Multiple Market-Clearing Prices, Electricity Market Design and Price Manipulation

Multiple market-clearing prices arise from degenerate pricing conditions that can occur in electricity markets under economic dispatch. A stand-alone profitability test can distinguish transactions that are consistent with workably competitive markets from transactions that serve no economic purpose other than to manipulate prices and profit from other financial contracts. Generalizing this standard to the degenerate conditions that give rise to multiple market-clearing prices provides a principled solution, without undermining the market-design foundations that integrate economic dispatch, locational prices and financial transmission rights.

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I. Introduction

The purpose of this article is to describe interactions between electricity market-clearing prices, financial transmission rights, and price manipulation. The emphasis is on the close connection in the market design, and the application when there is ambiguity in the determination of market-clearing prices. The motivation is to outline policy for defining and identifying price manipulation in special conditions such as those encountered by the California Independent System Operator (CAISO). The problem of dealing with multiple market-clearing

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prices is important in itself, and it implicates broader questions of electricity market design. The review supports a discussion of the principles to separate efficient market transactions from cases of price manipulation. The distinctions are important, even critical, in preserving the integrity and functionality of efficient electricity market design.

II. Electricity Market Design

Successful market design for organized electricity markets utilizes a coordinated spot market under an independent system operator. Organized electricity markets follow the market design built on the principles of bid-based, security-constrained economic dispatch with locational prices. The prices arise naturally as part of an economic dispatch. The complicated details of networks and strong interactions across locations appear in the economic dispatch, but the resulting prices and quantities have the usual interpretation of clearing the market. Given these market-clearing prices, all economic bids or offers would be included in the economic dispatch.

The design integrates the treatment of physical and certain financial transactions. Locational market-clearing prices apply for energy imbalances or purchases and sales in the spot market. The differences between locational prices capture the marginal cost of transmission. A financial transmission right provides a contract that hedges the price differences between locations and serves as the replacement for unworkable physical transmission rights (Hogan, 2010).

The design arose in part to address an intractable problem confronting restructured electricity markets based on the principles of open access and non-discrimination. The short version of a long story is that the strong interactions in electric networks precluded definition and use of any workable system of physical transmission rights. And without some replacement for the unavailable physical rights, efficient electricity markets would be impossible. The solution was to utilize the spot market prices and create financial transmission rights that could serve many purposes, including allowing users of the transmission system to match their physical transactions and provide firm delivered prices under forward contracts (Hogan, 1992). After many false starts and dead ends, all the organized markets in the United States have moved to incorporate the basic elements of this market design.

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The usual emphasis in discussions of locational market-clearing prices focuses on the sometimes counterintuitive nature of network interactions. However, there are other features of bid-based markets that can create counterintuitive results for market prices even without the impact of network interactions. An illustration, but not the only case, is the so-called ''degenerate'' pricing conditions that can arise with bids and offers expressed as step functions, as is common in electricity markets.

III. Market-Clearing Prices

The CAISO describes locational marginal prices that arise from an economic dispatch (CAISO, 2011). The details are important but are not the focus here, which is to elaborate on the implications of ambiguity in determining the market-clearing prices. The CAISO tariff does not explicitly address the issues when describing the relevant price calculations (CAISO, 2011, §27). A review of the conventional theory without any ambiguity, where market-clearing prices are unique, provides the background for the subsequent analysis that makes explicit some of the challenges in the more general case.

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