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Decomposing changes in competition in the Dutch electricity market through the residual supply index

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ABSTRACT

We propose to assess the influence of a number of events on the degree of competition in the Dutch electricity wholesale market over the period 2006–2011 through a decomposition method based on the residual supply index. We distinguish regulatory market-integration events, firm-level events and changes in the level of residual demand. We conclude that market-integration measures to improve competition have been effective, but that changes in residual demand appear to have been equally important. Firm-level events have only had a minor impact on the intensity of competition.

1. Introduction

The intensity of competition in markets is generally not constant as competitive conditions might change over time. Firms may gain (more) market power by, for instance, increasing the heterogeneity of their products, raising consumer switching costs or mergers and acquisitions. Market power might also change as a result of investments in additional capacity by firms or changes in the level of demand. Moreover, in some markets governments implement measures enhancing integration of regional markets into larger geographic markets, which might raise the number of competitors and, hence, reduce market power (Farrell and Shapiro, 1990). The ultimate net effect of these influences determines how competition evolves.

In order to better understand the development of competition over time, one should analyze the relative contribution of factors affecting competitive conditions. In this paper we develop a method for this decomposition analysis and apply it to the Dutch electricity (wholesale) market. We focus on this market over the period 2006–2011, as here a number of events occurred. We propose to assess the relative strength of several influences on competition in this market through a decomposition method based on the residual supply index (RSI). The RSI is broadly viewed as an appropriate measure for potential market power in electricity markets (Bergman, 2005; Gianfreda and Grossi, 2012; Sheffrin, 2002; Swinand et al., 2008; Twomey et al., 2005). It can be shown that the RSI is related to the Lerner index which more directly measures allocative efficiency (Newbery, 2009). The Lerner index, however, cannot directly be decomposed into factors which contributed to its development as is the case with the RSI. The RSI of a firm is measured by the ratio of the aggregate supply capacity remaining in the market after subtracting the capacity of that firm, relative to total demand. If the RSI of a firm is below 1, that firm is needed to meet demand, which makes it a pivotal player.

Our paper is related to studies which use structural indicators to analyze the impact of specific factors on competition. Most of these studies are forward looking, formulating scenarios on exogenous events. Küpper et al. (2008), for instance, estimate how an expected increase in cross-border transmission capacity would change the Herfindahl–Hirschman index and RSI. To the best of our knowledge our paper is the first that applies a backward-looking perspective on competition in electricity markets by assessing the impact of *all* major past events on competition through estimating the development of the RSI in a number of counterfactual situations.

By using hourly data, we are able to determine how the different events affected the RSI in the Dutch electricity market over the period 2006–2011. The data refer to production levels, capacities and marginal costs of all centralized production units (NMa, 2007). After determining the hourly merit order we are able to find the system-marginal plant,

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i.e. the plant with the highest marginal costs which is needed to produce the quantity of electricity demanded by electricity users. For the firm owning the system-marginal plant, we calculate the RSI, which we call the 'market RSI'. Next, we determine how this market RSI would have changed if certain events would not have happened. We define three types of events: market-integration events, firm-level events and changes in the level of residual demand. The market-integration events consist of physical extensions of cross-border capacity, market coupling and netting. The firm-level events consist of mergers and acquisitions as well as changes in the plant portfolio of companies. The demand events capture not only the development in aggregated domestic demand, but also the supply from decentralized generation units. The analysis is conducted for super peak hours, as especially during these hours market power might play a role (Borenstein et al., 2002). Super peak hours are defined as 10 am to 7 pm during working days.

Keeping all else equal, we find that the impact of the market-integration events in the Dutch electricity market on the market RSI was approximately five times as big (in absolute terms) as the impact of the firm-level events. We further find that another major factor behind competition was the decline in residual demand, which partly resulted from the growth in decentralized production.

The paper is structured as follows. Section 2 describes the European electricity market. Section 3 presents the theoretical approach, while Section 4 describes the events which have taken place in the Dutch electricity market. Section 5 presents the results, while Section 6 concludes.

2. Electricity markets

Electricity markets have a number of specific characteristics determining how competition can evolve (Tamaschke et al., 2005). The product is homogeneous which in the short and medium term can hardly be substituted by other products. As electricity cannot (cheaply) be stored, the product market consists of a range of consecutive (hourly) markets in which supply has to equal demand. The restricted capacity of connections with neighbouring networks limits competitive pressure from abroad.

