Endogenous entry in contests with incomplete information: Theory and experiments

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May 2016

Centro Vernon Smith de ECONOMÍA EXPERIMENTAL Universidad Francisco Marroquín

Introduction

- In all-pay auctions we typically see a lot of expenditures close to zero, and a lot of very aggressive expenditures.
  - Bimodal distribution of expenditures in complete information environments.
  - Bifurcation in incomplete information environments.
- Usually, there is overexpenditure on average.
  - Participants are often losing money.
- If there is an opportunity cost of entry, do we still see expenditures close to zero?

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- This paper examines all-pay auctions with:
  - Independent private values.
  - Endogenous participation.
  - Opportunity cost of participation.
- What is the effect of uncertainty regarding the number of contestants?
- Do entrants overexpend effort in such an environment?
- Do the payoffs of entering the contest end up being equal to the opportunity cost?
- How efficient are contests in this environment?

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Experimental Design

- In this experiment we examine perfectly discriminating contests with independent private values and endogenous entry.
  - The number of potential contestants is common knowledge.
  - There is a positive opportunity cost of participating in the contest, which is common knowledge.
  - When potential contestants decide whether or not to enter, they know both their value, and the opportunity cost.
- We employ a 2×1 between subject design in which we vary whether or not the number of entrants is revealed when contestants choose their effort levels.

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Experimental Design

- 6 sessions per treatment.
- In each experimental session 12 subjects participated in a series of 25 periods.
- Potential contestants were randomly and anonymously matched into groups of four in each period ($n = 4$).
- We also elicited risk preferences (and varied the order).
- Values were *iid* draws from a uniform distribution on $[0, 100]$. (F)
- The opportunity cost (c) was an *iid* draw from a discrete uniform distribution on $\{0, \ldots, 25\}$

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- To help alleviate boredom while waiting, those who elect not to enter engage in a pastime.
- Tic-tac-toe against the computer.
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- Subjects were students at Universidad Francisco Marroquín.
- Each session lasted about 1.5 hours.
- Each subject began with a starting balance of $Q54 \approx US\$6.73$ to cover any losses.
  - Participants were told that they could expend more than their remaining balance, but that if they went bankrupt they would not be paid for subsequent earnings.
  - No subjects went bankrupt.
- Each subject also received a participation fee of $Q20 \approx US\$2.50$.
- Average payoff: $Q88.71 \approx US\$11.09$

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- Average payoff: $Q88.71 \approx US\$11.09$

Experimental Design

- Subjects were students at Universidad Francisco Marroquín.
- Each session lasted about 1.5 hours.
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Predictions
Entry

- We consider symmetric Nash equilibrium.
- Potential contestants only enter if their value is above some entry threshold in equilibrium.
- This equilibrium entry threshold is the same regardless of whether or not the number of entrants will be revealed.
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Equilibrium effort

- Uninformed equilibrium effort:

$$\beta\left(v_i\right) = \int_{v_c}^{v_i} t\left(n-1\right)F\left(t\right)^{n-2} f\left(t\right)dt$$

- Informed equilibrium effort (m is the number of entrants):

$$\rho\left(v_i\right) = \int_{v_c}^{v_i} t\left(m-1\right)\left(\frac{F\left(t\right)-F\left(v_c\right)}{1-F\left(v_c\right)}\right)^{m-2}\left(\frac{f\left(t\right)}{1-F\left(v_c\right)}\right)dt$$

