# Spite vs. Risk: Explaining overbidding

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# Economic exchange

- How do institutions work?
  How do decision makers behave in a given institution?
- Which institutions?

| | | Sellers | |
|---|---|---|---|
| | | many | few |
| Buyers | many | market | auction |
| | few | auction | bargaining |

# Overbidding in first-price auctions

James C. Cox, Vernon L. Smith, and James M. Walker. (1983). Test of a heterogeneous bidder's theory of first price auctions. *Economic Letters, 12 (3-4).*

## Risk aversion → Overbidding

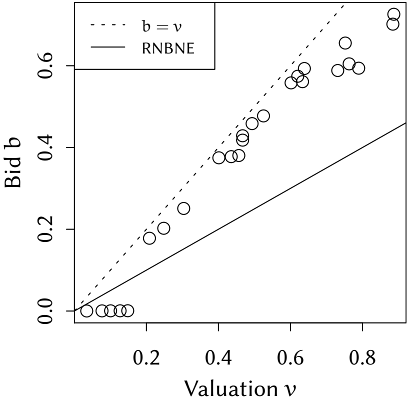
- *CRRA risk aversion:*

$$u(x) = \frac{x^{1-\rho} - 1}{1 - \rho}$$

- *CARA risk aversion:*

$$u(x) = 1 - \frac{e^{-rx}}{r}$$

- ⋮




$$b^*(v) = \frac{1}{2 - \rho} v$$

Risk aversion rationalises bids in auctions.

# Two auction formats

## First-price winner-pay auction

- highest bid wins
- winner pays own bid

## Second-price all-pay auction

- highest bid wins
- all bidders pay own bid, but not more than 2nd highest bid

(Example: competition, war of attrition, R&D,...)

First-price winner-pay auction:

- Risk
- Spite

$\vdots$

Second-price all-pay auction:

- Risk
- Spite

$\vdots$

Can one use the first-price winner-pay auction to disentangle risk and spite?

# Bayesian Nash Equilibria in Auctions

- Bidders maximise $E(u(x|b))$
- E.g. in the first-price winner-pay auction

$$E(u(x|b)) = u(v - b) \cdot P(b = \max(b_j))$$

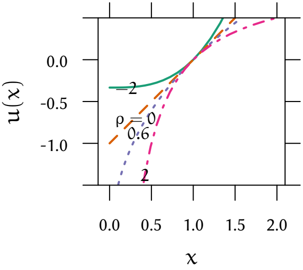
- Risk neutral bidders:

$$u(x) = x$$

- CRRA risk aversion:

$$u(x) = \frac{x^{1-\rho} - 1}{1 - \rho}$$

$\rho$ =coefficient of relative risk aversion.



# Risk and spite in the first-price winner-pay auction

Morgan, Steiglitz and Reis. (2003). The Spite Motive and Equilibrium Behavior in Auctions. *Contributions in Economic Analysis & Policy*, 2(1).

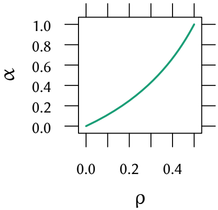
## Payoffs with Spiteful preferences

$$u(x) = x$$

$$\Phi^{!}_{i,\text{Spite}}(b,v) = \begin{cases} u\left(v_i - b_i\right) & \text{if } b_i > b_k \text{ (i wins)} \\ u\left(\frac{v_i - b_i}{2}\right) & \text{if } b_i = b_k \text{ (a tie)} \\ u\left(-\alpha(v_k - b_k)\right) & \text{if } b_i < b_k \text{ (k wins)} \end{cases}$$

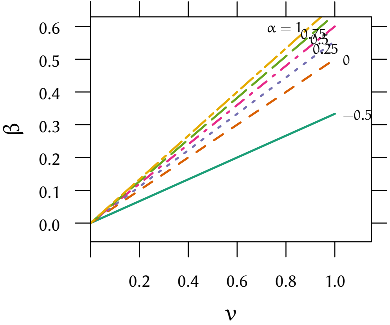
## $\longrightarrow$ equivalence of risk and spite

Morgan et. al: Risk averse bidders with CRRA utility use the same bidding function as a spiteful (but risk neutral) bidders with spite parameter $\alpha = \frac{\rho}{1-\rho}$.



# Equilibrium bids in first-price winner-pay auctions for spiteful/risk averse bidders ($\alpha = \frac{\rho}{1-\rho}$, $\rho = \frac{\alpha}{\alpha+1}$).

$$\beta^{I}_{\text{Spite}}(v) = v - \int_0^v \frac{F(t)^{1+\alpha}}{F(v)^{1+\alpha}}dt = v - \int_0^v \frac{F(t)^{1/(1-\rho)}}{F(v)^{1/(1-\rho)}}dt = \beta^{I}_{\text{Risk}}(v)$$




- Risk of losing $\longrightarrow$ reduce risk by increasing the bid.
- Spite of losing $\longrightarrow$ reduce spite by increasing the bid.

# Two auction formats

## First-price winner-pay auction

- Risk
- Spite

$\vdots$

## Second-price all-pay auction

- Risk
- Spite

$\vdots$

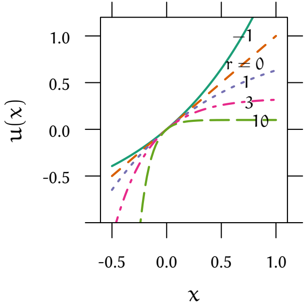
Can one use the second-price all-pay auction to disentangle risk and spite?

# Risk and spite in the second-price all-pay auction

## Risk

CARA risk aversion:

$$u(x) = \frac{1 - e^{-r \cdot x}}{r}$$




$r$ = coefficient of absolute risk aversion.

