

# **MARGINAL COST FUNCTION: ESTIMATION ADJUSTING FOR CONGESTION IN ITALIAN ELECTRICITY MARKET**

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## **(1) Overview**

This paper examines the market for wholesale supplies of electricity in Italy to determine if the generators are able to exercise market power. For a specific bid function and marginal cost function there is a portfolio of forward financial contracts that can rationalize that bid function as expected profit maximizing. Generation unit owner's contract position affects the unit bid behavior in the spot electricity market (Wolak 2000). Following Wolak (2000, 2003) we use the best response price concept in order to derive estimates of the cost function for a bidder in a competitive electricity market using actual bid information, the bid hedge contract position and the actual market outcomes.

## **(2) Methods**

We assume that the firm is able to observe the market demand and the bids submitted by all other participants. Consequently it firstly constructs the realized value of its residual demand function given market demand and bids and then selects optimal price associated with residual demand, firm's hedge contract position and marginal cost. Let  $C(q)$  the total variable cost associated with output  $q$  we write the profit function as:

$$\text{Profit}(q) = DR(p^*, e) \times p - C(DR(p^*, e)) - (p - PC) \times QC \quad (1)$$

From (1) we obtain the f.o.c (respect to  $p$ ):

$$p'(q) = DR'(p, e) \times (p' - C'(DR(p, e))) + (DR(p, e) - QC) = 0 \quad (2)$$

The first order condition can be used to compute an estimate of marginal cost at the observed market clearing price  $p^*$  as:

$$C'(DR'(p^*, e)) = [p^* - (QC - DR'(p^*, e))] / DR'(p^*, e) \quad (3)$$

Where  $DR(p^*, e)$  can be directly computed and  $p^*$  is directly observed, consequently residual demand computation is the only complication in order to obtain an estimate of marginal cost of firm at  $DR(p^*, e)$ . Different techniques are available for this computation and they provide substantial invariant results (Wolak 2003, pp. 149-50), among these we approximate  $DR'(p^*, e)$  as:

$$DR'(p^*, e) \sim [DR(p^* + z, e) - DR(p^*, e)] / z \quad (4)$$

However, the fact that IPEX is segmented in more than one market can change the relevant position of the residual demand curve that each supplier faces. This fact has to be explicitly taken in account when estimating residual demand. We know that if there are two zones when congestion arises, then equation (4) must be modified adding the transmission constraints when considering  $DR^{A(B)}$ , as follows:

$$\max\{T_{B-A}, \min[QD^{(B)A} - WTS_{in}^{B(A)}(p), T_{A-B}]\} \quad (5)$$

where A-B indicates the two zones after market segmentation,  $T_{A-B}$  the transmission capacity from A to B and  $T_{B-A}$  the inverse one. Using this correction we computed the corrected marginal cost.

## **(3) Results**

We present results of applying previous method. We used data on generator bids, market outcomes and quantity of the firm's forward contract obligations in order to obtain the actual DR faced by former monopolist in a representative off-peak demand period and on-peak period. These curves confirm the idea that former monopolist possesses great opportunities to exercise market power during high market power demand.

Former monopolist faces a higher DR during peak period than in low demand load period but we have to use different  $\delta$  value in order to check the robustness of these results. Using these information we estimate marginal cost function by equation 5 and test for its accuracy.

We use the marginal cost function and market outcomes in order to assess the magnitude of profit function and to compare different generation units in order to determine if substantial differences exist. Preliminary results show that in wholesale electricity Italian market Enel unit earn higher returns than units of others generators.

#### **(4) Conclusions**

Preliminary results indicate that there is an enormous differences of values of marginal costs between the dominant firm and the non-dominant competitors. In particular in wholesale electricity Italian market Enel unit earn higher returns than units of others generators. This evidence could be explained by observing that Enel sets the SMP in the majority of the auctions adopting a no-competitive behavior in forming its supply function. Finally, differences also exist among regional markets.

#### **References**

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