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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

NPRST



- **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? (1st vs. 2nd Price)

Background

NPRST



- **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



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JIS - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Home Search Favorites Media Print W Address http://localhost:8080/DIS/doAction Go

JISJob Incentive SystemUser : S22LoginTime : 07/04/2004 16:04Sign Off
JIS Home Auction Results Help

Bid On Job in Auction

Auction Details

Experiment ID : 4-7-04Fitness Score Weight : 80
Auction Type : FirstPriceBid Weight : 20
Level of Contention : Low (5 Jobs) - 6 biddersYou are Bidding On Auction : 1

Job ID	Fitness Score (Points/80)	My Minimum Bid	Maximum Allowable Bid	My Bid	Total Score (Points/100)
Job 1	56	25	100		
Job 2	52	25	100		
Job 3	52	40	100		
Job 4	40	40	100		
Job 5	52	40	100		

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
76 75 74 73 72 71 70 69 68 67 66 65 64 63 62 61 60 59 58 57 56
Total Score with this Bid (Points)
My Current Bid : 45My Current Total Score: 67
If you win this job with this bid, you will receive \$ 2
Save BidCancel

All Possible Minimum Bids

	Job 1	Job 2	Job 3	Job 4	Job 5
	10	25	40	30	40
	20	40	20	40	40
	35	50	35	35	20
	15	40	35	45	40
	15	25	15	40	35
	20	45	35	50	25
	50	25	35	30	50
	25	25	40	40	40
	25	35	30	40	35
	25	25	40	50	35

Summary (Min, Avg, Max)

Min	10	25	15	30	20
Avg	24	33	32	40	36
Max	50	50	40	50	50

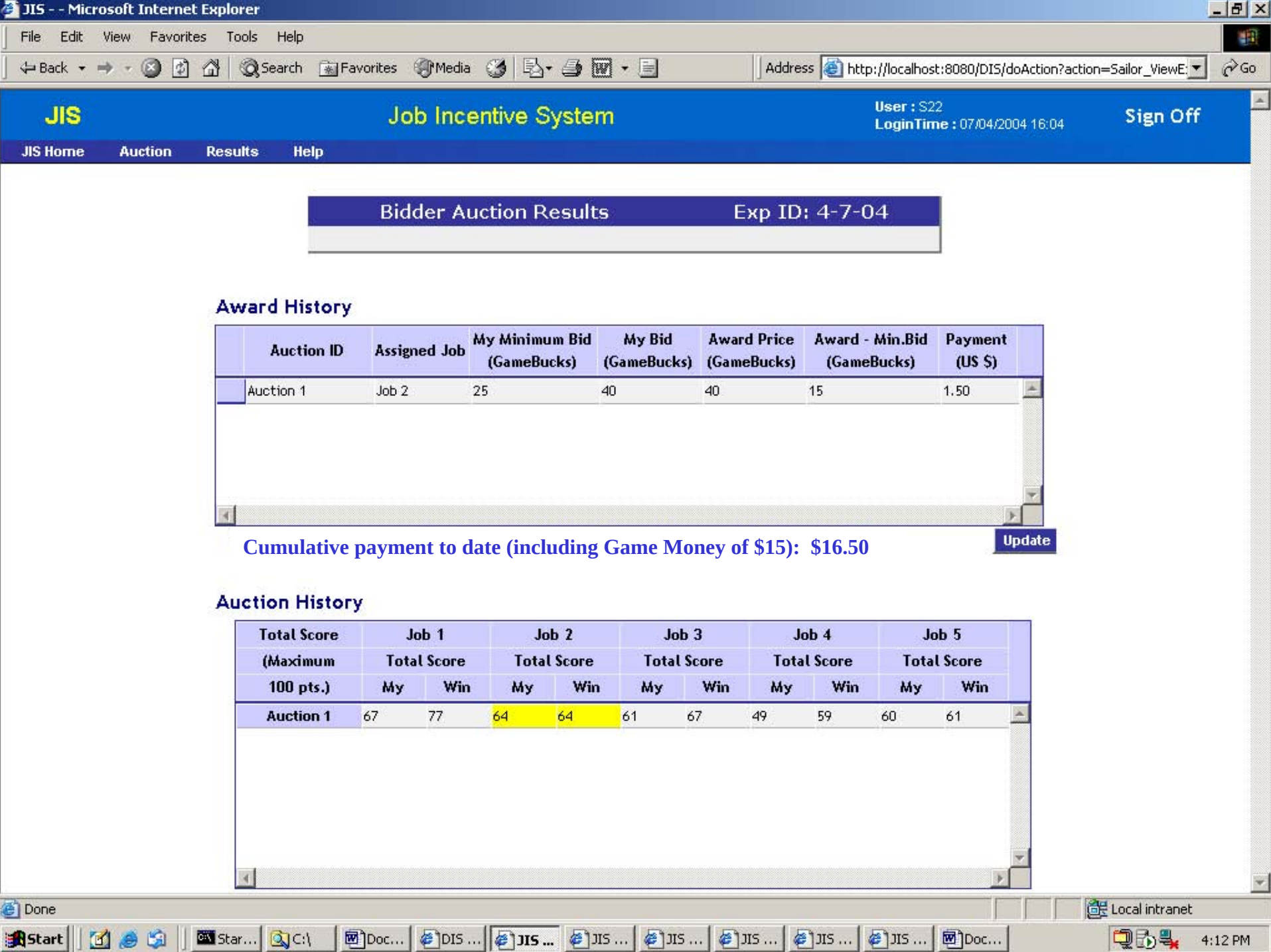
All Possible Fitness Scores (max 80)

	Job 1	Job 2	Job 3	Job 4	Job 5
	64	48	56	48	48
	56	52	52	40	52
	44	52	48	44	52

Summary (Min, Avg, Max)

