

Simultaneous Auctions of Imperfect Goods by Sellers of Different Reputations: An Analytical Model and Laboratory Experiment

Ravi Bapna, The Indian School of Business
Chrysanthos Dellarocas, The University of Maryland
Sarah Rice, The University of Connecticut

Contact email: srice@business.uconn.edu

Internet auction sites have evolved into markets where commodity goods such as electronics or DVDs are traded. Often several auctions for very similar (if not identical) items run simultaneously, and unit-demand bidders must adopt global multi-auction bidding strategies. Despite the increasing practical importance of such markets, there is relatively little theory on how unit-demand bidders should behave in simultaneous auctions of *imperfect* substitutes. In addition to informing buyer behavior, such research will help sellers better understand how their reputation impacts expected revenue in the presence of competition. Finally, this work will assist market operators in designing more effective auction mechanisms for simultaneous auction environments.

This paper studies settings where a number of sellers with differing reputations for honesty simultaneously offer sealed-bid, second-price auctions for imperfect substitute goods to unit-demand buyers. The first half of the paper is an analytical model characterizing the bidding equilibria and deriving expressions for the corresponding expected seller revenue and buyer surplus. The second part of the paper is a laboratory experiment that tests the model using economic incentives to elicit individual bidding behaviors.

The research questions central to this paper are as follows. 1) What is the effect of reputation on bidding strategy in simultaneous auctions for imperfectly substitutable goods? 2) In this market how does actual bidding behavior compare to the derived bidding strategies? 3) How do risk preferences affect bidding behavior in a market where seller reputations differ?

The model shows that when bidders are restricted to submit at most one bid there exists a unique Bayes-Nash equilibrium that has the following form: Auctions are ranked according to their expected valuation, taking into account both the value of the good and the seller's reputation. Buyers are divided into a finite number of zones, according to their types. Buyers whose types fall in the k -th zone randomize between the top k auctions, assigning increasingly higher probability to selecting lower auctions. In such equilibria auction revenue is an increasing convex function of seller reputation. When buyers are allowed to bid on an arbitrary number of simultaneous auctions all equilibria have the following properties: First, buyers at the bottom of the type distribution always place bids on all available auctions. Second, the number of simultaneous bids is a non-increasing function of buyer type. Third, if seller reputations are sufficiently high, there exists a threshold type above which buyers place only one bid. Compared to single-bid equilibria,

multi-bid equilibria generally result in lower buyer surplus and higher expected auction revenue for all sellers.

Using this theoretical result to motivate our laboratory experiment we employ economic incentives drawing from the work of Vernon Smith (1976) on induced value theory to control for heterogeneous values and study the decision making behavior of our market participants. We design an auction market where there are four bidders, each with a private value drawn from a uniform distribution. Bidders have the option to bid from four seller types, each with a different reputation rating (100%, 90%, 80%, 70%). The reputation score indicates the probability that the buyer will receive the purchased good. Our model assumes agents are risk neutral, however our auction setting has an element of risk, in that buying from a seller with anything other than a 100% reputation score could lead to lost revenue if the good is paid for but not shipped. As reputation scores decrease risk increases, thus we consider the risk type of subjects as having a possible effect on bidding behavior. To test the effects of risk type on bidding strategy we deploy a post experimental risk assessment to subjects, using a validated instrument developed by Weber, Blais and Betz (2006). This survey allows us to make inferences about bidding behavior based on risk type and helps explain any behavioral deviations from our model.

This paper contributes to the growing literature on simultaneous auctions. In the economics literature, Hausch (1986) studies whether sellers prefer to sell multiple goods through sequential or simultaneous auctions. Krishna and Rosenthal (1996) study simultaneous sealed-bid, second-price auctions of identical objects to a combination of unit-demand and multi-unit demand buyers. Rosenthal and Wang (1996) extend the analysis in settings with common values. Peters and Severinov (1997) study simultaneous auctions of identical objects where sellers compete with each other by setting different reserve prices. Ellison, Fudenberg and Mobius (2003) study the conditions under which two competing and otherwise identical auction sites of different sizes can coexist in equilibrium. In the management science literature, Byde (2001) and Bertsimas, Hawkins and Perakis (2002) propose dynamic programming bidding algorithms for a single item in simultaneous or overlapping online auctions.

Simultaneous auctions have also generated substantial interest in the computer science/intelligent agent community. A lot of this interest has been motivated by the International Trading Agent Competition (Wellman et al. 2001), an annual event that challenges its entrants to design an automated trading agent capable of bidding in simultaneous online auctions for complementary and substitute goods. Most of the work in this area (for example, Greenwald and Boyan 2001; Anthony and Jennings 2003; Preist, Byde and Bartolini 2001; Stone et al. 2001) focuses on ascending auctions and proposes heuristic bidding algorithms that are tested by their authors experimentally or through simulation.

For the sake of brevity the above summary of relevant literature is representative but not comprehensive. To the best of our knowledge there is nothing in the broader spectrum of literature that covers the topic of the current paper; namely a game-theoretic analysis in

conjunction with a laboratory experiment studying simultaneous second-price, sealed-bid auctions of imperfect substitutes by sellers with heterogeneous reputations.

The analytical model is completed and will be tested with the series of laboratory experiment scheduled to run in February and early March of 2008. The risk assessment data will also be collected at the time of the experiment. If accepted, we will present this data for discussion at the Utah Winter Conference in March 2008.