## Spite

$$u(x) = x$$

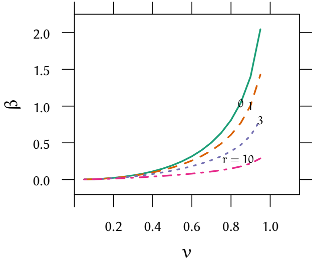
$$\Phi^{\text{II-AP}}_{i,\text{Spite}} = \begin{cases} u\left(v_i - b_k\right) & \text{if } b_i > b_k \text{ (i wins)} \\ u\left(\frac{v_i}{2} - b_i\right) & \text{if } b_i = b_k \text{ (a tie)} \\ u\left(-b_i - \alpha(v_k - b_i)\right) & \text{if } b_i < b_k \text{ } (k \neq i \text{ wins}) \end{cases}$$

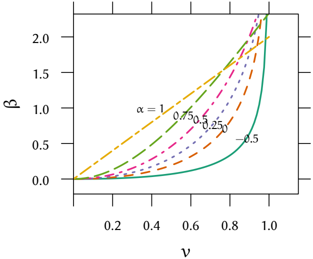
→ No equivalence of risk and spite

# Risk and spite in second-price all-pay auctions

$$\beta^{\text{II-AP}}_{\text{Risk}}(v) = \int_0^v \frac{(1-e^{-s\,r})\,f(s)}{r(1-F(s))}\,ds$$

$$\beta^{\text{II-AP}}_{\text{Spite}}(v) = \frac{\alpha+1}{\alpha}\left(v - \frac{\int_0^v (1-F(s))^{\frac{\alpha}{\alpha-1}}\,ds}{(1-F(v))^{\frac{\alpha}{\alpha-1}}}\right)$$

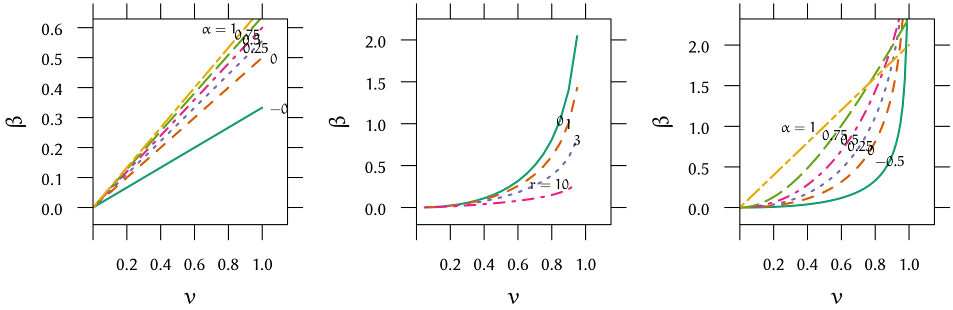



- Risk of losing and still paying a bid → reduce risk by <u>reducing</u> the bid.

- small $v$: bidder can't win, but can at least make the winner suffer.
- large $v$: bidder wins almost certainly (can't make anybody suffer), but has to pay a larger price.

# Two auction formats




## first-price winner-pay auction

$\longrightarrow$ Both risk and spite lead to an increase in bids.

## second-price all-pay auction

- Risk $\longrightarrow$ bids decrease
- Spite $\longrightarrow$ bids fist increase, then decrease

# Experiment

- Elicit preferences
  - risk
  - spite
  - SVO
  - rivalry.
- Auction:
  - either first-price winner-pay auction
  - or second-price all-pay auction
- Payment
  - only for one randomly selected task / auction

# Measuring spiteful preferences

- Marcus, Zeigler-Hill, Mercer, Norris (2014)
  $\longrightarrow$ Questionnaire
- Kimbrough, Reiss, (2012)
  $\longrightarrow$ Auction
- Own measure
  $\longrightarrow$ Slider measure

# Marcus, Zeigler-Hill, Mercer, Norris (2014)

The psychology of spite and the measurement of spitefulness. *Psychological Assessment*, 26(2):563–574.

- I would be willing to take a punch if it meant that someone I did not like would receive two punches.
- I would be willing to pay more for some goods and services if other people I did not like had to pay even more.
- If I was one of the last students in a classroom taking an exam and I noticed that the instructor looked impatient, I would be sure to take my time finishing the exam just to irritate him or her.
- If my neighbor complained about the appearance of my front yard, I would be tempted to make it look worse just to annoy him or her.
- It might be worth risking my reputation in order to spread gossip about someone I did not like.
- If I am going to my car in a crowded parking lot and it appears that another driver wants my parking space, then I will make sure to take my time pulling out of the parking space.
- I hope that elected officials are successful in their efforts to improve

# Kimbrough, Reiss, (2012)

Measuring the distribution of spitefulness. *PLOS ONE*, 7(8):1–8.

## Second price (winner pays) auction

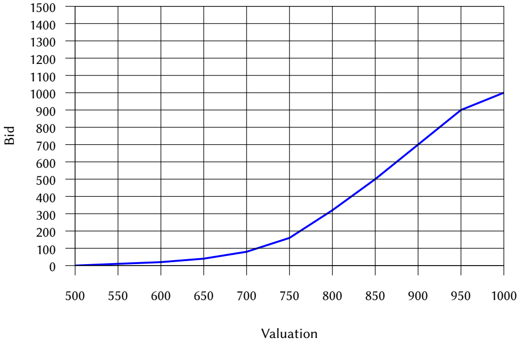
- Participants supply a bid function for a second price auction with one opponent.
- Bids are determined (for randomly drawn valuations) according to the stated bid functions.
- Participants are informed about the outcome.
- Participants can increase own bids by a percentage (between 0 and 100%) of difference between winner's and loser's bid.
  $\rightarrow$ Increased own bids don't change the allocation. They only diminish the winner's payoff.