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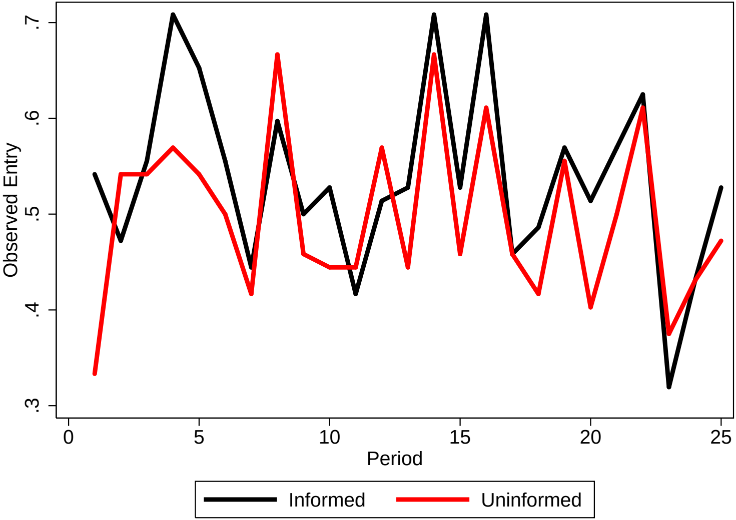
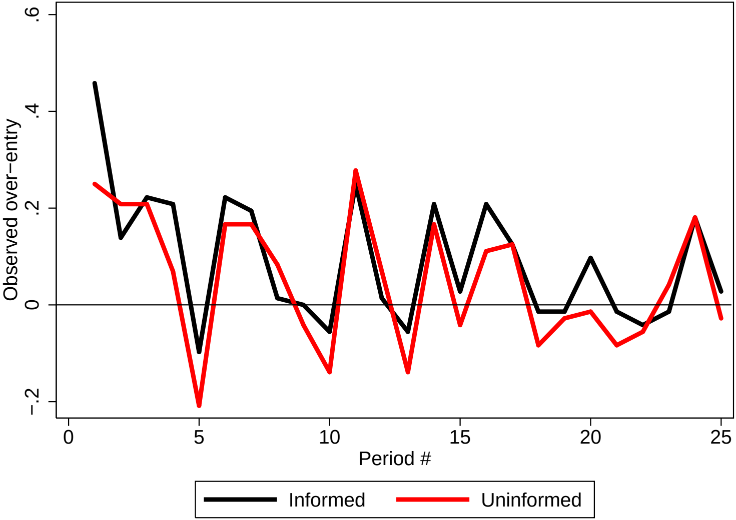
Expected total effort expenditure is the same regardless of whether the contestants know m when they choose their effort levels.

$$R = n(n-1) \int_{v_c}^{\bar{v}} (1 - F(t))\, tF(t)^{n-2} f(t)\, dt$$

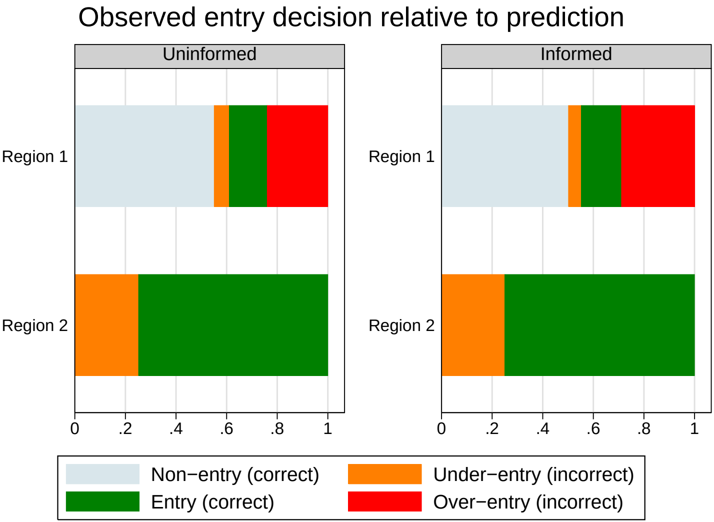
Entry


Observed Entry
.3
.4
.5
.6
.7
0
5
10
15
20
25
Period
Informed
Uninformed

Entry


Observed over−entry
.6
.4
.2
0
−.2
0
5
10
15
20
25
Period #
Informed
Uninformed

Entry


Observed entry decision relative to prediction
Uninformed
Informed
Region 1
Region 2
0
.2
.4
.6
.8
1
Non−entry (correct)
Under−entry (incorrect)
Entry (correct)
Over−entry (incorrect)

