

SPITE and COUNTER SPITE in AUCTIONS

Microworkshop at the University of Tokyo
Nov. 18, 2005

Naoko Nishimura*, Tatsuyoshi Saijo**,
Timothy Cason***, and Yoshikazu Ikeda*

*Shinshu University, Japan

**Osaka University, Japan

***Purdue University, USA

Value-Revealing Dominant Strategy (DS) Equilibrium

A Big Question on its Predictive Power

Many Experimental Reports of non-DS Behavior
= Particularly in PG Games (Ledyard 1995)

DS behavior is more observable when subjects
do not know their opponents' payoffs. (Saijo, et.al)

Second-Price (SP) Auctions are rarely used in practice.
Some Experimental Reports on Over-Bidding in SP
Auctions (Kagel 1995, etc.).

Too Big Equilibrium Set in SP auction.	Coordination
Many weakly dominated strategies	Problem

Alternative Reasoning

- Social Preferences as Alternative Reasoning

Fairness, Reciprocity, Altruism, Spite

Rabin (1993), Saijo, et al. (1995), Levine (1997), Ferh..



Mostly Non-market Context; PG, Bargaining, Contract..

This Research

- What about a Competitive Market?

Second Price Auctions and English Auctions

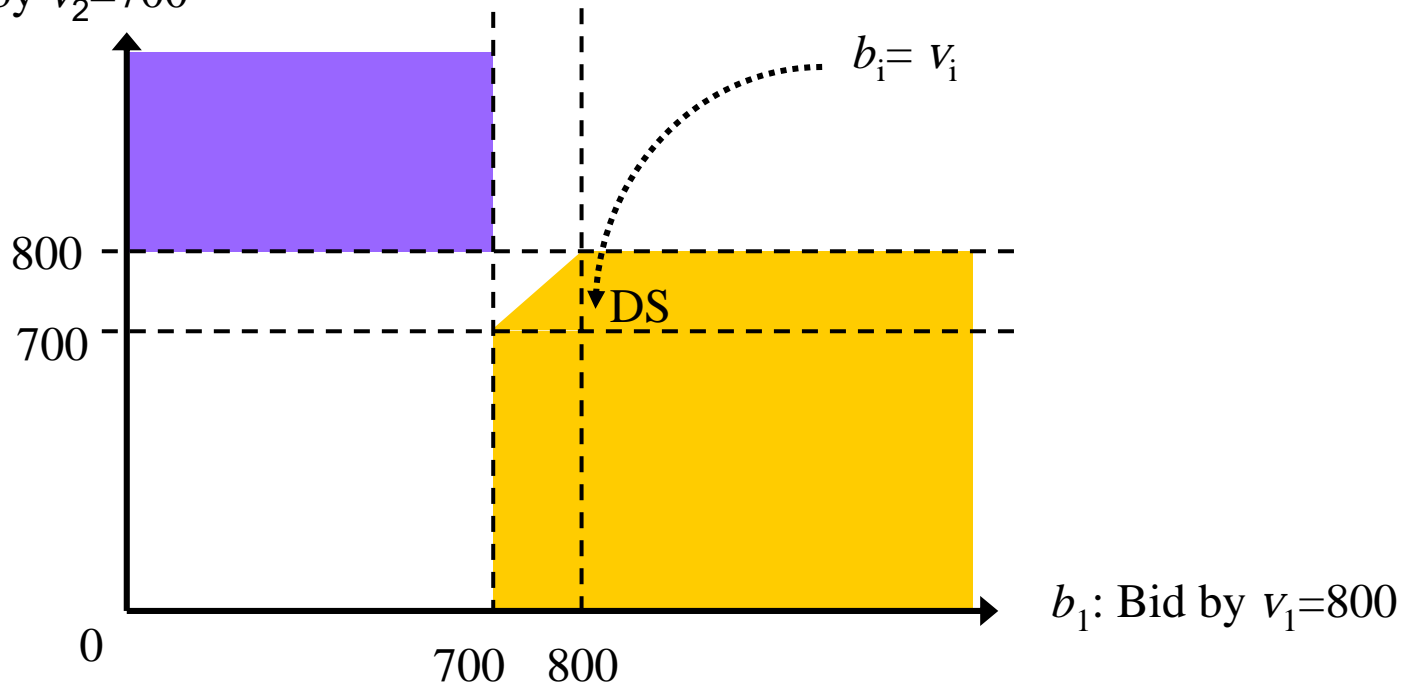
Do social preferences interfere with market performance?

Nash Equilibria in SP Auctions without Spite

- Single non-divisible good. Independent private values v_i
- Rule: The highest bidder wins
and pays the second highest bid price.

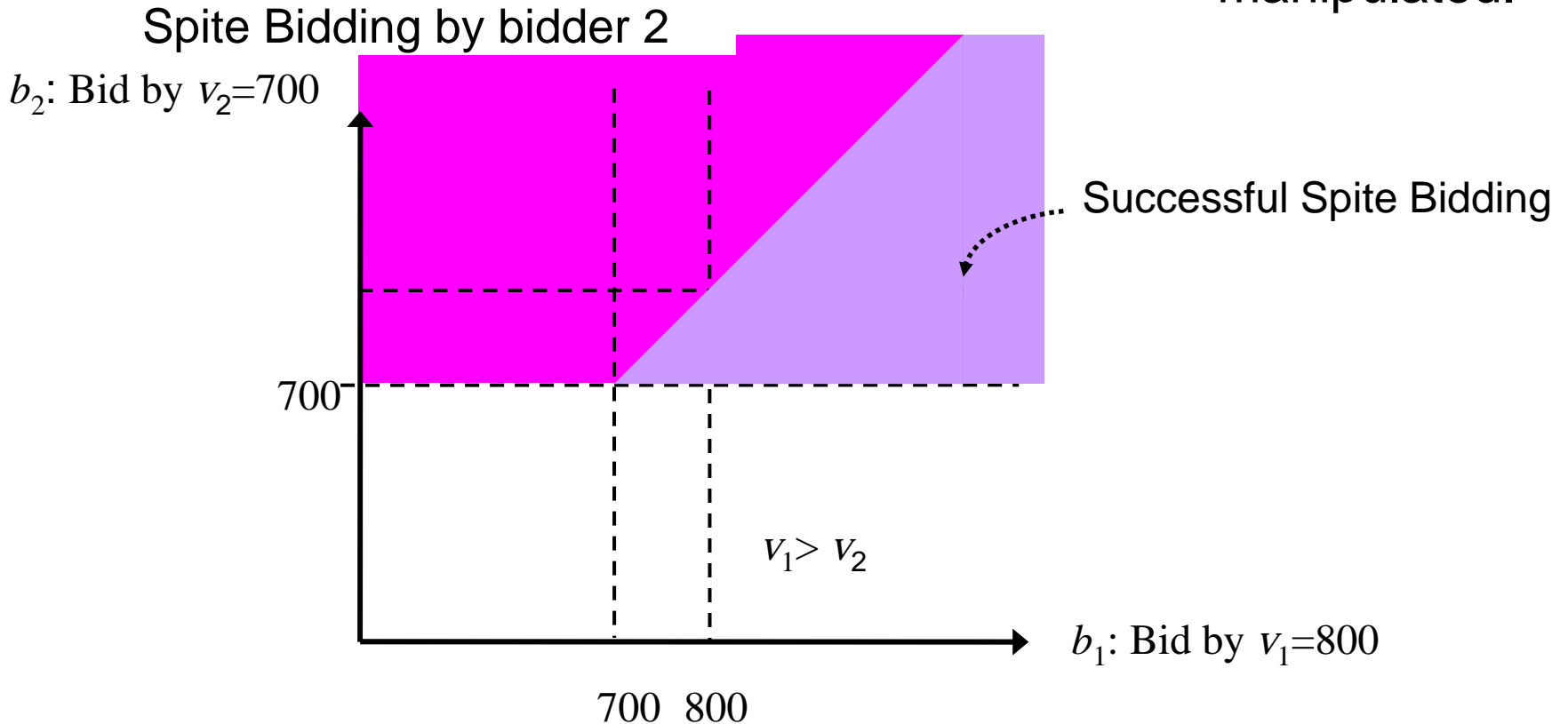
When $\{v_i\}_{i=1}^N$ are known. The highest value bidder wins.

b_2 : Bid by $v_2=700$



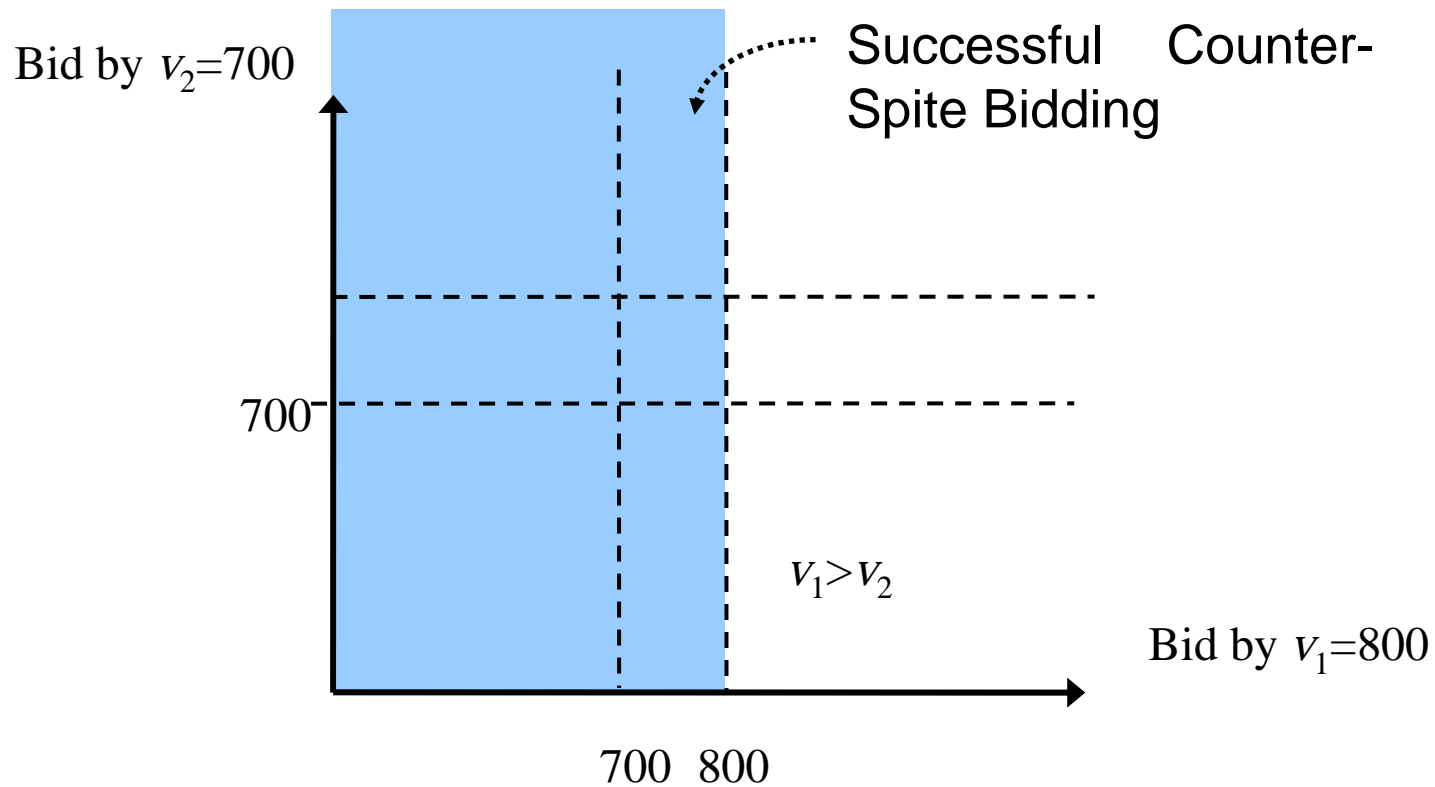
Spiteful Biddings

- i 's payment is independent of b_j . \Rightarrow No room to manipulate.
- i 's payment is dependent of b_j . \Rightarrow Plenty of room for being manipulated.



