Entry by Successful Speculators in Auctions with Resale

Marco Pagnozzi Krista J. Saral

August 2016

- Auctions are often followed by a **resale market**, where winners can resell items acquired:
  - Spectrum licenses
  - Treasury bills
  - Emission permits

- Auctions are often followed by a **resale market**, where winners can resell items acquired:
  - Spectrum licenses
  - Treasury bills
  - Emission permits
- **Speculators** (with no use value for the items on sale) may participate in order to resell to high-value bidders

- Auctions are often followed by a **resale market**, where winners can resell items acquired:
  - Spectrum licenses
  - Treasury bills
  - Emission permits
- **Speculators** (with no use value for the items on sale) may participate in order to resell to high-value bidders

"Should the seller encourage speculators, because additional bidders create more competition in the auction?

- Auctions are often followed by a **resale market**, where winners can resell items acquired:
  - Spectrum licenses
  - Treasury bills
  - Emission permits
- **Speculators** (with no use value for the items on sale) may participate in order to resell to high-value bidders

"Should the seller encourage speculators, because additional bidders create more competition in the auction?

Or should the seller discourage them, because value captured by speculators must come from someone else's payoffs — possibly the seller's?" (Milgrom, 2004)

- *Why should a high-value bidder let speculators win?*

- *Why should a high-value bidder let speculators win?*

- In **multi-object auctions**, bidders bid less than value for marginal units to keep the auction price low (*Demand Reduction*: Wilson '79; Ausubel & Cramton '98)
  – e.g., FCC auctions, German GSM auction, electricity markets ...

- *Why should a high-value bidder let speculators win?*

- In **multi-object auctions**, bidders bid less than value for marginal units to keep the auction price low (*Demand Reduction*: Wilson '79; Ausubel & Cramton '98)
  – e.g., FCC auctions, German GSM auction, electricity markets ...

$\Rightarrow$ Allocation may be inefficient and speculators may win

- *Why should a high-value bidder let speculators win?*

- In **multi-object auctions**, bidders bid less than value for marginal units to keep the auction price low (*Demand Reduction*: Wilson '79; Ausubel & Cramton '98)
  – e.g., FCC auctions, German GSM auction, electricity markets ...

$\Rightarrow$ Allocation may be inefficient and speculators may win

- **Resale** may exacerbate demand reduction: after letting speculators win, a bidder can buy in the resale market

Questions

- *How do bidders respond to the presence of a speculators?*

Questions

- *How do bidders respond to the presence of a speculators?*
  - Bidders reduce demand and accommodate speculators

Questions

- *How do bidders respond to the presence of a speculators?*
  - Bidders reduce demand and accommodate speculators
- *Can speculators obtain positive profit?*

Questions

- *How do bidders respond to the presence of a speculators?*
  - Bidders reduce demand and accommodate speculators
- *Can speculators obtain positive profit?*
  - Yes

Questions

- *How do bidders respond to the presence of a speculators?*
  - Bidders reduce demand and accommodate speculators
- *Can speculators obtain positive profit?*
  - Yes
- *How do speculators choose whether to enter an auction?*

Questions

- *How do bidders respond to the presence of a speculators?*
  - Bidders reduce demand and accommodate speculators
- *Can speculators obtain positive profit?*
  - Yes
- *How do speculators choose whether to enter an auction?*
- *How are speculators affected by competing speculators?*

Questions

- *How do bidders respond to the presence of a speculators?*
  - Bidders reduce demand and accommodate speculators
- *Can speculators obtain positive profit?*
  - Yes
- *How do speculators choose whether to enter an auction?*
- *How are speculators affected by competing speculators?*
- *What is the effect of speculators on seller's revenue?*

THEORETICAL BACKGROUND

Model

- **Uniform-price auction** for 2 identical units:
  - Each bidder places 2 sealed bids
  - 2 highest bids win 1 unit each
  - Winner(s) pay 3^{rd}-highest bid for each unit
- 1 **bidder** (B) with per-unit value $v_B \sim U[50, 100]$,
  1 or 2 **speculators** (S) with no value
- Speculator(s) simultaneously choose whether to enter auction or earn outside option c
- **Resale market**: if S wins, players trade through bargaining
  - r = resale price when S does not learn v_B, with $\mathbb{E}[r] > c$

