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From the Editor

Market power is a constant focus of attention in electricity markets around the world. The potential exercise of market power in real-time markets has received a lot of attention, given their known features of inelastic demand, non-storability and strict capacity limits. However, few analyses of the problem take into account the workings of electricity market institutions. Many real-time ("spot") markets operate alongside day-ahead markets which do not suffer from these problems. A recent paper by Steven Anderson for Harvard University's Kennedy School of Government looked at the interaction between day-ahead and real-time markets. Anderson found that a day-ahead market can (at least within the confines of his economic model) greatly reduce the effect of market power. In this article, Jonathan Falk discusses the implications of these findings, for competition policy and for electricity market design.

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Day-Ahead Markets and Market Power: A New Analysis

by Jonathan Falk, Vice President, NERA New York

Market Power, Market Structure and Market Institutions

Market power, in colloquial terms the ability to affect the terms of trade, is one of the major areas of enquiry in economics. A long and distinguished tradition focuses on the size of a seller vis-à-vis its competitors. The bigger the market share of a competitor, the more likely it can affect the terms of trade. An even larger literature focuses on the number of competitors and the distribution of their sizes, usually summarized by the Hirschman-Herfindahl Index. Receiving less focus are the particular market institutions through which sellers and buyers interact, though these are increasingly understood to be quite important in determining how well a market performs. It is not an accident that most financial markets are organized as double auction markets in which buyers and sellers constantly offer to buy and sell quantities, either through open outcry or their computer-simulated equivalents. Such markets have proved robustly efficient and resistant to attempts to monopolize by large buyers and sellers.

A prominent competitive electric market paradigm is the two-stage day-ahead/spot paradigm. Spot markets serve the obvious goal of exactly matching supply to demand, as the physics of electricity requires. Day-ahead markets resolve questions of start-up and market commitment: power sold day-ahead can guide the decision to start up a plant. In principle, day-ahead markets can also help risk-averse consumers plan their next-day consumption.

Analysts of market power, including regulators, have tended to ignore this market structure when carrying out their analyses. The analyses of market power in the California debacle of 2000-2001, for example, have almost uniformly chosen either spot markets or day-ahead markets for their analyses, arguing that the two markets reflect each other so closely that it suffices to look at one.

A recent dissertation by Steven Anderson[1] makes some useful first steps in helping to understand market power by sellers in two-stage markets. In the real world the problems are much more complex than the relatively simple problem Anderson has analyzed, but the daunting mathematics required to solve even this simple problem suggests one should be cautious when claiming the existence of undue market power on the basis of even simpler models.

What a Difference a Day Makes....

Anderson examines an electricity market for a single hour in which two sellers compete first in a day-ahead market and then in a spot market for an uncertain level of demand. The sellers have no capacity constraints, nor do they have any start-up costs or other so-called nonconvexities. Each seller bids a supply curve in a forward market that does not commit anyone to physical production, but which trades in financial "contracts for differences" that fix a price for a given quantity. Risk-averse consumers enter this market to get some protection against the risk of variation in the spot prices that will prevail on the next day. Then, sellers bid a second supply curve in the spot market, buyers take their actual physical demand, the spot market clears and profits are realized. In the model, sellers are presumed to know the cost structure of their competitors. In addition, sellers are assumed to know the offers their competitors made in the day-ahead market at the time they bid in the spot market.

This problem is of course dramatically simpler than the real-life problems faced by generators. The real world consists of 8760 auctions a year, not one, raising the possibility of strategic interactions over time. Real markets have capacity limitations and alternative sources of revenue in ancillary markets and export markets. The cost conditions of one's competitors are rarely known with certainty. Anticipating the strategy of a single competitor may (although this is unclear) be an easier problem than anticipating the aggregate response of many competitors. However, short of monopoly or collusive cartel, analysis of a duopoly should set a practical upper limit on the possibilities afforded for market power.

Anderson's day-ahead market works like the double auction financial market, which matches offers to supply against bids to buy. In the standard economics textbook example of a Cournot market, duopolists unilaterally offer a fixed quantity to the market and market power effects are pervasive. Perhaps surprisingly, several papers examining simple oral outcry double auction markets (like a stock exchange) have suggested that market power is nonexistent under a wide range of conditions, even with duopolies. These findings imply that concerns over market power are indeed quite sensitive to the market mechanisms employed.

Anderson's result falls squarely in the tradition which suggests that double auction markets are reasonably robust against manipulation. In an example calibrated to correspond roughly to the two-stage California market, a duopoly market achieves 95 percent of the welfare of a perfectly competitive market. Even more interesting, the two-stage market is more efficient than a single spot market alone, which achieves only 92 percent efficiency. It seems that, having fixed prices in a robustly competitive day-ahead market, the duopoly then has less incentive to exert market power in the real-time market. Stated another way, the

[1] "Analyzing strategic interaction in multi-settlement electricity markets: a closed-loop supply function equilibrium model," available at: http://www.ksg.harvard.edu/hepg/Papers/Anderson.analyz.strat.interaction.May.04.pdf

mere addition of a day-ahead market regains three-eighths of the damage caused in a spot market by the shift from perfect competition to duopoly.

