Simple-Offer vs. Complex-Offer Auctions in Deregulated Electricity Markets

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Motivation

- In April 2003 the U.S. Federal Energy Regulatory Commission proposed the *Wholesale Power Market Platform (WPMP)* for adoption by all U.S. wholesale power markets.
  - Envisions day-ahead, real-time, and ancillary service markets maintained by an ISO or RTO.

- White Paper: “The Federal Energy Regulatory Commission’s core mission under the Federal Power Act is to achieve wholesale electricity markets that produce just and reasonable prices and work for customers.”
Motivation

- The summer 2000 meltdown in the California wholesale power market is thought to have resulted in part from strategic generator behaviors encouraged by inappropriate market design features.
Motivation

Unconstrained Day-Of/ Hour-Ahead Market

<table>
<thead>
<tr>
<th>Hour</th>
<th>Price ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 June 2000 (M)</td>
<td>$500 - $800</td>
</tr>
<tr>
<td>27 June 2000 (T)</td>
<td>$1,000 - $1,200</td>
</tr>
<tr>
<td>28 June 2000 (W)</td>
<td>$1,200 - $1,000</td>
</tr>
<tr>
<td>29 June 2000 (T)</td>
<td>$500 - $800</td>
</tr>
<tr>
<td>30 June 2000 (F)</td>
<td>$500 - $800</td>
</tr>
</tbody>
</table>
Some Questions

• What market design features foster competitive behavior in the market?

• How different market rules affect outcomes if a market becomes more concentrated?

• Do competing suppliers end up offering their actual electricity generation costs?
Objective

• To compare the performance of two auction mechanisms – a complex offer auction and a simple offer auction - when suppliers act strategically.

• Criteria:
  – Price to consumers
  – Efficiency
  – Price volatility
  – Risk of losses
Overview of Wholesale Power Markets in the U.S.

• ISOs run daily auctions to allocate generation contracts to the suppliers of electric power:
  1. Suppliers submit complex-offers to the ISO
     – Offer structure: quantities, energy prices, plant start-up fees, and technical constraints.
  2. Buyers (LSEs) submit bids to the ISO.
  3. An ISO runs a market clearing algorithm that allocates generation contracts ensuring that the system demand and reserve requirements are met over a particular time period.
  4. Each selected supplier is paid his offered start-up fees and the market clearing price - MCP - (not the offered price!) for supplied units of electricity.

• It is a uniform-price sealed complex-offer auction.
Allocation Algorithms

1. Traditional Offer Cost Minimization (OCM)

2. Simple Offer Auction (SOA)
Offer Cost Minimization Auction

- The ISO minimizes the total offered cost of electricity, as if all selected sellers would be paid their offered prices and fees.

- *Sequentially*, after the offers are selected, a uniform MCP is determined as the highest accepted price for that period.

- All selected sellers receive their individual start-up fees and the uniform market clearing price for the supplied electricity during that period.
Simple Offer Auction

- The sellers can recover their generation costs – both fixed and variable – only through a uniform MCP.
- The ISO minimizes the total offered cost.
- Concerns about possible losses.
Environment: Supply
Environment: Off-Peak Demand

Price

“Must serve” Demand

Off-peak Demand

Supply (ATC)

Demand

Environment: Off-Peak Demand

Price

“Must serve” Demand

Off-peak Demand

Units

E E F G G
S3 S4 S6 S5 S2

H

S1

S4

Supply (ATC)

E E F G G
S3 S4 S6 S5 S2

H

S1

S4

Supply (ATC)

Environment: Off-Peak Demand

Price

“Must serve” Demand

Off-peak Demand

Units

E E F G G
S3 S4 S6 S5 S2

H

S1

S4

Supply (ATC)

Environment: Off-Peak Demand

Price

“Must serve” Demand

Off-peak Demand

Units

E E F G G
S3 S4 S6 S5 S2

H

S1

S4

Supply (ATC)
Environment: Shoulder 1 Demand

“Must serve” Demand

Interruptible Demand

Supply (ATC)

Demand

Interruptible

Demand

Supply 

(ATC)

Units

Price

280

240

200

160

120

80

40

S1

S2

S3

S4

S5

S6

E

E

F

G

G

S3

S4

S6

S5

S2

A

A

B

C

D

D

S4

S5

S6

Shoulder Demand

S1

S4
Environment: Peak Demand
Environment: Demand & Supply

- **Demand & Supply**

- **Interruptible Demand**

- **Off-peak Demand**

- **Shoulder Demand**

- **Peak Demand**

- **Must serve** Demand

- Supply (ATC)
Treatments

- Experimental Design (No. of Sessions; No. of Trading Days per Session)

<table>
<thead>
<tr>
<th></th>
<th>OCM</th>
<th>SOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Power</td>
<td>(4; 53)</td>
<td>(4; 53)</td>
</tr>
<tr>
<td>Power</td>
<td>(4; 53)</td>
<td></td>
</tr>
</tbody>
</table>
Findings: OCM/No Power

Day

Price

OCM 1
OCM 2
OCM 3
OCM 4
OCM price when true cost revealed
Maximum 100% efficient price
Off-peak
Shoulder 1
Shoulder 2

OCM/No Power
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280

Findings: OCM/No Power
Findings

1. The OCM auction does not elicit true cost telling, with an exception of shoulder 2 periods.

2. The supracompetitive buyer prices in the OCM auction are due to the heightened offers on both start-up fee and seller price dimensions.
Environment: Market Power

"Must serve" Demand

Interruptible Demand

Off-peak Demand

Shoulder Demand

Transfer of Ownership to Create Market Power

Supply (ATC)

Price

Units
Findings: OCM/Power

OCM/Power 1
OCM/Power 2
OCM/Power 3
OCM/Power 4
OCM price when true cost revealed
Maximum 100% efficient price

Day
Price

Off-peak
Shoulder 1
Shoulder 2
Peak
Findings

3. The buyer prices in the *No Power* treatments approach the prices in the *Power* treatments in a complex offer auction.
Environment: Demand & Supply

Price

“Must serve” Demand

Interruptible Demand

Off-peak Demand

Shoulder Demand

Peak Demand

Supply (ATC)

Units

A

B

C

D

E

F

G

H

S1

S2

S3

S4

S5

S6

2 4 6 8 10 12 14 16 18 20 22 24

40 80 120 160 200 240 280
Findings: SOA/No Power

- Off-peak
- Shoulder 1
- Shoulder 2
- Peak

Graph shows the price (y-axis) over time (x-axis) for different periods and scenarios.
Findings

4. The SOA results in lower buyer prices than the OCM.
Conclusions

• The good intentions of the complex offer auction are to help recover the avoidable fixed costs and reasonably appear to be benign, but the unexamined assumption of policy that people truthfully reveal their costs in a competitive environment have unintended consequences.
Conclusions

• The complex offer auction is not a truth revealing mechanism and does not easily elicit competitive behavior.

• The simple offer auction generates less strategic behavior and results in lower electricity prices than the complex offer auction.
Conclusions

• Keep market institutions simple!

• Allowing market participants to reveal more information and trying to make use of that information also opens more opportunities to act strategically.

• If there is a way to strike it rich, the market participants find it.
Let’s take a look at your data!