Strategic Bidding in Multi-unit Auctions with Capacity Constrained Bidders: The New York Capacity Market

Sebastian Schwenen, DIW Berlin

Belec, DIW Berlin, May 2015

Motivation

- Looking inside capacity markets: Offer a model-based analysis of bidding behavior.

- Applying the model to data from the NY capacity market, show that strategic firm behavior in capacity markets can lead to high rent extraction from generating firms.

- Offer novel empirical support for a class of models for multi-unit uniform price auctions (Fabra and von der Fehr, 2006).

Capacity markets

- Regulatory tool to stimulate investment in power markets.
- Some academics, policymakers, industry claim investment not sufficient, for many reasons.
- Capacity markets new in UK, FR, IT; discussed in German coalition treaty; in US since the early 2000's.
- The product traded is availability of power plants, for a specified time-horizon.
- In NY, capacity products procured by system operator (SO), on behalf of consumers (costs are passed on).

NYISO Market

Figure 1: NYISO Market.

- Nodal (zonal) energy market
- Automated market power mitigation
- Three (four since 2014) regional capacity markets
- Bid caps on capacity markets (summer / winter)
- Capacity forwards have to be notified to the ISO

Demand for capacity is constructed by ISO

Example demand curve:

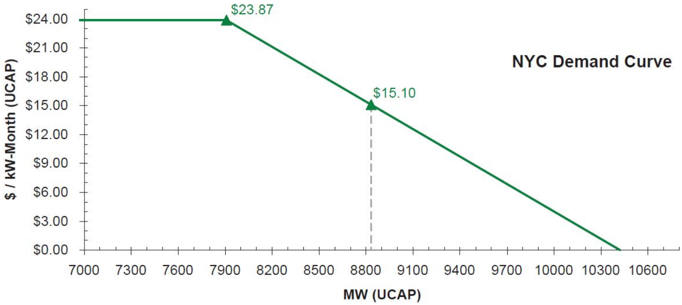

Figure 2: Capacity demand curve (ICAP) in NYC, winter 2006/07.

- Demand curve is applied for six month
- Spot auctions are conducted monthly

Market & data: The NYC capacity market

- 55 monthly multi-unit uniform price procurement auctions
- June 2003 until February 2008
- 1085 bids
- Bidder ID, functional form of demand, bid caps
- Data available at www.nyiso.com

	Mean	Min	Max
Number of bidders	15.3	3	35
Number of bids	19.7	4	63
Offer share largest firm	66.5%	35.8%	85.3%
Offer share two largest firms	88.0%	66.3%	99.8%
Offer share three largest firms	93.7%	83.7%	100%

Table 1: Auction statistics.

The model

- Firms offer their capacity k at price-bids b_j.
- SO sorts bids b_j in increasing order...
- and finds clearing bid b_p (pivotal bid needed for $\sum k \geq D$).
- Marginal costs normalized to zero (we observe zero bids).
- Framework relies on Fabra et al (2006), with capacity constraints
  a. one large firm clears the auction, setting b_p, earning some π_p
  b. competing firms bid low enough (below $\bar{b}_j$) such that for firm p undercutting is not profitable.

Results: example auction outcome

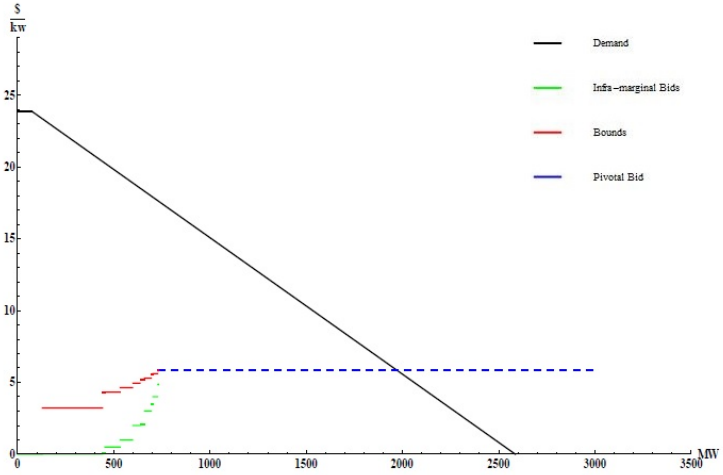

Figure 3: Auction April 2007 with bounds for inframarginal bids.

Results: The pivotal bidder

- The pivotal bid equals the bid cap in all auctions.
- In all auctions the largest bidder is the pivotal bidder.
- The pivotal bidder bids all its capacity at b_p.
- Sales and unsold capacity vary across auctions.

