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Original title on 712 A/B: An Experimental Analysis of the Relative Efficiency of Alternative Assignment Auction Formats

Revised title: Same as above

Presented in (input and Bold one): (WG20), CG__, Special Session ___, Poster, Demo, or Tutorial):

This presentation is believed to be:  
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE
An Experimental Analysis of the Relative Efficiency of Alternative Assignment Auction Formats
An Experimental Analysis of the Relative Efficiency of Alternative Assignment Auction Formats

R. Wesley Nimon, PI

Achieving Human Resource Solutions Through Innovative Research
Efficiency and Auction Design Research

• Basic Research Addresses a Few Fundamental Questions
  - How and what weight to apply to the Sailor’s bid?
  - Does contention level matter?
  - Which auction format is more efficient? (1\textsuperscript{st} vs. 2\textsuperscript{nd} Price)
Background

• Developed experimental software environment
  › Results to empirically inform the auction design

• Conducted experimental auctions
  › Southern Methodist University
  › University of Mississippi
  › University of Memphis
Basic Structure of the Experiments

- Subjects are presented with list of jobs
- Total Score = Fitness Score + Bid Score
- Optimization across Total Scores determines assignments
- For each job the bidder’s reservation wage (RW) is given
- For the awarded job the subject receives Gamebucks = Bid-RW
- Subjects exchange their Gamebucks for US dollars at a pre-announced exchange rate. This is their payment.
Experimental Auction Environment
Subject’s Screens
Bid On Job in Auction

<table>
<thead>
<tr>
<th>Job ID</th>
<th>Fitness Score (Points/80)</th>
<th>My Minimum Bid</th>
<th>Maximum Allowable Bid</th>
<th>My Bid</th>
<th>Total Score (Points/100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job 1</td>
<td>56</td>
<td>25</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Job 2</td>
<td>52</td>
<td>25</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Job 3</td>
<td>52</td>
<td>40</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Job 4</td>
<td>40</td>
<td>40</td>
<td></td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Job 5</td>
<td>52</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Choose your Bid - Job 1

Amount of Bid (GameBucks)

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

Total Score with this Bid (Points)

My Current Bid: 45  My Current Total Score: 67

If you win this job with this bid, you will receive $2

Save Bid  Cancel

All Possible Minimum Bids

<table>
<thead>
<tr>
<th>Job 1</th>
<th>Job 2</th>
<th>Job 3</th>
<th>Job 4</th>
<th>Job 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>25</td>
<td>40</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>20</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>35</td>
<td>50</td>
<td>35</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>15</td>
<td>40</td>
<td>45</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>15</td>
<td>40</td>
<td>45</td>
<td>45</td>
<td>40</td>
</tr>
</tbody>
</table>

All Possible Fitness Scores (max 80)

Job 1  Job 2  Job 3  Job 4  Job 5

| 64 | 48 | 56 | 48 | 48 |
| 44 | 52 | 52 | 40 | 52 |
| 56 | 52 | 52 | 40 | 52 |

Summary (Min, Avg, Max)

Min  Avg  Max

Job 1  Job 2  Job 3  Job 4  Job 5

| 20 | 25 | 40 | 30 | 20 |
| 24 | 33 | 32 | 40 | 36 |
| 50 | 50 | 40 | 50 | 50 |
Cumulative payment to date (including Game Money of $15): $16.50
First Price, Low Contention Auctions

Table 2
First Price, Low Contention, Winning Bids

```
Bid Weight (%)
0 20 40 60 80 100

(Avg. Bid/RW -1)*100
0 20 40 60 80 100

Memphis  OleMiss  SMU
```
Data

- 900 observations
- Only winning bids were used
- Initial rounds were excluded to account for improved level of task understanding

\[
\frac{\text{Bid}}{\text{RW}} = \hat{\beta}_0 + \hat{\beta}_1 (\text{Auction Round #}) + \hat{\epsilon}.
\]