Spiteful Biddings

Counter-Spite Bidding by bidder 1



The Model with Reciprocal Spite a la Rabin (1993)

■ Utility = Monetary Payoff + Psychological Payoff

$$U_2(b_2, b_{21}, b_{212}) = \pi_2(b_2, b_1) + \gamma_2 \cdot f_2(b_2, b_{21}) [f_{21}(b_{21}, b_{212}) + \delta_2(b_{21}, b_{212})]$$

$$\gamma_2 > 0$$

>Bidder 2's Monetary Payoff:

$$\pi_2(b_2, b_{21}) = (v_2 - b_{21})I_{b_2 > b_{21}} + 0 \cdot I_{b_2 < b_{21}} + (1/2)(v_2 - b_{21})I_{b_2 = b_{21}}$$

>Bidder 2's intention as to how spiteful toward bidder 1

$$f_2(b_2, b_{21})$$

>Bidder 1's spitefulness toward bidder 2 in bidder 2's expectation

$$[f_{21}(b_{21}, b_{212}) + \delta_2(b_{21}, b_{212})]$$

b_{21} : Bidder 2's first order belief as to which bid strategy bidder 2 thinks bidder 1 to take

b_{212} : Bidder 2's second order belief as to which bid strategy bidder 2 anticipates that bidder 1 thinks bidder 2 to take.

The Model with Reciprocal Spite a la Rabin (1993)

■ Bidder 2's Psychological Payoff:

>>How spiteful bidder 2 is to bidder 1

$$f_2(b_2, b_{21})$$

= $\frac{[\text{payoff that bidder 1 obtains if bidder 2 bids at } b_2] - [\text{payoff bidder 1 deserves}]}{\text{the range of conceivable payoff possibilities}}$

$$= \frac{\pi_1(b_{21}, b_2) - \hat{\pi}_1}{\pi_1^{\max}(b_{21}) - \pi_1^{\min}(b_{21})}$$

$$= \frac{[0 \cdot I_{b_2 > b_{21}} + (v_1 - b_2)I_{b_2 < b_{21}} + (1/2)(v_1 - b_2)I_{b_2 = b_{21}}] - (v_1 - v_2)}{[(v_1 - v_2) - 0]}$$

The Model with Reciprocal Spite a la Rabin (1993)

■ How spiteful bidder 2 anticipates bidder 1 to 2

= $\frac{[2\text{'s payoff that 2 thinks 1 would let 2 obtain}] - [\text{payoff bidder 2 deserves}]}{\text{the range of conceivable payoff possibilities}}$

$$f_{21}(b_{21}, b_{212}) = \frac{\pi_2(b_{212}, b_{21}) - \hat{\pi}_2}{\pi_2^{\max}(b_{212}) - \pi_2^{\min}(b_{212})}$$
$$= \frac{[(v_2 - b_{21})I_{b_{212} > b_{21}} + 0 \cdot I_{b_{212} < b_{21}} + (1/2)(v_2 - b_{21})I_{b_{212} = b_{21}}] - 0}{0 - [-(v_1 - v_2)]}$$

■ Disutility from losing

$$\delta_2(b_{212}, b_{21}) = 0 \cdot I_{b_{212} > b_{21}} + \frac{\max\{[(v_1 - v_2) - (v_1 - b_1)], 0\}}{v_1 - v_2} \cdot I_{b_{212} \leq b_{21}}$$

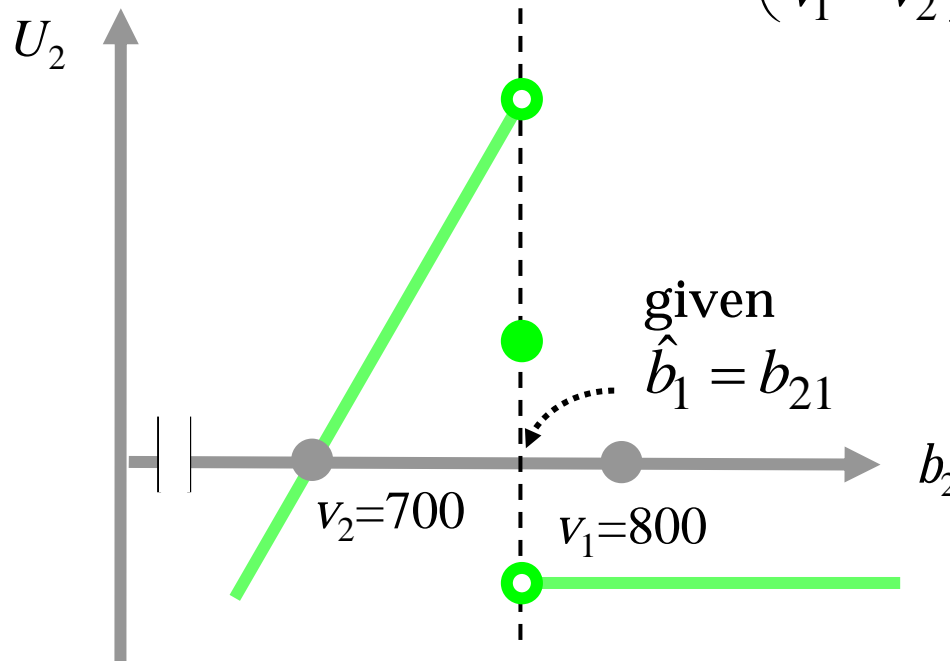
Bidder 2's Utility

- Expectations must be correct in Equilibrium

$$b_{21} = b_1, b_{212} = b_2$$

When $b_2 > b_{21}$, $U_2(b_2, b_{21}, b_{212}) = (v_2 - b_{21}) + \gamma_2(-1) \left[\frac{v_2 - b_{21}}{v_1 - v_2} \right]$

When $b_2 < b_{21}$, $U_2(b_2, b_{21}, b_{212}) = \gamma_2 \left(\frac{v_1 - b_2}{v_1 - v_2} \right) \left[\frac{\max\{(b_1 - v_2), 0\}}{v_1 - v_2} \right]$



Bidder 1's Utility

Bidder 1's Utility = Monetary Payoff + Psychological Payoff

$$U_1(b_1, b_{12}, b_{121}) = \pi_1(b_1, b_2) + \gamma_1 \cdot f_1(b_1, b_{12}) [f_{12}(b_{12}, b_{121}) + \delta_1(b_{12}, b_{121})]$$

Bidder 1's Monetary Payoff:

$$\pi_1(b_1, b_{12}) = (v_1 - b_{12})I_{b_1 > b_{12}} + 0 \cdot I_{b_1 < b_{12}} + (1/2)(v_1 - b_{12})I_{b_1 = b_{12}}$$

How spiteful bidder 1 to bidder 2

$$f_1(b_1, b_{12}) = \frac{\pi_2(b_{12}, b_1) - \hat{\pi}_2}{\pi_2^{\max}(b_{12}) - \pi_2^{\min}(b_{12})}$$
$$= \frac{[0 \cdot I_{b_1 > b_{12}} + (v_2 - b_1)I_{b_1 < b_{12}} + (1/2)(v_2 - b_1)I_{b_1 = b_{12}}] - 0}{0 - [-(v_1 - v_2)]}$$

b_{12} : Bidder 1's first order belief

b_{121} : Bidder 1's second order belief

Bidder 1's Utility

■ Bidder 1's Utility

$$U_1(b_1, b_{12}, b_{121}) = \pi_1(b_1, b_2) + \gamma_1 \cdot f_1(b_1, b_{12}) [f_{12}(b_{12}, b_{121}) + \delta_1(b_{12}, b_{121})]$$

How Spiteful bidder 1 anticipates bidder 2 is to 1:

$$f_{12}(b_{12}, b_{121}) = \frac{\pi_1(b_{121}, b_{12}) - \hat{\pi}_1}{\pi_1^{\max}(b_{121}) - \pi_1^{\min}(b_{121})}$$
$$= \frac{[(v_1 - b_{12})I_{b_{121} > b_{12}} + 0 \cdot I_{b_{121} < b_{12}} + (1/2)(v_1 - b_{12})I_{b_{121} = b_{12}}] - (v_1 - v_2)}{[(v_1 - v_2) - 0]}$$

■ Disutility from losing

$$\delta_1(b_{121}, b_{12}) = 0 \cdot I_{b_{121} > b_{12}} + \frac{\max\{[0 - (v_2 - b_2), 0]\}}{v_1 - v_2} \cdot I_{b_{121} \leq b_{12}}$$