# Interface of the bidding stage.

Please enter your bid for each potential valuation of the object

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Your valuation | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 |
| Your bid | 0 | 10 | 20 | 40 | 80 | 160 | 320 | 500 | 700 | 900 | 1000 |

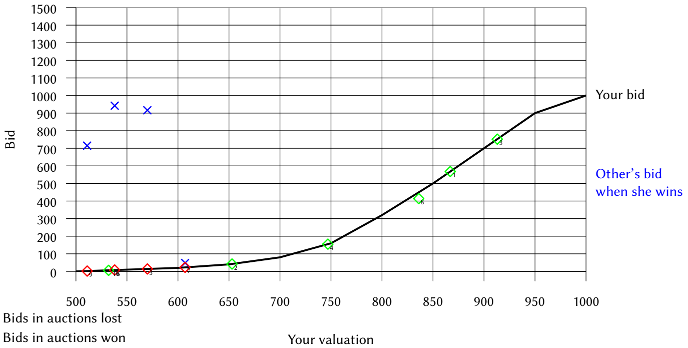
Draw




Ready

# Interface of the feedback stage.

| Auction | 9 | 10 | 6 | 5 | 7 | 2 | 4 | 8 | 1 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Your valuation | 511 | 532 | 538 | 570 | 607 | 653 | 747 | 836 | 867 | 913 |
| Your bid | 2 | 6 | 8 | 14 | 23 | 42 | 155 | 414 | 568 | 752 |
| Other's valuation | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| Other's bid | 715 | smaller | 942 | 916 | 48 | smaller | smaller | smaller | smaller | smaller |
| Won/lost | lost | won | lost | lost | lost | won | won | won | won | won |




The other's valuation is independent of your valuation

Ready

# Interface of bid adaptation

Please choose an adjustment for your winning and losing bids. Then click "Ready".

You are the highest bidder for these auctions.
By how many percent do you increase your bid for the auctions where you are the highest bidder?

0% 100%

26%

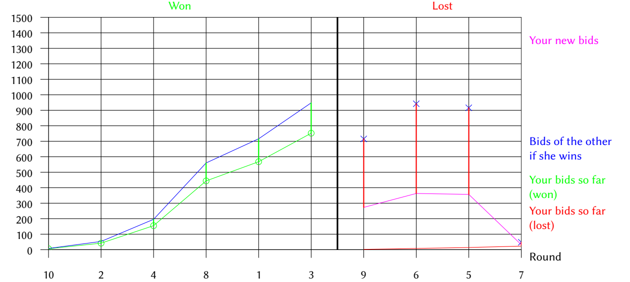
Note: You pay the bid of the other bidder.

You have lost these auctions.
By how many percent do you increase your bid relative to the bid of the other bidder, for the auctions you have lost?

0% 100%

38%

Note: The other bidder pays your bid.

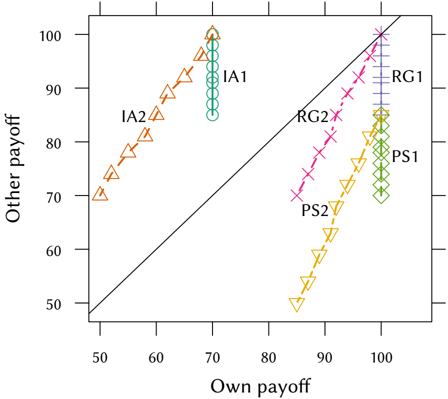



| Round | 10 | 2 | 4 | 8 | 1 | 3 | 9 | 6 | 5 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|
| Your valuation | 532 | 653 | 747 | 836 | 867 | 913 | 511 | 538 | 570 | 607 |
| Bid (so far) | 6 | 42 | 155 | 444 | 568 | 752 | 2 | 8 | 14 | 23 |
| Bid (new) | 8 | 53 | 196 | 560 | 716 | 948 | 273 | 363 | 357 | 32 |

Ready

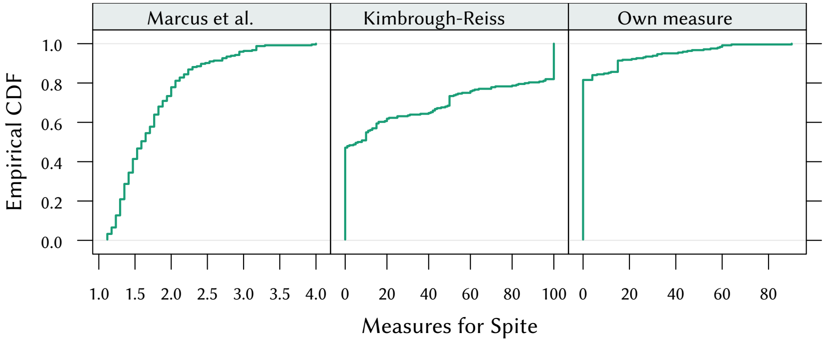
# Own measure of spitefulness.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | You | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |
| IA1 | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Other | 100 | 98 | 96 | 94 | 92 | 91 | 89 | 87 | 85 |
| | You | 70 | 68 | 65 | 62 | 60 | 58 | 55 | 52 | 50 |
| IA2 | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Other | 100 | 96 | 92 | 89 | 85 | 81 | 78 | 74 | 70 |
| | You | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| RG1 | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Other | 100 | 98 | 96 | 94 | 92 | 91 | 89 | 87 | 85 |
| | You | 100 | 98 | 96 | 94 | 92 | 91 | 89 | 87 | 85 |
| RG2 | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Other | 100 | 96 | 92 | 89 | 85 | 81 | 78 | 74 | 70 |
| | You | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| PS1 | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Other | 85 | 83 | 81 | 79 | 78 | 76 | 74 | 72 | 70 |
| | You | 100 | 98 | 96 | 94 | 92 | 91 | 89 | 87 | 85 |
| PS2 | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | Other | 85 | 81 | 76 | 72 | 68 | 63 | 59 | 54 | 50 |



