Perception Bias in Tullock Contests

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Background

- The classical contest literature supposes that players have accurate perceptions of their own effort, and the corresponding lobbying effectiveness and effort costs.
- Sometimes contestants may have psychological influences which lead to biased perceptions of their own situation.
  - An underconfident contestant may be pessimistic about his lobbying effectiveness and discount his own effort (ie. think he is not working hard enough).
  - An overconfident contestant may be overly optimistic about his lobbying effectiveness and psychologically inflate his own effort.

Background

- Biased assessment of one's own situation is a prominent behavioral regularity
- Overbidding is one of the two main behavioral phenomena found in experimental contests; overbidding rate is 72 percent in reviewed studies, Sheremeta (2013)
- Overconfidence has been studied in various economic settings including
  - consumers' selection of menus of contracts (Grubb, 2015, 2009 etc.)
  - CEO overconfidence (Malmendier and Tate, 2015, 2008 etc.)
  - overconfidence in entry decisions (Camerer and Lovallo, 1999)
- The argument has often been made that overconfidence is evolutionarily advantageous (Johnson and Fowler, 2011)

What We Do in this Project

- In this paper we relax the assumption of accurate perceptions and allow for contestants having potentially biased beliefs about their own lobbying effectiveness.
  - We consider the scenario where the opponent is informed about the bias of other players but may still himself be biased/uninformed
  - Corresponds to the idea of it being difficult to know one's own flaws or procrastination, distance enhances objectivity, etc.
- We focus on the case in which lobbying effectiveness is affected while cost perception remains unaffected. We also consider the situation in which misperception of one's own effort affects the belief on lobbying effectiveness as well as the perceived total cost of effort.
  - Note, the case of only cost perception being affected is considered by Ludwig, Wichardt and Wickhorst (2011)

Model Setup

- Two players (1 and 2) participate in a Tullock contest.
- Use parameter θ_i to measure player i's perception bias when his perceived lobbying effectiveness is θ_i while his real lobbying effectiveness is 1.
- When θ_i is equal to 1, player i has no perception bias. When θ_i is larger than 1, player i is overconfident. When θ_i is smaller than 1, player i is underconfident.
- The opponent is informed about the bias of other players but not about his own bias.
- The two players simultaneously exert effort in the contest.

Key Behavioral Assumption

- Player i sticks to his own perception of both players' lobbying effectiveness, ignoring why the other player's perception is different from his, and maximizes his expected payoff.
- Expected payoff of the two players in the contest:

$$\begin{cases} U_1 = \dfrac{\theta_1 x_1}{\theta_1 x_1 + x_2} - x_1 \\ U_2 = \dfrac{\theta_2 x_2}{x_1 + \theta_2 x_2} - x_2 \end{cases} \tag{1}$$

Black and Blue OR White and Golden &Yanny OR Laurel

Model Setup

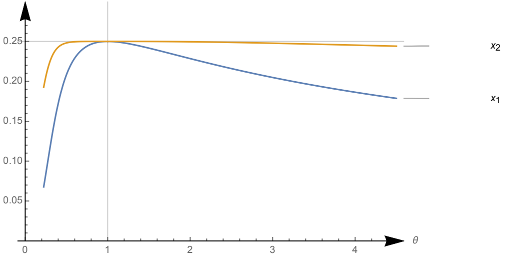
- Benchmark: One biased player, player 1.
- General Case: Two biased players, player 1 and 2.
- Extensions
  - Perception biases under heterogenous valuations of the prize
  - Bias affects the belief on lobbying effectiveness as well as the perceived total cost of effort.

Benchmark Model: One biased player, player 1

Proposition 1.1

There is a unique equilibrium of the game. Both individual effort and total effort are maximized when player 1 has no perception bias.

$$\begin{cases} U_1 = \dfrac{\theta x_1}{\theta x_1 + x_2} - x_1 \\ U_2 = \dfrac{x_2}{x_1 + x_2} - x_2 \end{cases}$$



- This differs from the general finding in the literature that confidence has a tendency to enhance effort. This is due to our bias parameter θ applying to both the numerator and denominator of reward component, which balances out the inflationary (deflationary) effect of the bias on reward (cost).
  - Prior studies have bias on either reward or cost terms but not lobbying effectiveness.
- Since Player 1's effort is maximized when player one has no perception bias, Player 2 is not very motivated when Player 1's effort is very small(Player 1 is not exerting much effort, so Player 2 doesn't need to either).