- Parameterization of Experiments
  - High (3 jobs/6 bidders) to Low (5 jobs/6 bidders) Contention Level
  - Bid Weights: 10%, 20%, 33%, 50%, 66%, & 80%
  - First Price
Regression Model Estimated

\[ \text{Bid} = \beta_0 + \beta_1 \text{Contention} + \beta_2 \text{Memphis} + \beta_3 \text{Mississippi} + \beta_4 (\text{BidW})^{-1} + \beta_5 \text{RW} + \beta_6 \text{FS} + \epsilon \]

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Intercept</th>
<th>Contention</th>
<th>Memphis</th>
<th>Mississippi</th>
<th>(BidW(^{-1}))</th>
<th>RW</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.36</td>
<td>-24.42</td>
<td>0.07</td>
<td>1.05</td>
<td>12.51</td>
<td>0.759</td>
<td>0.146</td>
</tr>
<tr>
<td></td>
<td>2.99***</td>
<td>14.87***</td>
<td>0.13</td>
<td>1.47</td>
<td>12.9***</td>
<td>25.03***</td>
<td>4.08***</td>
</tr>
</tbody>
</table>

First Price Auctions
Dependent Variable: Bid
Rsquare = 0.63
Elasticity Estimates

• Bid to Bid-Weight Elasticity (Low Contention)

\[ \varepsilon_{\text{Bid}, \text{BidW}} = -0.35 \text{ and } -0.10 \]

at 10% and 50% Bid-Weights, respectively

- Increase in Bid Weight from 10% to 50%
  › Approximately a 28% reduction in bid amounts
Assessment of Market Power

\[ \text{Bid} = \hat{\beta}_0 + \hat{\beta}_1 (RW) + \hat{\beta}_2 (Fitness) + \varepsilon . \]

<table>
<thead>
<tr>
<th>Factors Limiting Market Power</th>
<th>Coefficient on the Fitness Score</th>
<th>Memphis</th>
<th>Mississippi</th>
<th>SMU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified VL</td>
<td>0.226</td>
<td>-0.025</td>
<td>0.121</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7***</td>
<td>-0.4</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>High Contention Only</td>
<td>0.279</td>
<td>0.02</td>
<td>0.0268</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.8***</td>
<td>0.19</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>High Bid Weight Only</td>
<td>0.121</td>
<td>0.151</td>
<td>0.219</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.5***</td>
<td>4.9***</td>
<td>3.08***</td>
<td></td>
</tr>
<tr>
<td>High Bid Weight and High Contention</td>
<td>-0.019</td>
<td>-0.079</td>
<td>0.043</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.2</td>
<td>-1.2</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

*** indicates significance at the P value < 0.01 level
Back-up Slides
1st Price vs. Generalized 2nd Price Auction

1st Price Auction

- Bid Weight = 2%
- Max Bid = $500

- Bids Received
  - $500
  - $500
  - $500

Generalized 2nd Price Auction

- Bid Weight = 2%
- Max Bid = $500

- Bids Received
1st Price vs. Generalized 2nd Price Auction

1st Price Auction
• Bid Weight = 2%
• Max Bid = $500

Generalized 2nd Price Auction
• Bid Weight = 2%
• Max Bid = $500

• Bids Received
  - $500
  - $500
  - $500

• Bids Received
  - $500
  - $350
  - $250
# First vs. Second Price Auction Format

## First to Modified VL Auction

<table>
<thead>
<tr>
<th>% Change in Bid/RW and Payment</th>
<th>Bid-weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Bid/RW</td>
<td>-24.6%</td>
</tr>
<tr>
<td>Payment</td>
<td>60.2%</td>
</tr>
<tr>
<td></td>
<td>-2.6%</td>
</tr>
<tr>
<td></td>
<td>70.6%</td>
</tr>
</tbody>
</table>

| Contention: High               |           |
| Bid/RW                        | -24.6%    | -6.9%     |
| Payment                       | 60.2%     | 81.5%     |
| Contention: Low               | -2.6%     | -22.3%    |
| Payment                       | 70.6%     | 8.3%      |