Results: Infra-marginal bidders

- Roughly 95 % of all low bids are explained by the model.
- Much violations happened in the first five auctions: learning?
- Low bids were mainly submitted either at zero or just below the bound.

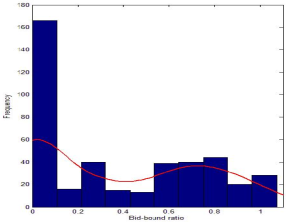

Figure 4: Histogram bid-bound ratio.

Best-response function regressions

OLS regressions for best response functions of low bids:

- The pivotal bidder earns π_p.
- When undercutting, this bidder sells either all capacity, k_p,
- or serves residual demand at a lower price, $D(b_j) - K_{j-1}$.

Coming from the model, estimate:

$$ln(b_j) = \beta_0 + \beta_1 ln(\pi_p) + \beta_2 ln\left(D(b_j) - K_{j-1}\right) + ...$$

$$ln(b_j) = \beta_0 + \beta_1 ln(\pi_p) + \beta_2 ln(k_p) + ...$$

Results: Best-response function regressions

Low bids react to the pivotal bidder's capacity:

	(1) $ln(b_j^W)$	(2) $ln(b_j^L)$	(3) $ln(b_j^L)$	(4) $ln(b_j^L)$
$ln(\pi_p)$	1.751***	1.094***	0.862***	1.583***
	(0.0945)	(0.0582)	(0.0333)	(0.0524)
$ln(\bar{k}_p)$	-2.761***			
	(0.0750)			
$ln(a)$	0.793***	0.0855	0.0865**	0.154***
	(0.0916)	(0.0569)	(0.0289)	(0.0445)
D_s	-0.453***	-0.140*	-0.0320	-0.375***
	(0.0698)	(0.0616)	(0.0224)	(0.0495)
$ln(D(b_j) - K_{j-1})$		-1.724***	-0.927***	-2.497***
		(0.0460)	(0.0495)	(0.0579)
β_0	-0.168	3.877***	0.224	4.660***
	(1.191)	(0.672)	(0.202)	(0.526)
N	85	336	80	239
adj. R^2	0.961	0.906	0.983	0.924

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Conclusion

- When firms are capacity constrained, coordination on pivotal bidder seems simple.
- Inframarginal firms can react with their bids to maintain this equilibrium over different auctions.
- From a consumer/antitrust perspective, capacity markets cannot be recommended to enhance security of supply.
- Remedies are difficult to implement: DCA? Bid floors? Price Caps?

Thank you for your attention.

sschwenen@diw.de

Appendix: The model

The pivotal bidder finds

$b_p^* = \min\{\arg\max_b b\left(D(b) - K_{p-1}\right), b^{cap}\}$,

while the low bidders have to bid lower than

$$\bar{b}_j := \begin{cases} b_j\left(D(b_j) - K_{j-1}\right) = \pi_p & \text{if } \bar{k}_p > D(b_j) - K_{j-1} \\ b_j \bar{k}_p = \pi_p & \text{if } D(b_j) - K_{j-1} > \bar{k}_p. \end{cases}$$

to not be underbid by the pivotal bidder.

Appendix: Low bid profit equivalence

- There is no significant relation between amount of capacity bid and distance to its bound.

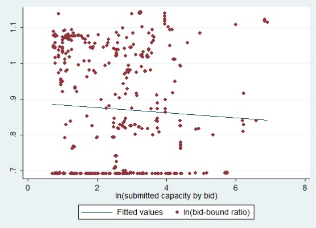

Figure 5: Bid-bound ratio over submitted capacity.

Appendix: Results pivotal bids

- The bid cap is binding in nearly all auctions.

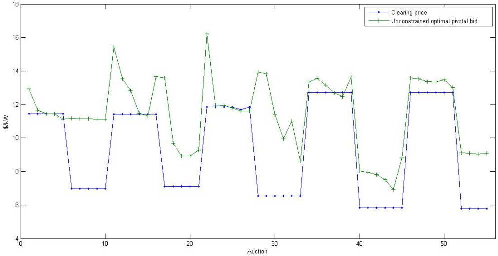

Figure 6: Unconstrained optimal and observed high bids.

Appendix: Counterfactuals

- With truth-telling (or no withholding), the auctioneer could have saved around 40% of procurement costs while at the same time procuring more capacity.

- With properly adjusted bid floors, the observed equilibria can be destroyed and auction prices lowered.