Multi-Unit Auctions with Resale: An Experimental Analysis

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July 2013

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- *Should resale be allowed?*
- *How should the resale market be structured?*

Why does resale happen?

- Bidders do not participate in the auction
  (Milgrom, 1987; Bikhchandani & Huang, 1989)
- Bidders' valuations change after the auction
  (Haile, 2000, 2003)
- Value uncertainty (in 1^{st}-price auctions)
  (Gupta & Lebrun, 1999; Hafalir & Krishna, 2007)
- Auction price affects bargaining in resale market
  (Pagnozzi, 2007)
- Strategic behavior: **demand reduction** and **speculation**
  (Garratt & Tröger 2006; Pagnozzi, 2009, 2010)

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- **Resale** increases strong bidders' incentive to **reduce demand**, because they can purchase after the auction the units lost

Overview

In **multi-object** uniform-price auctions with **asymmetric** bidders and resale through **bargaining**:

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2. Demand reduction and speculation emerge when the auction winner can resell
3. Effect of resale on efficiency and seller's revenue
4. Effects of changing the resale market structure

THEORETICAL BACKGROUND

Model

- 2 units of an identical good for sale
- **Uniform-price auction**: the 2 highest bids win, and winner(s) pay the 3^{rd}-highest bid for each unit
- 2 **asymmetric bidders**:
  - S (strong) demands 2 units and has high value $v_s \sim U[30; 50]$
  - W (weak) demands 1 unit and has low value $v_w \sim U[10; 30]$

$\longrightarrow$ Either S wins both units or S and W win one unit each

W's Bidding Strategy without Resale

- It is a dominant strategy for W to bid v_W (as in a single-object 2^{nd}-price auction)

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$\Rightarrow$ S reduces demand if and only if

$$v_S - 0 > 2(v_S - \mathbb{E}[v_W]) \quad \Leftrightarrow \quad v_S < 2\mathbb{E}[v_W] = 40$$

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- S's incentive to reduce demand giving up 1 unit is lower when he has a higher value

Resale Market

- After the auction, if W wins a unit, he can resell it to S
- Resale takes place through **bargaining**
- Gains from trade are $v_S - v_W$
- S obtains a share α of the gains from trade
  W obtains a share $(1 - \alpha)$ of the gains from trade

  (results are robust to many alternative models of resale market)

W's Bidding Strategy with Resale

- W bids up to the expected resale price

$$\alpha v_W + (1 - \alpha)\,\mathbb{E}\left[v_S\right] \equiv \mathbb{E}\left[r\right]$$

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- W speculates because of the option to resell and bids higher than v_W

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- Demand reduction allows S to win 1 unit at price 0 and then purchase the other unit from W in resale (rather than pay $\mathbb{E}[r]$ for both units)

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1. **Without resale**, W bids v_w and S reduces demand if and only if $v_s < 40$
2. **With resale**, W bids above v_w and S always reduces demand

EXPERIMENTAL DESIGN

Uniform-Price Ascending Clock Auction

- Bidders choose when to drop out of the auction as the price increases
- When one bidder drops out, the auction is over (# of units on sale = # of units demanded)
- Winner(s) pay the dropout price for each unit

Treatments - between subjects design

1. **No Resale**

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2. **Complete Information Resale:** after the auction, if W won, bidders learn values and participate in resale
3. **Incomplete Information Resale:** same as complete info, but bidders do not learn values before resale

Resale market: one bidder, chosen with probability $\frac{1}{2}$, makes take-it-or-leave-it offer to the other (Calzolari & Pavan '06)
$\Rightarrow$ in expectation, bidders obtain $\frac{1}{2}$ of gains from trade

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4. **Bargain** (unstructured): as Incomp Resale + bidders can make multiple offers and communicate in computerized chat

