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Price discovery in restructured electricity markets

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Abstract

We empirically investigate the degree of integration that existed prior to the cost increases that caused emergency conditions in the Western Systems Coordinating Council (WSCC), particularly California, during the summer of 2000. Evidence from Granger causality tests and common features analysis over the period from December 1994 to September 1999 indicates a moderate degree of integration among these markets. However, price effects throughout the region were often only unidirectional, did not exhibit the characteristics of perfect substitutability, and were significantly influenced by institutional changes in the California market. Most importantly, our research suggests that these markets were not as highly integrated as earlier research had indicated.

JEL classification: L94; L14; C22

Keywords: Price discovery; Energy markets; Vector autoregression; Granger causality; Market integration

1. Introduction

During the 1990s the U.S. electricity industry was restructured in an effort to promote competition. Given the network characteristics of electricity transmission, the industry had been regulated both at the state and federal levels prior to restructuring. In an effort to encourage competitive markets, Congress passed the Energy Policy Act of 1992, mandating open access to

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the transmission system for wholesale power. This was followed by the Federal Energy Regulatory Commission (FERC) Order 888, which provides rules concerning non-discriminatory, open access transmission operations and tariffs for wholesale power. It requires vertically integrated utilities to offer access for wheeling wholesale power at a single tariff rate comparable to what they would charge to themselves. As a result a number of states developed or instituted restructuring plans for their electricity systems. The most notable of these restructuring plans was developed and implemented in California. An independent system operator (ISO) was set up to control transmission flow, and a spot market for wholesale power exchange, the California PX, was eventually implemented in 1998. Because California is a net importer of electric power, restructuring in that state required that the wholesale markets in surrounding states also deregulate. The Western Systems Coordinating Council (WSCC) fulfilled this condition for deregulation in the nation's largest state.

However, the California wholesale electricity market has often been dysfunctional since the completion of its restructuring in 1998, suffering from extremely high and volatile prices for sustained periods. Speculations abound for California's troubles, but predominant among them are (1) reliance on spot market transactions required by the initial market design and the concomitant inability of load serving entities to engage in forward contracting; (2) local market power of some suppliers due to transmission constraints; and (3) a lack of retail price signals reflecting changing cost conditions in electricity supply.

The current paper focuses on the first two issues. Specifically, we empirically investigate the degree of market integration that existed prior to the cost increases that caused emergency conditions in the summer of 2000. Our results indicate a moderate degree of integration among these markets. However, price effects throughout the region were often only unidirectional (especially among off-peak prices), did not exhibit characteristics associated with perfect substitutability among markets, and were significantly influenced by institutional changes in the California market that encouraged the use of short-term spot market transactions as opposed to more stable long-term contracts. Most importantly, our research suggests that these markets were not as highly integrated as earlier research had indicated.

2. Background

Coordination in the transmission network is an important issue for reliable electricity supply. Electricity follows the path of least resistance and cannot be stored. Furthermore, congestion in part of the network may create transmission bottlenecks. Every transmission line has a thermal capacity that sets an upper limit on the flow of power on that line. Thermal constraints on a single line affect the power flow on other lines in the network through Kirchoff's laws. A change in generation or demand at any node will influence the power flow on the constrained line, which in turn influences flow on other parallel lines in the network. Voltage magnitude constraints are another source of congestion on transmission lines. Even when the thermal limits are not constraining, voltage limits can constrain transfer capacity of the network. Hence, through centralized coordination of generation and transmission, congestion can be managed. Some argue that free markets cannot deal with such issues and that central coordination and regulation are needed to address these ''loop-flow'' problems. Most experts reject these arguments, but we still must be aware of the potential inefficiencies of developing competitive networks and sensitive to evidence of their existence, so that corrective action can be appropriately designed and implemented before problems get out of hand.