Price guarantee and subsidy in windfarm auctions

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Wind power

- Worldwide challenge ahead: renewable-energy transition
- Wind power is an important renewable-energy technology
- Governments worldwide have opened locations for wind farms
- Aims: Promoting wind energy, efficiency, transparency, revenue
- Tool: Auctions (globally, 2.17 GW in Q2 2020)
  - US: cash auction (ascending clock)
  - UK: contract for difference auction, royalty+cash auction (pay-as-bid)
  - Germany: strike price auction (pay-as-bid)
How to auction wind farm licenses?

Auction design problem
• Selecting the most cost-efficient electricity producer
• Inducing the winning electricity producer to build and maintain the windfarm

Policy instruments
• Price guarantee
• Price subsidy

Method
• Lab experiment
Our setting mimics real-life features of wind-farm auctions

• Uncertain electricity price in the future, which implies uncertain revenue for bidders
• The winner invests before knowing the electricity price
• Bidders face a common uncertainty about how costly it is to build the windfarm
• Bidders differ in production efficiency
• Bidders are protected by limited liability
Our setting

- $n$ bidders
- First-price sealed-bid auction (pay-as-bid)
- Bidder $i$’s payoffs when winning: $pq_i - \frac{(q_i)^2}{2\gamma_i} - X$
- Fixed costs $X = \frac{1}{n} \sum_{i=1}^{n} x_i$
  - $x_i$: bidder $i$’s private signal about the fixed costs
  - $x_i \sim U[0,300]$ i.i.d.
- Productivity $\gamma_i$ private information
  - $\gamma_i \sim U[6,10]$ i.i.d.
- Electricity price $p \sim U[10,20]$
Experimental design

<table>
<thead>
<tr>
<th></th>
<th>No price guarantee</th>
<th>Price guarantee</th>
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<tbody>
<tr>
<td>No subsidy</td>
<td>$p \sim U[10,20]$</td>
<td>$\bar{p} = 15$</td>
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<tr>
<td>Subsidy</td>
<td>$p + s \sim U[13,23]$</td>
<td>$\bar{p} + s = 18$</td>
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- Between subjects
- Fixed groups, $n = 3$, 16 groups per treatment (4x16x3=192 participants)
- 25 rounds
- Subjects start with an endowment €12
- Bidder’s payoff = max {endowment + earnings over 5 random rounds, €4}
Hypotheses (based on risk averse bidders)

- The government’s expected payoff: \( G = E\{\lambda q + b^{(1)} - sq\} \)
- Subsidy: \( s = 3, \lambda = 7 \)
- H1: \( G \) is greater with subsidy than without
- H2: \( G \) is greater with price guarantee than without
First glance at the data
First glance at the data
First glance at the data
First glance at the data

Variance of government payoff

<table>
<thead>
<tr>
<th></th>
<th>NSNG</th>
<th>NSYG</th>
<th>YSNG</th>
<th>YSYG</th>
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<tbody>
<tr>
<td>Mean</td>
<td>266</td>
<td>202</td>
<td>210</td>
<td>206</td>
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Conclusion (preliminary)

- **Government payoff** greater with **price guarantee**
  - The price guarantee boosts efficiency
  - The price guarantee boosts bids

- **Government payoff** only greater with **subsidy** in the case of a price guarantee

- The price guarantee and the subsidy combined dampen **government payoff volatility**

- The auction + price guarantee + subsidy is easy to implement and may revolutionize the way in which windfarm locations are allocated