-2012, along with additional market data. As an initial step we estimate a series of probit models along the lines of Løland, Ferkingstad and Wilhelmsen (2012) to ascertain that periods with congested and non-congested transmission lines are predictable. We construct supply functions for periods that are congested as well as for periods with no congestion. For selected periods that are predicted to be congested and are congested we compare the supply functions for dominant firms with their corresponding supply functions in periods that are predicted to not to be congested and are not congested. The comparison is mainly graphical where we look for shifts in the supply functions.

Results

We find that a probit model of congestion is able to predict occurrence of congestion with a higher degree of success than a naive forecasting model. Thus we conclude that producers could predict the occurrence of congestion. Our comparison of the supply functions reveals differences between submitted bid functions in congested periods as compared to non-congested periods for a large number of periods, bidding areas and firms. The supply functions are very stable over time within periods with continued congestion/non-congestion. These findings are consistent with our hypothesis of strategic bidding conditional upon predicted market congestion.

Conclusions

Out analysis of bidding behavior in the Italian electricity market provide additional evidence in support of the supply function equilibrium in electricity market. Furthermore, the pattern observed in aggregate data from the NordPool area with higher prices periods with congestion on the transmission lines can also be found in individual bid data in the Italian market. Thus, it appears that electricity producers are able to strategically adapt their bids to the (anticipated) market conditions. Such behavior is consistent with the supply function equilibrium theory in a setting where producers are learning about the market and market conditions in a repeated setting.

Market power is generally defined as the ability of producers to set price over and above marginal cost. In a market with a limited number of participants and limited market size the supply function equilibrium theory predicts prices above marginal costs. Our empirical results underscores the importance of market size. The equilibrium prices depend on the market size and the predictability of congestion.

As the European electricity market becomes more highly integrated through market coupling the predictability of transmission congestion becomes an important factor for market participants. Furthermore, the ability to predict and ultimately influence both congestion and price will be important for the performance of the markets. The findings in this paper also raises questions about strategic bidding and market power in an electricity market with nodal pricing. Repeated interaction in a market provides an excellent environment for learning and hence for strategic behavior conditional upon predictions about the market conditions.

References

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