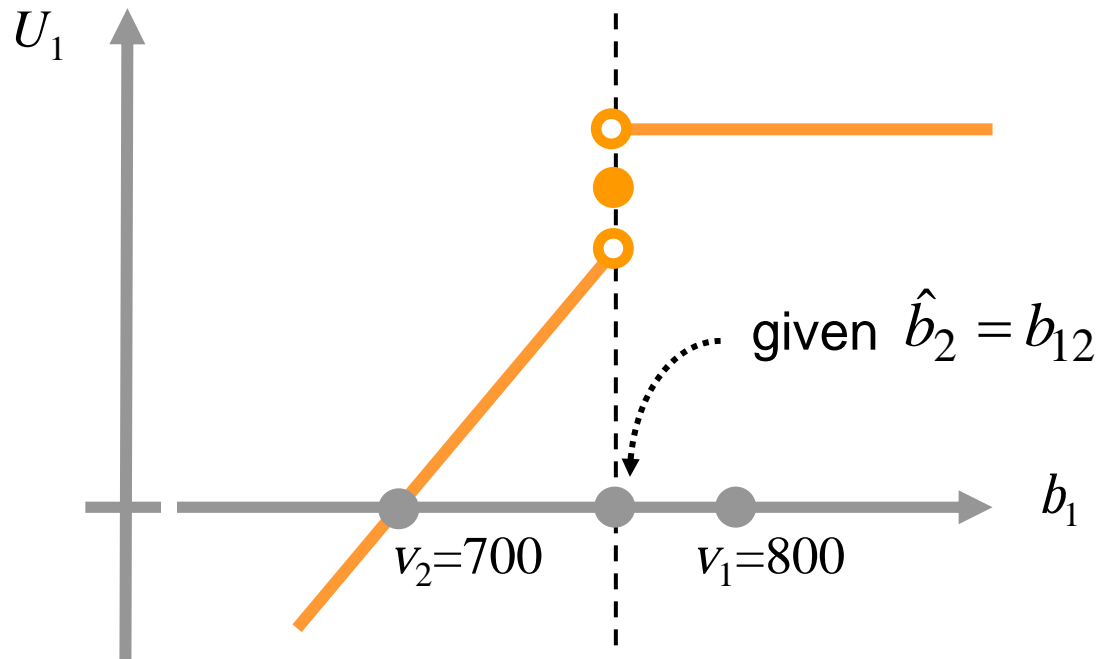
Bidder 1's Utility

- Expectations must be correct in Equilibrium

$$b_2 = b_{12}, b_{121} = b_1$$

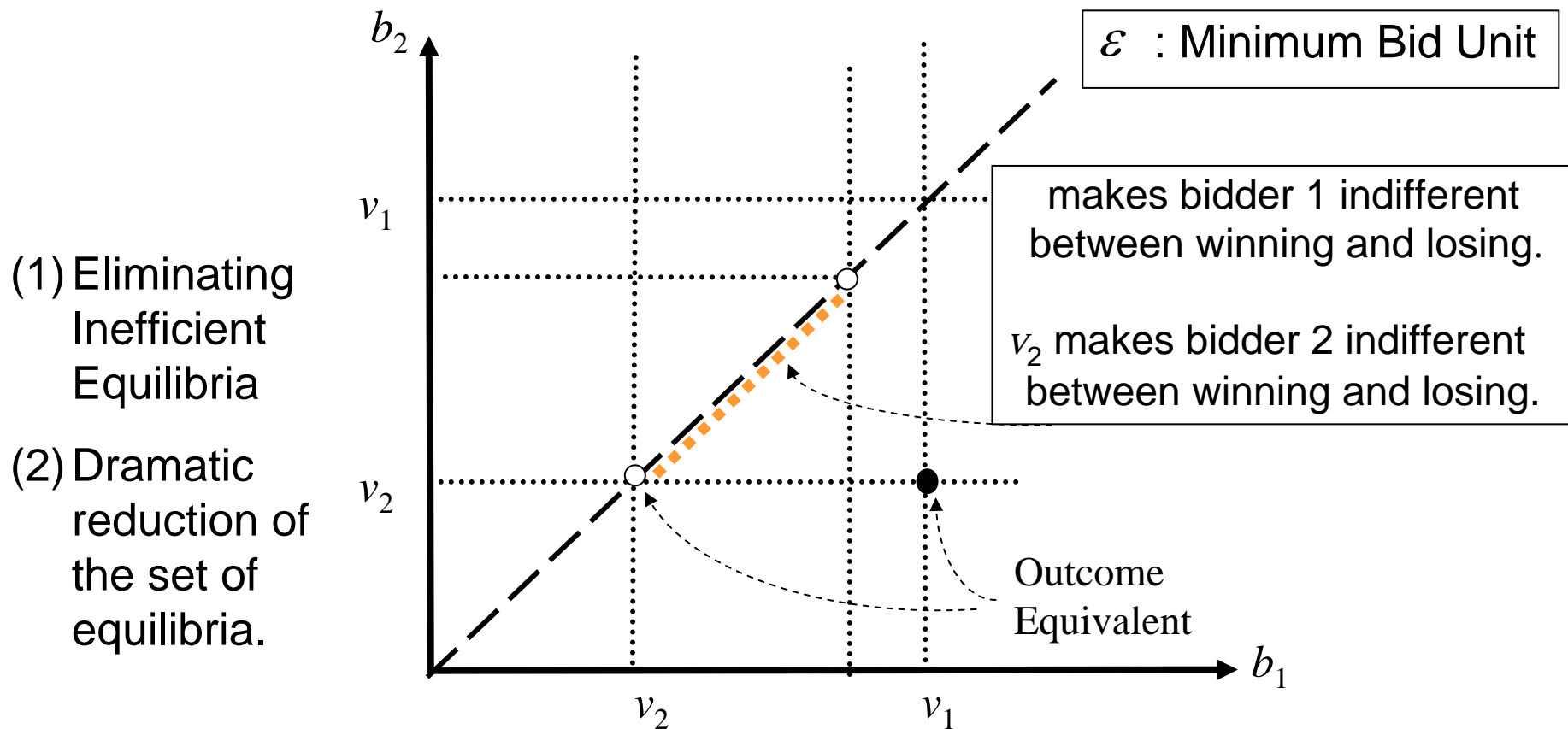
When $b_1 > b_{12}$, $U_1(b_1, b_{12}, b_{121}) = v_1 - b_{12}$

When $b_1 < b_{12}$, $U_1(b_1, b_{12}, b_{121}) = \gamma_1 \left[\frac{v_2 - b_1}{v_1 - v_2} \right] \left[\frac{\max\{[0 - (v_2 - b_2)], 0\}}{v_1 - v_2} - 1 \right]$



Equilibrium in Second Price Auctions: V s are known

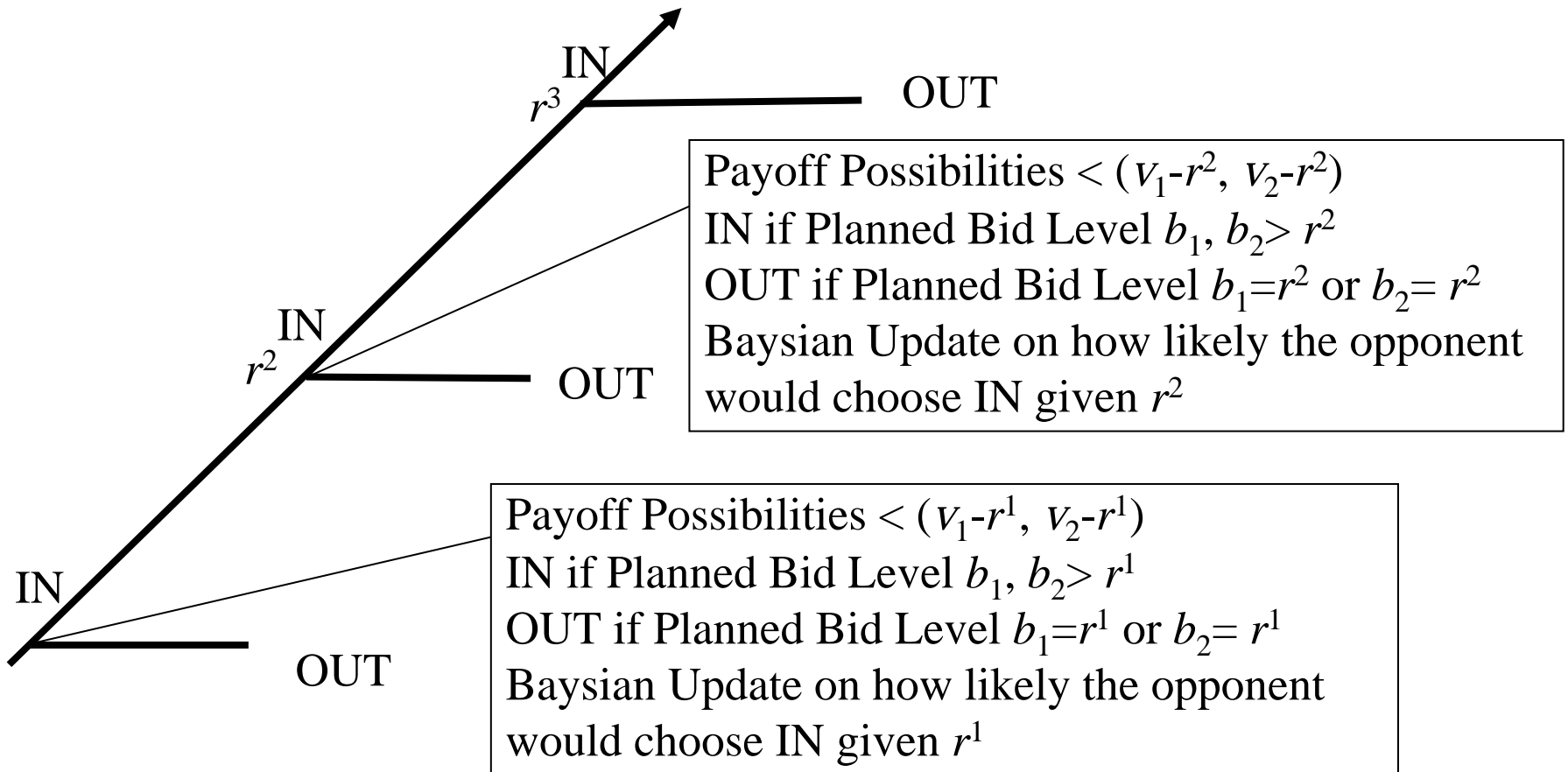
- Expectations must be correct in Equilibrium.
- Equilibrium bid must be a best response to one's beliefs



$$E_{SP} \equiv \{(b_1, b_2) \in (z\varepsilon, z\varepsilon - \varepsilon) \mid b_1 \in (v_2, \beta], b_2 \in (v_2, \beta), \varepsilon > 0, z \in I\}$$

English Auctions

■ Sequential Reciprocity a la Dufwenberg & Kirchsteiger (2004)



Equilibrium in English Auctions: Vs are known

- Expectations must be correct in an equilibrium**

$$b_2(r) = b_{12}(r), b_{121}(r) = b_1(r) \quad b_{21}(r) = b_1(r), b_{212}(r) = b_2(r)$$

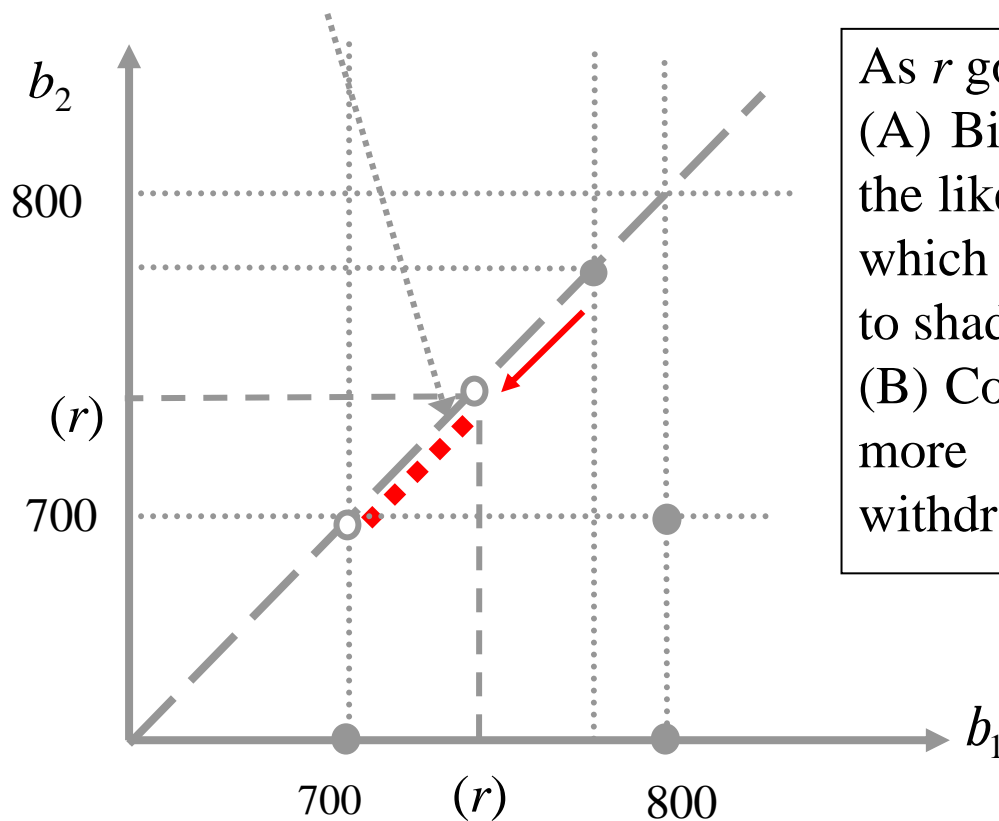
$$U_1(b_1(r), b_2(r), b_{12}(r), b_{121}(r)) = (v_1 - b_{12}(r))I_{b_1(r) > b_{12}(r)} \\ + \gamma_1 \left[\frac{v_2 - b_1}{v_1 - r} \right] \left[\frac{\max\{[0 - (v_2 - b_2)], 0\}}{v_1 - r} - 1 \right] I_{b_1(r) < b_{12}(r)}$$

$$U_2(b_2(r), b_1(r), b_{21}(r), b_{212}(r)) = \left\{ (v_2 - b_{21}(r)) + \gamma_2(-1) \left[\frac{v_2 - b_{21}(r)}{v_1 - r} \right] \right\} I_{b_2(r) > b_{21}(r)} \\ + \gamma_2 \left(\frac{v_1 - b_2}{v_1 - r} \right) \left[\frac{\max\{(b_1 - v_2), 0\}}{v_1 - r} \right] I_{b_2(r) < b_{21}(r)}$$

Equilibrium in English Auctions: V_s are known

■ Smaller equilibrium set toward $(V_2 + \varepsilon, V_2)$

Set of Equilibria at r : below 45 degree line by ε



As r goes up, $\beta(r)$ comes down.

(A) Bidder 1 thinks that bidder 2 revises the likelihood of 1 staying further upward, which gives more opportunity to bidder 2 to shade 1's payoff.