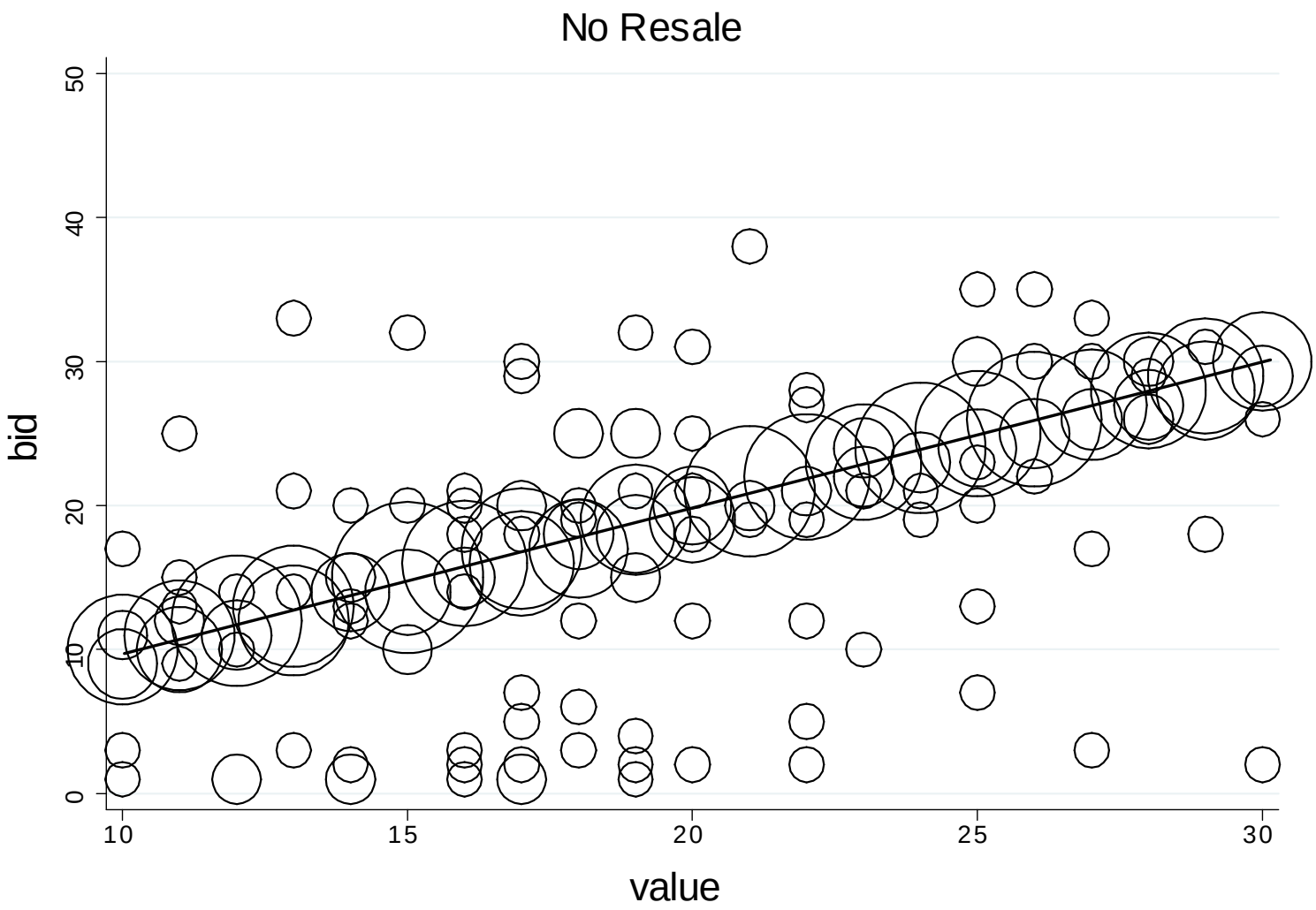
Sessions Information

- 3 sessions of 16 subjects per treatment
  (48 subjects per treatment)
- All sessions had 30 auction periods,
  except Bargain (20 periods due to 2 hour limit)
- All 12 sessions were run in the xs/fs laboratory at FSU
  in March and June 2011, and October 2012
- Mostly undergraduate subjects

