Available online at www.sciencedirect.com
ScienceDirect
Utilities Policy 16 (2008) 307–320
UTILITIES POLICY
www.elsevier.com/locate/jup

Econometric models of power prices: An approach to market monitoring in the Western US

Matthew Barmack [a], Edward Kahn [b], Susan Tierney [b], Charles Goldman [c,*]

[a] Pacific Gas and Electric Company, San Francisco CA, USA
[b] Analysis Group, Suite 1750, Two Embarcadero, San Francisco, CA 94111 USA
[c] Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Mailstop 90R4000, Berkeley, CA 94720 USA

Received 15 May 2007; accepted 10 December 2007

Abstract

Given the limitations of data and resources available for market monitoring in electricity markets where regional transmission organizations (RTO) do not exist, we argue that econometric models of power prices could provide a useful screening tool for market monitoring. To explore its feasibility, we developed several econometric models of power prices at two major trading hubs in the West: Palo Verde and Mid-Columbia. We show that our models explain a large portion of the variation in power prices in Palo Verde and can establish a benchmark that can be used to identify outlier prices that are potentially the result of anti-competitive behavior.

Keywords: Market monitoring; Electricity markets; Deregulation; Market power; Electricity prices

1. Introduction

Regional Transmission Organizations (RTOs) or Independent System Operators (ISO) in the US generally have dedicated market monitoring functions.[1] By market monitoring, we mean the systematic analysis of market behavior and outcomes to identify behavior that is inconsistent with well-functioning competitive markets. Such behavior may include the exercise of market power, e.g., withholding supply from the market in order to raise price. The market monitors may be RTO/ISO staff members, independent consultants or both. Market monitors in organized markets typically have access to data on the hourly operation of individual units, their bids into various centrally administered bid-based markets (e.g., markets for energy and/or ancillary services), estimates of units' variable costs, hourly prices at multiple locations and for multiple products, and detailed information on transmission constraints. This paper explores one approach, econometric models of power prices, to wholesale power market monitoring in the Western Interconnection (outside of California and Alberta) where there is no organized wholesale market. Because of the absence of publicly and/or centrally collected data for the Western US wholesale power markets outside of California, it is generally infeasible to replicate the analyses performed by market monitors in organized markets.[2] Therefore it is necessary to approach market monitoring in a different way than has been done in organized markets.

Approaches to market monitoring can be broadly classified as ex-ante analyses which focus on identifying the possibilities

* Corresponding author. Tel.: +1 510 4864637; fax: +1 510 4866996.
E-mail addresses: mbarmack@alum.mit.edu (M. Barmack), ekahn@analysisgroup.com (E. Kahn), stierney@analysisgroup.com (S. Tierney), cagoldman@lbl.gov (C. Goldman).

[1] RTOs with "Day One" functions include the following types of grid operations: open-access transmission service, congestion management, ancillary services and interregional planning. RTO with "Day Two" functions include all the functions of a Day One RTO as well as operation of a bid-based, security-constrained market with economic dispatch, locational pricing, and financial transmission rights or capacity markets. http://www.ferc.gov/press-room/press-releases/2004/2004-4/10-06-04.asp.

[2] For examples of the analyses performed by the CAISO market monitor, see http://www.caiso.com/docs/2005/01/13/2005011316200513508.html, California Independent System Operator (2006).

0957-1787/$ - see front matter
doi:10.1016/j.jup.2007.12.001

of anticompetitive behavior in the future or as ex-post analyses which focus on determining whether the market was competitive for a time period under consideration. Ex-ante analysis techniques that seek to identify the possibilities for anticompetitive behavior include market concentration measures (a somewhat crude approach) as well as market simulations using oligopolistic models. Ex-post analysis of market prices essentially attempts to establish a benchmark for wholesale prices in a well-functioning competitive market. The simplest ex-poste approach involves constructing a competitive benchmark using a simple generation supply stack (i.e., supply resources are stacked in economic merit order to meet load in a region to form a supply curve). The competitive benchmark price for a given period is then determined at the point on this curve corresponding to the period's load adjusted for certain ancillary service requirements. Divergences between competitive benchmark prices and observed prices may be attributable to the exercise of market power. This approach was applied by Wolfram (1999) to the UK market and Borenstein et al. (2002), Borenstein and Bushnell (1999) and Joskow and Kahn (2002) to the California market. It may be well suited to markets with relatively simple network configurations, such as California, but it is poorly suited to analyzing the exercise of market power across broad geographic regions with internal transmission constraints that bind only intermittently.