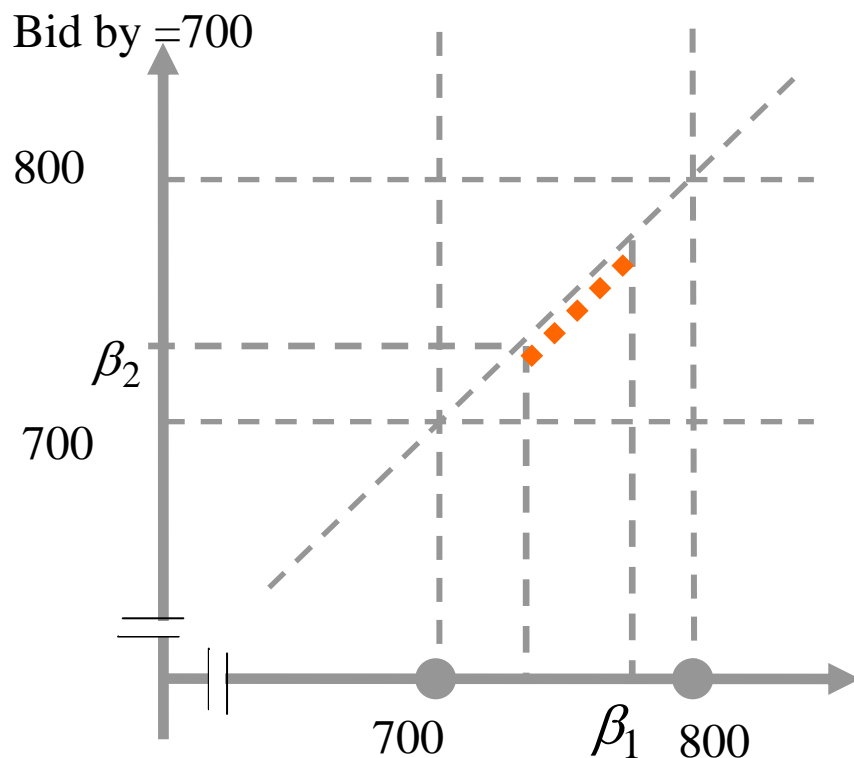
(B) Compare to before, bidder 1 can give more damage to 2 if 1 decides to withdraw.

The Model with Non-Reciprocal Spite

Morgan, Steiglitz, and Reis (2002)

- Bidders' Utilities:** $u_i(x; b_i, b_j) = (v_i - b_j)I_{b_i > b_j} - \lambda_i(v_j - b_i)I_{b_i < b_j}$

$$\lambda_i \in (0,1), i = 1,2$$



$$\beta_1 = \frac{v_1 + \lambda_1 v_2}{1 + \lambda_1}$$

$$\beta_2 = \frac{\lambda_2 v_1 + v_2}{1 + \lambda_2}$$

- Bid Decision in SP = Bid Decision in English Auctions**

Summary

- **The size of equilibrium set become much smaller by human nature, spite, under SP auctions.**

The location of equilibrium set is different depending upon the way in which spite motivates individuals.

- **Yet English auctions is superior to SP auctions in taking an advantage of human nature to produce better outcomes, when we look at the reciprocal spite case.**

Test Hypotheses

■ When values are known: (VA1)

H1: An individual with the second highest value bids higher than her value. **YES**

H2: An individual with lower value bids higher in a fixed group (pair) than in a randomly formed group (pair).
In 6P, YES.

H3: An individual with lower value bids more conservatively in English Auctions than in Second Price Auctions. **YES**

H4: An individual with lower value bids higher in Second Price Auction than in the game with same payoff structure but no auction context (=PT).

NOT REALLY: Rather individual with higher value bid lower in SP.

When Values are Unknown

- $\{v_i\}_{i=1}^N$ are Random Variables with known distribution F .
- Symmetric Equilibrium Bidding Strategy:
 $b_i = b_i(v_i)$ is continuous, monotonically increasing and differentiable.
- Reciprocal Spite Bidding Model
 $z =$ the second highest value

$$V_i(x; v_i) = \int_0^x (v_i - b(x)) + \gamma_i \left(\frac{0 - m(v_i, z)}{|v_i - z|} \right) \left(\frac{(v_i - b(z)) - m(v_i, z)}{|v_i - z|} \right) dF(z)$$

$$+ \int_x^{\bar{v}} \gamma_i \left(\frac{(z - b(x)) - M(v_i, z)}{|v_i - z|} \right) \left(\frac{\max\{[\max\{m(v_i, z), 0\} - (z - b(z))], 0\} - m(v_i, z)}{|v_i - z|} \right) dF(z)$$

where $m(v_i, z) = \max\{(v_i - z), 0\}$

When Values are Unknown

- Reciprocal Spite Bidding Model
 $z =$ the second highest value

$$\text{F.O.C.} \quad \left. \frac{\partial V_i(x; v_i)}{\partial x} \right|_{x=v_i} = 0 \quad \rightarrow \quad b_i^* = \beta_i^*(v_i) = v_i$$

Dominant Strategy

Do not Over Bid

- Non-reciprocal Spite Bidding Model

$$U_i(x; v_i) = \int_0^x [v_i - b(x)] dF(z) - \lambda_i \int_x^{\bar{v}} [z - b(x)] dF(z)$$



$$\text{F.O.C.} \quad \left. \frac{\partial U_i(x; v_i)}{\partial x} \right|_{x=v_i} = 0 \quad \rightarrow \quad b_i^* = b_i^*(v_i) > v_i$$

Always Over Bid

Nash Equilibrium Bidding Strategy

More Test Hypotheses

- **When values are unknown: (VA2)**

H5: More spiteful biddings should be observed when values are known (VA1) than when values are unknown (VA2) **YES**

H5': An individual follows the value-revealing dominant strategy when values are unknown (VA2) **YES.**

Experimental Design Structure

- **Spite needs a target.**

Less Uncertain, More Spite

- Known vs. Unknown
- Number of competitors (2P/6P)
- Group Formation; Fixed vs. Random Matching

- **Spite is enhanced by CONTEXT.**

- Second-Price (SP) vs. English Auction (EA)
- Second Price Auction vs. No-context (Payoff Table only)
- Culture (future project)

- **Questionnaires (Free Answer Style)**

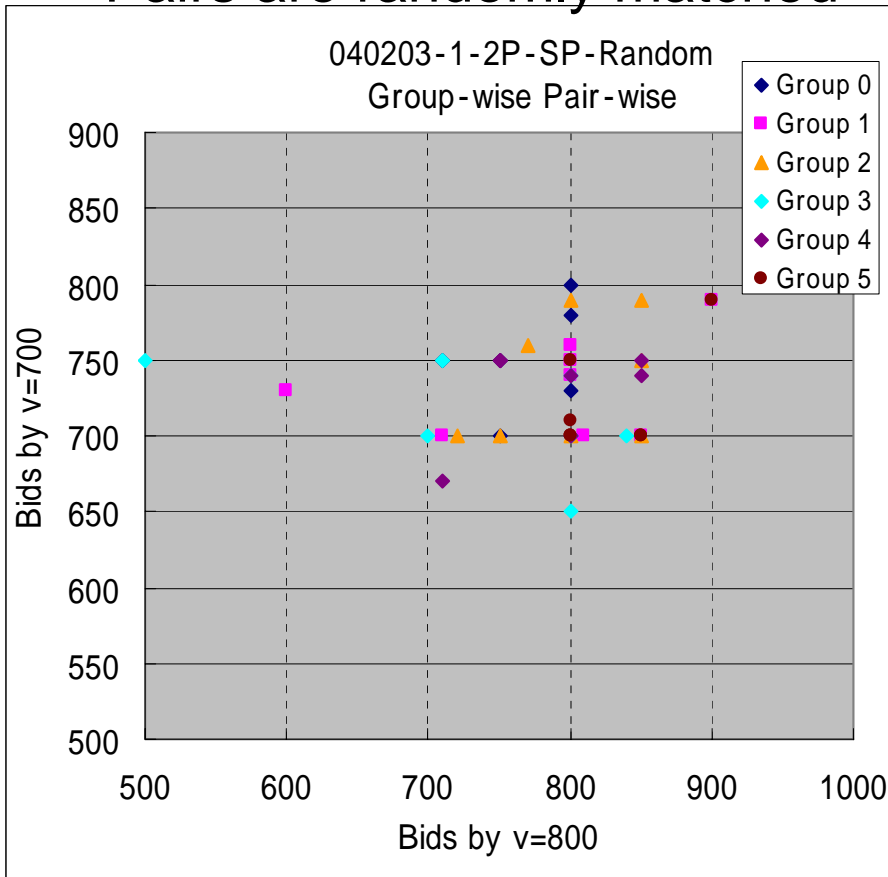
The Experimental Design

Location	Shinshu	Shinshu	Shinshu	Shinshu	Shinshu	Shinshu
Date	2-Dec-03	4-Dec-03	5-Dec-03	6-Dec-03	3-Feb-04-a	3-Feb-04-b
# of Subjects	12	12	12	12	12	12
Start-up Payment	1,000 yen	1,000 yen	1,000 yen	1,000 yen	1,000 yen	1,000 yen
Type of Auction	EA & SP	EA & SP	EA & SP	EA & SP	PT & SP	PT & SP
Group-size	2P	2P	6P	6P	2P	2P
Group-Formation	Random/Fix	Random/Fix	Random/Fix	Random/Fix	Random/Fix	Random/Fix
VA1: Values List	700/800	700/800	1000/1200/1400/ 1600/1800/2000	1000/1200/1400/ 1600/1800/2000	700/800	700/800
VA2: Values Range	500-800	500-800	500-2000	500-2000	N/A	N/A
# of rounds per each group formation						
VA1; EA/PT	6	6	6	6	8	8
VA1; SP	6	6	6	6	8	8
VA2, EA/PT	6	8	8	8	N/A	N/A
VA2, SP	10	8	8	8	N/A	N/A
Min. Bid Unit	10	10	10	10	10	10
Bid Increment in	10	10	10	10	N/A	N/A

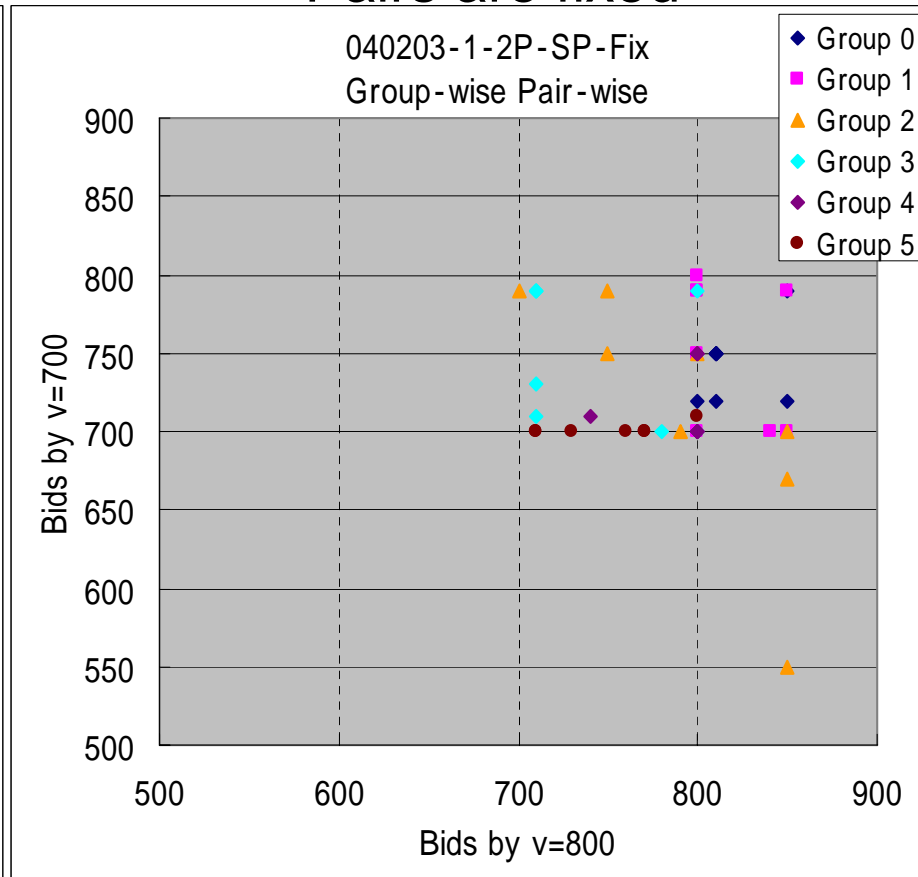
Results: Second-Price Auctions

- **Two-Person Individual Pair-wise Bid Data 040203-1**
Value pair $(v_H, v_L) = (800, 700)$ is known.