Auction with 1 Speculator

- Multiple equilibria

Auction with 1 Speculator

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(v_B,\ 0)$ *and S bids* $(50,\ 0)$

Auction with 1 Speculator

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(v_B,\ 0)$ *and S bids* $(50,\ 0)$

$\Rightarrow$ B and S win 1 unit each at price 0

Auction with 1 Speculator

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(v_B,\ 0)$ *and S bids* $(50,\ 0)$

$\Rightarrow$ B and S win 1 unit each at price 0

$\Rightarrow$ S resells to B at a price r

Auction with 1 Speculator

- Multiple equilibria

- **Proposition**: *There is an equilibrium where B bids* $(v_B,\ 0)$ *and S bids* $(50,\ 0)$

$\Rightarrow$ B and S win 1 unit each at price 0

$\Rightarrow$ S resells to B at a price r

- **Proof**: To win 2 units, B pays 50 and earns

$$2\left(v_B - 50\right) < \underbrace{v_B + \left(v_B - r\right)}_{\text{equilibrium profit}} \quad \Leftrightarrow \quad r < 100 \qquad \blacksquare$$

Auction with 1 Speculator

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(v_B,\ 0)$ *and S bids* $(50,\ 0)$

$\Rightarrow$ B and S win 1 unit each at price 0

$\Rightarrow$ S resells to B at a price r

- **Proof**: To win 2 units, B pays 50 and earns

$$2\left(v_B - 50\right) < \underbrace{v_B + \left(v_B - r\right)}_{\text{equilibrium profit}} \quad \Leftrightarrow \quad r < 100 \qquad \blacksquare$$

- S always enters since $\mathbb{E}[r] > c$

Auction with 2 Speculators

- Multiple equilibria

Auction with 2 Speculators

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(0,\ 0)$, S_1 *bids* $(100,\ 100)$, *and* S_2 *bids* $(\mathbb{E}[r],\ \mathbb{E}[r])$

Auction with 2 Speculators

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(0,\ 0)$, S_1 *bids* $(100,\ 100)$, *and* S_2 *bids* $(\mathbb{E}[r],\ \mathbb{E}[r])$

$\Rightarrow$ S_1 wins 2 units at price $\mathbb{E}[r]$ and resells at price r

Auction with 2 Speculators

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(0,\ 0)$, S_1 *bids* $(100,\ 100)$, *and* S_2 *bids* $(\mathbb{E}[r],\ \mathbb{E}[r])$

$\Rightarrow$ S_1 wins 2 units at price $\mathbb{E}[r]$ and resells at price r

$\Rightarrow$ S_1's and S_2's profit $= 0$

Auction with 2 Speculators

- Multiple equilibria
- **Proposition**: *There is an equilibrium where B bids* $(0,\ 0)$, S_1 *bids* $(100,\ 100)$, *and* S_2 *bids* $(\mathbb{E}[r],\ \mathbb{E}[r])$

$\Rightarrow$ S_1 wins 2 units at price $\mathbb{E}[r]$ and resells at price r

$\Rightarrow$ S_1's and S_2's profit $= 0$

- Competition among speculators eliminates their profit

Entry

- Entry game with 2 speculators
  (when players play equilibria described)

	Enter		Stay out	
Enter	0	0	$\mathbb{E}[r]$	c
Stay out	c	$\mathbb{E}[r]$	c	c

Entry

- Entry game with 2 speculators
  (when players play equilibria described)

	Enter		Stay out	
Enter	0	0	$\mathbb{E}[r]$	c
Stay out	c	$\mathbb{E}[r]$	c	c

- 2 asymmetric equilibria: (Enter, Stay out)

Entry

- Entry game with 2 speculators
  (when players play equilibria described)

		Enter		Stay out	
Enter		0	0	$\mathbb{E}[r]$	c
Stay out		c	$\mathbb{E}[r]$	c	c

- 2 asymmetric equilibria: (Enter, Stay out)
- Unique *symmetric* mixed-strategy equilibrium:
  S enters with probability $1 - \frac{c}{\mathbb{E}[r]}$

Theoretical Predictions

- With 1 speculator, B may reduce demand and allow S to obtain positive profit (but may also outbid S)
- Entry by S depends on expectation of B's reaction
- Multiple speculators have lower incentive to enter, and may not earn more than outside option

