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Resource externalities and the persistence of heterogeneous pricing behavior in an energy commodity market

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ABSTRACT

In competitive product markets, repeated interaction among producers with similar economic characteristics would be expected to result in convergence of their behaviors. If convergence does not occur, it raises fundamental questions related to the sustainability of heterogeneous competitive strategies. This paper examines the prices submitted to the British wholesale electricity market by four coal-fired plants, separately owned, approximately of the same age, size and efficiency, and located in the same transmission network zone. Due to the repetitive nature of the spot market, one would expect convergence in strategies. Yet, we find evidence of persistent price dispersion and heterogeneous strategies. We consider several propositions for these effects including market power, company size, forward commitments, vertical integration and the management of interrelated assets.

1. Introduction

The persistence of heterogeneity in product markets poses questions of efficiency, contestability and competitiveness, as well as those related to sustainable strategic differentiation. From a product pricing perspective, considerations of customer segmentation e.g. with respect to market power and price elasticity, as in Ramsey (1927), have been widely applied to understand stable price discrimination, while the resource-based view, e.g. Wernerfelt (1984), has contributed to a prolific body of theory on the competitive advantage that sustains a long-term differentiation in assets and capabilities among producers. Thus, with homogeneous products, the analysis of sustained heterogeneous pricing has often been motivated by transactional or behavioral considerations related to the customer or the customer–producer relationship. These include demographic segmentations (Graddy, 1997), negotiating abilities (Gneezy et al., 2009), searching inclinations (Salop and Stiglitz, 1977), as well as preferences to deal with particular counterparties (Becker, 1975; Kirman and Vriend, 2001). Yet, if we look at a commodity product, sold in a competitive wholesale market, perhaps anonymously on both sides through an exchange, with no brand value, no price–quantity variations (leading to discounts), equally accessible at the same transaction costs to all consumers, produced by different companies with the same technologies and marginal costs, we would generally expect to see convergence to similar prices being offered by the producers. If price heterogeneity emerges persistently in such a context, the relevant externalities may be quite subtle.

In this paper we look at the case of wholesale electricity from this perspective, which is a product market of considerable social and economic impacts. While it is well known that power markets tend not to be perfectly competitive, with the market power effects leading to higher than marginal cost clearing prices, nevertheless, the repeated daily interactions among generators in their auction and exchange markets would be expected to lead to similar technologies offering similar prices to the market. Indeed, energy regulatory authorities maintain surveillance and market power mitigation procedures with wholesale marginal costs as references (OFGEM, 2009). In this study, we report

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an empirical analysis which shows distinctly different pricing strategies being sustained over time from different companies offering an apparently homogeneous product.

We took a yearly sample of half-hourly prices from four major and well-established companies which have been competing in the British electricity wholesale market for many years. Each owned a very similar coal-fired plant, in terms of size, vintage and thermal efficiency, located in the same transmission region of the country, yet, being separately owned, they appeared to pursue different pricing strategies for these facilities in the same product market. Furthermore, as we examine electricity being offered into the instantaneous spot market, with no storage and no product discrimination, the reasons for this persistent behavior should be related to company-specific, resource-related market externalities.

The next section provides more detail on the market setting, related research and some empirical conjectures. The data are described in Section 3. Section 4 reports on the time series dynamics of offer prices, and in Section 5 we explore leader–follower relationships among them. Section 6 summarizes the observations and implications.

2. The power trading context

The spot market plays a key role in power markets, as it does in most commodities trading, but in electricity, because of the need for instantaneous balancing of production and consumption, the spot market is often more precisely referred to as the real-time, system "balancing" market. The counterpart to all trades between producers and consumers in real time is the network system operator. While substantial continuous bilateral trading between generators, retailers and speculators takes place ahead of real time, supplemented in many markets by exchanges and a day-ahead auction, within an hour or more of real-time all market participants have to stop forward trading, nominate their physical commitments and then deal directly with the system operator until physical delivery.

During balancing activities, the system operator makes continuous calls on generators (or consumers) to increase or decrease supply (or consumption) as necessary and to the extent that they have indicated flexibility at particular prices. In this way, the system operator ensures adequate supply, reserve and the physical stability of the electrical system in terms of voltage and frequency, according to the required quality and reliability standards. As such, the balancing mechanism (BM) facilitates real-time operations to ensure security of supply, and provides the price signals that guide the valuation of electricity derivatives and investments in new capacity.

