The Impact of Information and Pricing Patterns on Coordinated Behavior in Wholesale Electricity Markets

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Overview

There are growing concerns that the increase in renewable generation capacity and deployment of demand-side resources such as rooftop solar panels will generate more uncertainty in wholesale electricity markets on both the supply and demand side. This has motivated regulators and policymakers to increase information transparency in wholesale electricity markets (e.g., see von der Fehr (2013)). On one hand, increased market transparency and the publication of near real-time information can allow electric generators to respond more efficiently to rapidly changing market conditions. On the other hand, there are concerns that increased information transparency can facilitate market power execution to increase market prices. These concerns are particularly relevant in concentrated wholesale electricity markets where firms interact repeatedly.

In this paper, we investigate the impact of near real-time information on firm behaviour in the context of Alberta's wholesale electricity market. In Alberta's market, firms submit hourly price-quantity offers to supply electricity. Firms are able to make adjustments up to two hours before the market clears. In addition, during our sample period, the Alberta Electric System Operator published the Historical Trading Report (HTR) at the end of each hour which included a de-identified list of each firms' price-quantity offers. This provided firms with detailed information on their rivals' offer behaviour and market conditions in near-real time.

In 2013, Alberta's Market Surveillance Administrator (MSA) raised concerns that firms may be utilizing the detailed information in the HTR to elevate market prices. More specifically, concerns were raised that firms may be bidding in a certain way to "tag" their bids in order to coordinate on higher wholesale market prices (MSA, 2013). The MSA documented examples under which a firm would "tag" its offers at high prices and hold them in place throughout the day establishing a "high-priced shelf". Then, throughout the day, other firms were observed to elevate their offers upwards under the high-priced shelf revealed in the HTR. This induced the Alberta Utilities Commission to investigate the case leading to the eventual cancelling of the HTR (AUC, 2017).

We investigate if firms were utilizing near-real time bidding information to either coordinate on a particular non-cooperative market equilibrium or if firm behaviour is consistent with outcomes that are more profitable than those that would be predicted from standard non-cooperative behaviour. As a result, our analysis is closely related to the empirical literature that tests whether electricity generators behave in a way that is consistent with non-cooperative expected profit-maximization (e.g., Wolak (2000) Sweeting (2007), and Hortascu and Puller (2008)). Further, we extend the analysis undertaken in Brown et al. (2018) which illustrated that firms are able to identify particular rival's offer behaviour from the information revealed in the HTR, and provided initial evidence that firms responded to information revealed in the HTR.

Methods

Our analysis focuses on two large electricity generators in Alberta's electricity market. The first firm, Capital Power, on certain days bid in several of its peaker natural gas units at high prices with a unique pattern that was subsequently revealed in the HTR. This established a high-priced shelf that was often held throughout the day. The second firm, TransCanada, systematically elevated portions of its coal assets to price-levels below the high-priced offer shelf. These units often set the market-clearing price in the early evening hours on these "tagged" days.

We establish an empirical methodology to test if firms were maximizing their expected wholesale (spot) market profits, given the bidding behaviour of rival firms. First, we estimate each firm's expected spot profits from observed offer behaviour on tagged and non-tagged days using a Monte Carlo simulation approach to account for uncertainty in market-level demand and wind output. Second, we estimate the firms' expected spot market profits that would arise if they employed alternative counterfactual offer curves. We consider an array of counterfactuals that reflect both an upward and downward shift in their offer curves.

Third, we compare the expected profit levels from the observed and counterfactual offer curves on tagged and non-tagged days, including estimates on ramping and unit start-up costs to account for important dynamic costs and operational constraints. This approach allows us to investigate if firms were behaving in a manner consistent with expected profit maximization given rival offer behaviour, and if the results differ depending on whether Capital Power was employing its unique offer pattern and establishing a high-priced shelf of price-quantity bids.

Results

Our empirical analysis finds that Capital Power was foregoing substantial expected wholesale profits by elevating its bids on several of its peaker natural gas units on days where it was employing its unique offer pattern and establishing a high-priced shelf. More specifically, we illustrate that Capital Power could have elevated its expected spot market profits substantially by unilaterally lowering its bids on these assets to ensure they are called upon to supply electricity. The expected wholesale profits exceed the dynamic start-up costs associated with turning-on the peaker gas asset(s). We also find that TransCanada could have elevated its expected wholesale profits by bidding more aggressively on days where it was elevating the bids on a portion of its coal assets. The increase in expected profits are systematically larger on days where Capital Power was employing its unique offer pattern and TransCanada elevated its bids on its coal assets to prices up under the tagged high-priced shelf. These gains are in excess of the costs of ramping (cycling) a coal asset.

We find that firms were not behaving in a manner consistent with expected profit-maximization that would arise in a non-cooperative equilibrium. Further, we demonstrate that firms could have elevated their static expected profits by unilaterally bidding more aggressively in the wholesale market on days where Capital Power was employing its unique offer pattern. These findings suggest that either firms do not behave in a manner consistent with static expected profit maximization or the information revealed in the HTR facilitated higher wholsale market prices via the establishment of an observable high-priced offer shelf and subsequent economic withholding by another large strategic player.

Conclusions

Our analysis raises caution to regulators when undertaking policies that increase information disclosure in concentrated electricity markets where firms interact repeatedly. While a certain degree of information disclosure can help firms form expectations about future market prices, it can also lead to concerns that firms are utilizing this information to coordinate on higher market prices. Consequently, our findings support a balanced approach to information disclosure such as providing aggregated information of firms' unit availability and bidding behaviour (e.g., by publishing the amount of generation in certain price-bands), improving the system operator's price, market-demand, and wind forecasts, and providing detailed information on generation unit outages in near real-time.

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