EXPERIMENT DESIGN

Treatments – between subjects design

- **1 speculator (1S):** 1 B and 1 S, both in the auction

Treatments – between subjects design

- **1 speculator (1S):** 1 B and 1 S, both in the auction
- **1 speculator entry (1SE):** 1 B and 1 S,
  S chooses whether to enter the auction

Treatments – between subjects design

- **1 speculator (1S):** 1 B and 1 S, both in the auction
- **1 speculator entry (1SE):** 1 B and 1 S,
  S chooses whether to enter the auction
- **2 speculators entry (2SE)**: 1 B and 2 S,
  Ss simultaneously choose whether to enter the auction

Treatments – between subjects design

- **1 speculator (1S):** 1 B and 1 S, both in the auction
- **1 speculator entry (1SE):** 1 B and 1 S,
  S chooses whether to enter the auction
- **2 speculators entry (2SE)**: 1 B and 2 S,
  Ss simultaneously choose whether to enter the auction
- **Resale market**:

Treatments – between subjects design

- **1 speculator (1S):** 1 B and 1 S, both in the auction
- **1 speculator entry (1SE):** 1 B and 1 S,
  S chooses whether to enter the auction
- **2 speculators entry (2SE)**: 1 B and 2 S,
  Ss simultaneously choose whether to enter the auction
- **Resale market**:
  - Unstructured bargaining: multiple offers, chat and exit option

Treatments – between subjects design

- **1 speculator (1S):** 1 B and 1 S, both in the auction
- **1 speculator entry (1SE):** 1 B and 1 S,
  S chooses whether to enter the auction
- **2 speculators entry (2SE)**: 1 B and 2 S,
  Ss simultaneously choose whether to enter the auction
- **Resale market**:
  - Unstructured bargaining: multiple offers, chat and exit option
  - Speculators can communicate with B, not between each other

Experiment Details

- University students at xs/fs laboratory at FSU
- 15 auctions and $\sim$20 subjects per session, random rematching, same values between treatments
- Endowments= 50ECU for B, 400ECU for S

EXPERIMENT RESULTS

Entry by S

%	*S* enters	n=2	n=3
1SE	79	79	-
2SE	67	40	47

- *S* enters more often in 1SE than 2SE ($p<0.05$)

Entry by S

%	S enters	n=2	n=3
1SE	79	79	-
2SE	67	40	47

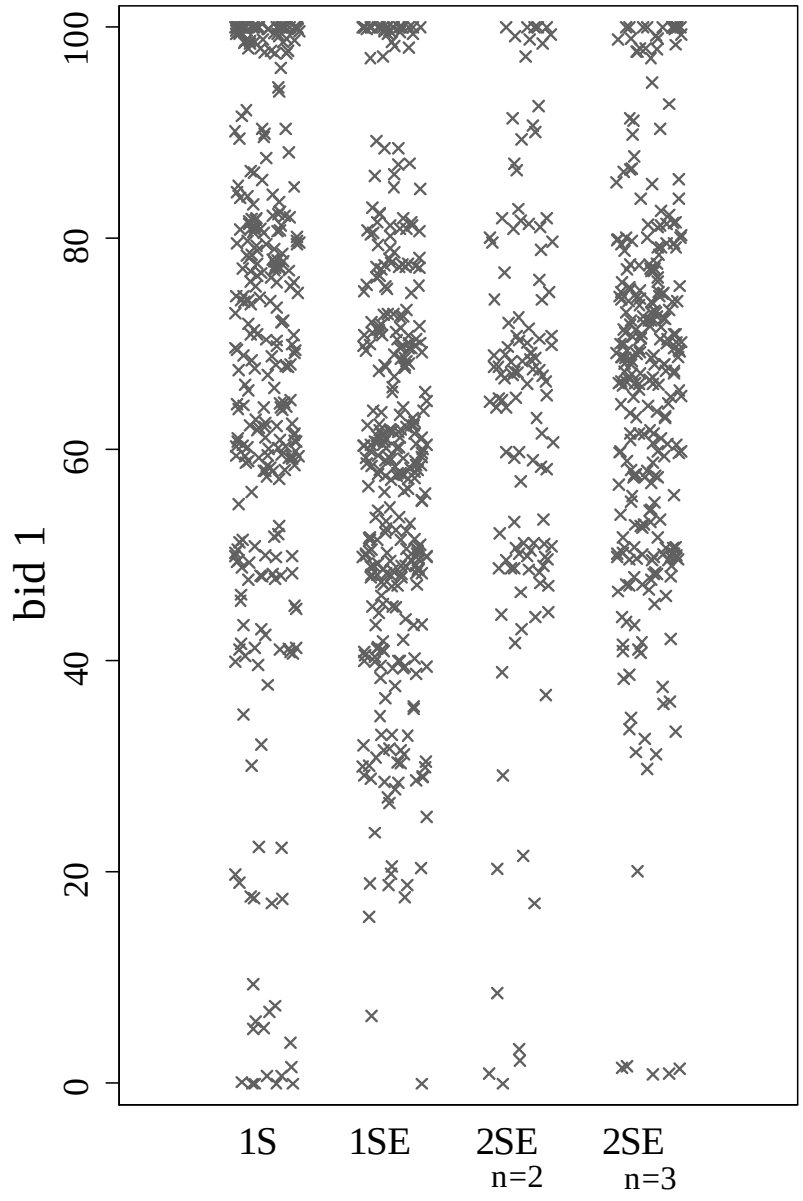
- S enters more often in 1SE than 2SE ($p<0.05$)
- Auctions with at least 1 S: 79% in 1SE and 87% in 2SE