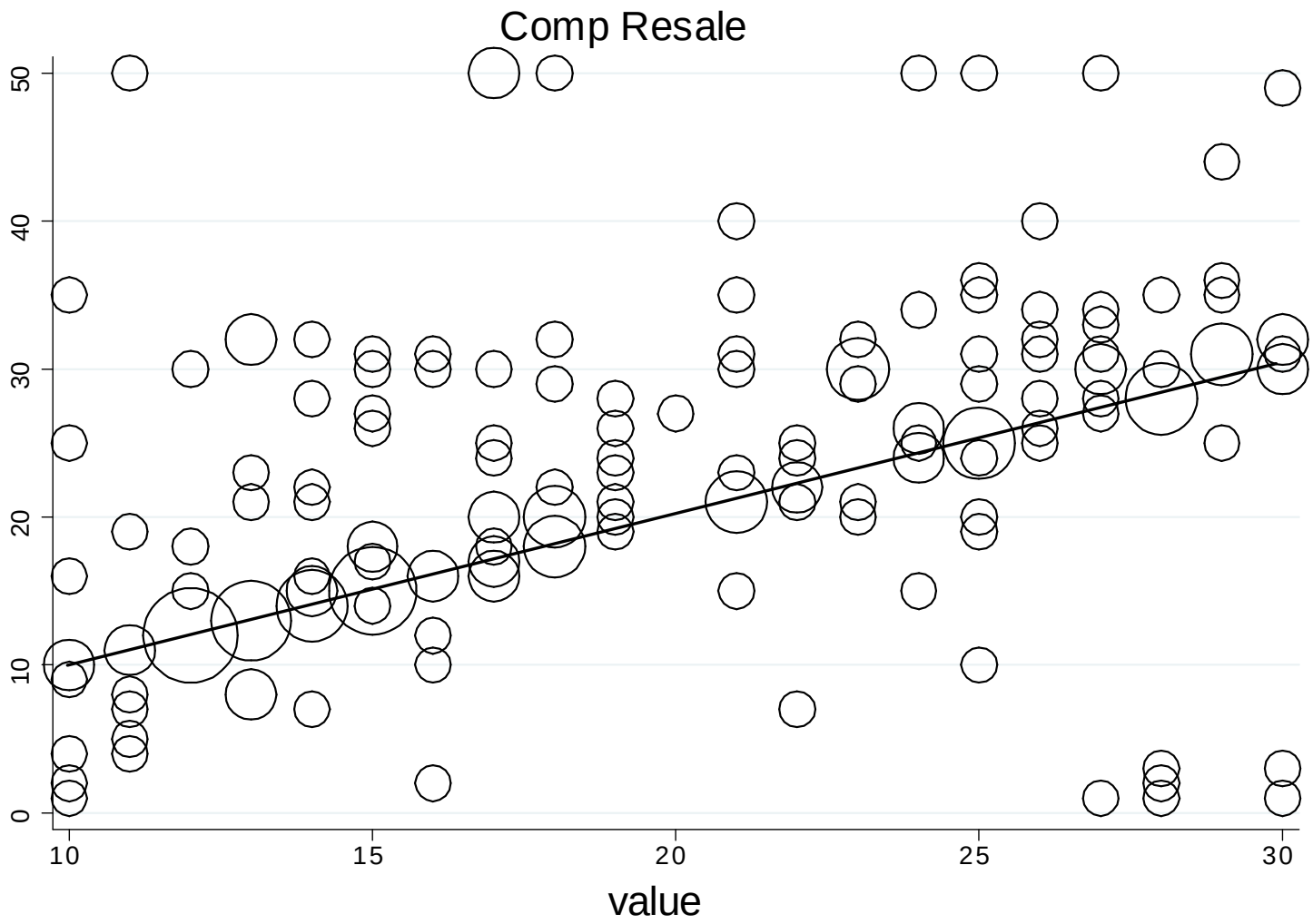
RESULTS

No Resale: *W bids value with high frequency*

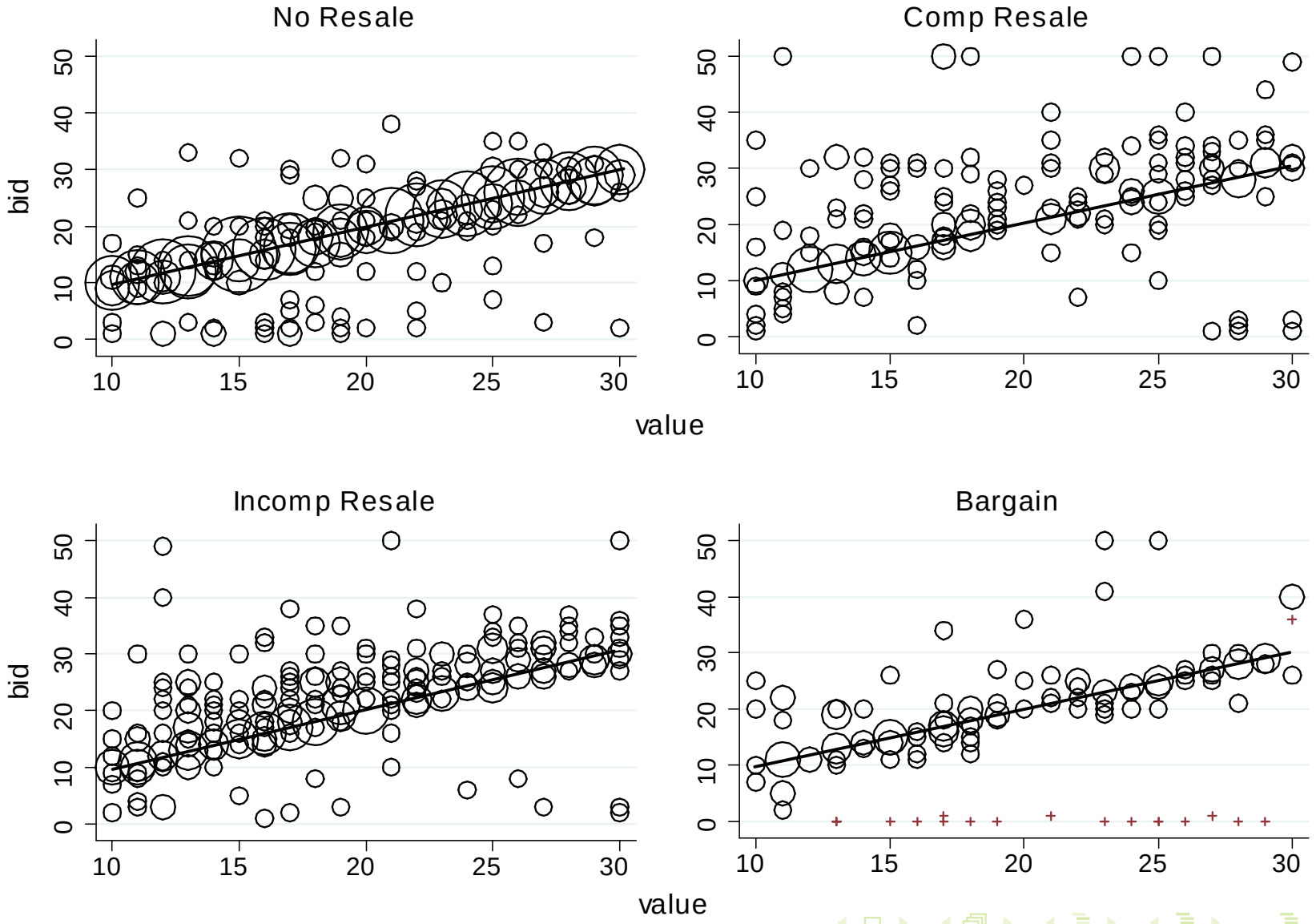
(Weighted scatterplot of observed bids vs. value)