Production cost models, such as Prosym and GE-MAPS, can also be utilized to develop competitive benchmark wholesale electricity prices and might address some of the limitations associated with supply stack models. For example, production cost models can handle transmission and operating constraints, and represent the relationship between loads and resources in great detail. The main downsides associated with production cost models for market monitoring is that they are expensive to obtain, set up and maintain, and probably too complicated to run very often unless a model has been taken in-house by a market monitoring organization with staff trained and dedicated to the function (Barmack et al., 2006).

Given the limitations of data and resources available for market monitoring in regions without organized markets, we argue that econometric models of power prices could potentially provide a useful screening tool for market monitoring. Econometric models can be used to develop statistical relationships between wholesale prices and readily observable factors that influence power prices, such as fuel prices and loads. Prices that deviate in a statistically significant manner from the prices predicted by econometric models may merit further investigation and indicate the exercise of market power. To explore the feasibility of this approach, we developed several econometric models of day-ahead on-peak power prices at two major trading hubs in the West: Palo Verde and Mid-Columbia. Our models establish a benchmark that can be used to identify outlier prices that are potentially the result of anti-competitive behavior and may warrant further investigation. The remainder of the paper proceeds as follows. Section 2 describes some of the key distinguishing characteristics of wholesale power markets in the West outside of California. Section 3 presents results of simple econometric models that could be implemented by a West-wide market monitor. Section 4 extends these models for one region where congestion issues seem fundamental.

2. Wholesale power markets in the West outside of California

Wholesale markets in the Western Interconnection outside of California and Alberta are different than organized markets with RTOs in at least four main ways. First, there is no centralized West-wide unit commitment and dispatch. Consequently, the information that RTOs collect in the process of performing unit commitment and dispatch, such as unit-specific bid information, are simply not available for market monitoring. In addition, non-RTO markets do not produce the highly geographically and temporally disaggregated prices that are the result of a market-based centralized unit-commitment and dispatch. As Federal Energy Regulatory Commission (FERC) has noted:

> What information is available to regulators (and when) depends largely on the structure of the market. Locational marginal, day-ahead, and real-time pricing, along with capacity and ancillary services within RTO markets, are almost entirely transparent and make much information available in real time. Such transparency rests on standardized operations and large, centralized mechanisms to collect and disseminate the information. By contrast, most natural gas markets and bilateral electric markets provide far less detailed information, depending instead on trade publications to provide price indices (FERC, 2005, p. 36).

Second, in the Western US, there is a substantial amount of trade through bilateral electric markets. Volumes on the Intercontinental Exchange (ICE), an electronic platform for trading standardized natural gas, power, and other energy-related contracts, offers one measure of such trading activity outside of RTO-mediated markets. For example, ICE volumes for on-peak deliveries to Palo Verde, the most liquid of several hubs in the Southwest, averaged 20 953 MW in 2004, relative to annual load in the entire Southwest (excluding California) of 180 154 Gigawatt hours (GWh).[3] Volumes on the ICE for on-peak deliveries to Mid-Columbia, the most liquid hub in the Pacific Northwest, averaged 23 636 MW relative to annual load in the entire Pacific Northwest of 223 148 GWh.[4] In contrast, for New York, an RTO market, ICE volumes for on-peak delivery to the most liquid delivery point (Zone A) averaged only 3445 MW in 2004 compared to annual net generation of 160 210 GWh — or approximately one-fifth the level of on-peak deliveries of ICE volumes as is exhibited at Palo Verde and Mid-Columbia.[5]

Third, many US utilities in the West outside of California are essentially vertically integrated, obviating to a large degree the need to purchase from wholesale markets to serve load. To the

[3] FERC (2005, p. 121).

[4] FERC (2005, p. 99).

[5] We divide on-peak deliveries of ICE volumes in a particular region by the total annual load in the same region for this comparison.