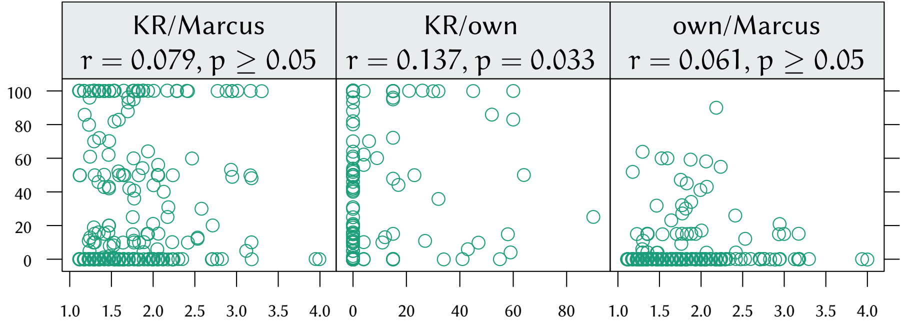

Spite = sum of points (all six measures) by which other payoff is reduced.

# Distribution of Measures for Spite.




| | | Cronbach $\alpha$ | $PC_1$ |
|---|---|---|---|
| Consist. within | Marcus | $0.863$ (CI $= [0.83, 0.903]$) | 33.2% of the varian |
| | own | $0.707$ (CI $= [0.635, 0.788]$) | 76.6% of the varian |
| Consist. across | all | $0.118$ (CI $= [0.0277, 0.216]$) | |

# Joint Distribution of Measures for Spite.




- Three different measures of spite may measure different aspects of spite.

$\longrightarrow$ we take the sum of normalised values (same SD) as measure for “spite”

# Other controls

## Risk aversion

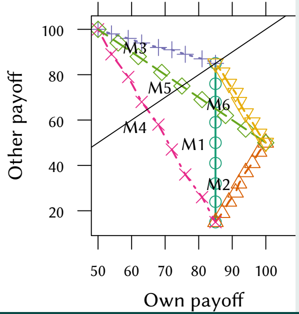
Holt, Laury, (2002). Risk aversion and incentive effects. *American Economic Review*, 92(5):1644–1655.

| 2€ | 1.6€ | 3.85€ | 0.1€ |
|---|---|---|---|
| 0.1 | 0.9 | 0.1 | 0.9 |
| 0.2 | 0.8 | 0.2 | 0.8 |
| 0.3 | 0.7 | 0.3 | 0.7 |
| 0.4 | 0.6 | 0.4 | 0.6 |
| 0.5 | 0.5 | 0.5 | 0.5 |
| 0.6 | 0.4 | 0.6 | 0.4 |
| 0.7 | 0.3 | 0.7 | 0.3 |
| 0.8 | 0.2 | 0.8 | 0.2 |
| 0.9 | 0.1 | 0.9 | 0.1 |
| 1.0 | 0.0 | 1.0 | 0.0 |

cor(risk/spite):$r = 0.004$, $p > 0.05$

## Social value orientation

Murphy, Ackerman, Handgraaf, (2011). Measuring social value orientation. *Judgment and Decision Making*, 6(8):771–781.




## Rivalry

Back, Küfner, Dufner, Gerlach, Rauthmann, Denissen, (2013). Narcissistic admiration and rivalry: Disentangling the bright and dark sides of narcissism. *Journal of Personality and Social Psychology*, 105(10):1013–1037.

1. Most people are losers.
2. I am often edgy when I am criticised.
3. I secretely rejoice over the failures of my opponents.
4. Other people have no value.
5. I am annoyed when another person steals my thunder.
6. I want my competitors to fail.
7. Most people will never amount to anything.
8. I can't bear when other people occupy centre stage.
9. I enjoy when another person is inferior to me.

# Experiment

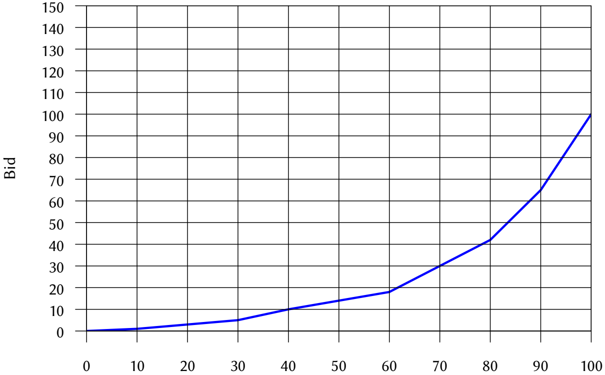
- Elicit preferences
  - risk
  - spite
  - SVO
  - rivalry.
- Auction:
  - either first-price winner-pay auction
  - or second-price all-pay auction
- Payment
  - only for one randomly selected task / auction

# Interface of the bidding stage.

Please enter your bid for each potential valuation of the object

| Your valuation | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Your bid | 0 | 1 | 3 | 5 | 10 | 14 | 18 | 30 | 42 | 65 | 100 |

