A Measure of market power in the German electricity market

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Short abstract

This paper contributes to the literature proposing a new methodology to measure market power in the electricity market. We apply this method to the German market. We assume that profit maximization can be described for both supplier and buyers in the framework of the conjectural variation. We estimate the aggregate supply and demand elasticitities for every hour and use it to estimate the Lerner index for the main four suppliers in every hour: RWE, EON, EnBW, Vattenfall. We find some empirical evidence of market power.

1 Introduction

The analysis of market power is an important tool of the regulator in the electricity market.
Market power is the ability of the economic agent (supplier or buyer) to act as a price-setter, rather than price-taker as in competition, by enacting a pricing strategy. The existence of market power reduces welfare.
This paper contributes to the literature proposing a new methodology to measure market power in the electricity market. We apply this method to the German market.

2 The theoretical model

We assume that profit maximization can be described for both supplier and buyers in the framework of the conjectural variation of market quantity Q with respect to q_j expressed by agent j, following the classical approach by Appelbaum (1982).

In the case of seller, the minimal structure allows to describe profit maximization is:

$$\max \pi_j = pq_j - C(q_j) \qquad (1)$$

where q_j is the output, p is the output price; p= p(Q) is the aggregate demand function of electricity in the wholesale market; $Q=[q_j+SO_{\neq j}]$ is the sum of q_j the output of seller *j* and $SO_{\neq j}$ is the supply of all other participants except *j*. Thus, the residual demand for buyer *j* is:

$$DR_j(q)=p(Q-SO_{\neq j}) \qquad (2)$$

The maximization yields:

$$\partial\pi_j/\partial q_j = p[q_j+SO_{\neq j}] + (1+\theta_j) \times \partial p/\partial q_j \times q_j = MC_j \qquad (3)$$

where

$$\theta_j = \partial SO_{\neq j} / \partial q_j \quad (4)$$

is the reaction of all other suppliers to the change in the supply behavior of j, or the conjectural variation of supplier j.

The eq. (3) can be multiplied by p/p×Q/Q and defining the market share of supplier j $s_j = q_j/Q$ can be rearranged as:

$$(p\text{-}MC)/p = [(s_j/\varepsilon_D)\times(1+\theta_j)] \quad (5)$$

where $\varepsilon_D = \partial Q/\partial p \times p/Q$ is market demand elasticity.

Note that θ_j denotes the potential degree of collusion (equal to 1 for Cournot, as $\partial DO_j/\partial q_j = 0$ and equal to zero for competition, as $\partial DO_j/\partial q_j = -1$).

The term on the l.h.s. of equation (5) expresses the mark-up that the oligopolists j can exert in the market, i.e. it expresses a Lerner-type measure of oligopoly power composed of two parts, namely, the inverse demand elasticity (equal to $1/\varepsilon_S$) and the conjectural elasticity (equal to $s_j\times\theta_j$), which constitutes a measure of coordinated market power (Reimer 2004 and Puller 2007) with respect to the price which is coherent with profit-maximizing strategy of supplier *j*.

Buyer profit max

In the case of buyer, the minimal structure allows to describe profit maximization is:

$$\max \pi_j = zx_j - pq_j \quad (6)$$

where $x_j = f_j(q_j)$ is the production function, z is the exogeneous output price; p= p(Q) is the aggregate supply function of electricity in the wholesale market; $Q=[q_j+DO_{\neq j}]$ is the sum of q_j the demand of buyer *j* and $DO_{\neq j}$ is the demand of all other participants except *j*. Thus, the residual supply for buyer *j* is:

$$SR_j(q)=p(Q-DO_{\neq j}) \quad (7)$$

The profit maximization yields:

$$\partial\pi_j/\partial q_j = z\, \partial f/\partial q_j - \partial p/\partial Q\times\partial Qp/\partial q_j = 0 \quad (8)$$

which can be rearranged as:

$$[(z\partial f/\partial q_j)-p]/p = [(s_j/\varepsilon_S)\times(1+\varphi_j)] \quad (9)$$

where $\varepsilon_S = \partial Q/\partial p\times p/Q$ is market supply elasticity, $s_j= q_j/Q$ is consumer j market share and

$$\varphi j=(1+\partial DO_j p/\partial qj) \quad (10)$$

is the conjectural variation term denoting the potential degree of collusion (equal to 1 for Cournot, as $\partial DOj\ p/\partial qj = 0$ and equal to zero for competition, as $\partial DO_j/\partial q_j=-1$).