Complete Information Resale: *W bids above value with high frequency*



- Without resale, W tends to bid value
- With resale, W bids above value much more often



Bidding by W – Random Effects Tobit
(unobserved bids censored at the auction price)

W's Bid	Coefficient
Constant	0.870 (1.444)
v_w	0.993*** (0.053)
Comp Resale	**13.248***** (2.285)
Incomp Resale	**6.951***** (2.162)
Bargain	**6.747***** (2.545)
$v_w \times$Comp	–0.316*** (0.092)
$v_w \times$Incomp	–0.117 (0.084)
$v_w \times$Bargain	–0.236** (0.108)

- Bids are higher with resale, especially in Complete Resale

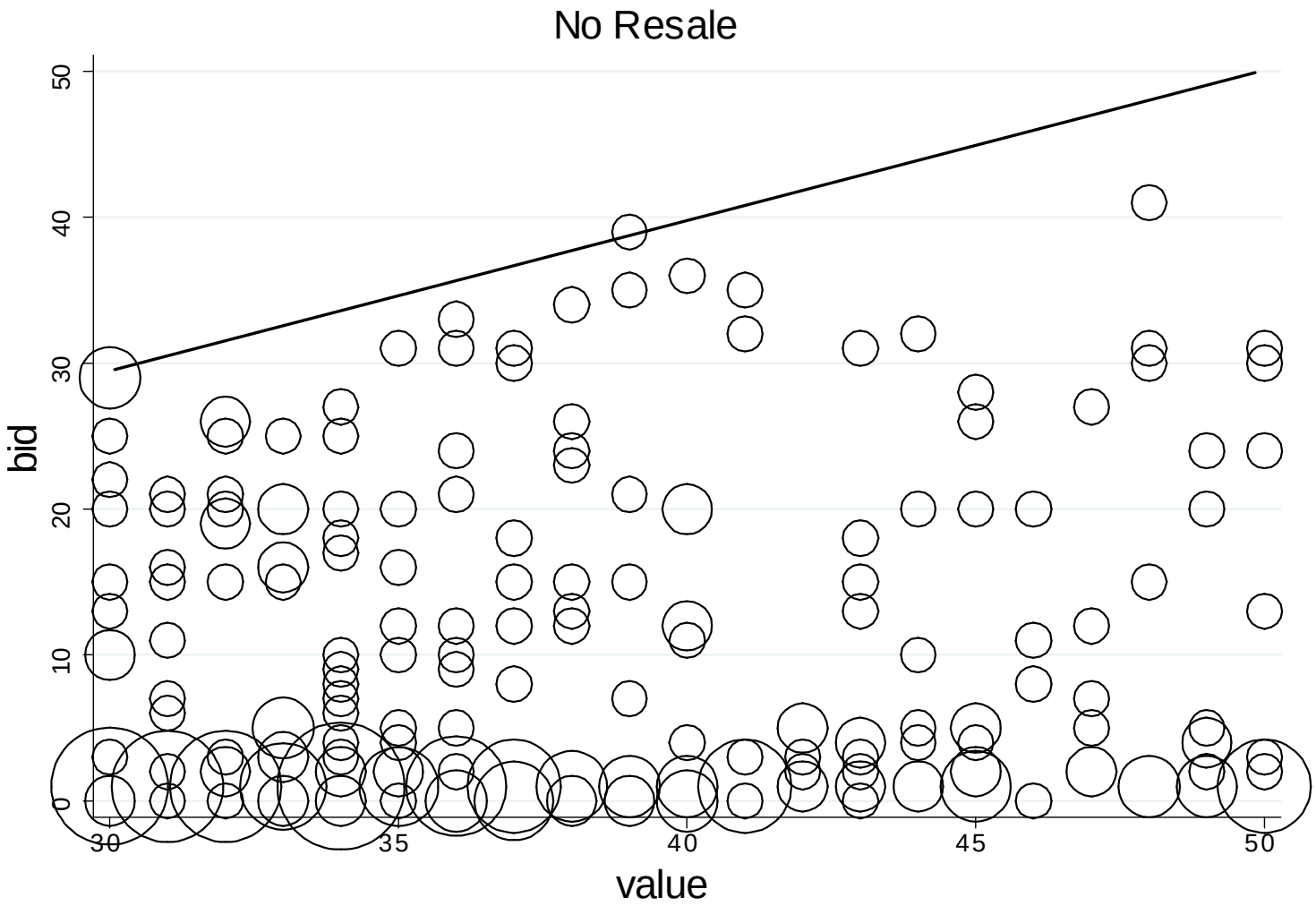
*** and ** indicate statistical significance at 1% and 5%

