ESTIMATION OF SUPPLY FUNCTION EQUILIBRIA (SFE) FOR THE GERMAN ELECTRICITY GENERATION MARKET – SIMULATION OF MARKET STRUCTURES AND MARKET POWER

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1. Motivation

Rising prices in the German wholesale electricity market have spurred discussions about the potentials and the abuse of market power. Particularly since the introduction of emission certificates, electricity prices increased continuously - closely related to rising certificate prices. The oligopolistic structure of the German market with four major players owning 90% of the capacities (Bundeskartellamt, 2006) leads to the presumption of significant market power potentials. A more detailed look at the market structure reveals that E.ON and RWE already own up to 60% of generation capacities. This market structure creates incentives for strategic behavior to distort competitive price-quantity outcomes.

In order to simulate the market structure and estimate market power potentials the supply function equilibria approach (SFE) is for the first time used for the German electricity generation market. The underlying theory has been developed by Klemperer and Meyer (1989). It is generally considered to be a more appropriate modeling of market power than traditional Cournot or Bertrand oligopolies, because firms in electricity markets often compete by offering a schedule of prices and quantities rather than using only quantity or price as a strategic variable.

The SFE approach explicitly considers demand uncertainties, typical for the electricity sector where bids are settled before demand is realized. In result, one obtains optimal supply schedules for the bidding firms. A drawback of those models is the absence of a single solution: there is rather a bundle of supply functions which are all equilibria to the game. In the case of asymmetric players, non-linear cost functions, or capacity constraints it maybe even impossible to find a unique solution. However, the boundaries of the SFE, the Cournot and the marginal cost line, can be calculated without modeling the SFE itself and allow to determine the most and the least competitive outcomes of a market. Over the past years, several theoretical contributions have been made to find and to select equilibria under varying assumptions (e.g. Anderson and Hu, 2005, and Holmberg, 2005).

2. Methodology

In this paper models predicting supply function equilibria are tested for the German wholesale electricity market. First, the approach of Green and Newbery (1992) for symmetric players which has been developed for the British electricity spot market is used. This model is applied with slight modifications to the German wholesale electricity market using capacities and marginal cost data of all generating units of strategic players above 100 MW. We consider the four main players in the market being strategic players while the fringe is assumed to behave as a price-taker. Therefore, the total demand function has to be modified subtracting the capacities of the competitive fringe.

A second approach of Evans and Green (2005) uses the actual market shares of the firms and a linear approximation of the marginal cost function. The model assumes hypothetically symmetric players for the calculation procedure using the inverse of the Herfindahl index. It was coded in GAMS with the same data set for the German market as used in the first model.

3. Results

The Green/ Newbery model yields the highest and lowest supply function equilibrium for the given market, which describes the range of optimal bid functions. Results show a significant markup on competitive prices for most demand realizations. The second model of Green and Evans gives the slopes of the (one) linear supply function for each player and the whole market. The latter can be compared with the slope of the linear market supply function in the case with symmetric players. Similar to the original paper, I find that the slopes are similar in both cases; thus the applicability of the model can be confirmed. Again, there are considerable markups on marginal costs for most load realizations (Figure 1)
4. Conclusion

Using supply function equilibria with its realistic simulation of the strategic behavior of the players it can be shown that there are significant market power potentials in the German electricity generation market due to its oligopolistic structure. While markups on marginal costs are considerable, simulated prices lie below the predictions of traditional Cournot models. Further research should include an empirical analysis of actual wholesale electricity prices to evaluate the applicability of SFE models to the German market.

References