Draw

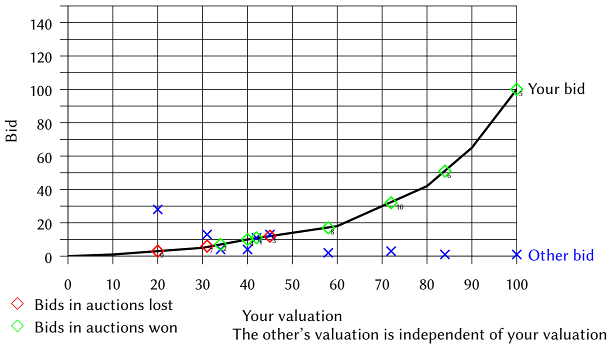



You are in round 1 out of 20 rounds

Ready

# Interface of the feedback stage.

| Auction | 9 | 7 | 2 | 4 | 1 | 3 | 8 | 10 | 6 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Your valuation | 20 | 31 | 34 | 40 | 42 | 45 | 58 | 72 | 84 | 100 |
| Your bid | 3 | 6 | 7 | 10 | 11 | 12 | 17 | 32 | 51 | 100 |
| Other's valuation | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| Other's bid | 28 | 13 | 4 | 4 | 11 | 13 | 2 | 3 | 1 | 1 |
| Won/lost | lost | lost | won | won | won | lost | won | won | won | won |
| Points gained/lost | -3 | -6 | 30 | 36 | 31 | -12 | 56 | 69 | 83 | 99 |




The other's valuation is independent of your valuation

You are in round 1 out of 20 rounds

Ready

# Experiment

- Elicit preferences
  - risk
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  - SVO
  - rivalry.
- Auction:
  - either first-price winner-pay auction
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  - only for one randomly selected task / auction

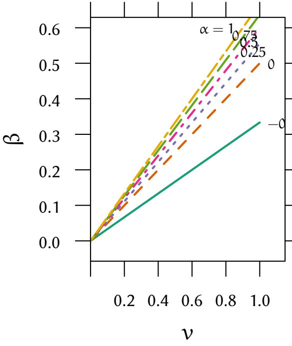
# Hypotheses

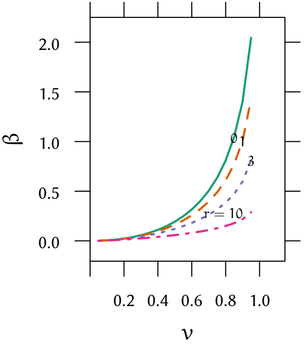
## first-price winner-pay auction:

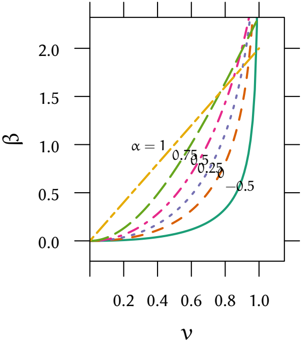
- spite $\longrightarrow$ higher bids.
- risk $\longrightarrow$ higher bids.

## Second-price all-pay auction:

- risk aversion: $\longrightarrow$ lower bids
- low $v$: spite $\longrightarrow$ higher bids
  high $v$: spite $\longrightarrow$ lower bids

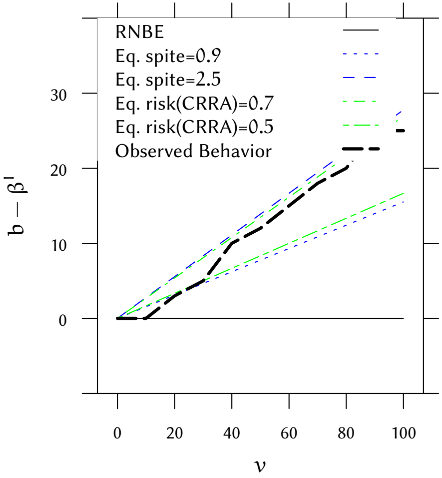


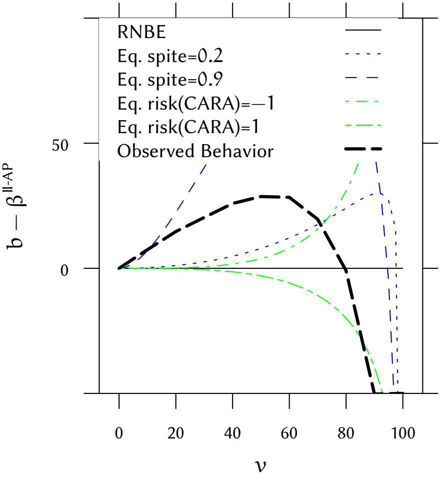



# Median overbidding: Theory and observations.

first-price winner-pay




second-price all-pay




bids consistent with risk/spite

bids consistent with spite, not risk

# Fitting bids in the first-price winner-pay auction

$$\beta^{I}_{\text{Spite}}(v) = v - \int_0^v \frac{F(t)^{1+\alpha}}{F(v)^{1+\alpha}} dt = v - \int_0^v \frac{F(t)^{1/(1-\rho)}}{F(v)^{1/(1-\rho)}} dt = \beta^{I}_{\text{Risk}}(v)$$

Trivially both spite and risk explain bids equally well.

# Fitting bids in the second-price all-pay auction

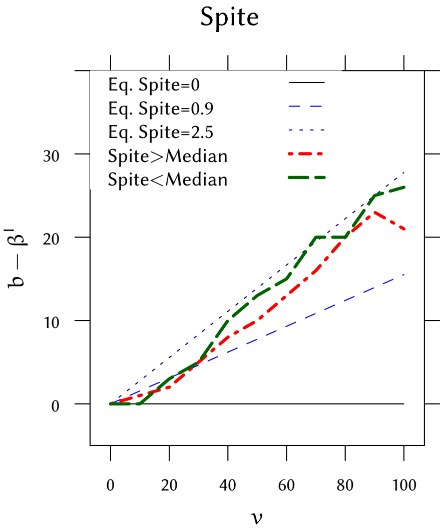
$$\mathrm{Bid}_{i,t,j,v} = \beta^{T}_{\text{II-AP}} + \zeta_{i,j} + \eta_j + \epsilon_{i,j,k,l}$$

