



Bidding asymmetries in multi-unit auctions: Implications of bid function equilibria in the British spot market for electricity[☆]

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Abstract

This paper introduces and tests Bid Function Equilibria (BFE) in the British spot market for electricity. BFE extend von der Fehr and Harbord's (1993) multi-unit auction model of wholesale electricity markets by allowing firms to have heterogeneous costs for different generating units. Pure-strategy equilibria in BFE predict asymmetric bidding by producers: a single firm (the "price-setter") bids strategically while other firms ("non-price-setters") bid their costs. We test for asymmetries in firms' bid functions in the British spot market between 1993 and 1995 and find strong empirical support for the theory. We conclude that BFE have important implications for the design and governance of electricity markets.

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1. Introduction

Within the United States and throughout the world, the deregulation of wholesale electricity markets is well underway. Despite the consensus that these markets can generally benefit from competition, concerns that deregulated energy markets are especially vulnerable to market power continue to persist (Borenstein et al., 2002).¹ In the United States, the Federal Energy Regulatory Commission (FERC) has prescribed a universal wholesale market design which it hopes will be less susceptible to market power and manipulation.² Despite the FERC's laudable intentions, there is concern over whether regulators have an accurate understanding of market equilibrium in these markets.

In this paper, we introduce and test Bid Function Equilibria (BFE), a model of firm behavior in wholesale electricity markets. BFE were developed by Crespo (2001) to extend von der Fehr and Harbord's (1993) multi-unit auction model of wholesale electricity markets by allowing firms to have heterogeneous costs for the different generating units they control.³ This has the advantage of better reflecting the institutional reality of most wholesale electricity markets and clarifying the implications of multi-unit auction theory for firms' bid functions.⁴ The primary implication of BFE is that behavior is *asymmetric*: the firm that sets the clearing price (the "price-setter") behaves strategically while all other firms ("non-price-setters") bid close to their marginal costs. This has important implications for the nature of markups over costs ('bid markups') across firms in a wholesale market equilibrium. We test these implications in the England and Wales (E&W) spot market for electricity.

Figs. 1 and 2 provide examples of asymmetric bidding in E&W data. They show the marginal costs and bids for each generating unit by each producer in the E&W market on two days: November 28, 1993 and October 19, 1995. Bids for the individual generating units have been aggregated as they would by the National Grid Company (NGC) to form an aggregate supply curve. Also shown is the maximum (across 24 half-hour periods) daily demand (load) on each day. In Fig. 1, National Power is the price-setter for the majority of high-demand periods. The top panel in the figure shows the aggregate supply curve at all loads while the bottom panel focuses on the aggregate supply curve near the maximum load. While all producers are bidding close to or below marginal cost for units far to the left of the maximum load, only National Power is bidding significantly above cost adjacent (and to the left) of the maximum load.⁵ The picture reverses, however, in Fig. 2. Here, PowerGen is the price-setter for the majority of high-demand periods and it is they, not National Power, that is bidding above costs to the immediate left of the maximum load.

Our results use E&W data from January 1, 1993 to December 31, 1995 and demonstrate strong support for the theory. First, using variation in bids for individual generators across time, we find

¹ See also Wolfram (1999), Wolak and Patrick (2001), Sweeting (2005), and Hortacsu and Puller (2006). Wolak (2005) provides an overview of the recent regulatory experience in wholesale electricity markets.

² Federal Energy Regulatory Commission White Paper: Wholesale Power Market Platform (Issued April 28, 2003).

³ Independently, Garcia-Diaz and Marin (2003) developed a similar model tailored to the Spanish whole sale electricity market. We discuss the differences between our respective contributions below.

⁴ Homogenous marginal costs for a firm's generating units eliminate incentives to increase profit on (low-cost) infra-marginal units by submitting high bid prices for (higher-cost) marginal units that forms the basis for strategic bidding by the price-setter in a BFE. Given that producers in most electricity markets maintain a portfolio of generation capacity with heterogeneous costs, we think understanding such incentives may be important.

⁵ Note in particular that NP's units that serve peak demand in Fig. 1 have marginal costs less than those of rival generators.

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