Demand Reduction by S:

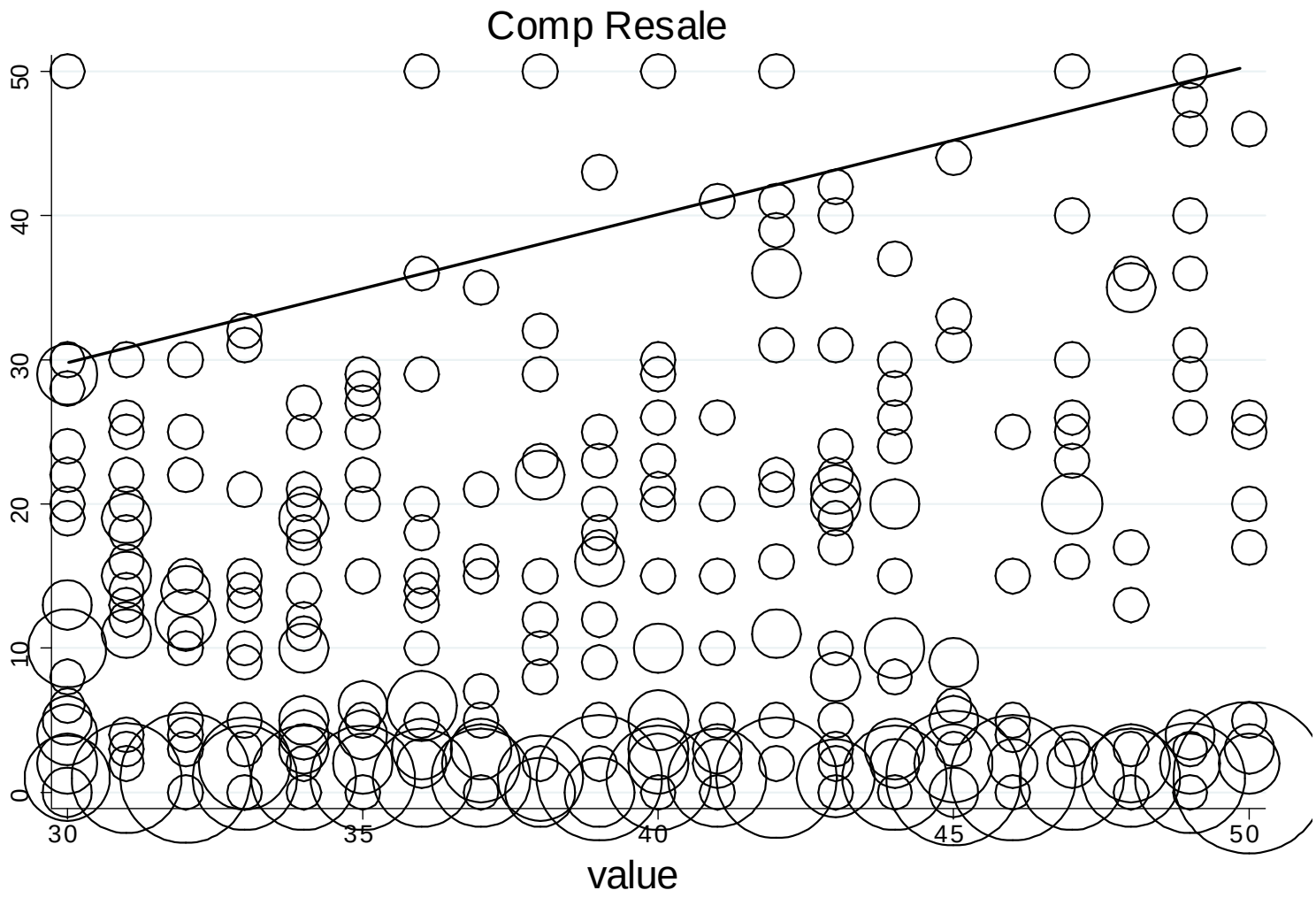
	S's bids ≤ 2		W Wins	
	$v_s < 40$	$v_s > 40$	$v_s < 40$	$v_s > 40$
No Resale	30%	12%	52%	25%
Comp Resale	37%	43%	77%	72%
Incomp Resale	29%	22%	72%	53%
Bargain	48%	50%	74%	71%

There is evidence of more demand reduction in later periods (learning)

