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Experimental tests of Tullock's contest with and without winner refunds

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ABSTRACT

We examined experimentally the two-agent, complete-information Tullock's contest, with and without refund for the winner. We find that the average bids in the refund group are higher than the average bids in the group without a refund, consistent with the theory. However, the auctioneer does not increase his profit if he changes the design of the contest by reimbursing the winner's cost of effort. We also find underbidding for the low-valuation players and overbidding for the high-valuation player in a contest with a refund. Some players chose the corner solution of staying out of the game by biding zero.

1. Introduction

In many economic situations, economic agents participate in a contest to win a prize. On the way to winning the prize, the agents expend resources that do not directly contribute to the prize. The participants' efforts can be quite costly and losers are not always compensated for this effort. In winner-take-all contests with a single prize, all contestants bear the cost of their efforts regardless of whether they win or lose, but only the contestant with the highest bid wins the prize. Winner-take-all contests have been applied to R&D races (Dasgupta, 1986), lobbying activities (Che and Gale, 1998), promotions in labor markets (Rosen, 1986) and sports contests (Szymanski, 2003).

Tullock's (1980) rent-seeking model suggests that in winner-take-all contests the agent who exerts the greatest effort has the highest probability of winning. However, the winner, like the other players, does not get a refund for his efforts. A regular all-pay contest is a limiting case since the agent who exerts the highest effort wins the prize.

Now, consider the example of an economic situation where the auctioneer reimburses to the winner for the cost of his effort. We ask: how is this going to affect the agents' effort? There is some theoretical literature that examines how reimbursing the winner for his efforts affects that effort. Riley and Samuelson (1981) introduced the *Sad Loser Auction*, a two-player all-pay auction where the winner (the highest bidder) gets his bid back and wins the prize. Cohen and Sela (2005) adapted Tullock's model to show that by using a simple non-discriminating rule, the auctioneer can determine which contestant has the highest probability of winning. In particular, they show that if the auctioneer reimburses the winner's cost of effort in a two-player contest, a unique internal equilibrium with un-dominated strategies is created, where a weak contestant is more likely to win than a stronger one. Matros (2008) analyzes the n-player case. He finds all multiple equilibriums in pure strategies and discusses their properties. Matros and Armanios (2009) consider Tullock's contest with reimbursements. They show that the winner-reimbursed contest maximizes net total spending while the loser-reimbursed contest minimizes net total spending.

In practice, there are some examples of contests with reimbursements. In politics, in a primary election, candidates raise and spend money with the goal of being their party's choice candidate in the general election. All losers pay the costs and

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are not able to advance, while the winner advances to the general election and receives increased funding to compete in this election (Kaplan et al., 2002). In economics, Kaplan et al. (2002) provide an example: in the Joint Strike Fighter contract, the agents (Boeing and Lockheed Martin) were required to design a prototype to test in flight. Both companies built this prototype up-front to win this government contract. The winning company got the contract, and the government reimburses the winner its costs of entry through the purchase of the later completed jets. Moreover, the contract also had a loser-reimbursement mechanism because both agents were given a total of USD 2.2 billion to demonstrate their concepts in the final competition. Another important use of effort reimbursement is the case of litigation. Baye et al. (2005) discuss the legal systems around the world and the need for reform of the American justice system. One of the propositions was to modify the American legal system (in which all litigants pay their own legal expenditures) by requiring that the loser reimburse the winner for legal fees up to the amount actually spent by the loser. The rationale was that this would reduce legal expenditures and the number of cases brought to court, since every dollar the loser paid its attorneys would ultimately result in two dollars paid by the loser. Other legal systems (such as the British and Continental) also require losers to compensate winners for a portion of their legal costs. Unlike the theoretical models, in the case of the legal system the loser reimburses the winner's cost and not the auctioneer.

In recent years, researchers have used experimental procedures to test all-pay contests and Tullock's (1980) variations of the rent-seeking model. Millner and Pratt (1989) were the first to use an experimental procedure to examine Tullock's (1980) rent-seeking model. Their experiment involved two participants and was based on Tullock's analysis as a lottery. Their results exhibited average dissipation rates significantly higher than those predicted by the Cournot–Nash risk-neutral prediction. Potters et al. (1998) compared Tullock's contest experimentally to the all-pay auction and found that for proportional probabilities, the mode of the bid distribution is clearly at the predicted level and the distribution becomes more concentrated around that level during the last ten rounds. For perfect discrimination, they are unable to refute the possibility that the mean bid and dissipation level are as predicted. Other studies that experimentally investigated contests[1] have shown that human behavior is not always consistent with theoretical prediction.

Motivated by the theoretical literature and the application of the all-pay auction with reimbursement to the winner, we conducted a class experiment with one-shot decision-making in different Tullock's (1980) rent-seeking contest scenarios.[2] There were two experimental treatments, one treatment for a contest with a refund to the winner and the other treatment for a contest without a refund to the winner. To the best of our knowledge this is the first experimental study that tests the effect of reimbursement to the winner on the players' effort. Of the 121 undergraduate students participating in the experiment, half of them participated in a contest without a refund to the winner, and the other half participated in contest with a refund to the winner. Subjects made decisions for all scenarios without receiving any feedback about the other players' choices. In each scenario, each person knew the other person's fixed amount but could not know who the other person was. This is consistent with the model's assumption of complete-information where each player knows the other player's value. Each player played low-valuation role in some of the contests and the high valuation role in others. We used scenario experiments in order to test the two types of contests in different valuations and different roles for each player. We tested the behavior in scenarios with low valuations, high valuations, small differences between the players' valuations, high differences between the players' valuations and even the same valuation for the two players. Once all decisions were made, pairs of players were randomly selected in each class separately and one scenario was randomly selected by computer program. The probability of winning this contest was calculated using the two players' bids in the selected contest as in Tullock's (1980) rent-seeking model. The winner of this lottery was paid a prize.

The experimental results partly support the theory. We find that the average bids in the contest with a refund are significantly higher than the average bids in the contest without a refund. In addition, the average bids of the low-valuation player in the contest with a refund are higher than the values themselves. Finally, although the average bids in the refund contest are greater than the average bids in the no-refund contest, the revenue of the auctioneer is not greater in the refund contests. In each contest some participants with the low valuation prize chose not to play (zero bids). However, when analyzing the average bids of those participants who did bid positive prices we still find that the experimental results partly support the theory.

The finding that the player in a contest with a refund is biased by his own valuation, even though the theory suggests that the bid depends only on the competitor's valuation, can explain the gap between the theory and the experimental findings. This creates underbidding for the low-valuation players and overbidding for the high-valuation player.

The rest of the paper is organized as follows. Section 2 outlines the study's main hypotheses, Section 3 presents the experimental method and Section 4 presents the experimental results. Finally, Section 5 summarizes and concludes.

2. Hypotheses

Consider Tullock's (1980) model with two players, A and B. The values of the players are V_A and V_B, respectively, and $V_B > V_A$. Suppose the first player bids P_A for V_A, and his competitor bids P_B for V_B. Hence, the probabilities of winning the contest for the two players are $\frac{P_A}{P_A+P_B}$ and $\frac{P_B}{P_A+P_B}$ respectively.

[1] For more experimental studies see Amaldoss and Rapoport (2005), Anderson and Stafford (2003), Gneezy and Smorodinsky (2006), Linster et al. (2001), Onculer and Croson (2005) and Schmitt et al. (2004, 2006).

[2] Some other studies using scenario experiments are Anderson and Stafford (2003), and Anderson and Freeborn (2010).