COMPETITION AND EFFICIENCY IN ALBERTA'S ELECTRICITY FUTURES MARKET

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Overview

Alberta has operated an energy-only electricity market for more than two decades. It has sought to incentivize investment by explicitly permitting non-cooperative or unilateral exercise of market power to provide for fixed cost recovery and address the 'missing money' problem. Many other jurisdictions have mandated a capacity market to address this issue. Such market designs have become increasingly complex administratively and some jurisdictions and regulators (including FERC) are reconsidering the wisdom of relying heavily on the capacity market construct. On the other hand, events in Texas may lead to increased scrutiny of energy-only market design. A thorough understanding of the Alberta market design, industry structure, and the efficacy of relatively light-handed regulation, is invaluable for informing the evolution of electricity markets worldwide, particularly as energy systems decarbonize.

An important component of the Alberta market design is a vigorous futures market in which buyers can protect themselves against high prices and sellers can secure revenue streams. In the absence of a capacity market, futures markets comprise an important mechanism for signalling and supporting investment, thereby promoting resource adequacy and dynamic efficiency. They also contribute to competitive price formation through the reduction in incentives for the exercise of market power in the spot market.

This paper considers competition, efficiency, and liquidity in Alberta's electricity futures market. Our analyses are organized along two broad strands. The first investigates the relationship between futures and spot prices; the second models the evolution of futures prices as the date of delivery approaches. In both cases, the inability to store electricity in a cost-effective manner is fundamental to the economics of these markets.

Methods

We have assembled a uniquely rich dataset of about 12,000 observations on monthly flat contracts with delivery periods that correspond to the 156 months from April 2008 to March 2021. Given that liquidity increases in the year preceding delivery, most of our analysis focuses on trades during this period.

Economic theory posits an equilibrium relationship between futures and expected spot prices. Discounting aside (non-storability means that there are no relevant carrying costs), risk aversion may mean that futures prices will not equal expected spot prices. More importantly, from an empirical perspective, expected spot prices are unobserved. Notwithstanding this, there is a substantial literature that compares futures prices to subsequently observed spot prices.

We consider various tests of market efficiency, the simplest being of the 'unbiasedness hypothesis'. The underlying idea is to assess whether the futures price at time t for delivery period T, $F_{t,T}$ provides an unbiased forecast of S_T the spot price in period T:

$$S_T = \beta_0 + \beta_1 F_{t,T} + \varepsilon_t. \tag{1}$$

We test the unbiasedness hypothesis for various intervals in advance of delivery.

Embedded within futures prices are expectations of spot market conditions. We therefore augment equation (1) with variables X_t that reflect changes in forecasts or expectations. These include information about the realizations of variables such as weather, supply and transmission outages, and natural gas prices (a key input cost). To the extent that realizations of these variables differ from forecasts, the futures price would have inaccurately forecast the observed spot price. Put another way, the futures price is a forecast of expected conditions not realized conditions. The augmented model takes the form:

$$S_T = \beta_0 + \beta_1 F_{t,T} + X_t'\boldsymbol{\theta} + \varepsilon_t \tag{2}$$

We expect that variables that are more predictable are more likely to be statistically significant than variables that cannot be accurately forecast. In particular, natural gas is a storable commodity (and is therefore subject to intertemporal price arbitrage) that trades in a highly liquid market of its own. To the extent that natural gas prices in the delivery month are say higher than forecast at the time the electricity futures traded, then subsequent spot prices will exceed futures prices. The deviation of observed natural gas prices from forecasts may explain some of the variation of the observed spot price that is not explained by the futures prices.

Futures prices are affected by expectations of conditions during the delivery month. They may also be affected by current market conditions to the extent that these may inform future expectations. Our basic model is:

$$\begin{aligned}\log\left(F_{t,T}\right) = \alpha_0 + MO_t\delta + \beta_1 lavg_t + \beta_2 \text{lvar}_t \\ + \beta_3 lfpng_{t,T} + \beta_4 lfoutage_{t,T} + \beta_5 lfatc_{t,T} + \beta_6 bp_{t,T} + \varepsilon_t\end{aligned} \quad (3)$$

where *MO* is a vector of monthly dummies; *lavg* and *lvar* are the mean and coefficient of variation for current 30-day spot prices; *lfng, lfoutage, lftc* are forecasts of natural gas prices, outages, transfer capacity; and *BP* is the balancing pool share in the delivery month. Variables beginning with *l*, are in logarithmic form.

Results

Our findings indicate that (i) futures prices very near to delivery provide an unbiased forecast of spot prices, (ii) this holds even in the non-augmented model (1), suggesting that most relevant information about the delivery period is known just before it begins, (iii) the forecast becomes more precise as the time to delivery decreases, (iv) certain information that is realized after futures prices have been determined, is statistically significant in explaining differences between futures prices and spot prices in the delivery period, and (v) we can distinguish the expected spot price from the observed spot price.

We also find robust statistical evidence that futures prices are affected by levels and variation in current spot prices. (Higher order moments are insignificant.) While this would not be unusual for a storable commodity, it is somewhat surprising for electricity. This is because non-storability has the effect of rendering each contract, corresponding to a distinct delivery period, to be a separate product with limited or no substitutability.

Conclusions

The energy-only design makes the Alberta electricity market particularly useful for informing discussion of the evolution of electricity markets. Due to the absence of a capacity market, the futures market plays an important role in reducing investor risk. Further, compared to most electricity markets, the offer strategies of Alberta market participants are subject to relatively little regulation, with greater reliance on, and confidence in the role of competition. This heightens the importance of futures markets in both reducing and modulating the exercise of market power, and in providing large consumers and retailers with options to hedge their cost risk.

The findings lend support to a conclusion that the Alberta futures market is competitive and makes efficient use of information. As electricity markets transition to greater use of intermittent, non-emitting resources, these characteristics are highly desirable in markets where necessary investments are made by competitive firms without explicit contracts or directions from government or government entities.

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