Pairs are randomly matched



Pairs are fixed



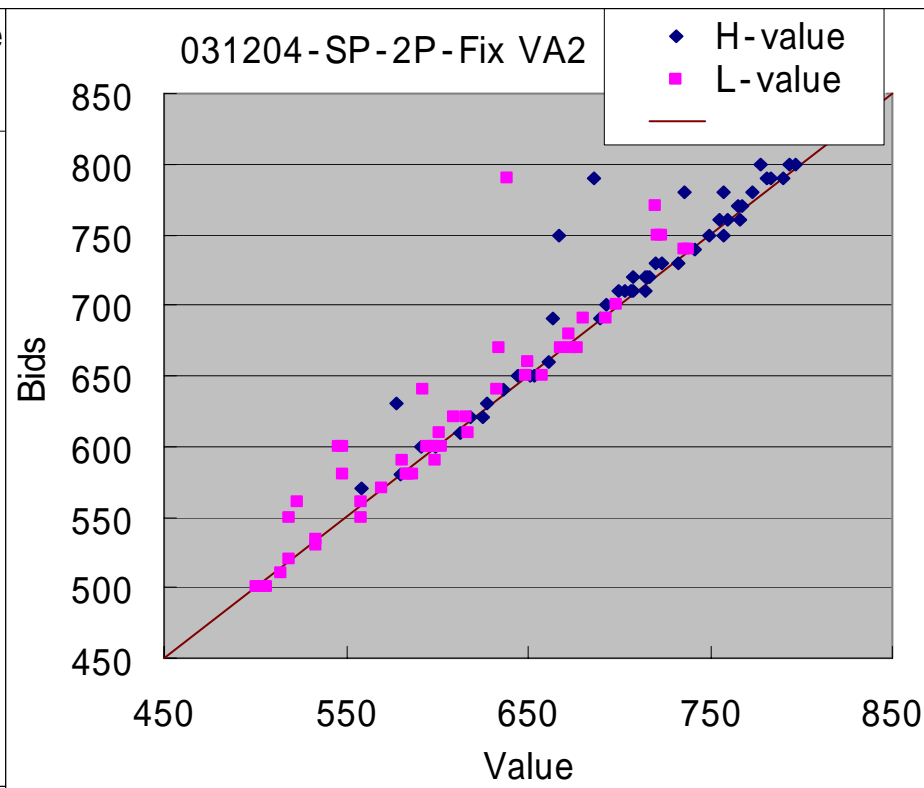
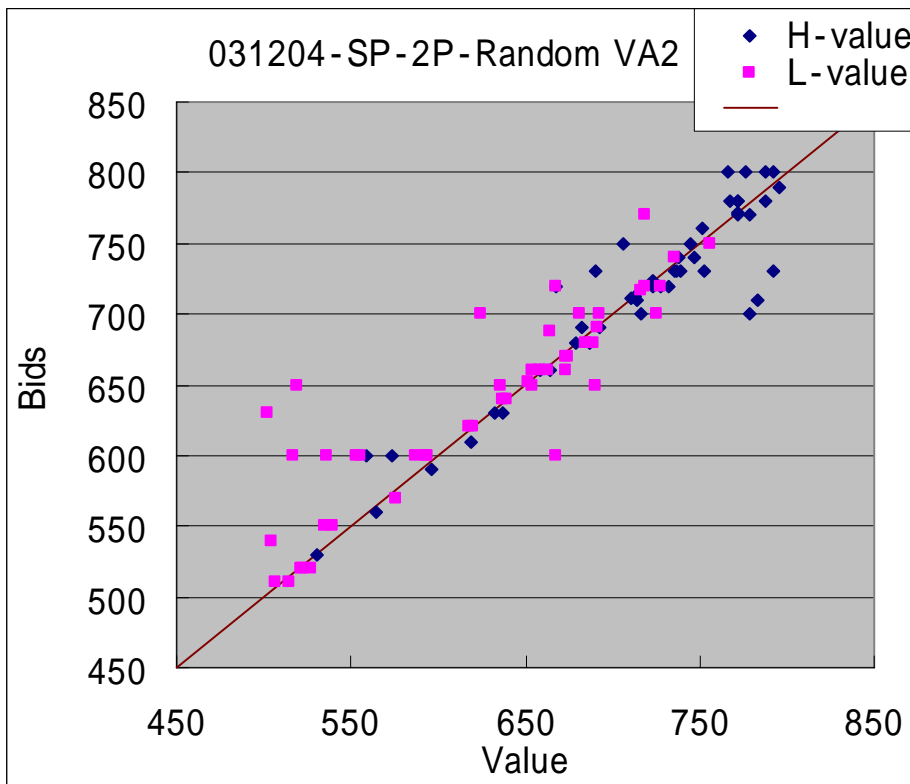
Results: Second-Price Auctions

■ Two-Person Individual Bid Data 031204

Each value is drawn from $[500, 800]$ independently.

Pairs are randomly matched

Pairs are fixed



Results: Second-Price Auctions

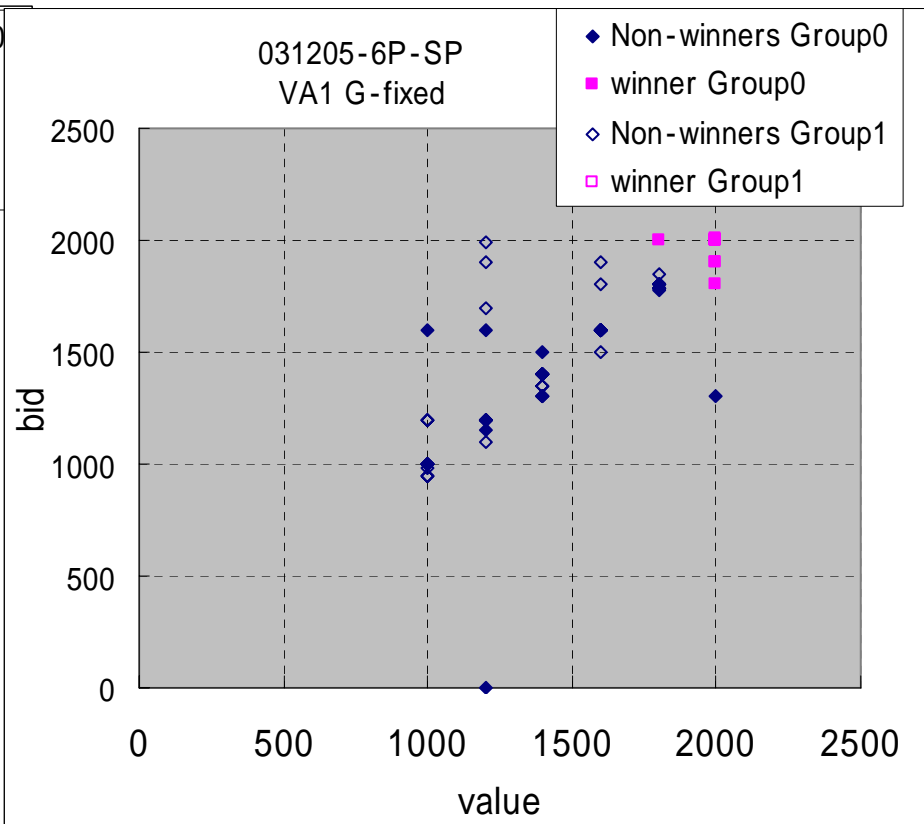
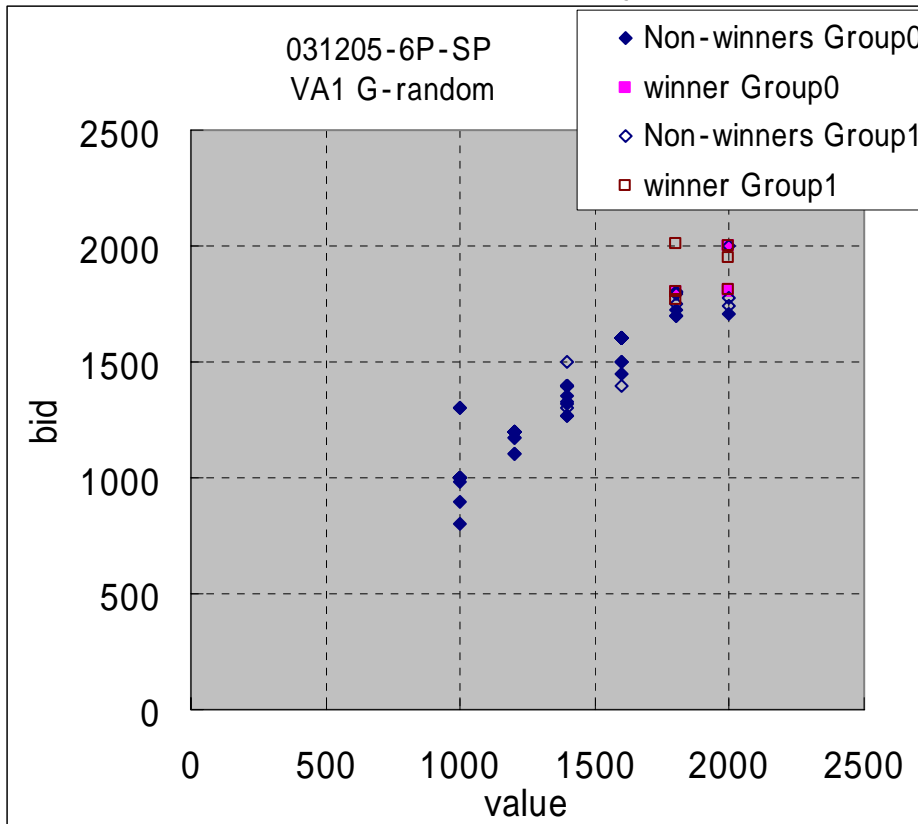
■ Six-Person 031205

Individual Bids and Corresponding Assigned Values

The value list $\{1000, 1200, 1400, 1600, 1800, 2000\}$ is known.