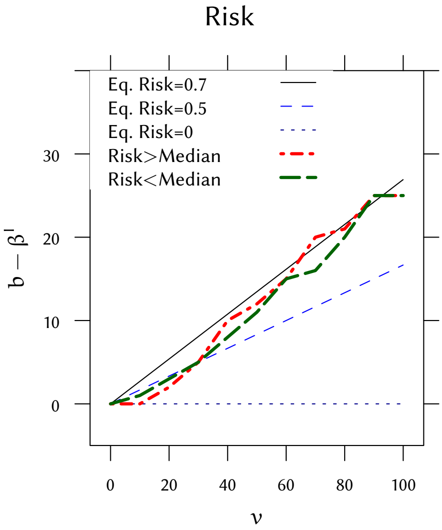
- $\mathrm{Bid}_{i,t,j,v}$ bid of subject $i$ in group $j$ in period $t$ for valuation $v$
- $\beta^{T}_{\text{II-AP}}$ theoretical bidding function with/without spite/risk.
- $\zeta_{i,j}$ random effect for bidder $i$ in group $j$
- $\eta_j$ random effect for group $j$
- $\epsilon_{i,j,k,l}$ residual

## Result

Behavior in the second-price all-pay auction is significantly better described by a theory of spite but not by a theory of risk aversion.

# Spite and risk in the first-price winner-pay auction

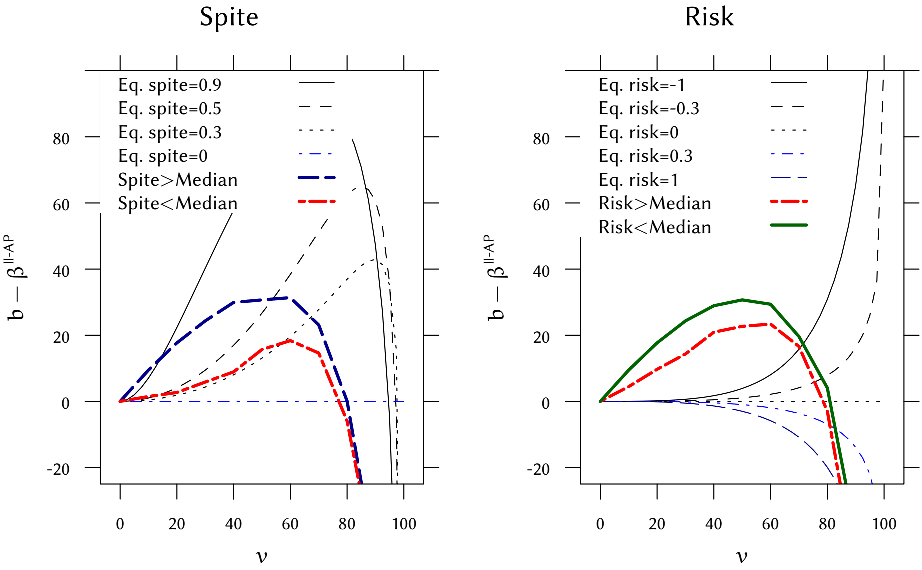



spite has "perverse" effect.

risk has "expected" effect.

# Median overbidding in the second-price all-pay auction.




Spite + risk have “expected” effect.

# Overbidding for the first-price winner-pay auction

$$
\begin{aligned}
\mathrm{Bid}_{i,t,j,v} - \beta^{I} = & \beta_0 + \beta_1 \mathrm{Period} + \beta_2 v + \zeta_{i,j} + \eta_j + \epsilon_{i,j,k,l} + C_M \\
C_1 = & 0 \\
C_2 = & \beta_3 \mathrm{Spite}_i + \beta_4 \mathrm{Spite}_i \times v \\
C_3 = & C_2 + \beta_5 \mathbb{1}_{\female} + \beta_6 \mathrm{Risk}_i + \beta_7 \mathrm{rivalry}_i + \beta_8 \mathrm{SVO}_i + \beta_9 \mathrm{IA}_i \\
C_4 = & \beta_{10} \mathrm{Risk}_i + \beta_{11} \mathrm{Risk}_i \times v \\
C_5 = & C_4 + \beta_{12} \mathbb{1}_{\female} + \beta_{13} \mathrm{Spite}_i + \beta_{14} \mathrm{rivalry}_i + \beta_{15} \mathrm{SVO}_i + \beta_{16} \mathrm{IA}_i
\end{aligned} \tag{1}
$$

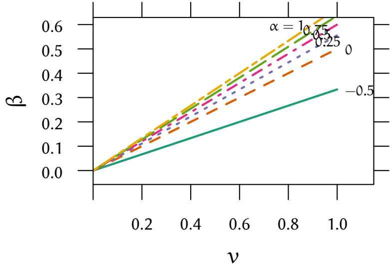
| | |
|---|---|
| $\zeta_{i,j}$ | random effect for bidder $i$ in group $j$ |
| $\eta_j$ | random effect for group $j$ |
| $\epsilon_{i,j,k,l}$ | residual |
| $C_1$ | base specification |
| $C_2$, $C_3$ | control for spite |
| $C_4$, $C_5$ | control for risk |

