All-pay auctions—an experimental study

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Abstract

This paper reports the results of a repeated all-pay auction game. The auction form used is the simplest possible, complete information, perfect recall and common value. Our main findings are that in such an auction, over-bidding is quite drastic, and the seller's revenue depends strongly on the number of bidders in early stages. However, after a few rounds of play, this dependence completely disappears and the seller's revenue becomes independent of the number of participants. The results are confronted with two solution concepts of economic theory, the Nash-equilibrium and the symmetric Logit equilibrium.
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1. Introduction

Many economic allocations are decided by competition for a prize on the basis of costly activities. Some well-known examples for such competitions are research and development (R&D) races, political campaigns, awarding of monopoly licenses, selling franchises, and so on. In such contests, participants' efforts are quite costly, and losers are not compensated for these efforts. To model such situations, in which competition involves real expenditures, or 'rent seeking' behavior, researchers find the all-pay auction quite appealing.

In an all-pay auction, the winner is determined according to the highest bid, and all players pay a fraction of their bid. The logic of using the all-pay auction to model such competitions is rooted in the assumption, commonly used in the rent seeking literature (e.g., Tullock, 1980),

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that the probability of winning the prize is an increasing function of the efforts. An all-pay auction is a limiting case in which the prize goes to the competitor who exerts the highest effort.

One well-known phenomenon observed in empirical studies of rent seeking activities is over-dissipation. It turns out that in a variety of cases where rent-seeking behavior is exercised, total efforts exceed the value of the prize. Krueger (1974), for example, estimates that annual welfare costs induced by price and quantity controls in India are approximately 7% of gross national product. In Turkey, the figures are estimated as somewhat higher.

This paper reports the results of an experiment in the simplest form of an all-pay auction. First, participants' efforts are actually equal bids in the experiment. Second, the game we use is one of complete information and perfect recall,[1] and the prize we use is one of common value (making the game symmetric). Focusing on such a reduced form of the all-pay auction is an attempt to differentiate between patterns of behavior induced by the mechanism itself and patterns induced by the complexity that is usually found in a 'real-world' environment where there is an inherent asymmetry among players and where complete information as well as perfect recall may be lacking.

Our findings show that indeed the all-pay auction mechanism, without the extra 'real world' complications, is sufficient to induce irrational (in the expected utility sense) behavior. Our main findings are that subjects tend to over-bid, and in most rounds of the experiment the auctioneer's revenues (i.e., total bids) reached twice to three times the value of the prize, even after a few rounds of play. At the early stages of the game the quantitative nature of the over-bidding phenomenon depends strongly on the number of bidders participating in the auction. However, in later rounds of play, the overbidding is quite independent of the number of bidders.

We compare our results with two theoretical solution concepts, Nash equilibrium, which is based on the assumption that players are fully rational, and the symmetric Logit equilibrium, suggested by Anderson et al. (1998), which is based on a model of bounded rationality of the players. It turns out that neither model can fully account for the actual behavior of our subjects in the experiment. The Nash equilibrium, on the one hand, either fails to predict the excessive over-bidding observed or assumes that players are risk loving in an implausible manner. On the other hand, the symmetric Logit equilibrium can explain behavior in early stages of the experiment, assuming a relatively large noise factor, but fails to account for the independence of the seller's revenue with respect to the number of bidders at the later stages.

The study of auctions has a long tradition in experimental economics (see Kagel, 1995 for a survey of this literature). However, the number of experimental studies of all-pay auctions is quite limited. Most of these are designed to test Tullock's model of efficient rent seeking. Consequently, the experiments take on a relatively complicated form, and the allocation of the prize is determined by a lottery where each player's probability of winning is an increasing function of his bid. To the best of our knowledge, Millner and Pratt (1989) were the first to test this model experimentally. They found large dissipation, contradicting the Nash equilibrium forecast. However, Shogren and Baik (1991) observed behavior much closer to the Nash equilibrium prediction.

The closest work related to our experiment is that of Davis and Reilly (1998).

In their paper, they report the result of an experiment of an all-pay auction with four players. This experiment was run as part of a general scheme to understand the consequences of introducing

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[1] The game design is such that all the information on past play, in particular the history of bids of all individuals, is at the players' disposal.