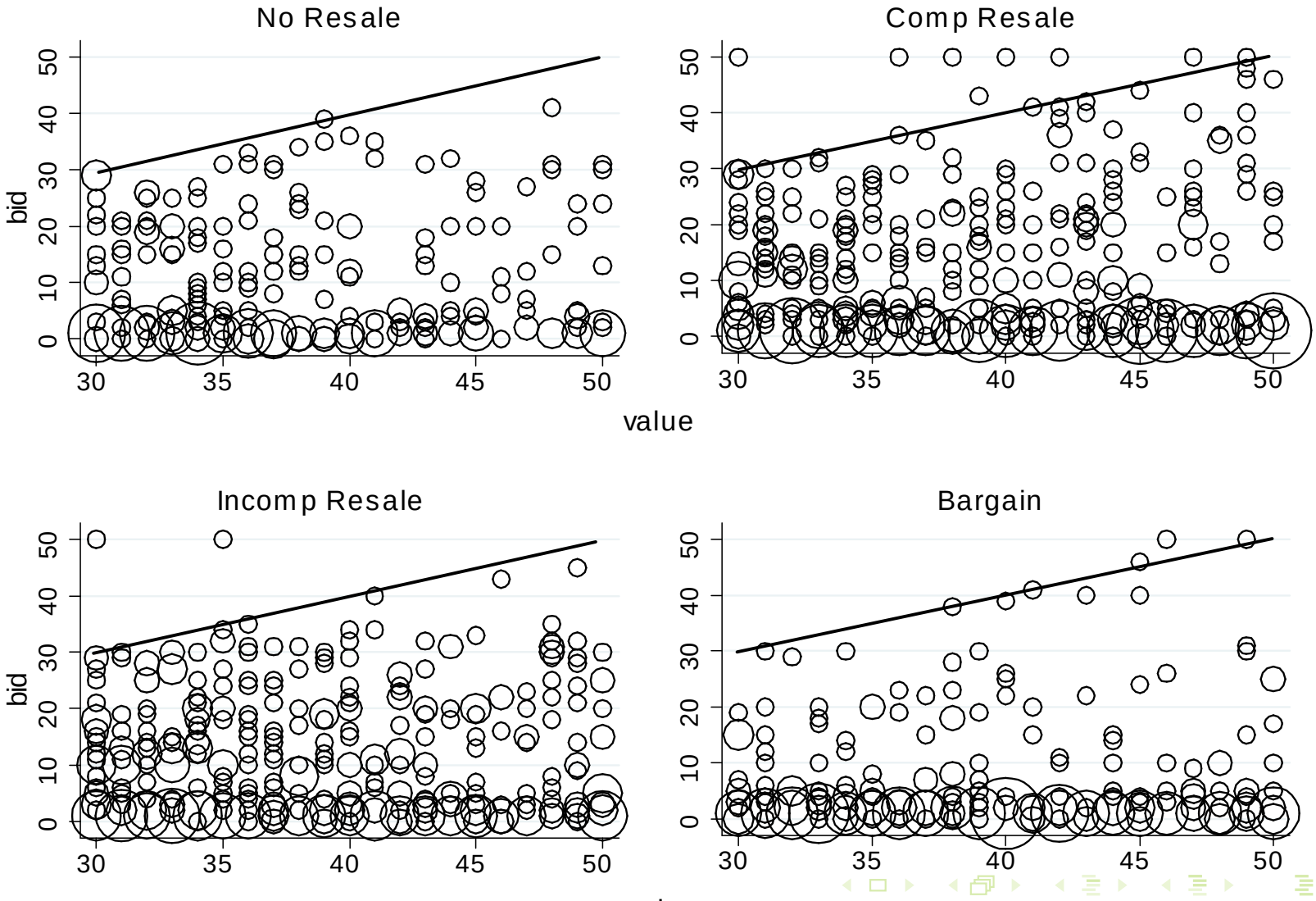
No Resale: *S reduces demand more frequently when* $v_S < 40$, *less frequently when* $v_S > 40$



Complete Information Resale: *S reduces demand with high frequency for all values*



- Without resale, S reduces demand more when $v_s < 40$
- With resale, S reduces demand more frequently, for all values
- Uncertainty in resale reduces demand reduction by S



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Strong Bid	Coefficient
Constant	0.078
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v_s	0.560***
	(0.086)
$v_s > 40$	4.721***
	(1.497)
Comp Resale	–5.894**
	(3.031)
Incomp Resale	–2.635
	(3.034)
Bargain	–8.615***
	(3.065)
Comp $\times v_s > 40$	–8.621***
	(1.505)
Incomp $\times v_s > 40$	–6.410***
	(1.538)
Bargain $\times v_s > 40$	–9.257***
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- Without resale S bids higher when $v_s > 40$

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- When $v_s > 40$ in *all* resale treatments
  S bids lower than without resale

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- When $v_s < 40$ in Comp Resale and Bargain S bids lower than without resale