That said, welfare calculations are more important to economists than they are to policy-makers, who are often more concerned with prices. It is possible to have very few welfare losses, but very high prices, if customers are price-insensitive in the quantities they purchase. Anderson does not present explicit calculations of expected prices in his dissertation, though he points out that "if such distribution effects are also of interest to policy makers, it is straightforward to use the present model [to calculate them]". I suspect that his failure to do so himself suggests that under certain circumstances prices will be quite high, albeit lower in the two-stage market than in a simple spot market.

Not that duopoly prices are necessarily a problem. After all, few policy-makers would be willing to tolerate a duopoly if they have the power to ban one.[2] An analysis with three, four or five companies would be more relevant to practical policy-making in electricity markets (particularly small ones). Furthermore, ignoring entry conditions always makes a market look less competitive than it is. Among Anderson's proposed extensions to his model are expansions to more market participants.

Key Lessons for Electricity Market Policy

Rather than focus on Anderson's specific results, which are undoubtedly closely tied to the highly simplified structure he has examined, I would like to focus on the central lessons of his analysis for real-world policy—which, I think, have little to do with his numerical conclusions.

- Mathematical simulation of likely market results in markets as complicated in electricity are unlikely to be of much help to regulators. Toy models yield toy results. There are no robust conclusions beyond the sorts of commonplace statements which require no modeling at all: monopolies are bad, more competitors are better, elastic customer demand reduces market power. Current modeling techniques do not allow us to quantify the differences in any definitive way.
- Market structure matters. Offering quantities (as in a standard Cournot model) is quite different from offering prices and quantities (as in a Klemperer-Meyer model). An active demand side of the market is quite different from a passive demand side. And now, we have reason to believe, two-stage markets yield different results from single-stage markets.
- Very little work has been done on how actual competitors bid in actual markets. The computational difficulty of Anderson's methods in highly simplified settings is dwarfed by the full computational complexity of the real problems faced by sellers making 8,760 offers a year in multiple markets against competitors seeking to hide commercially sensitive data. The standard economist's answer to

[2] That said, there are many markets in which the largest two firms have very large market shares, e.g. soft drinks, without any particular concerns that markets are uncompetitive.

About NERA

NERA Economic Consulting is an international firm of economists who understand how markets work. Our more than 40 years of practical experience creating strategies, studies, reports, expert testimony and policy recommendations reflects our specialisation in industrial and financial economics. Our global team of 500 professionals operates in 16 offices across North and South America, Europe, Asia and Australia.

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this bewildering complexity is that competitors need not solve these equations; the successful players act *as if* they can solve these equations, much as a football player runs to the spot where the ball will land as if he can solve the differential equation defining the ball's trajectory. But this reasoning, however valid in mature markets, makes no sense in nascent electricity markets where the search for successful strategies has barely begun. Three-year-olds are not good at predicting where the ball will land. If the optimal strategy is simple, efforts directed at uncovering it may yield insight. When the strategy is known to be complicated, wait-and-see may be the best regulatory approach to allegations of market abuse.

Keynes famously remarked that "practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist." Regulators are practical men (and women). The desire to transform a hard social problem into a technical mathematical one is laudable where it is feasible. Although Anderson's paper contains good mathematical work, its simplifications and shortcomings demonstrate clearly that regulatory policy will be dominated for some time to come by the clash of traditional economic paradigms: those who stress the dynamic effects of relatively untrammeled competition (call them the neo-Hayekians and neo-Schumpterians) *versus* those who stress market failure and the need to protect efficiencies from the messiness of the real world (call them neo-Pigovians and neo-Samuelsonians[3]). The insights which the application of mathematics has brought to economics over the last 150 years are real – but they are not yet precise enough to resolve this fundamental battle between paradigms.

[3] With apologies to Professor Samuelson, who is far from defunct.

Our Practice

NERA is at the forefront of the continuing transformation of the energy industries worldwide. We have pioneered in developing approaches for introducing competition in segments such as power generation (where competition is workable) and for improving the regulation of sectors (where it is not). We work with companies and governmental bodies worldwide to design competitive power markets and to develop tariffs and rules of access for regulated transmission and distribution systems for electricity and gas and transport of oil and oil products. With industry restructuring, we also help companies develop strategies for exploring new opportunities and minimizing new risks, including issues related to climate change and other environmental initiatives.

We help our clients to develop new regulatory strategies and, when needed, support our clients with analysis and testimony before regulatory commissions, antitrust and competition policy agencies, and domestic and international courts. Our economists help clients to decide which lines of business to pursue; to divest assets no longer consistent with their strategy; to identify and evaluate opportunities for mergers, acquisitions and investment; and to develop bidding, trading, contracting, and marketing strategies and organizations. Our work also includes designing and conducting energy auctions, providing strategy and valuation, advice on mergers and acquisitions, the financing of energy companies, and the financial restructuring of distressed companies.