Groups are randomly formed

Groups are fixed



Results: Second-Price Auctions

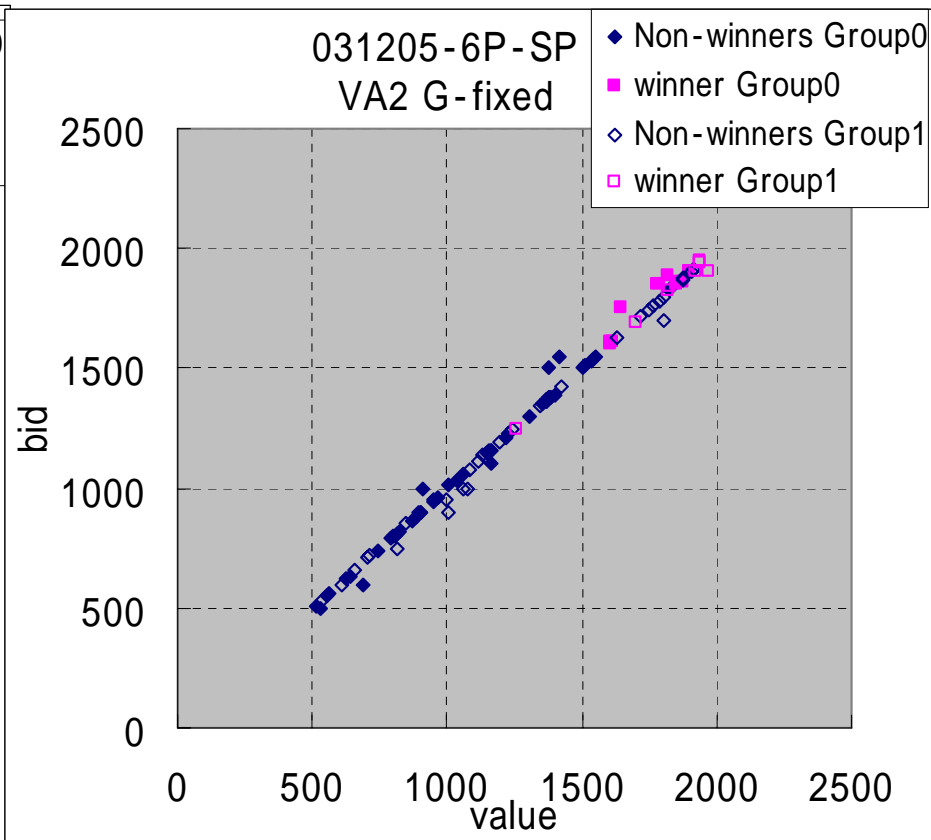
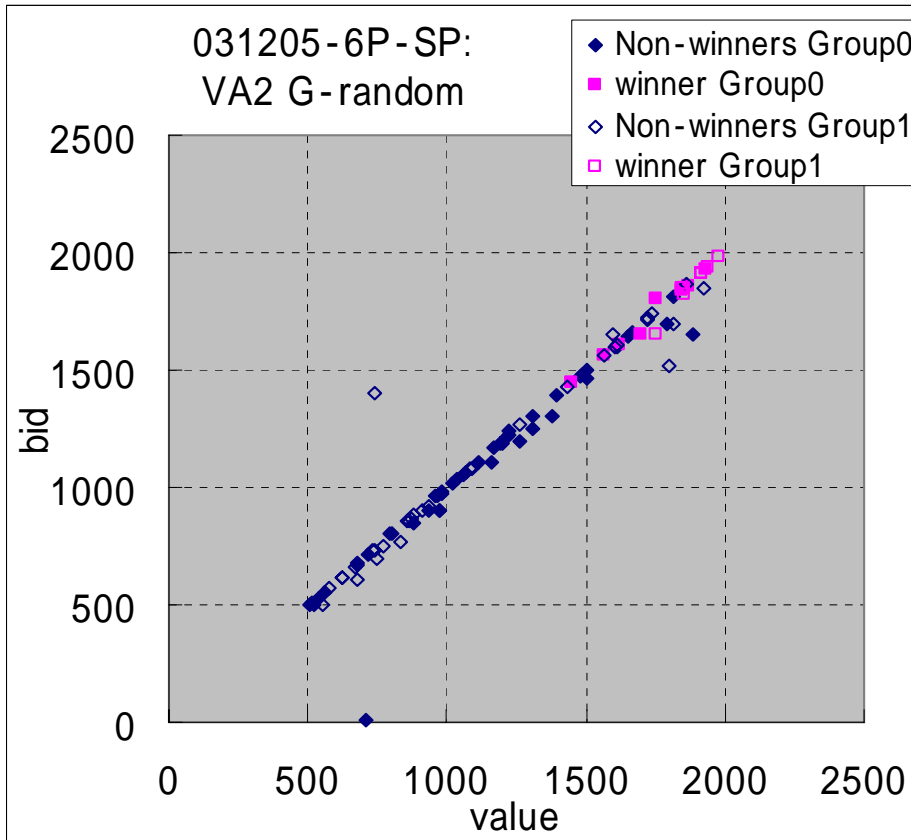
■ Six-Person 031205

Individual Bids and Corresponding Assigned Values

Each value is drawn from $[500, 2000]$ independently.

Groups are randomly formed

Groups are fixed



Results: Second-Price Auctions

■ Average Individual Bids when Values are known.

Random vs. Fix

Group-size	Session	G-Random		G-Fix		t-test		F-test	
		v=800	v=700	v=800	v=700	v=800	v=700	v=800	v=700
2P	031202	745.56	671.39	766.29	685.71	0.13	0.29	0.00	0.46
	031204	796.67	726.39	839.44	725.83	0.02	0.94	0.13	0.74
	040203-1	785.74	727.87	784.58	730.00	0.92	0.80	0.01	0.07
	040203-2	811.67	754.38	799.58	748.33	0.26	0.45	0.55	0.13
		v=2000	v=1800	v=2000	v=1800	v=2000	v=1800	v=2000	v=1800
6P	031205	1883.33	1786.67	1909.17	1815.83	0.71	0.33	0.08	0.35
	031206	1984.17	1795.83	1965.00	1821.67	0.43	0.08	0.46	0.66

■ Average Individual Bids Difference (v-b) when Values are unknown.

Random vs. Fix

Group-size	Session	G-Random		G-Fix		t-test		F-test	
		v-higher	v-lower	v-higher	v-lower	v-higher	v-lower	v-higher	v-lower
2P	031202	6.51	5.77	6.02	-24.23	0.92	0.02	0.07	0.00
	031204	2.37	-15.08	-9.83	-11.77	0.04	0.00	0.29	0.00
		v-highest	v-second	v-highest	v-second	v-highest	v-second	v-highest	v-second
6P	031205	25.63	40.56	-4.06	-3.41	0.12	0.05	0.05	0.09
	031206	29.94	21.63	3.75	11.69	0.13	0.86	0.00	0.00

Results: Second-Price Auctions

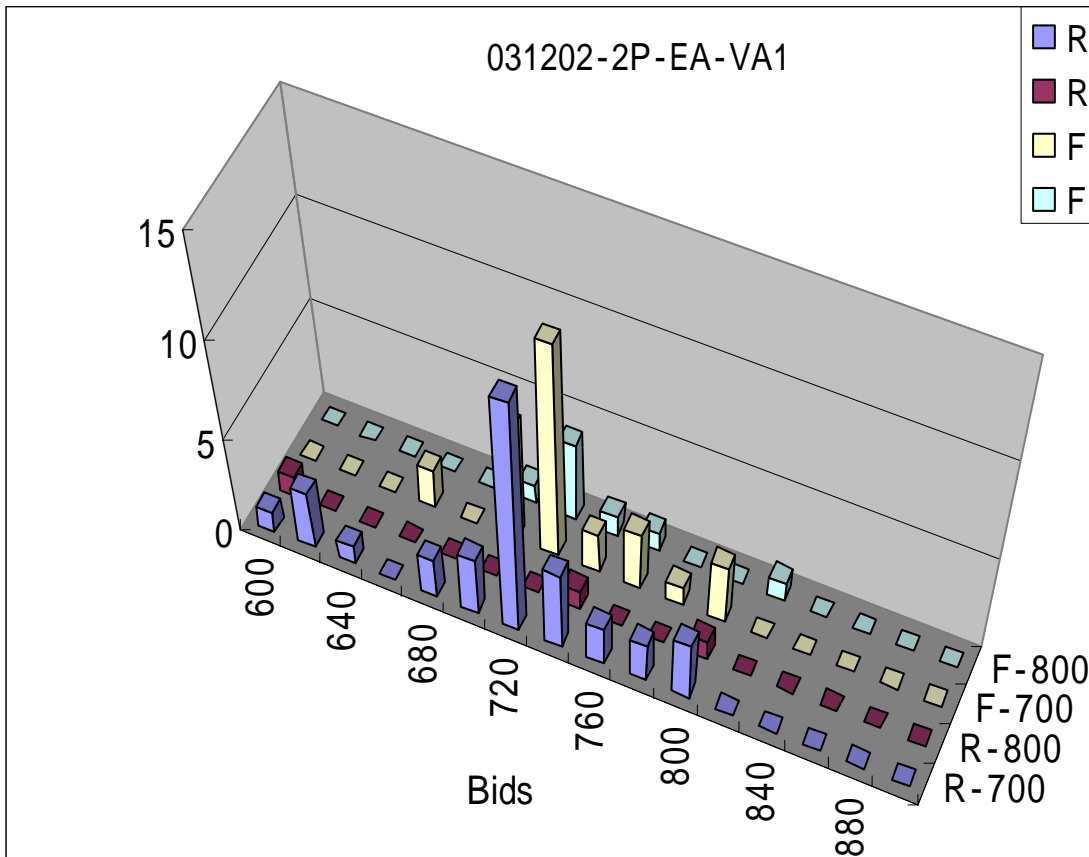
- Comparison between **Bids** by Highest Value Bidder and Second-Highest Value Bidder based on Average Individual **Bid Difference (v-b)**.

Session G-size		031202		031204		031205		031206	
		2P		2P		6P		6P	
		Random	Fix	Random	Fix	Random	Fix	Random	Fix
Values	t-test	0.10	0.48	0.02	0.38	0.02	0.10	0.45	0.02
Known	F-test	0.32	0.74	0.00	0.00	0.23	0.00	0.00	0.17
Values	t-test	0.87	0.02	0.03	0.70	0.54	1.00	0.70	0.52
Unknown	F-test	0.00	0.00	0.01	0.08	0.60	0.40	0.91	0.05

- Bidding behavior is quite different between highest value bidders and second-highest value bidders.

Results: English Auctions

- **Two-Person Individual Pair-wise Bid Data 031204**
Value pair $(v_H, v_L) = (800, 700)$ is known.



Average Bids
made by Non-Winners

VA1	V=700	V=800
G-Random	684.24 (131.48)	503.33 (428.29)
G-Fix	717.64 (35.01)	722.50 (34.54)

VA2	V-lower	V-higher
G-Random	640.48 (79.28)	612.96 (74.72)
G-Fix	616.67 (74.23)	613.33 (84.68)

Significant in F-test

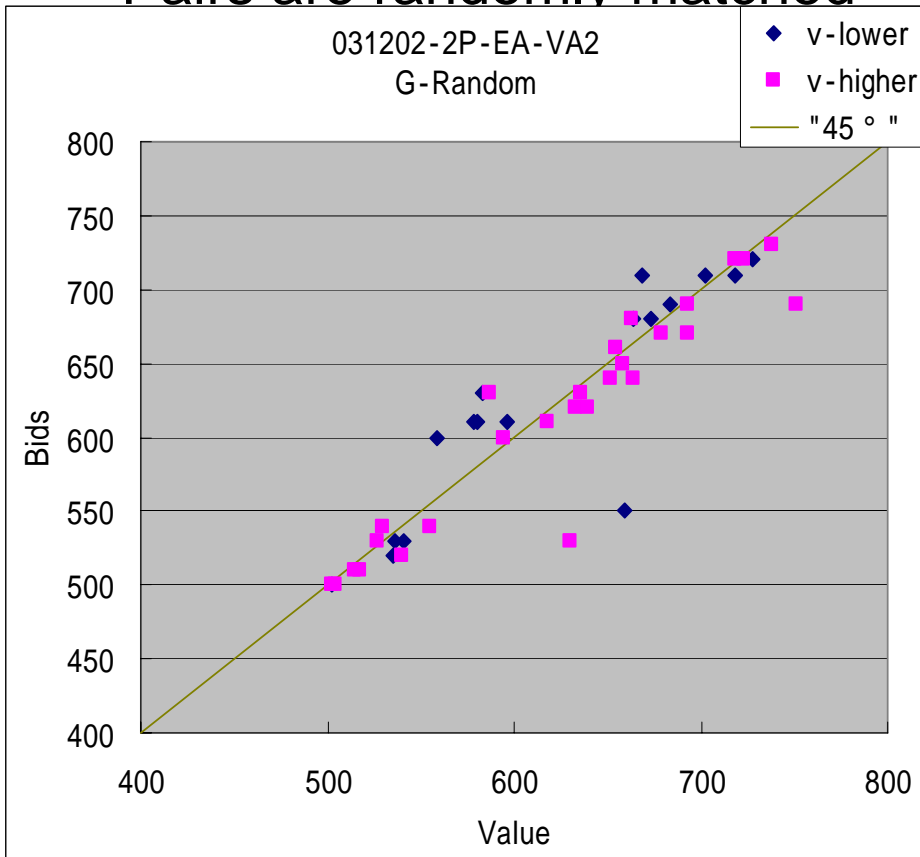
More bids by $v=800$ appeared in G-Fix.