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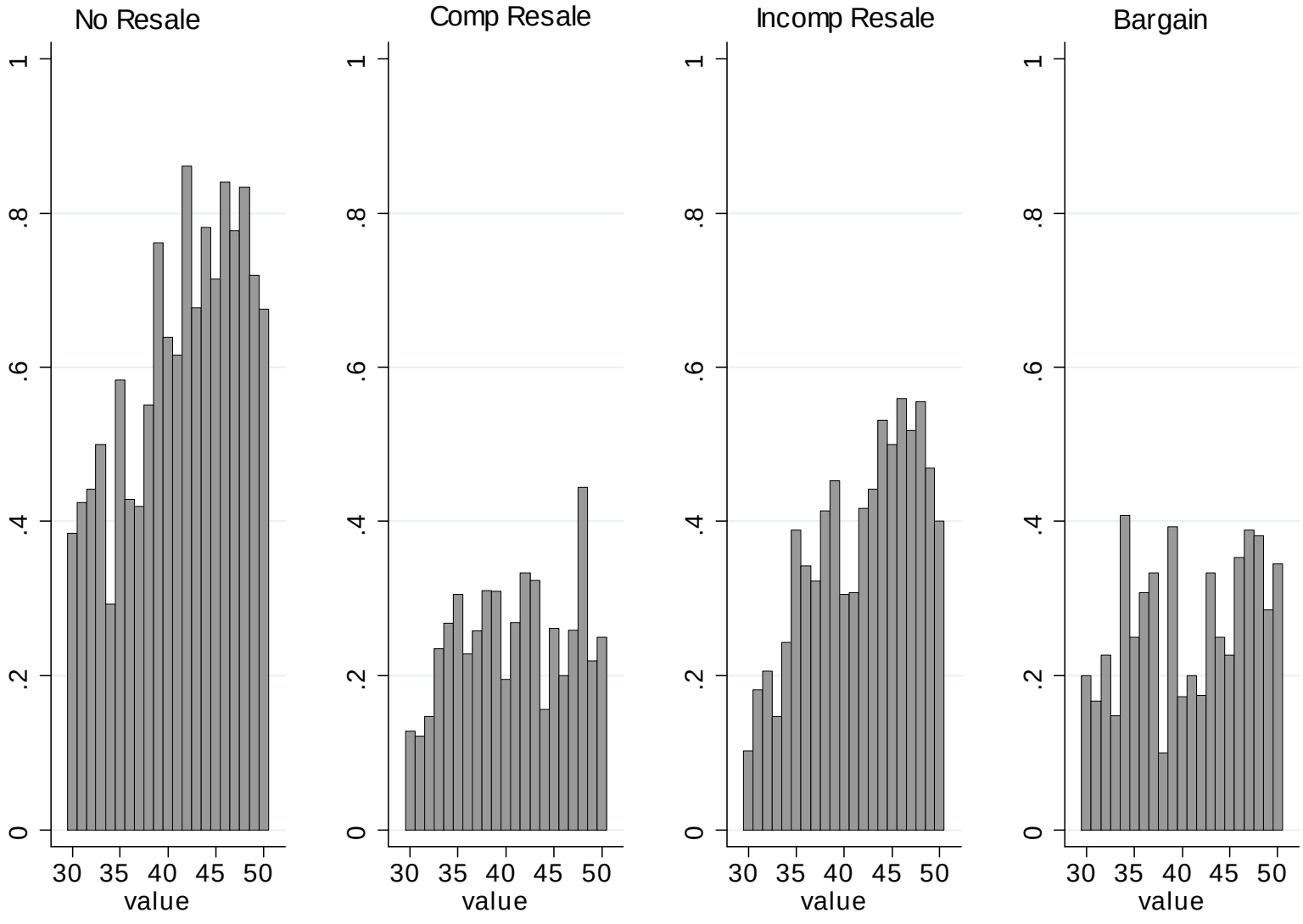
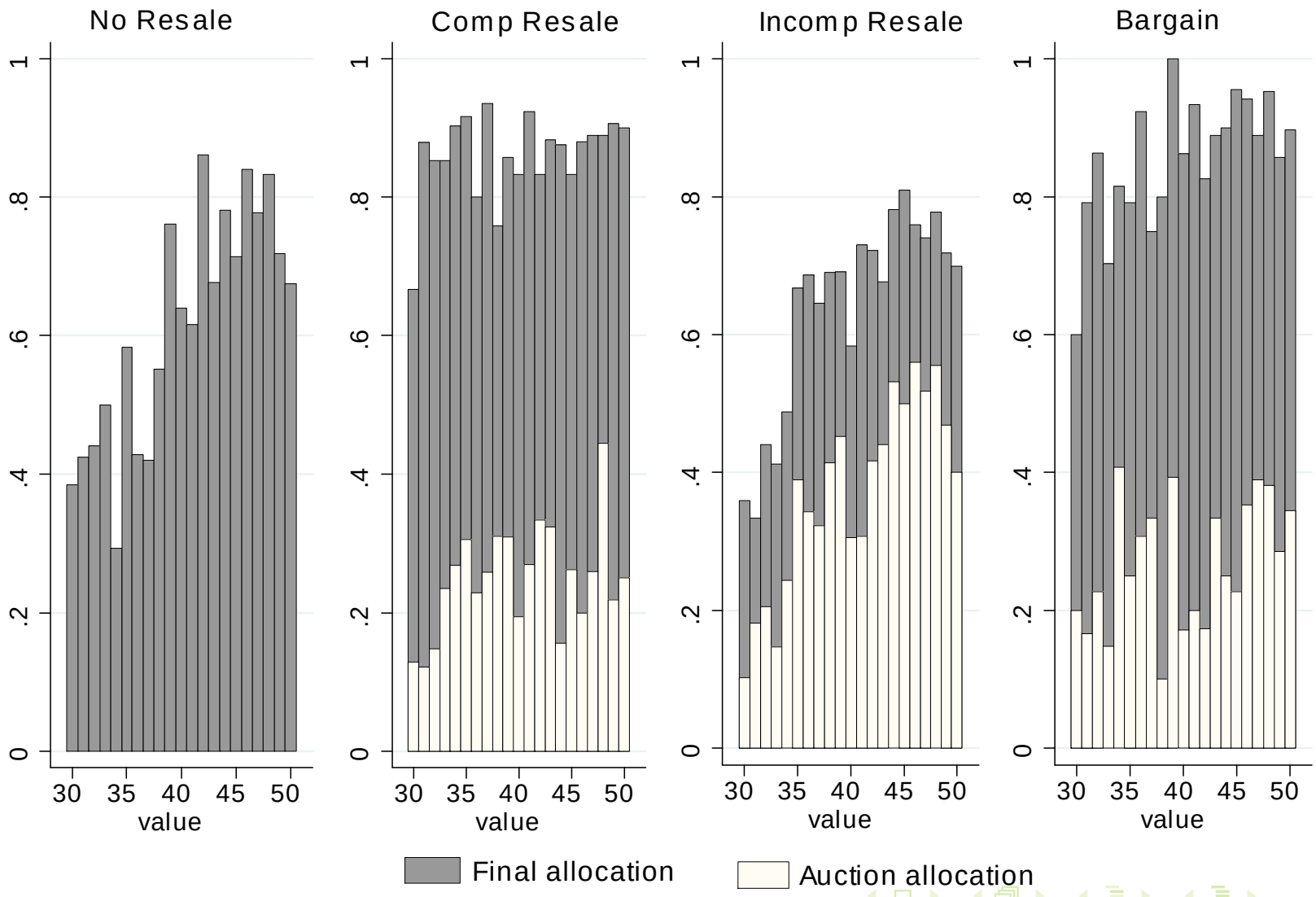
Auction Efficiency: with demand reduction, the auction allocation is inefficient $\Rightarrow$ symmetry and resale reduce auction efficiency

