Measuring Efficiency in Wholesale Electricity Markets

The mechanisms of the bid-based economic dispatch and market power mitigation algorithms which result in the market clearing price epitomize the complexity of the new regulatory regime. The augmented Lerner Index presented here offers a method to objectively assess the efficiency of the new structure.

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I. Introduction

Efficiency gains from competition in the generation segment of the electrical power industry were the philosophical impetuous for restructuring policies. However, it remains difficult to determine the efficiency of the restructured industry. The index presented here is an attempt to provide a relative quantification of efficiency through the approximation of a rate of profit per unit of energy earned by supply resources in transmission organizations with locational market clearing prices.[1] The Lerner Index will be augmented to provide a theoretically appealing and mechanically practical calculation.

II. History

The unique nature of electrical production, distribution, and consumption resulted in early government regulation of the industry. Government-sanctioned vertically integrated utility holding companies with exclusive rights to service territories were the industry's status quo. These utility companies faced direct state

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regulation of rates to fund generation, transmission, and local distribution, and in order to protect consumers from monopolists.[2]

Philosophical sentiment influenced legislative authorities to begin the deregulation of many traditionally regulated industries, including the electric utility industry in the 1970s. Three decades later, regional transmission organizations began implementing formal markets for the commitment and dispatch of generation with the direction provided by the Federal Energy Regulatory Commission's (FERC) Order 2000.[3] These markets allowed some state governments to remove utility generating assets from their direct rate regulation. The owners of generation assets in those states which restructured would rely on new market forces to fund their operations. The changes in wholesale market structure and technology have also initiated an increased push for new retail rate designs.

Transforming this historically concentrated industry into a competitive marketplace has provided regulators with an evolving puzzle. While vertical market power will still be exercised through the many affiliate relations that remain, a new challenge for regulators is to address horizontal market power in market transactions. Controlling the influence of horizontal market power is especially important when developing efficient time-of-use or real-time retail rates which could reduce interpersonal and intertemporal subsidies.

III. Theory

The measures presented here are derived from an expression formalized by Abba Lerner in 1934. Lerner addressed the nature and consequence of monopoly power and arrived at the conclusion that ''the mark of the absence of monopoly power is the equality of price or average receipts to marginal cost.''[4] Lerner objected to the notion of measuring ''monopoly in terms of the proportion of supply of a commodity under single control.'' Instead he suggested measuring the degree of monopoly power by taking the ratio of monopoly revenue – that is, revenues above cost – to total revenue. Therefore, the measure will be bounded by zero in the case of perfect competition and one when monopoly power allows prices to rise ad infinitum.[5] When industries and firms do not have constant average costs the ratio of monopoly revenue to total revenue is equivalent to the following.

$$\frac{p - mc}{p} \tag{1}$$

where p is price and mc is marginal cost.[6] This degree of monopoly power index has become commonly known as the Lerner Index.[7]

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IV. Wholesale Electrical Energy Markets and the Lerner Index

Market participants provide energy supply offers to the market operator for each generating or demand resource under their control.[8] The supply offers include a discrete number of price–quantity pairs defining an increasing step or piecewise affine function indicating willingness to sell into the market.[9] The compilation of supply offers for all resources serves as the primary input for the cost minimizing dispatch and price algorithms.[10] The compilation of supply offers could be colloquially referred to as the market supply curve or supply stack.

The price associated with the quantity in the supply stack needed to meet load sets the market price. This price will be paid to all resources committed to supply energy in an unconstrained system. When physical constraints bind in the transmission network price divergence occurs between different localities in the