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Two-bidder all-pay auctions with interdependent valuations, including the highly competitive case ☆

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Abstract

We analyze symmetric, two-bidder all-pay auctions with interdependent valuations and discrete type spaces. Relaxing previous restrictions on the distribution of types and the valuation structure, we present a construction that characterizes all symmetric equilibria. We show how the search problem this construction faces can be complex. In equilibrium, randomization can take place over disjoint intervals of bids, equilibrium supports can have a rich structure, and non-monotonicity of the equilibrium may result in a positive probability of allocative inefficiency when the value of the prize is not common. Particular attention is paid to the case in which an increase in a bidder's posterior expected value of winning the auction is likely to be accompanied by a corresponding increase for the other bidder. Such environments are "highly competitive" in the sense that the bidder's higher valuation also signals that the other bidder has an incentive to bid aggressively.

JEL classification: D44; D82; D72

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1. Introduction

Consider an emerging industry, in which potential entrants are considering irrevocable research and development investments to develop a new product. It is believed the entrant who develops the best product will dominate. Suppose an entrant privately observes information which suggests that demand in the industry will be high, so the successful firm will obtain high profits. Higher profits are good news for the entrant – provided it is the entrant who will obtain them! If a competitor is likely to observe similar information, then the entrant may expect to face fierce competition in the research and development stage; this is bad news. Because such information is both good and bad news, determining what equilibrium behavior will look like is a potentially difficult problem.

Much existing research in all-pay auction models has ruled out this case by restricting the distributions of types such that being a "higher" type is unambiguously good news. This occurs, for example, if types are statistically independent; see e.g., Amann and Leininger (1996). In a setting with affiliated values and continuous strategy and type spaces Krishna and Morgan (1997) formulate a condition such that increasing a bidder's type is unambiguously good news for that bidder; in their words, this rules out the case that types and values are "too affiliated." With that assumption, bidding strategies and equilibrium payoffs are monotonically increasing in type. More recently, Siegel (2014) analyzes a setting with finite sets of types under a discrete analogue of the assumption of Krishna and Morgan, but without requiring affiliation. He shows that equilibrium bidding strategies are monotonic in a stochastic sense, and provides a constructive algorithm for finding equilibrium. Siegel notes that "it would be valuable to extend the analysis to...non-monotonic equilibria."

This paper carries out that extension by providing a complete analysis of symmetric equilibria in symmetric, two-bidder all-pay auctions with a finite set of types. This complements the work of Krishna and Morgan and of Siegel by bringing into focus the role that monotonicity assumptions play both in the structure of equilibria, and in the complexity of constructing an equilibrium. We provide a characterization of all symmetric equilibria, and we show that there always exists a symmetric equilibrium in which all types randomize in a piecewise-uniform way over a finite number of intervals of bids.

One way in which monotonicity may fail is when types are highly correlated. For example, suppose the two entrants in the emerging industry from the first paragraph base their judgments in part on public information, and/or use similar methodologies. Then, their information about the profitability of the market (their types) will be strongly correlated, as will their posterior assessments of the value of winning. In this sense, the contest can be thought of as being highly competitive. In addition to being economically plausible, there are models in the literature on winner-pay auctions with exactly this property. A prominent example is found in Kagel and Levin (1986) and Casari et al. (2007), who employ a model in which there is a common value, and conditional on that common value each bidder receives a signal about the value which is an independent draw from a uniform distribution over a small interval centered on the true value. This environment does not satisfy the Krishna–Morgan–Siegel monotonicity condition. Athey (2001) notes that the single crossing property fails in all-pay auctions with this information structure.