

## Price instability in multi-unit auctions

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The deregulation of wholesale electricity markets started more than 20 years ago, and ever since then there has been a dispute amongst researchers over the degree of price instability in electricity markets. We develop a new theoretical model that allows us to analyse this issue in greater detail. We predict that price instability is significant when demand is high and that price instability is negligible when demand is low.

Deregulated wholesale electricity markets around the world are organised in a similar way. Each producer chooses a supply function that indicates how much it is willing to produce at different prices. A producer is willing to produce more when the price is high, as it then becomes profitable to allow plants with a high cost to produce electricity. If the cost of a plant increases, e.g. due to higher fuel prices, then the producer will offer its power at a higher price in the electricity market. Prices are unstable when minor changes in costs have a large impact on the price.

Some researchers argue, based on theoretical studies of wholesale electricity markets, that the price instability is very pronounced, while other researchers have argued the opposite. This dispute has been on-going for more than 20 years. In this study we present a new and more detailed theoretical analysis of wholesale electricity markets and similar multi-unit auctions. Our analysis shows that the price instability is low when competition in the market works well, so that prices are near the marginal cost of producing electricity. This is the case for most electricity markets when demand is low. On the other hand, mark-ups can be huge during the rare events when demand approaches production capacity in the market. In such cases, we predict that price instability can lead to price volatility with a magnitude between 1% and 10% of the spot price.

Price instability is unfortunate as it introduces unnecessary uncertainty in the market. Based on our study we can identify improvements in the market design that will reduce price instability. One source of price instability is the bidding format that is determined by the market operator and which producers use when offering supply.

The bidding format typically requires that each producer specifies its supply function by means of a list of price-quantity-pairs, where the quantity of a pair indicates how much the producer is willing to produce at the price of the pair. We show that the price instability is reduced if the bidding format allows for more price-quantity pairs, so that producers can specify their supply functions with a higher degree of precision.

The bidding format also determines which price levels and quantity levels are allowed when producers specify their supply functions. The tick-size is the difference between two valid neighbouring price levels and the lot-size is the difference between two valid neighbouring quantity levels. Both this study and previous ones indicate that bidding formats with large tick-sizes and small lot-sizes reduce price instability in wholesale electricity markets.

Price instability can also occur due to technical constraints and non-convex costs in the production technology, and such price instability is more difficult to address.

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