Min	44	48	48	40	48
Avg	54	50	52	44	50
Max	64	52	56	48	52

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JIS

Job Incentive System

User : S22

LoginTime : 07/04/2004 16:04

Sign Off

JIS Home

Auction

Results

Help

Bidder Auction Results

Exp ID: 4-7-04

Award History

Auction ID	Assigned Job	My Minimum Bid (GameBucks)	My Bid (GameBucks)	Award Price (GameBucks)	Award - Min.Bid (GameBucks)	Payment (US \$)
Auction 1	Job 2	25	40	40	15	1.50

Cumulative payment to date (including Game Money of \$15): \$16.50

Update

Auction History

Total Score (Maximum 100 pts.)	Job 1		Job 2		Job 3		Job 4		Job 5	
	Total Score		Total Score		Total Score		Total Score		Total Score	
	My	Win	My	Win	My	Win	My	Win	My	Win
Auction 1	67	77	64	64	61	67	49	59	60	61

Done

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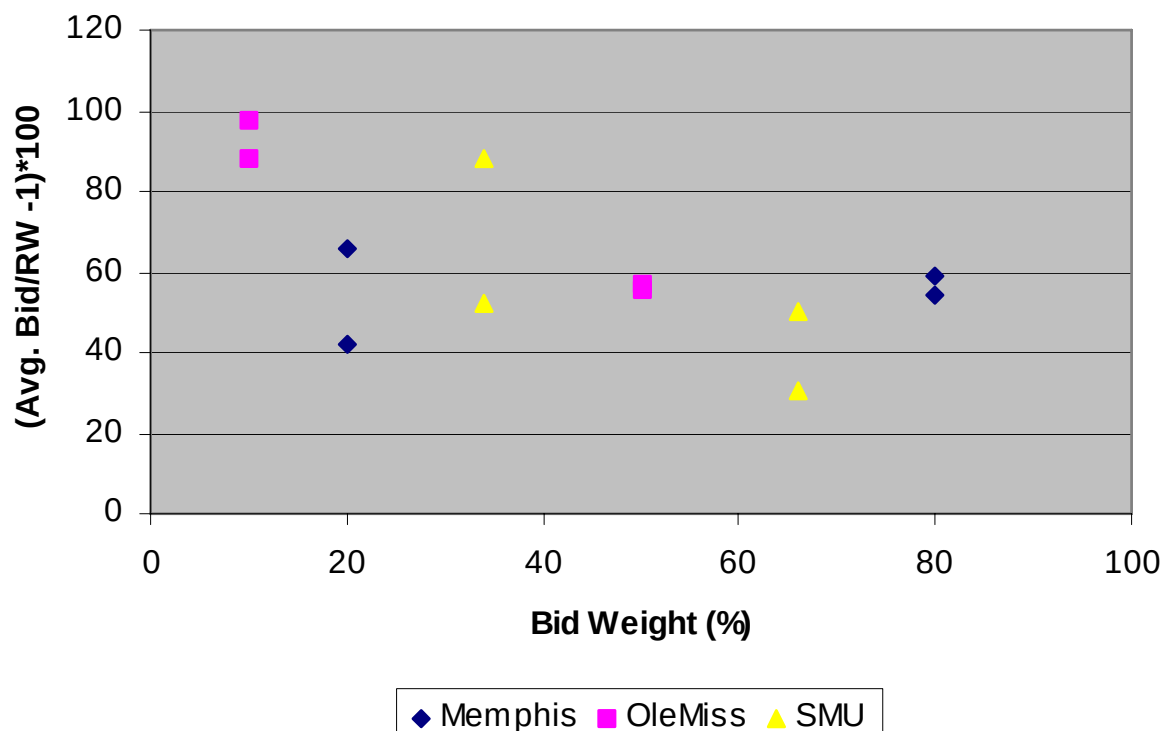
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First Price, Low Contention Auctions

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Table 2
First Price, Low Contention, Winning Bids



Data

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

$$\frac{\text{Bid}}{\text{RW}} = \hat{\beta}_0 + \hat{\beta}_1 (\text{Auction Round \#}) + \hat{\varepsilon}.$$

- 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

$$\text{Bid} = \hat{\beta}_0 + \hat{\beta}_1 \text{Contention} + \hat{\beta}_2 \text{Memphis} + \hat{\beta}_3 \text{Mississippi} + \hat{\beta}_4 (\text{BidW})^{-1} + \hat{\beta}_5 \text{RW} + \hat{\beta}_6 \text{FS} + \hat{\varepsilon}$$

First Price Auctions
Dependent Variable: Bid
Rsquare = 0.63

Independent Variables

Intercept	Contention	Memphis	Mississippi	$(\text{BidW})^{-1}$	RW	FS
8.36	-24.42	0.07	1.05	12.51	0.759	0.146
2.99***	14.87***	0.13	1.47	12.9***	25.03***	4.08***

Elasticity Estimates

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- **Bid to Bid-Weight Elasticity (Low Contention)**

$$\epsilon_{\text{Bid}, \text{BidW}} = -0.35 \text{ and } -0.10$$

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

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

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

*** indicates significance at the P value < 0.01 level

Back-up Slides



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1st Price vs. Generalized 2nd Price Auction

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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

NPRST



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
 - \$500
 - \$350
 - \$250

First vs. Second Price Auction Format

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First to Modified VL Auction

% Change in Bid/RW and Payment			
		Bid-weight	
		20%	80%
Contention: High	Bid/RW	-24.6%	-6.9%
	Payment	60.2%	81.5%
Contention: Low	Bid/RW	-2.6%	-22.3%
	Payment	70.6%	8.3%