Results: English Auctions

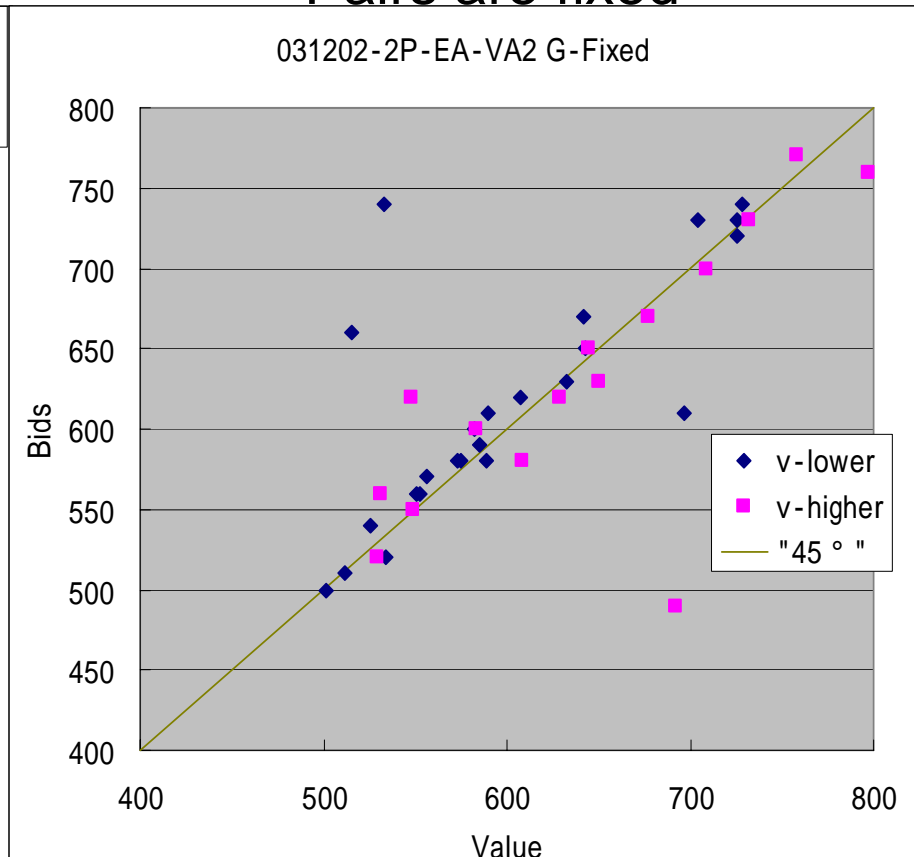
■ Two-Person 031204

Losing Individual Bids and Corresponding Assigned Value
Each value is drawn from [500,800] independently.

Pairs are randomly matched



Pairs are fixed



Results: English Auctions

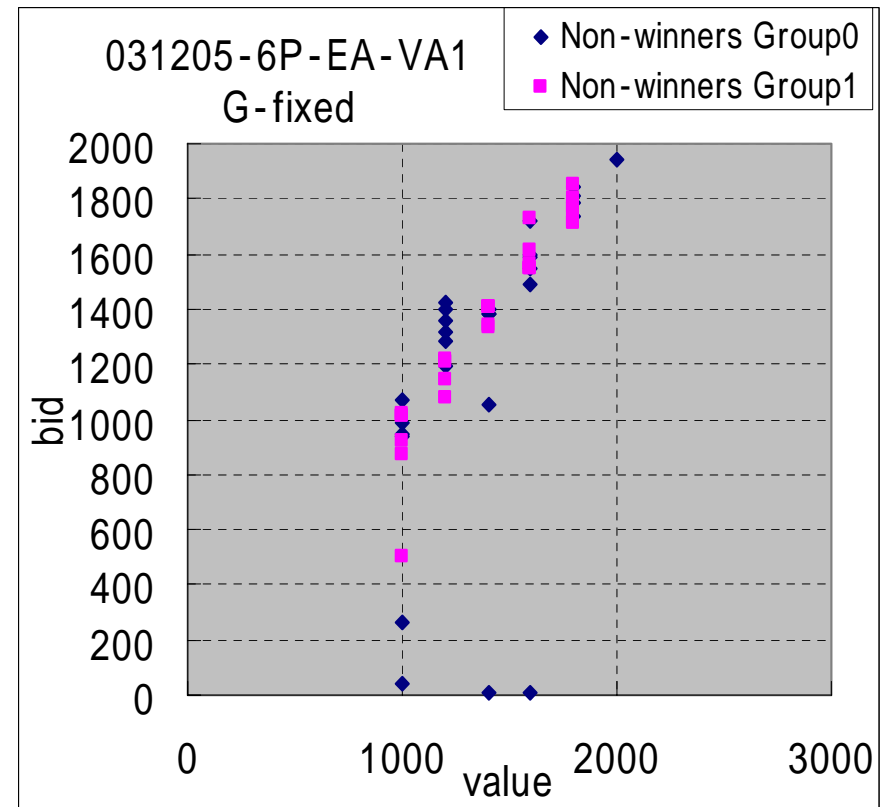
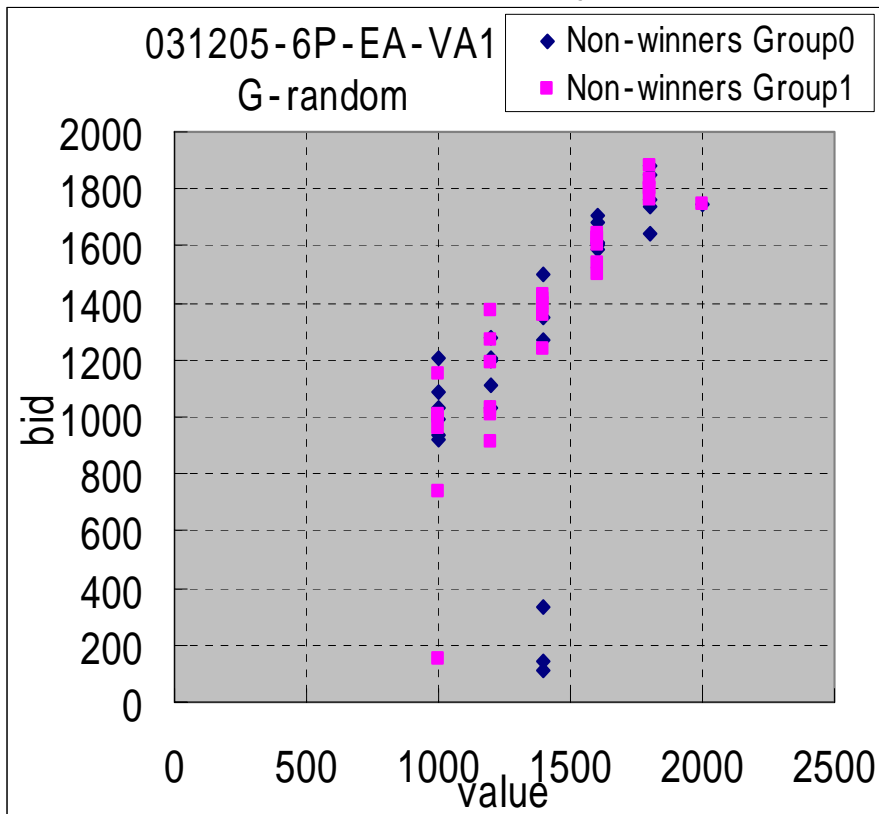
■ Six-Person 031205

Losing Bids and Corresponding Assigned Values

The value list $\{1000, 1200, 1400, 1600, 1800, 2000\}$ is known.

Groups are randomly formed

Groups are fixed

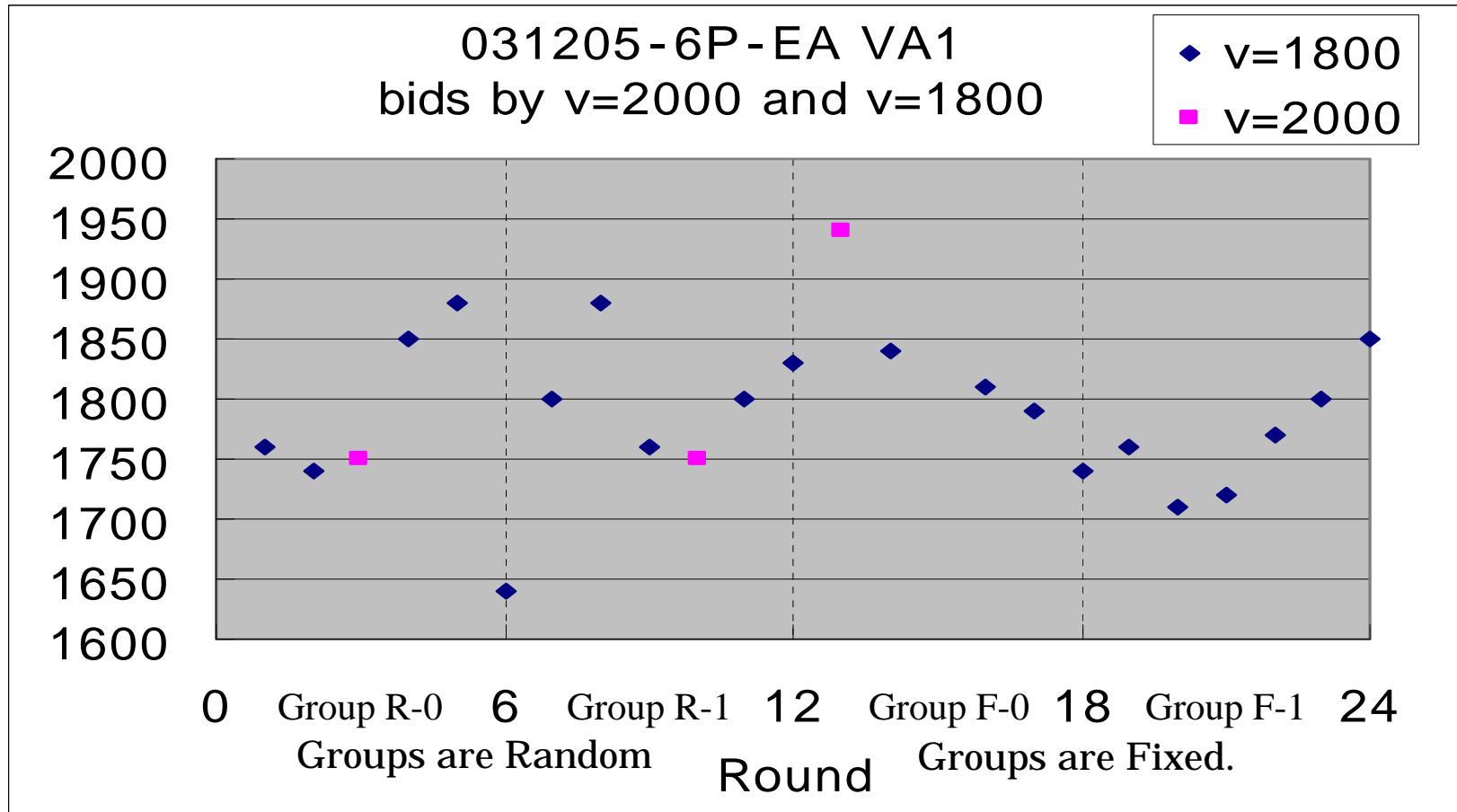


Results: English Auctions

■ Six-Person 031205

Time Series Bids made by Non-winners

The value list $\{1000, 1200, 1400, 1600, 1800, 2000\}$ is known.