Entry
Relative to Nash

Entry relative to Nash predictions

	Observed Entry
$v_i < v_c$, uninformed	0.303
$v_i \geq v_c$, uninformed	0.738
$v_i < v_c$, informed	0.365
$v_i \geq v_c$, informed	0.752

- Entry is higher than predicted.
  - Uninformed: Sign test, $p = 0.0156$
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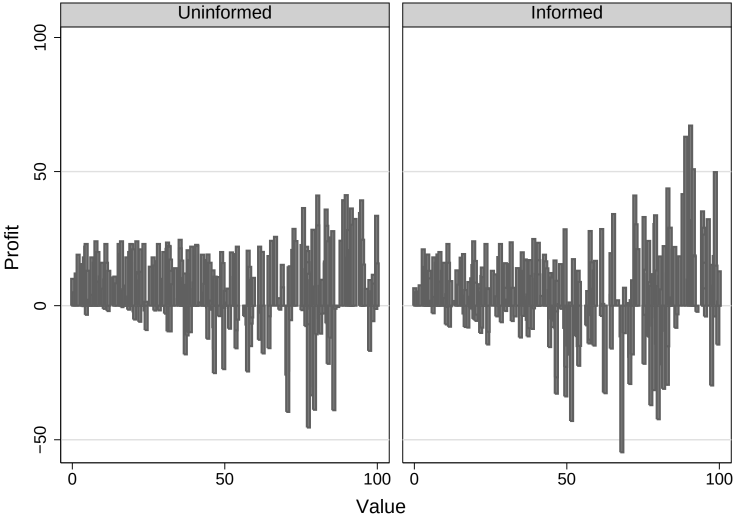
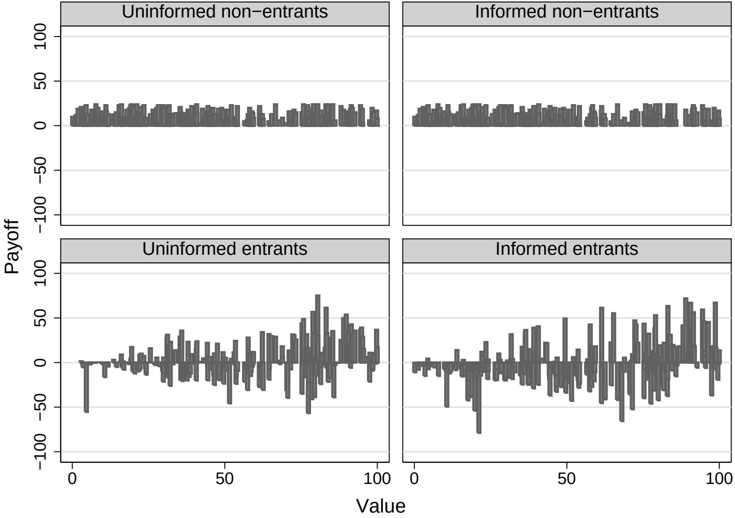
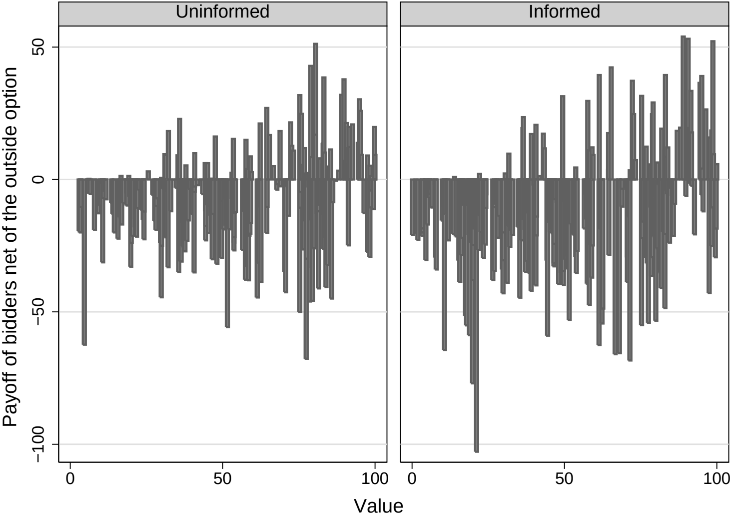
Payoffs