Benchmark Model: One biased player, player 1

Also can be seen from the Figure of efforts:

Proposition 1.3

Player 2's effort is always no smaller than player 1's effort.

Proposition 1.4

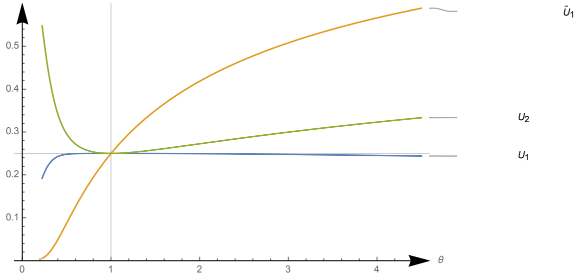
Player 1 and Player 2 collectively exert no more than $\frac{1}{2}$ unit of effort.

The welfare enhancing effects of overconfidence generally found in prior studies are not sustained in our setting. Instead, perception bias would always induce a welfare loss for the contest organizer.

Benchmark Model: One biased player, player 1

Proposition 1.5

Player 1's perceived utility $\tilde{U}_1$ is monotonically increasing in θ. Player 1's realized utility U_1 is maximized when Player 1 is unbiased ($\theta = 1$). Player 2's realized utility U_2 and perceived utility $\tilde{U}_2$ is always no smaller than Player 1's realized utility U_1.



General Case: Two Biased Players, Player 1 and 2

- When allowing for both players to be potentially biased, the analysis is more complicated.
- Multiple equilibria exist in some situations. We first examine those cases, and then the two biased player patterns when unique equilibrium exists.

General Case: Two Biased Players, Player 1 and 2

First consider the case that both players are underconfident ($\theta_i < 1$)

Proposition 2.1.1

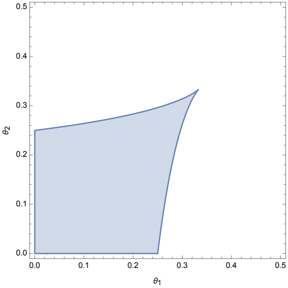
There can be multiple equilibria for some θ_1 and θ_2 parameters (in this case, 3 equilibria exist). Multiple equilibria tend to occur when both players are very underconfident (θ_i near 0)

Proposition 2.1.2

For the multiple equilibria cases, there is one relatively symmetric equilibrium in terms of effort exerted and two asymmetric ones in which one player exerts most of the effort while the other player exerts very little effort. The symmetric equilibrium yields the largest total effort among these three possible equilibria.

General Case: Two Biased Players, Player 1 and 2

Figure below shows the range of θ_i for which unique equilibrium exists.



The boundaries are $\theta_2 = \frac{-2+9\theta_1 \pm 2\sqrt{1-9\theta_1+27\theta_1^2-27\theta_1^3}}{27\theta_1^2}, 0 \leq \theta_1 \leq \frac{1}{3}$

The high effort player doesn't think he is exerting much effort (he is quite underconfident), while the low effort player doesn't find it worthwhile to compete (since he is also underconfident)

Numerical Example

	$\theta = \frac{1}{3}$	$\theta = \frac{1}{2}$
Effort Level	$\frac{3}{16}$	$\frac{2}{9}$
Realized Utility	$\frac{5}{16}$	$\frac{5}{18}$
Perceived Utility	$\frac{1}{16}$	$\frac{1}{9}$

Table: Special Case of Unique Equilibrium

$\theta = \frac{1}{4}$	Player 1	Player 2
Effort Level	$\frac{4}{25}$	$\frac{4}{25}$
Realized Utility	$\frac{17}{50}$	$\frac{17}{50}$
Perceived Utility	$\frac{1}{25}$	$\frac{1}{25}$

