Wholesale Generator Incentives to Exercise Market Power in the California Electricity Market

During periods of tight supply, even electricity suppliers with relatively small market share may have an incentive to withhold capacity to drive up market prices. Using a simulation model structured as a noncooperative game and market data broadly representative of the California electricity market, these incentives, and potential remedies, are explored.

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A more complete description of the analysis described in this article is available from the authors.

As a result of a 1996 state electricity restructuring law, California's three major investor-owned utilities (the "utilities") sold about 18,000 MW of older natural gas-fired generating units in 1998. Although the utilities retained rights to a considerable amount of other generation (through ownership or long-term contracts), the units sold were mid-merit and peaking units that were frequently "on the margin" and thus expected to set market clearing prices during the vast majority of hours in a typical year. The majority of the divested units were sold to five different companies (the "wholesale generators") in roughly equal shares in order to reduce the potential for these new owners to influence prices and exert market power.

The results are well known. In the first two years after restructuring, wholesale prices were relatively low, and warnings by various market monitoring bodies that market power was being exercised in California's electricity markets[1] went largely unheeded. In the summer of 2000,

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however, market conditions in the Western United States changed dramatically and wholesale prices climbed to an unprecedented level. For instance, in January 2001, a generally low-load period, wholesale prices averaged about $300/MWh,[2] over 10 times the average prices a year earlier. In addition, a significant number of units in California have been unavailable due to outages, prompting concerns that capacity is being deliberately withheld from the market.

It has been suggested that electricity markets may be structurally different than other markets due to the need to meet demand on a real-time basis without the benefit of product inventories, the short-run inelasticity of demand, and the lack of well-developed real-time pricing and demand-response institutions.[3] Taken together, these factors mean that during periods of increasingly tighter markets, even suppliers with relatively small market shares may have the incentive to withhold capacity. Thus, the traditional tools for evaluating the likely presence of market power—i.e., market shares and Herfindahl-Hirschman indices—may be inadequate to assess the potential for market participants to exercise market power.

This article reports the results of an investigation into the incentives for suppliers to exercise market power in electricity markets. Using a game theory approach, the behavior of a handful of oligopolistic wholesale generators is simulated by treating them as participants in a noncooperative game. These suppliers do not overtly collude, but instead learn from their past successes and failures in following various capacity withholding strategies in an effort to raise market prices. Rather than modeling these potential behaviors in a purely hypothetical context, model parameters are purposely chosen to broadly portray the approximate supply and demand relationships in the California electricity market. The purpose of this simulation model is not to make specific quantitative forecasts or predictions, but rather to illustrate some basic tendencies toward noncompetitive market outcomes and to broadly evaluate the likely results of various remedial policies—price caps, long-term contracts, and further divestitures of generating plants.

The behavior of a handful of oligopolistic wholesale generators is simulated using a game theory approach.

Typical summer peak demand in the portion of California controlled by the California Independent System Operator (ISO) is about 46,000 MW. Subtracting "must-take" generation owned or controlled by California's major utilities leaves about 16,000 MW of residual demand (sometimes called the "net short" position), which is met by the new owners of the approximately 18,000 MW of gas-fired mid-merit, and peaking units sold by the utilities. Since outage rates of about 10 percent can be expected, supplies are extremely tight, with capacity reserves falling to near zero even on typical summer days.

In a perfectly competitive uniform-price auction[4] market, these wholesale generators would bid all their available supplies at their marginal operating costs and then accept whatever market-clearing price resulted from the auction. Low-cost suppliers would earn inframarginal profits; marginal producers would simply recover their marginal operating costs, except during occasional peak periods when prices are set by price-responsive demand. In a monopoly market, the single supplier (or a group of colluding suppliers) could restrict output to create an artificial scarcity, driving prices upward to maximize profits. Oligopoly markets fall somewhere in between these two extremes. If all the suppliers withhold some capacity, they can drive prices upward, and reap super-competitive profits. Having done so, however, there is an incentive for individual suppliers to increase their output a little, thus increasing their market share and profits at the expense of their rivals. This creates a natural tension in the market that acts to limit the amount of capacity withholding. When supplies are tight, the risk that one wholesale generator faces of having its capacity withholding strategy undercut by a rival declines, increasing the incen-

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