Payoffs


Uninformed non−entrants
Informed non−entrants
Uninformed entrants
Informed entrants
Payoff
Value
100
50
0
−50
−100
0
50
100

Payoffs


Uninformed
Informed
Payoff of bidders net of the outside option
50
0
−50
−100
0
50
100
0
50
100
Value

Payoffs

- Payoffs are lower than predicted.
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- Payoffs of entrants are less than the opportunity costs.
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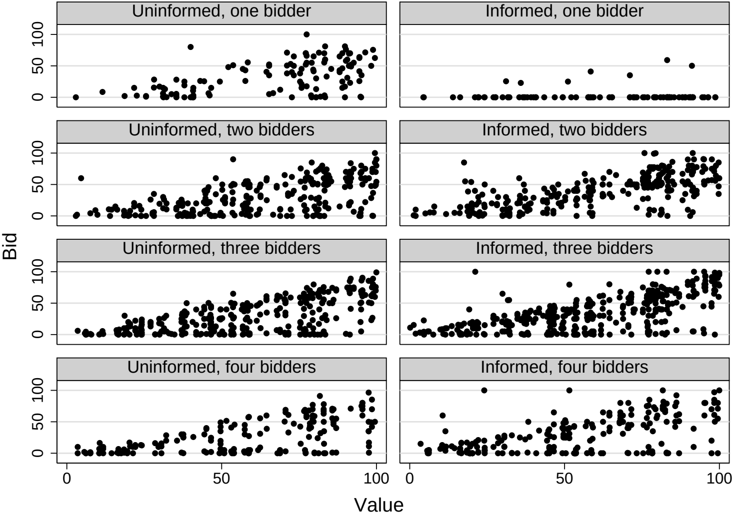
Effort expenditure



Effort expenditure

- Effort expenditures are higher than predicted.
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  - Informed: Sign test, $p = 0.0156$
- We can't reject that effort expenditures are equal across information structures.
  - Robust rank order test, $p = 0.2542$

Effort expenditure

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Total expenditure

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- Total expenditure is higher when contestants are informed.
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Efficiency

- v_{winner} = the value of the contest winner.
- v_{max} = the value of the contestant with the highest value.
- v_{min} = the value of the contestant with the lowest value.
- Allocative efficiency

$$\frac{v_{winner}}{v_{max}}$$

- Total efficiency

$$\frac{(v_{winner} - mc) - (min(v_{min} - nc, 0))}{max\,(v_{max} - c, 0) - (min(v_{min} - nc, 0))}$$

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Allocative efficiency

- Allocative efficiency is lower than predicted when contestants are informed.
  - Sign test, $p = 0.0156$
- We can't reject that allocative efficiency is equal to its prediction when contestants are uninformed.
  - Sign test, $p = 0.1094$
- We can't reject that allocative efficiency is equal between information structures.
  - Robust rank order test, $p = 0.1373$

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  - Robust rank-order test, $p =$ [illegible]

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Total efficiency

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  - Uninformed: Sign test, $p = 0.0156$
  - Informed: Sign test, $p = 0.0156$
- We can't reject that total efficiency is equal between information structures.
  - Robust rank order test, $p = 0.1873$

Total efficiency

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  - Informed: Sign test, $p = 0.0156$
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  - Robust rank order test, $p = 0.14573$

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Conclusion
Summary of results

- We observe overentry in both information structures, but entry is higher when contestants are informed.
- While effort expenditure is not significantly different across information structures, the higher entry when m is revealed means that total expenditure is higher when contestants are informed.
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