



# Multi-unit auctions with uncertain supply and single-unit demand

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**Wholesale electricity markets around the world are cleared by a uniform-price auction. Pay-as-bid auctions are often used when system operators procure ancillary services for electric-power systems. In this paper, we show that uniform pricing is often a preferable format. But in practice, prices are sometimes at the collusive level in uniform-price auctions. We show how such outcomes can be avoided.**

We study a multi-unit auction, where bidders have access to different information. We simplify the problem by assuming that all bidders have a small size, so that they nearly lack market power. We allow the procured volume of the auctioneer to be uncertain.

Under our assumptions, we find that electricity prices would be lower with uniform pricing compared to pay-as-bid pricing. Electricity prices would be even lower if the market is more transparent. For example, disclosure of historical bid data would, under our assumptions, contribute to lower electricity prices.

But there is a catch, uniform-price auctions can, depending on the circumstances, have multiple equilibria. Some of them can lead to prices at the collusive level. In practice, this problem has for example frequently been observed in auctions procuring production capacity in the U.S.

We find that problematic equilibria in uniform-price auctions can exist, even if producers have a small size, one plant each. We identify circumstances where uncertainty in the traded volume of the auctioneer is sufficient to get a unique equilibrium, which is well behaved. Under such circumstances, a well-chosen price floor or price cap would also give a unique equilibrium.

There are circumstances where the introduction of a price floor (minimum price) would counter-intuitively lead to lower prices when capacity is procured. This is possible as a price floor can knock out problematic equilibria in uniform-price auctions. Under more general

circumstances, an auctioneer needs to introduce both a price cap and a price floor to get a unique equilibrium. We also show that price-sensitive demand can be used to give a unique equilibrium.

Our study considers the case where bidders have limited market power. If bidders have significant market power, then a large elasticity with respect to the price or large uncertainty in the supply of the auctioneer is likely to be needed to avoid prices at the collusive level in uniform-price auctions. Similarly, if bidders have significant market power, then price caps and price floors would have to be more restrictive than in our model to ensure a unique equilibrium.

The implications are similar for the related multi-unit auctions that central banks and treasuries organise to trade securities.

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