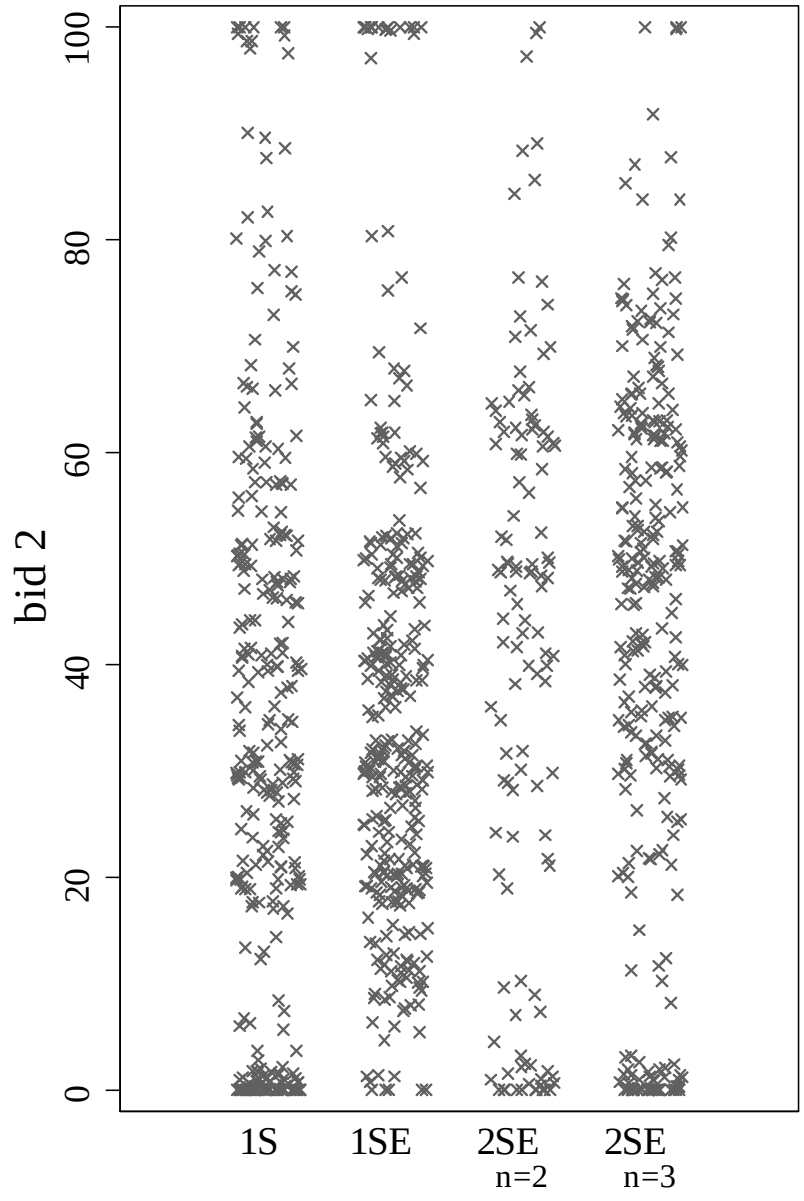
Entry by S

%	S enters	n=2	n=3
1SE	79	79	-
2SE	67	40	47

- S enters more often in 1SE than 2SE ($p<0.05$)
- Auctions with at least 1 S: 79% in 1SE and 87% in 2SE
- 47% of auctions in 2SE had 2 speculators

