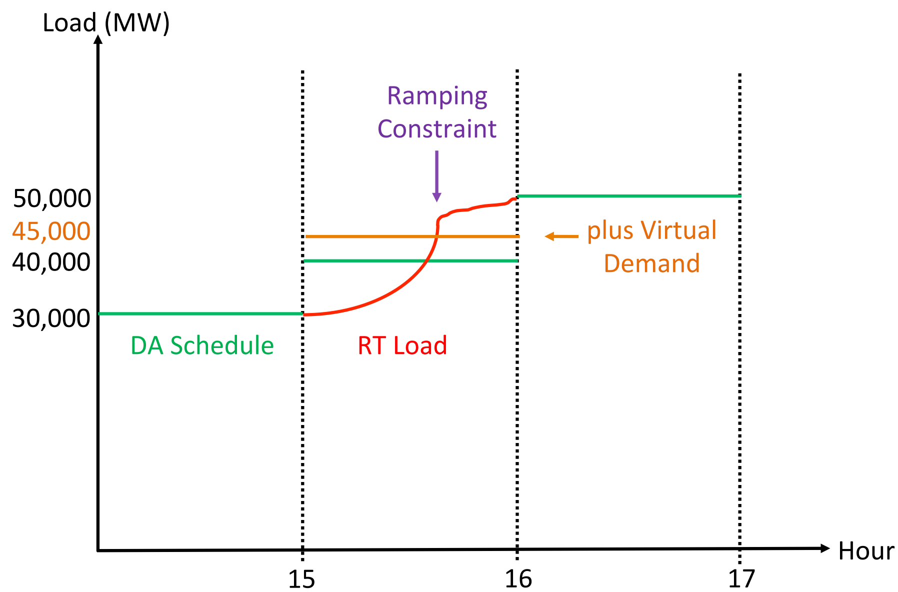
When Financial Trading Only Makes Things Worse

by: John E. Parsons

The role of financial traders in commodity markets is controversial. Advocates argue that they improve the pricing to better reflect information about expected demand and supply. Detractors complain that they often manipulate prices or otherwise move the market away from the fundamentals of supply and demand. The U.S. Federal Energy Regulatory Commission (FERC) in recent years has vigorously prosecuted a number of cases against financial traders in wholesale electricity markets, and controversy has swirled about whether these prosecutions have hurt or helped the operation of the markets.

Recently, Dr. John Parsons, a CEEPR affiliate and faculty member in the Finance Group at MIT's Sloan School of Management, worked as a Visiting Scholar in FERC's Division of Analytics and Surveillance (DAS) to study financial trading in U.S. electricity markets. Working with four colleagues in DAS, Dr. Parsons completed a study of a unique type of financial trading known as Virtual Bidding. That study has been issued as CEEPR Working Paper 2015-002, "Financial Arbitrage and Efficient Dispatch in Wholesale Electricity Markets."[1] The research helps understand certain situations in which virtual bidding not only fails to improve system performance, but also adds to system costs.

The Inability of Virtual Bidding to Solve the Ramping Problem



The green lines in the figure shows the Day-Ahead dispatch schedule for three successive hours, assuming no virtual bidding. Generation awards in the Day-Ahead market are for a block of power. There is no granularity below the hourly time scale. The red line in the middle hour shows how load evolves through the hour when the Real-Time market schedule is developed. The high ramp rate in the middle of the hour exceeds the capacity of the units dispatched in the Day-Ahead market and forces the system operator to reach for other resources with the capacity to ramp quickly. This is what causes the infrequent, but extremely severe price spikes in the Real-Time market. The orange line shows the impact of virtual demand bids. The total generation award in the hour is increased. However, like all bids into the Day-Ahead market, virtual bids only express demand at an hourly granularity. The virtual demand increases the total generation award for the hour, but does not specify the need for the sharp ramp capacity. The added generation may not be alleviate the ramping constraint. In fact, in many circumstances, increases the level of generation awarded can reduce the ramping capacity, exacerbating the problem.