The term on the l.h.s. of equation (9) expresses the mark-down that the oligopsonists j can exert in the market, i.e. it expresses a Lerner-type measure of oligopsony power composed of two parts, namely, the inverse supply elasticity (equal to $1/\varepsilon_S$) and the conjectural elasticity (equal to $s_j\times\varphi_j$), which constitutes a measure of coordinated market power, with respect to the input price which is coherent with profit-maximizing strategy of consumer *j*.

3 The estimation procedure

The availability of individual bid data could allow to measure market power directly using the residual demand elasticity on the supply side and the residual supply elasticity on the demand side:

$$\varepsilon_{DR} = \partial(Q\text{-}SO_{\neq j})/\partial p \times p/q_j = \partial DR_j(q)/\partial p \times p/q_j \quad (11)$$
$$\varepsilon_{SR} = \partial(Q\text{-}DO_{\neq j})/\partial p \times p/q_j = \partial SR_j(q)/\partial p \times p/q_j \quad (12)$$

Eqs. (11) and (12) are the residual demand elasticity for supplier j and the residual supply elasticity for buyer j, respectively.

This allows to rewrite eqs. (5) and (9) as follows:

$$(p\text{-}MC)/p = [(1/\varepsilon_{DR})\times(1+\theta j)] \quad (13)$$
$$[(z\partial f/\partial q_j)\text{-}p]/p = [(1/\varepsilon_{SR})\times(1+\varphi_j)] \quad (14)$$

We use an estimate of s_j for the main sellers and buyers in the market and we can use eqs. (5) and (9) assuming that there is Cournot behavior so that:

$\varphi_j = 0$

$\theta_j = 0$

and estimate the mark-up and the mark-down in the market:

$$(p\text{-}MC)/p = (s_j/\varepsilon_D) \quad (15)$$
$$[(z\partial f/\partial q_j)\text{-}p]/p = (s_j/\varepsilon_S) \quad (16)$$

4 Empirical results

We use data from the TU data bank. See Figure 1. We estimate the aggregate supply and demand elasticitities for every hour. We estimate the share of the main four suppliers in every hour: RWE, EON, EnBW,Vattenfall.

First, we consider off-peak hours when must-run and base-load plants make the total (almost) supply, coal and nuclear. We know the capacity of each company and we impute a market share proportional to the capacity in every hour.

Second, we consider the peak-hours and we add gas-fired flexible units to the base-load. We know the capacity of gas-fired units of the main companies and we impute an additional share to the market share.

We estimate the share of the main buyers in every hour using the load profile of the main distributors, which are serving the final market. We estimate the equations (15) and (16).

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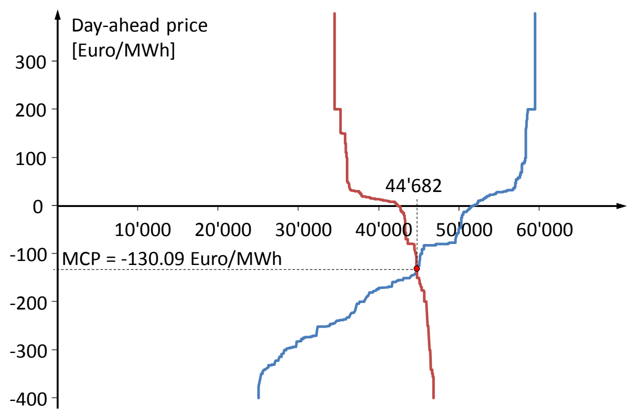

Figure 1. Aggregate supply and demand - Bid and Ask Curves at the EPEX
[Delivery Monday, 07.05.2016, 14-15 h]