In Britain, the balancing market is organized in compliance with the British Electricity Trading Transmission Arrangements (BETTA) that went into force in April 2005, extending to Scotland the New Electricity Trading Arrangements (NETA) for England and Wales adopted in March 2001. Electricity is delivered in half-hourly trading periods for each day of the year. Generators are allowed to contract with customers until 1 h ahead of actual delivery ("gate-closure") in various bilateral ways, including the continuous power exchange managed by APX. At the gate-closure, the generators are required to notify their traded volumes to the System Operator, National Grid. For a producer, this final physical notification (FPN) will be at the level of all of its generating facilities. In addition, at the gate-closure all generating plants must submit offers and bids for incremental adjustments to the FPNs. Multiple offers and bids are allowed for the same generating plant. An offer indicates the willingness to be paid in order to increase the amount of power generated (or to decrease demand, in the case or retailers). Conversely, by means of a bid, a generating unit is willing to pay National Grid to reduce its generation. Bids are thus used by the system operator if the amount of electricity on the system needs to be reduced. The settlement of accepted offers and bids is based on a pay-as-bid rule. Generators and retailers who deviate from the notified FPNs are charged by the system operator for these imbalances. Participants whose imbalance is a net shortfall (i.e. generators who deliver less than they are contracted to deliver, suppliers who consume more than contracted) are charged the system buy price (SBP). The participants whose imbalance is a net spill are paid the system sell price (SSP). The imbalance prices for a settlement period are computed as the volume-weighted averages of the accepted offers (for the SBP) and bids (for the SSP) related to that period. Under normal circumstances, the SBP exceeds the SSP, sometimes considerably. The spread between them encourages participants to meet their physical positions accurately.

Evidently, from a theoretical perspective, the analysis of market participant behavior in this context should relate to research on pay-as-bid auctions (Green and McDaniel, 1999; Federico and Rahman, 2003; Ren and Galiana, 2004a,b). This research, as applied to electricity markets, has highlighted a number of factors that would affect the dispersion in offer prices, such as marginal costs, location, forward commitments, generator size, vertical integration, and asset management. We indicate the implications of each of these as follows.

Marginal costs

Given the real-time nature of BM trading and the non-storability of power, short-run marginal costs (fuel) will determine the floor price to any offer, and in general, to the extent that the market is competitive, this will be the most fundamental factor in the dispersion of offers. In pay-as-bid auctions with time-varying demand and competitive risk-neutral generators, all infra-marginal offers align to the system marginal offer, whereas the offer prices for the plants that are not scheduled depend both on own marginal costs and on the marginal cost of the next most expensive generator (Green and McDaniel, 1999; Federico and Rahman, 2003; Ren and Galiana, 2004a,b). The optimal supply functions, as derived for example by Holmberg (2009) for risk-neutral oligopolistic generators offering portfolios of units, are strictly increasing with marginal costs.

Location

Because of transmission constraints, facilities can be sited advantageously with respect to the system balancing needs of the network operator, and so extract abnormal rents in their pricing (Borenstein et al., 1997, Gilbert et al., 2004).

Forward commitments

The heavily cited Allaz and Vila (1993) result leads to the expectation that with greater forward commitments, we would see lower spot prices, at least in a short-run. Consistently, the risk-neutral generators modeled by Sioshansi and Oren (2007) and Hortaçsu and Puller (2008) submit offer prices closer to marginal costs, the larger their forward commitments.[1] This raises the question of why do some companies have larger forward commitments than others. The agent-based simulation analysis by Sanchez et al. (2009), allowing learning and risk aversion in a supply function competition model, shows that the larger players prefer to exercise market power in the balancing market, while smaller companies prefer the security of contracting forward. This suggests an indirect effect of company size and risk preferences on offer strategies. Hence, the next factor, size.

[1] We have not found any analysis of the effects of strategic forward trading specifically on pay-as-bid spot auctions; thus our considerations are based on models of uniform-price auctions. We expect the basic mechanism behind the Allaz–Vila effect to apply to pay-as-bid auctions but perhaps less intensively, since pay-as-bid auctions are expected to be less prone to the exercise of market power.