# Estimation results for Equation (1) (overbidding for the first-price winner-pay auction).

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| Period | $-0.09^{***}$ (0.02) | $-0.09^{***}$ (0.02) | $-0.09^{***}$ (0.02) | $-0.09^{***}$ (0.02) | $-0.09^{***}$ (0.02) |
| $v$ | $0.21^{***}$ (0.003) | $0.21^{***}$ (0.003) | $0.21^{***}$ (0.003) | $0.21^{***}$ (0.003) | $0.21^{***}$ (0.003) |
| Spite | | 0.53 (0.40) | 0.33 (0.51) | | $-0.15$ (0.50) |
| Spite $\times v$ | | $-0.01^{***}$ (0.002) | $-0.01^{***}$ (0.002) | | |
| Risk | | | $-0.06$ (0.79) | $-1.46^{+}$ (0.80) | $-1.59^{*}$ (0.80) |
| Risk $\times v$ | | | | $0.03^{***}$ (0.003) | $0.03^{***}$ (0.003) |
| Male | | | $-4.98^{**}$ (1.65) | | $-4.98^{**}$ (1.65) |
| Rivalry | | | 0.86 (0.86) | | 0.86 (0.86) |
| SVO | | | 0.04 (0.06) | | 0.04 (0.06) |
| IA | | | 0.46 (0.63) | | 0.46 (0.63) |
| Constant | $1.96^{+}$ (1.01) | $1.96^{+}$ (1.02) | $2.92^{+}$ (1.60) | $1.96^{+}$ (1.02) | $2.92^{+}$ (1.60) |
| Observations | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 |
| Log Likelihood | $-69{,}248.54$ | $-69{,}233.82$ | $-69{,}227.71$ | $-69{,}200.08$ | $-69{,}194.64$ |
| Akaike Inf. Crit. | 138,509.10 | 138,483.60 | 138,481.40 | 138,416.10 | 138,415.30 |
| Bayesian Inf. Crit. | 138,555.70 | 138,545.80 | 138,582.40 | 138,478.30 | 138,516.30 |

*Notes:* $^{+}: p < 0.1$; $^{*}: p < 0.05$; $^{**}: p < 0.01$; $^{***}: p < 0.001$;. Standard errors in parentheses

- $C_1$ Overbidding in the first-price winner-pay auction is consistent with the theory of spiteful-agents and also with theory on risk averse agents.
- $C_2, C_3$ Contrary to the theoretical prediction, more spite leads to a less steep bidding slope in the first-price winner-pay auction (the interaction of Spite $\times$ $v$ is negative and significant).
- $C_4, C_5$ In line with theory, more risk aversion leads to a steeper bidding slope in the first-price winner-pay auction.



# Overbidding in the second-price all-pay auction

$$
\begin{aligned}
\mathrm{Bid}_{i,t,j,v} - \beta^{\text{II-AP}} &= \beta_0 + \beta_1 \mathrm{Period} + \zeta_{i,j} + \eta_j + \epsilon_{i,j,k,l} + C'_M \\
C'_1 &= s(v) \\
C'_2 &= C'_1 + \beta_2 \mathrm{Spite}_i + \beta_3 \mathrm{Spite}_i \cdot v_{[0,50]}(v) + \beta_4 \mathrm{Spite}_i \cdot v_{[50,100]}(v) \\
C'_3 &= C'_2 + \beta_5 \mathrm{IA}_i + \beta_6 \mathbb{1}_{♀} + \beta_7 \mathrm{Risk}_i + \beta_8 \mathrm{rivalry}_i + \beta_9 \mathrm{SVO}_i \\
C'_4 &= C'_1 + \beta_{10} \mathrm{Risk}_i + \beta_{11} \mathrm{Risk}_i \cdot v_{[0,50]}(v) + \beta_{12} \mathrm{Risk}_i \cdot v_{[50,100]}(v) \\
C'_5 &= C'_2 + \beta_{13} \mathrm{IA}_i + \beta_{14} \mathbb{1}_{♀} + \beta_{15} \mathrm{Spite}_i + \beta_{16} \mathrm{rivalry}_i + \beta_{17} \mathrm{SVO}_i
\end{aligned} \tag{2}
$$

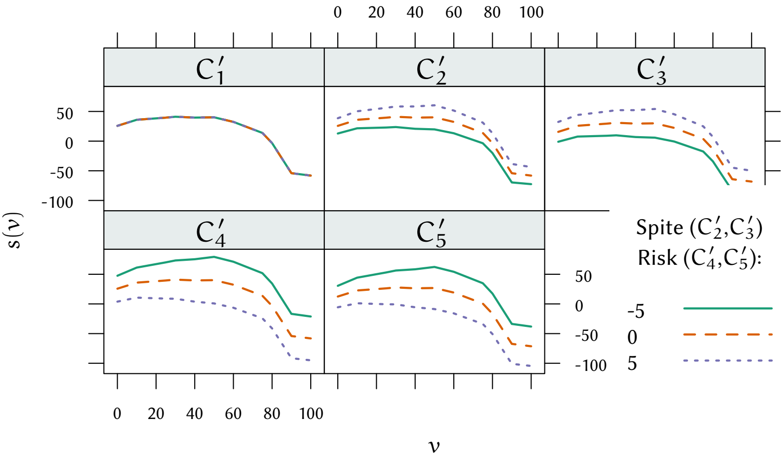
| | |
|---|---|
| $\zeta_{i,j}$ | random effect for bidder $i$ in group $j$ |
| $\eta_j$ | random effect for group $j$ |
| $\epsilon_{i,j,k,l}$ | residual |
| $s(v)$ | thin plate regression spline over the valuation |
| $v_{[0,50]}(v)$ | $= \min(0, v/50 - 1)$ |
| $v_{[50,100]}(v)$ | $= \max(0, v/50 - 1)$ |