S Bidding


bid 1
0
20
40
60
80
100
1S
1SE
2SE
n=2
2SE
n=3


bid 2
0
20
40
60
80
100
1S
1SE
2SE
n=2
2SE
n=3

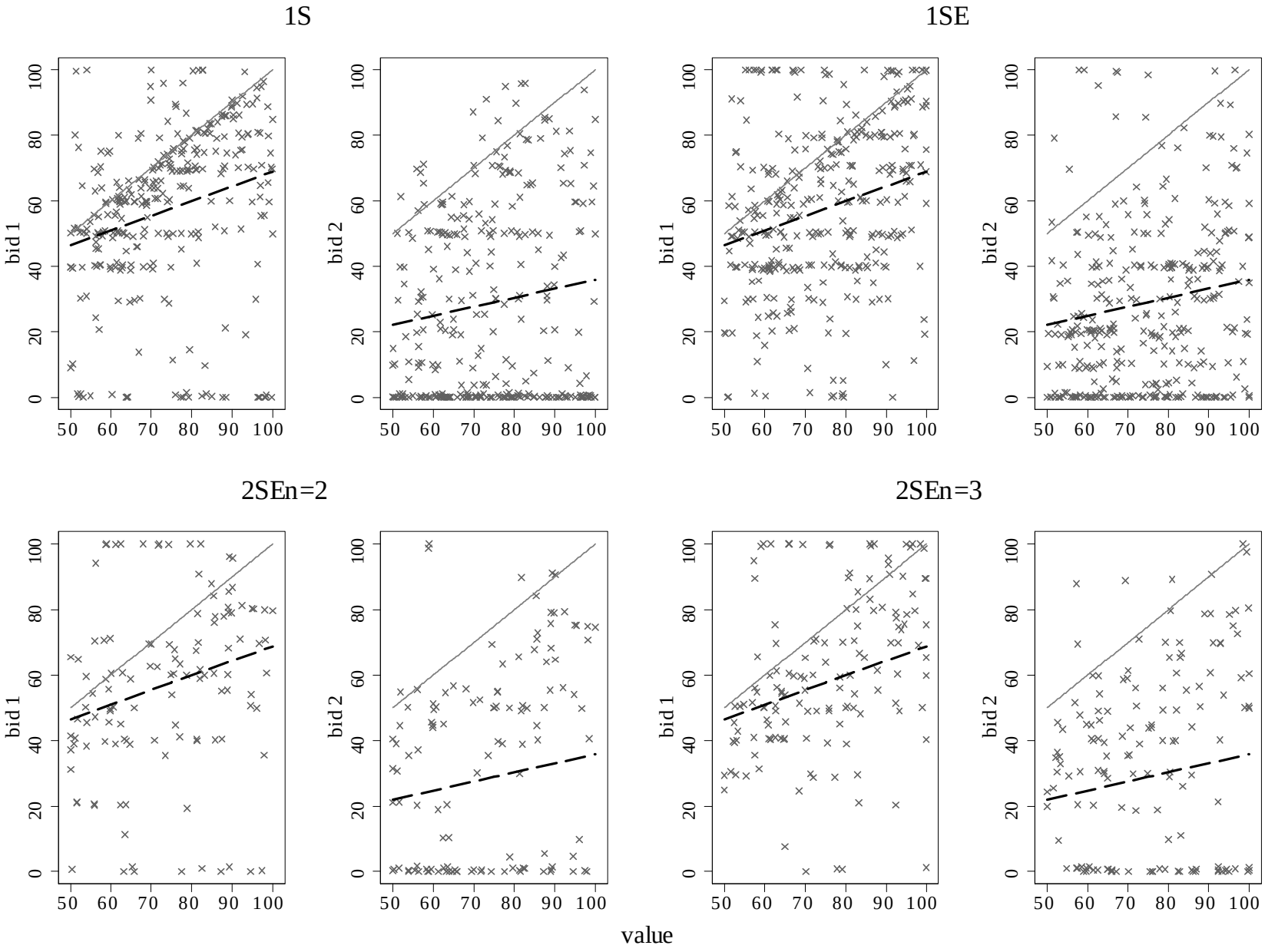
Average Bid by S

	bid 1	bid 2
1S	69	34
1SE	60	36
2SEn=2	63	41
2SEn=3	66	42

- Average bid > 0: speculation
- Bid 1 $\gg$ bid 2: demand reduction

(one-sided sign test on session averages, p=0.004)