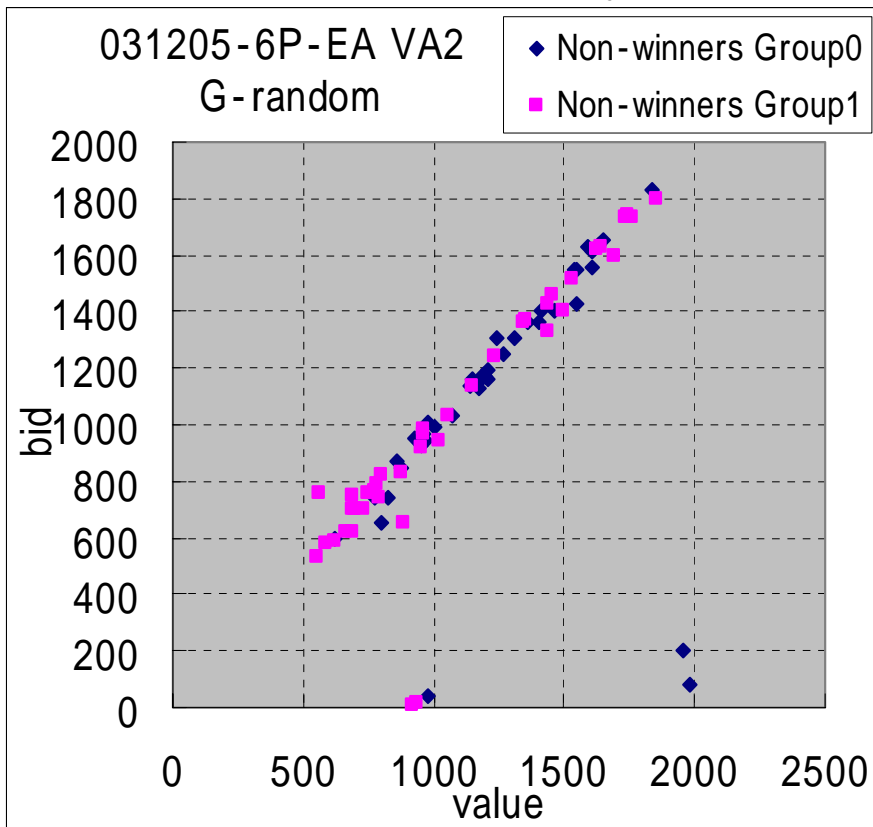


Results: English Auctions

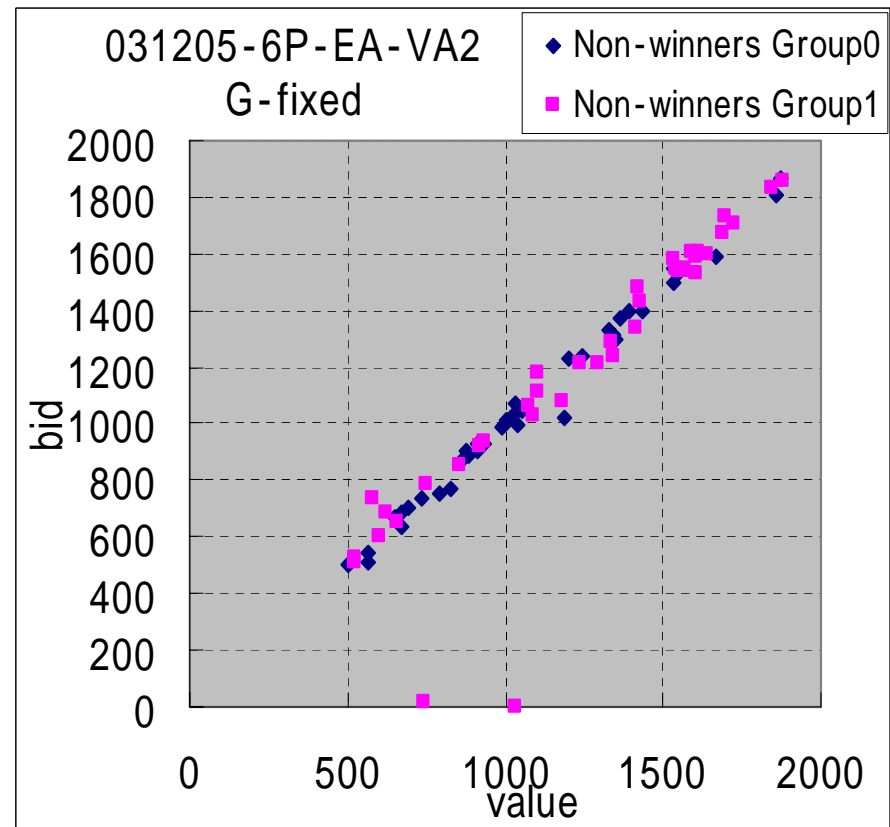
■ Six-Person 031205

Losing Individual Bids and Corresponding Assigned Values
Each value is drawn from [500,2000] independently.

Groups are randomly formed



Groups are fixed



Results: English Auctions

- Average Individual **Bids** when Values are known.

Random vs. Fix

Group-size	Session	G-Random		G-Fix		t-test		F-test	
		v=800	v=700	v=800	v=700	v=800	v=700	v=800	v=700
2P	031202	698.00	709.68	674.44	714.81	0.57	0.50	0.00	0.04
	031204	503.33	684.24	722.50	714.64	0.47	0.21	0.00	0.00
		v=2000	v=1800	v=2000	v=1800	v=2000	v=1800	v=2000	v=1800
6P	031205 + 031206	1695.00	1778.33	1835.00	1673.18	0.40	0.25	0.20	0.00

- Average Individual **Bid Difference (v-b)** when Values are unknown.

Random vs. Fix

Group-size	Session	G-Random		G-Fix		t-test		F-test	
		v-higher	v-lower	v-higher	v-lower	v-higher	v-lower	v-higher	v-lower
2P	031202	17.58	17.47	7.33	-2.42	0.92	0.02	0.07	0.00
	031204	9.74	-5.67	8.00	-17.46	0.87	0.38	0.00	0.03
		v-highest	v-second	v-highest	v-second	v-highest	v-second	v-highest	v-second
6P	031205 + 031206	1288.00	17.04	1511.50	93.44	0.73	0.12	0.50	0.00

Results: English Auctions

- Comparison between **Bids** by Highest Value Bidder and Second-Highest Value Bidder based on Average Individual **Bid Difference (v-b)**.

		031202		031204		031205+031206	
		Random	Fix	Random	Fix	Random	Fix
Values	t-test	0.00	0.01	0.37	0.00	0.00	0.40
Known	F-test	0.08	0.00	0.00	0.53	0.78	0.08
Values	t-test	1.00	0.29	0.08	0.09	0.14	0.10
Unknown	F-test	0.28	0.44	0.19	0.46	0.00	0.32

Results: English Auctions

■ Number of Observed Bids

# of Data		v-highest		v-second highest	
Session	Values	Random	Fix	Random	Fix
031202 (2P)	Known	5	9	31	27
	Unknown	31	15	17	33
031204 (2P)	Known	1	6	31	26
	Unknown	27	24	21	24
031205+06 (6P)	Known	2	0	16	20
	Unknown	3	2	29	30

Results: Second Price Auctions vs English Auctions

■ Two-Person Price Data when values are known

2P VA1		031202				031204			
		EA	Random SP	EA	Fix SP	EA	Random SP	EA	Fix SP
Group 0	Average	701.67	591.67	698.33	700.00	703.33	725.00	713.33	746.67
	Stdev	7.53	99.48	4.08	0.00	58.88	19.75	15.06	30.11
	t-test	0.04		0.36		0.43		0.04	
Group 1	Average	701.67	700.00	735.00	700.00	695.00	765.00	728.33	700.00
	Stdev	13.29	4.08	37.82	12.25	75.56	36.74	48.75	11.69
	t-test	0.58		0.07		0.19		0.20	
Group 2	Average	708.33	650.00	736.67	700.00	578.33	721.67	726.67	736.67
	Stdev	11.69	81.49	38.30	6.32	287.85	27.87	22.51	42.27
	t-test	0.14		0.07		0.28		0.62	
Group 3	Average	700.00	691.67	716.67	675.00	725.00	725.00	746.67	710.00
	Stdev	8.94	16.02	26.58	61.24	36.19	37.28	36.15	0.00
	t-test	0.30		0.17		1.00		0.06	
Group 4	Average	713.33	640.00	633.33	633.33	585.00	713.33	683.33	718.33
	Stdev	25.03	90.55	136.19	103.28	281.83	30.11	27.33	46.65
	t-test	0.11		1.00		0.32		0.15	
Group 5	Average	723.33	691.67	708.33	705.00	728.33	700.00	700.00	741.67
	Stdev	37.24	16.02	9.83	5.48	26.39	10.95	12.65	37.64
	t-test	0.10		0.49		0.05		0.04	
Total	Average	708.06	700.00	704.72	705.00	669.17	725.00	716.39	725.28
	Stdev	20.54	71.35	66.48	53.10	169.88	29.90	34.57	35.17
	t-test	0.00		0.17		0.08		0.28	

Results: Second Price Auctions vs English Auctions

■ Six-Person Price Data when values are known

EA vs SP			Random		Fix	
VA1-6P			EA	SP	EA	SP
031205	Group 0	Average	1770.00	1738.33	1806.67	1765.00
		Stdev	85.79	1738.33	78.91	1765.00
		ttest	0.45		0.39	
	Group 1	Average	1803.33	1810.00	1768.33	1870.00
		Stdev	47.61	1810.00	51.93	1870.00
		ttest	0.88		0.03	
	Total	Average	1786.67	1774.17	1787.50	1817.50
		Stdev	68.40	81.52	66.76	93.14
		ttest	0.69		0.38	
031206	Group 0	Average	1731.67	1793.33	1790.00	1841.67
		Stdev	86.81	5.16	30.33	58.45
		ttest	0.14		0.09	
	Group 1	Average	1746.67	1798.33	1770.00	1843.33
		Stdev	83.35	4.08	79.25	83.83
		ttest	0.19		0.15	
	Total	Average	1739.17	1795.83	1780.00	1842.50
		Stdev	81.52	5.15	58.15	68.90
		ttest	0.03		0.03	
G-Total	Average	1762.92	1785.00	1783.75	1830.00	
	Stdev	77.49	57.56	61.35	81.13	
	ttest	0.27		0.03		

Results: Second Price Auctions vs English Auctions

■ Two-Person Price Data when values are unknown

		031202				031204			
		Random		Fix		Random		Fix	
		EA	SP	EA	SP	EA	SP	EA	SP
Group 0	Average	587.50	615.60	608.75	593.00	597.50	618.50	693.75	641.25
	Stdev	57.01	58.54	86.43	69.61	85.48	75.99	65.01	71.00
	t-test	0.42		0.68		0.71		0.15	
Group 1	Average	566.25	632.00	576.25	624.00	617.50	657.50	618.75	581.25
	Stdev	58.54	71.44	67.60	69.79	81.37	46.21	69.78	48.53
	t-test	0.10		0.16		0.43		0.23	
Group 2	Average	631.25	631.67	576.25	653.00	636.25	632.50	631.25	597.50
	Stdev	86.10	40.21	56.30	78.04	83.14	78.33	65.12	109.64
	t-test	0.99		0.03		0.69		0.47	
Group 3	Average	601.25	585.00	581.25	578.00	593.75	621.38	582.50	604.25
	Stdev	72.59	107.28	67.70	43.67	66.96	68.69	85.31	65.48
	t-test	0.76		0.91		0.54		0.58	
Group 4	Average	590.00	572.00	592.50	586.00	663.75	674.75	601.25	667.50
	Stdev	42.09	73.06	52.85	80.03	73.67	46.20	87.41	70.46
	t-test	0.60		0.84		0.29		0.12	
Group 5	Average	612.50	592.00	628.75	605.00	641.25	606.25	562.50	624.29
	Stdev	612.50	77.97	628.75	40.07	641.25	65.45	562.50	43.53
	t-test	0.73		0.42		0.72		0.01	
Total	Average	598.13	604.40	593.96	606.50	625.00	635.15	615.00	619.23
	Stdev	79.05	72.98	67.18	67.69	77.16	65.77	78.79	74.00
	t-test	0.71		0.34		0.49		0.79	

Results: Second Price Auctions vs English Auctions

■ Six-Person Price Data when values are unknown

EA vs SP			Random		Fix	
VA2-6P			EA	SP	EA	SP
031205	Group 0	Average	1556.25	1510.00	1538.75	1628.75
		Stdev	190.78	246.69	211.08	201.38
		t-test	0.68		0.40	
	Group 1	Average	1540.00	1631.25	1641.25	1687.50
		Stdev	270.08	284.93	137.57	281.16
		t-test	0.52		0.68	
	Total	Average	1548.13	1570.63	1590.00	1658.13
		Stdev	226.04	264.96	180.07	238.19
		t-test	0.80		0.37	
031206	Group 0	Average	1777.50	1490.00	1556.25	1662.50
		Stdev	96.62	338.82	260.05	202.26
		t-test	0.05		0.38	
	Group 1	Average	1677.50	1496.25	1555.00	1542.50
		Stdev	176.94	270.18	259.73	249.61
		t-test	0.14		0.92	
	Total	Average	1727.50	1493.13	1555.63	1602.50
		Stdev	147.08	296.06	251.08	228.05
		t-test	0.01		0.58	
G-Total	Average	1637.81	1531.88	1572.81	1630.31	
	Stdev	208.55	279.16	215.63	231.12	
	t-test	0.09		0.31		