– Average efficiency (winner's value/S's value): No Resale 0.82, Comp 0.64, Incomp 0.71, Bargain 0.65



Final Efficiency: Resale increases efficiency after the auction, but also demand reduction $\Rightarrow$ ambiguous effect on final efficiency

– Average efficiency not significantly different between No Resale (= 0.82) and Incomp Resale (= 0.85)



- **Seller's Revenue:**
  - Resale reduces revenue because it induces S to reduce demand
  - Resale increases revenue (when S does not reduce demand) because it induces W to bid aggressively

	No Resale	Comp Resale	Incomp Resale	Bargain
Average Revenue	14.61	11.94	14.05	8.47
Revenue - W wins	8.01	8.64	9.98	5.25
Revenue - S wins	18.81	21.85	21.06	17.22

– Significant difference between revenue with No Resale and either Comp Resale or Bargain (WMW, $p < 0.001$)

– No significant difference between revenue with No Resale and Incomp Resale ($p = 0.319$)

What are the effects of changing the resale market structure?

- **Comp Resale**: t-o-l offers with complete information
- **Incomp Resale**: t-o-l offers with incomplete information
- **Bargain**: multiple offers and communication

	Resale Possible (W won the auction)	Successful Resale
Comp Resale	75%	81.1%
Incomp Resale	63.2%	42.2%
Bargain	73.1%	79.5%

Average Resale Price, Earnings, Offer

	Resale Price (Auction Price)	Earnings Weak / Strong	Resale Offer Weak / Strong
Comp Resale	29.56 (11.94)	9.45/10.20	32.47/25.45
Incomp Resale	27.38 (14.05)	8.74/12.59	32.45/17.93
Bargain	27.44 (8.47)	8.35/12.43	-

- Prices are higher in resale than in auction, and highest in Comp
- S earns more than W in resale
- S makes more aggressive offers in Incomp (WMW, $p<0.001$)

Total Earnings: Auction + Resale Profits

Average Total Earnings	No Resale	Comp Resale	Incomp Resale	Bargain
Weak Bidder	4.61	12.45	7.55	15.83
(std. dev)	(8.823)	(14.273)	(10.795)	(12.620)
Strong Bidder	38.33	37.43	34.93	44.62
(std. dev)	(17.061)	(18.348)	(17.905)	(17.147)

cumulative earnings restricted to 20 periods for comparison to bargain treatment

- W obtains higher profits with resale (WMW, $p<0.001$)
- S obtains higher profits with resale only in Bargain

Conclusions

- Experiments of **multi-object** auction with resale and
  - **asymmetric** bidders
  - resale through **bargaining**
- Without resale, strong bidders with low values reduce demand more
- With resale, weak bidders speculate and
  strong bidders reduce demand more frequently
- Resale does not necessarily increase efficiency and
  reduce the seller's revenue
- More efficient resale market reduces auction efficiency and revenue