$\theta = \frac{1}{4}$	Player 1	Player 2
Effort Level	$\frac{2(3-\sqrt{5})}{45}$	$\frac{2(3+\sqrt{5})}{45}$
Realized Utility	$\frac{11(3-\sqrt{5})}{90}$	$\frac{11(\sqrt{5}+3)}{90}$
Perceived Utility	$\frac{9-4\sqrt{5}}{45}$	$\frac{9+4\sqrt{5}}{45}$

General Case: Two Biased Players, Player 1 and 2

Proposition 2.2

The relationship between a player's effort level x_i and his or her own bias magnitude θ_i: player i' effort x_i is monodically increasing in his or her own bias magnitude θ_i under the condition $\theta_i \in (0, \frac{2\sqrt{\theta_{-i}}-1}{\theta_{-i}})$

Proposition 2.3

The relationship between a player' effort level x_i and his opponent's bias magnitude θ_{-i}: If player i is overconfident, his effort x_i is monodically increasing in his or her opponent's bias magnitude θ_{-i} under the condition θ_{-i} less than $\frac{2\sqrt{\theta_i}-1}{\theta_i}$

Proposition 2.4

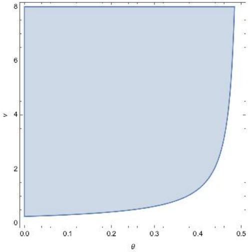
Total effort(determined by the sum of individual players' efforts) might monotonically increase in θ_i (or θ_{-i}).

Extension: Heterogenous Valuations of the Prize

Proposition 3.1

There is a non-monotonic relationship between the total effort and the valuations of the prize by players.

When the perception bias of effort and heterogeneous valuation parameters apply to different players, the relationship between the total effort and player' s prize valuation v is non-monotonic when $\theta \in (0, \frac{1}{2})$ and starts decreasing at $v \in (\frac{1}{4-8\theta}, +\infty)$.



Numerical Example

	x_1	x_2	$x_1 + x_2$
$\theta = \frac{1}{4}, v = \frac{1}{3}$	0.241923	0.0420508	0.283973
$\theta = \frac{1}{4}, v = \frac{1}{2}$	0.222222	0.111111	0.33333
$\theta = \frac{1}{4}, v = 1$	0.0840236	0.205845	0.289868

Table: Non-monotonic relationship

	x_1	x_2	$x_1 + x_2$
$\theta = 1, v = \frac{1}{2}$	$\frac{2}{9}$	$\frac{1}{9}$	$\frac{1}{3}$
$\theta = 1, v = 1$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
$\theta = 1, v = 2$	$\frac{2}{9}$	$\frac{4}{9}$	$\frac{2}{3}$

Table: Classical Setting

Extension: Perception Bias of Effort

$$\begin{cases} U_1 = \dfrac{\lambda_1 x_1}{\lambda_1 x_1 + x_2} - \lambda_1 x_1 \\ U_2 = \dfrac{\lambda_2 x_2}{x_1 + \lambda_2 x_2} - \lambda_2 x_2 \end{cases}$$

Proposition 3.3.1

The range of θ parameters for which unique equilibrium exists is the same as under the λ bias structure.

Proposition 3.3.2

A player's effort is monotonic in his own perception bias λ_i.

Proposition 3.3.3

Overconfidence generally cause a decreased total effort .

Summary

- We analyze the Tullock contest when players potentially have biased perception about their own lobbying effectiveness.
- In the benchmark model, players' biased perception applies to benefits (lobbying effectiveness) instead of costs (of effort) and provides somewhat different results compared to prior studies.
  - overconfidence is not typically helpful as previous results suggest.
- There is a multiple equilibria issue for cases where both players are highly underconfident, which generate equilibria with asymmetric effort levels due to the perception bias.
- There is a non-monotonic relationship between effort and bias for the case where both players may be biased
  - Also true in the cases of only heterogenous prize valuations and biased effort.

Thank you!