Virtual bidding is a type of financial trade that is unique to organized electricity markets. A bidder can speculate on the spread or difference between the Day-Ahead and the Real-Time hourly prices at a certain location. Virtual Bids are placed in the Day-Ahead auction, and they clear like all other bids. Virtual demand bids clear if the price bid is greater than the auction clearing price, while virtual supply bids clear if the price bid is less. The bidder earns a gross cash payoff on a cleared bid equal to the price spread: demand bids earn the Real-Time price less the Day-Ahead price, while supply bids earn the reverse. The bidder also pays some costs, so the net cash payoff is less than the spread. The payoff is always cash: the bidder never actually takes power, and never actually supplies power. Consequently, financial players can enter the market using these bids.

The promise of virtual bidding is that it improves the pricing and dispatch of generation. For example, in order to optimize the commitment of thermal generation, system operators need to forecast the amount of wind generation that will flow the next day. One tool at their disposal is the Day-Ahead offers by wind generators themselves. However, these generators have historically underbid the quantity of generation they end up supplying into the Real-Time market. Financial traders have noticed this, and they make virtual supply bids into the Day-Ahead market which reflect their estimates of the shortfall. As a result, the cleared physical supply in the Day-Ahead market more accurately forecasts the actual physical supply in the Real-Time market.

Unfortunately, this promise is not always realized. Virtual bidding can shape the aggregate level of supply and demand at a given location in a given hour. So long as the system problems crystallize to a shortage or surplus of aggregate supply or demand at a given location and given hour, then virtual bidding has the potential to improve the situation.

Unfortunately, the unit commitment and optimal power flow problems that these wholesale market auctions are used to solve are much more complex than is acknowledged in the metaphor of an aggregated supply curve and an aggregated demand curve. The true unit commitment problem has to confront many fixed costs and discrete choices created by things like ramping constraints which raise the computational complexity enormously. The true optimal power flow problem needs to respect an array of complex power flow constraints such as thermal limits on the network cables and voltage limits. These complexities sometimes undermine the effectiveness of virtual bidding.

The paper uses the problems experienced in the California market as a case study to help illustrate the problem. California's new market design began operation in 2009, and immediately it exhibited a peculiar pricing anomaly.

On average, the Real-Time price was higher than the Day-Ahead price. This was due to a very few hours, less than 1% of all hours, when for a short interval of perhaps 5-minutes or so the load was ramping up at an extremely fast rate that exceeded the ramping capability of most of the units that had been dispatched in the Day-Ahead market. In the other 99% of the hours, the Day-Ahead price actually exceeded the Real-Time price by a small amount. During those 1% of hours when load was ramping very quickly, there was no general shortage of supply. Many of the units that had been dispatched for that hour had extra capacity. But they did not have the capacity to ramp up quickly enough to take advantage of that capacity within the 5-minute interval that it was required. Therefore, the system operator had to turn to other, expensive units and raise the price dramatically.

This price anomaly was an opportunity exploited by financial traders who placed a large quantity of profitable virtual demand bids. Unfortunately, this did not improve system operation. In 99% of the hours, the Day-Ahead price was already above the Real-Time price, and the virtual demand bids only increased the Day-Ahead price yet further. In 1% of the hours, the virtual demand bids increased the total supply scheduled, raising the Day-Ahead price. Unfortunately, this increased supply often did nothing to solve the ramping problem and the system operator was still forced to turn to other, expensive units. Because virtual bids can only be placed for a full hour of generation, which the system was not short of, and not for the short 5-minutes of ramping capacity that the system actually needed, the virtual bids could not effectively solve the problem. Instead, virtual bidding simply added to total system cost, while also producing profits for financial traders that would have to be paid by customer charges.

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The research generalizes this illustrative example, and shows how the underlying problem with virtual bidding can manifest itself in different situations. It explains how the usual diagnostic of convergence can sometimes fail to accurately reflect whether or not virtual bidding is improving system performance. The research emphasizes that task of evaluating the costs and benefits of virtual bidding is a very demanding one.

Dr. Parsons' colleagues at FERC's Division of Analytics and Surveillance who co-authored this research are Cathleen Colbert, Jeremy Larrieu, Taylor Martin, and Erin Mastrangelo .

[1] Parsons, J. E., C. Colbert, J. Larrieu, T. Martin, and E. Mastrangelo (2015), "Financial Arbitrage and Efficient Dispatch in Wholesale Electricity Markets." *CEEPR WP-2015-002,* MIT, February 2015.