Modeling the wind auctions as a participation game

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Consider the following case

- To enter to an industry:
  - need to win a license in an auction
  - To enter the auction: considerable (sunk) bid preparation costs
• Renewables were supported by feed-in tariffs in many EU countries
  - big drawbacks (costly and hard to control)

• New system by auctioning the support in a reversed auction
  - Limited number of “support units”
  - Win support units by bidding the price you would like to have guaranteed for your project
Focus on German auctions for support to onshore wind (EEG 2014)

- Bid eligibility requirement
  - permits necessary for the realization of the project.
  - form of (sunk) bid preparation costs
  - can be up to 10% of total project cost!

Bid preparation costs is a well-known phenomena

- Recent case: British printing firm De La Rue
  - lost bid for printing order of new UK passports
  - profit warning, due to the large bid preparation costs.
  - £4m for contract of £490m -> 0.8%!
The model - setup

Stage 1

- The Auctioneer announces an auction with $U$ units and CAP price.
- $N$ potential bidders decide simultaneously whether to enter and pay $\delta LFC$.
- Mixed strategy: each potential bidder enters with probability $q$.

Stage 2

- $n$ actual bidders entered (common knowledge).
- Other bidders receive outside option $OO$.
- Actual bidders bid in an reverse
The model - solving

**Stage 1**
- There are $N$ potential bidders
- Bidder enters with probability $q$

$q^* : \Pr[n \leq U | q] \cdot \pi^H + \Pr[n > U | q] \pi^L = OO$

**Stage 2**
- $n$ bidder entered
- If
  - $n \leq U : b_{CAP}$
  - $n > U : b_{MC + (1-\delta)LFC}$

$\pi^H = CAP - MC - LFC$

$\pi^L = -\delta \cdot LFC$
$$\alpha[q] = \sum_{n=1}^{U} \left( q^{n-1} (1 - q)^{N-n} \right) \binom{N - 1}{n - 1}$$

$$\Pr[n \leq U \mid q] \cdot \pi^H + \Pr[n > U \mid q] \pi^L = OO$$
The simulation

Simulation parameters

- \( N = 30 \) (potential bidders)
- \( U = 1, \ldots, 25 \) (units on sale, varies)
- \( MC = 5 \)
- \( CAP = 100 \)
- \( \delta = 10\% \)
- average of 50 000 draws

**FIXED**

- \( LFC = 40 \)

**DISTRIBUTION**

- \( LFC \) i.i.d. \([30, 50]\)
Fixed costs identical  \( \text{CAP} = 100 \)

- Equilibrium bid + lcost
- Equilibrium bid
- Lcost (UPA without)
\[ \text{CAP} = 100 \]

Fixed costs iud [30, 50]

- Equilibrium bid + lcost
- 均衡投标 (Equilibrium bid)
- Lcost (UPA without)

\[ \frac{U}{N} \cdot 100 \]
$CAP = 100$

Probability $q$

- Red line: Fixed costs identical
- Blue line: Fixed costs iud

$x = \frac{U}{N} \cdot 100$
Units in excess rel. to units used

\[
\frac{E[\max(0, n - U)]}{E[\min(U, n)]} \cdot 100
\]
• Decreasing CAP may help?
Fixed costs identical

**CAP = 100**

- Equilibrium bid + lcost
- Equilibrium bid
- Lcost (UPA without)

Fixed costs identical

**CAP = 60**

\[ \frac{U}{N} \cdot 100 \]
Decreasing CAP may help?

- Lowers cost
- Increases cost of non-build capacity due to potential shortage of entry
• Pre-investment costs only 1%
Fixed costs identical

Equilibrium bid + lcost
Equilibrium bid
Lcost (UPA without)

Probability $q$

$\delta = 0.01$

Fixed costs iid [30, 50]
• Conclusion

- Theory predicts that sunk pre-investment in an auction:
  • Creates a stochastic process of entry
  • Excess entry \rightarrow increases auction price, wasted sunk costs
  • Shortage of entry \rightarrow unimplemented projects
  • This results to higher bids than the same auction without pre-investment

- Lowering the CAP price
  • Reduces excess entry
  • Increases shortage of entry

- Lowering the pre-investment
  • Lowers excess entry and shortage of entry
  • Make auction closer to an ideal case (solar vs. wind)
If anybody wants to know:
- **Assumptions**
  - One-shot game
  - UPA instead of DA
  - Single-unit demand

\[ \alpha[q] = \sum_{n=1}^{U} \left( q^{n-1}(1-q)^{N-n} \right) \binom{N-1}{n-1} \]

\[ \alpha[q^*] \cdot u \left[ \pi_P^H + W \right] + (1-\alpha[q^*]) \cdot u \left[ \pi_P^L + W \right] = u[OO+W] \]
<table>
<thead>
<tr>
<th>Symbol</th>
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<tr>
<td><strong>Exogenous variables</strong></td>
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<tr>
<td>$U$</td>
<td>Capacity on auction</td>
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<tr>
<td>$N$</td>
<td>Population of potential bidders</td>
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<tr>
<td>$LFC$</td>
<td>The levilized fixed cost for the full project</td>
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<td>$MC$</td>
<td>Marginal cost of producing (assumed constant)</td>
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<tr>
<td>$\delta LFC$ (where $0 &lt; \delta &lt; 1$)</td>
<td>The (administrative) cost of entry in the auction auction</td>
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<td>$CAP$</td>
<td>A price cap set by the regulator</td>
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<td>$OO$</td>
<td>The outside option of the potential bidders</td>
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<td>$VOUL$</td>
<td>Value Of Uncontracted Load</td>
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<tr>
<td>RA</td>
<td>risk aversion parameter in the utility function $u[x] = x^{RA}$</td>
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<tr>
<td><strong>Endogenous variables</strong></td>
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<tr>
<td>$n$</td>
<td>The number of actual bidders</td>
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<tr>
<td>$q$</td>
<td>Probability of entering (endogeneous)</td>
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<tr>
<td>$\alpha = P[n \leq U</td>
<td>M, q]$</td>
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