B Bidding


1S
1SE
2SEn=2
2SEn=3
bid 1
bid 2
value
0
20
40
60
80
100
50
60
70
80
90
100

Average Bid by B

	bid 1	bid 2	bid 2 $\leq$10
1S	57	29	45%
1SE	58	27	36%
2SEn=2	56	34	37%
2SEn=3	61	35	30%

- Bid 1 $\gg$ bid 2: demand reduction

  (one-sided sign test on session averages, p=0.004)

- No significant treatment effects

Units won by S

%	0	1	2
1S	16	58	26
1SE	16	61	23
2SEn=2	16	45	39
2SEn=3	10	33	57

- Speculators win!

Units won by S

%	0	1	2
1S	16	58	26
1SE	16	61	23
2SEn=2	16	45	39
2SEn=3	10	33	57

- Speculators win!
- Most frequent allocation (when S enters):

Units won by S

%	0	1	2
1S	16	58	26
1SE	16	61	23
2SEn=2	16	45	39
2SEn=3	10	33	57

- Speculators win!
- Most frequent allocation (when S enters):
  - S and B win 1 unit each in 1S and 1SE

Units won by S

%	0	1	2
1S	16	58	26
1SE	16	61	23
2SEn=2	16	45	39
2SEn=3	10	33	57

- Speculators win!
- Most frequent allocation (when S enters):
  - S and B win 1 unit each in 1S and 1SE
  - S wins 2 units in 2SE

Resale Frequency

%	Resale Market	Resale Success
1S	84	81
1SE	84	85
2SEn=2	84	86
2SEn=3	90	74

- Bidders accommodate speculators

Resale Frequency

%	Resale Market	Resale Success
1S	84	81
1SE	84	85
2SEn=2	84	86
2SEn=3	90	74

- Bidders accommodate speculators
  - Resale market in over 84% of auctions with speculator(s)

Resale Frequency

%	Resale Market	Resale Success
1S	84	81
1SE	84	85
2SEn=2	84	86
2SEn=3	90	74

- Bidders accommodate speculators
  - Resale market in over 84% of auctions with speculator(s)
  - S resells 82% of units acquired

Prices

	Auction Price	Resale Price
1S	37	50
1SE	37	48
2SEn=2	41	55
2SEn=3	60	66

- Resale price $>$ auction price

Prices

	Auction Price	Resale Price
1S	37	50
1SE	37	48
2SEn=2	41	55
2SEn=3	60	66

- Resale price $>$ auction price
- Auction price highest in 2SEn=3

Prices

	Auction Price	Resale Price
1S	37	50
1SE	37	48
2SEn=2	41	55
2SEn=3	60	66

- Resale price $>$ auction price
- Auction price highest in 2SEn=3

$\Rightarrow$ Demand reduction and lack of competition reduce revenue

Average Earnings

	S	S (last 5)	B	B (last 5)
1S	8	16	52	67
1SE	7	13	55	62
2SE	–2	7	32	42

- S earns positive profit in 1S and 1SE, but less than outside option

Average Earnings

	S	S (last 5)	B	B (last 5)
1S	8	16	52	67
1SE	7	13	55	62
2SE	–2	7	32	42

- S earns positive profit in 1S and 1SE, but less than outside option
- S makes losses in 2SE

Average Earnings

	S	S (last 5)	B	B (last 5)
1S	8	16	52	67
1SE	7	13	55	62
2SE	–2	7	32	42

- S earns positive profit in 1S and 1SE, but less than outside option
- S makes losses in 2SE
- S and B earnings improve over time

Conclusions

- Role of speculators in multi-object auctions with resale
- Bidders accommodate speculators by reducing demand and then buying in the resale market, regardless of the number of speculators
- Speculators earn positive profit, which induces entry
- Competition among speculators erodes their profit and increases the seller's revenue