The response of supply to changes in demand is mainly determined by the merit order of power plants. Plants with relatively high marginal costs are only used during super peak hours, while plants having relatively low marginal costs can be used for supplying a base load. The latter may have relatively high fixed costs as they are more often dispatched enabling them to generate sufficient compensation for investment costs. As a consequence of the volatile demand and the rather short-term fixed generation capacity, the tightness of the market as well as the positions of individual firms in the merit order change continuously. The position of a firm in the merit order and the steepness of the latter influence both the incentive and the possibility to withhold capacity in order to exercise market power and, hence, increase its profits (Green, 2011).

Until the mid-1990s, electricity markets in most European countries were characterized by publicly owned, vertically integrated companies operating in isolated regions, exempted from competitive pressure. With the introduction of competition, firms were often split into network operators (both for transmission and distribution) subject to regulatory supervision and commercial electricity companies operating on markets. In addition, the European Commission pursued integration of national markets into (regional) European markets in order to increase the size of the relevant geographic markets. A number of regulatory measures have been taken to realize this (EC, 2007). Cross-border barriers within the EU have been significantly reduced over the past decade through harmonization of trade conditions, extension of physical connections and more efficient utilization of existing connections.

Simultaneously with the process of integrating national markets, a number of events happened at the firm level. Green (2006) saw an 'unprecedented wave' of cross-border mergers and acquisitions. During 1998–2007, the annual number of mergers and acquisitions within the European energy sector increased (Leveque and Monturus, 2008). In the beginning, most of the deals were domestic, but later on cross-border deals became dominant. The concentration tendencies on firm level may have reduced the intensity of competition in the electricity market (Möst and Genoese, 2009).

More recently, electricity markets show a significant growth in decentralized generation capacity, in particular renewable generation capacity. Wind-powered generation has grown strongly in many countries, in particular in Germany, where it has almost doubled to about 25 GW nowadays, but to a lesser extent also in the Netherlands (EWEA, 2012). This increase in renewable generation capacity reduces the residual demand for the conventional power plants.

3. Measuring market power

3.1. Residual supply index

In studies of market power in the electricity market, Cournot models are widely used (e.g. Borenstein et al., 2002; Joskow and Kahn, 2002; Müsgens, 2006; Puller, 2007). These models are in particular useful for a short-term analysis when firms face capacity constraints (Willems et al., 2009). In order to decompose the development of market power we use a measure which is related to this type of model.

Let us take a market at (super peak) hour t with n capacity constrained electricity firms. Let $mc_i(t)$ be the marginal costs of firm i, where $mc_1(t) \leq mc_2(t) \leq \ldots \leq mc_n(t)$. The system-marginal firm ($i = s$) denotes the firm with the highest marginal costs ($mc_s(t)$) that is used to meet demand. The standard measure for market power of firm i at hour t is the Lerner index $L_i(t) = (p(t) - mc_i(t)) \,/\, p(t)$, where p is the market price. The Lerner index measures the intensity of competition by the degree to which price exceeds marginal costs. As a benchmark, we first consider perfect competition. The system-marginal firm is determined by the point of intersection of the market demand and the supply curve. The Lerner index of the system-marginal firm is equal to zero, i.e. under perfect competition this firm has no market power.[1] We notice that the Lerner index of each (capacity-constrained) inframarginal firm with marginal costs smaller than $mc_s(t)$ is positive. This does not reflect some allocative inefficiency, but rather that such a firm can produce more cheaply than the system-marginal firm, i.e. with marginal costs below the competitive equilibrium price. Hence, in order to analyze market power the Lerner index of the system-marginal firm is relevant.

Returning to the Cournot case, we recall that in the equilibrium of the standard model (without capacity constraints) the Lerner index of firm i at hour t can be written as $L_i(t) = s_i(t) \,/\varepsilon(t)$, where s_i is the market share of firm i and ε the (absolute value of the) price elasticity. Hence, the degree of market power of firm i is determined by its market share and the elasticity of demand. The relationship between the Lerner index and market share, however, is not straightforward for the electricity industry where market power strongly depends on the magnitude of demand, given the non-storability of electricity, and the short-term inflexibility of both supply (capacity) and demand (Borenstein et al., 1999; Willems et al., 2009). Therefore, for this industry it is common to relate the market power of a firm to an indicator for its pivotality.

The generally used measure for pivotality is the residual supply index (RSI), which was introduced by Sheffrin (2002). The RSI[2] of firm $i = 1, \ldots, n$ at hour t is:

$$\mathrm{RSI}_i(t) = \frac{X_i(t)}{D(t)}, \tag{1}$$

[1] It might happen that the demand curve intersects the supply curve at a point where the latter jumps from level $mc_s(t)$ to $mc_{s+1}(t)$. In that case $p(t)\ \varepsilon\ (mc_s(t), mc_{s+1}(t)]$. For brevity we disregard that case here.

[2] The RSI is dimensionless as capacity is measured in MW, while demand is measured in MWh/h.