# Estimation results for Equation (2) (overbidding in the second-price all-pay auction).

| | $C'_1$ | $C'_2$ | $C'_3$ | $C'_4$ | $C'_5$ |
|---|---|---|---|---|---|
| Period | -0.40*** (0.05) | -0.40*** (0.05) | -0.40*** (0.05) | -0.40*** (0.05) | -0.40*** (0.05) |
| Spite | | 4.06* (1.69) | 4.83* (1.96) | | 4.10* (1.95) |
| Spite $\times\ v_{[0,50]}$ | | 1.49** (0.47) | 1.49** (0.47) | | |
| Spite $\times\ v_{[50,100]}$ | | -1.18* (0.47) | -1.18* (0.47) | | |
| Risk | | | -6.02* (2.91) | -7.85* (3.08) | -7.10* (2.94) |
| Risk $\times\ v_{[0,50]}$ | | | | -3.48*** (0.86) | -3.48*** (0.86) |
| Risk $\times\ v_{[50,100]}$ | | | | 0.46 (0.86) | 0.46 (0.86) |
| Male | | | -19.05** (6.11) | | -19.05** (6.11) |
| Rivalry | | | -0.70 (3.09) | | -0.70 (3.09) |
| SVO | | | 0.41+ (0.24) | | 0.41+ (0.24) |
| IA | | | -1.84 (2.51) | | -1.84 (2.51) |
| Constant | 14.92*** (3.15) | 14.89*** (3.11) | 14.83* (6.48) | 14.87*** (3.10) | 14.83* (6.48) |
| Observations | 23760 | 23760 | 23760 | 23760 | 23760 |
| Log Likelihood | -120506.69 | -120499.39 | -120490.12 | -120493.49 | -120484.68 |
| Akaike Inf. Crit | 241027.38 | 241018.78 | 241010.24 | 241006.97 | 240999.36 |
| Bayesian Inf. Crit. | 241083.91 | 241099.54 | 241131.38 | 241087.73 | 241120.5 |

*Notes:* $^{+}: p < 0.1$; $^{*}: p < 0.05$; $^{**}: p < 0.01$; $^{***}: p < 0.001$;. Standard errors in parentheses

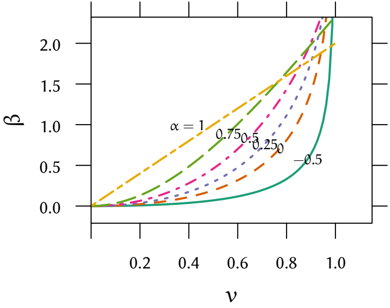
# Estimation results for the spline from Equation (2) (overbidding).

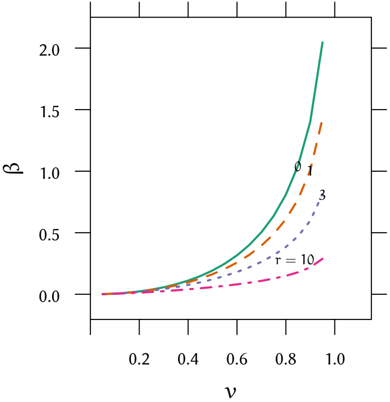



$C_1, \ldots, C_5$ In line with spiteful preferences, bidders bid more than the RNBNE for small valuations and, respectively, less for large

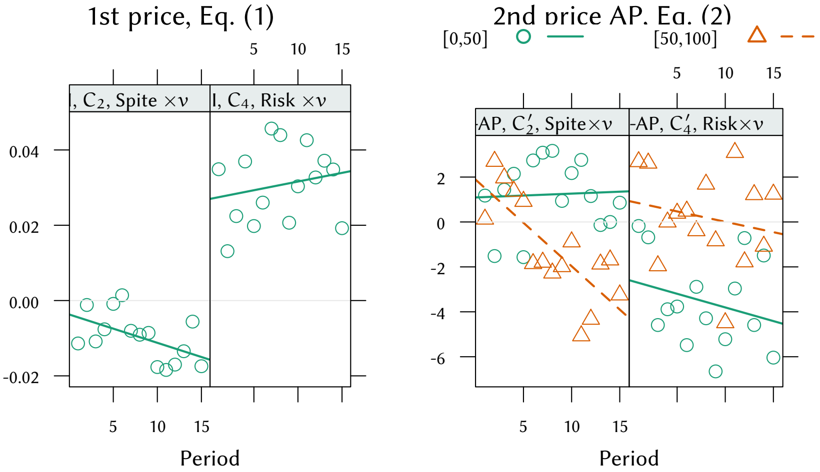
$C_2', C_3'$ Bids increase in spite for low valuations and they increase less for high valuations.

$C_4', C_5'$ Increased risk aversion leads to lower bids.



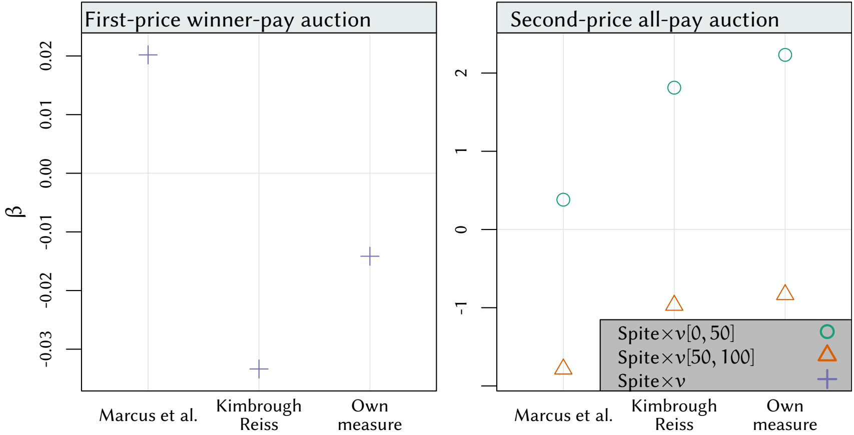



# Learning




Effects become stronger over the experiment.

# Different measures for spite




Only Marcus et al. has expected effect.

All three measures of spite have the same (expected) effect.

# Summary

## First-price winner-pay auction

Risk explains bidding behaviour well

## Second-price all-pay auction

Spite explains bidding behaviour well