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Frictions in internet auctions with many traders: A counterexample

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HIGHLIGHTS

- Peters and Severinov (2006) (PS) characterize a PBE in a competing auctions environment.
- PS environment is frictionless: all buyers are linked to all sellers.
- PS characterize a PBE using a simple bidding rule.
- We show that when frictions are present, the PS bidding rule is not efficient nor a PBE.
- Researchers should be cautious when using this rule in markets with frictions like eBay.

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ABSTRACT

We show that when frictions are present, the Peters and Severinov (2006) (PS) bidding rule is no longer efficient nor a PBE of the PS game. Researchers should be cautious when using the PS bidding rule in markets with frictions like eBay.

1. Introduction

In a seminal paper, Peters and Severinov (2006) (PS henceforth) characterize a perfect Bayesian equilibrium (PBE) in a competing auctions game similar to buyer–seller trading platforms such as eBay, Amazon, or Taobao. In their setting, sellers offer a homogeneous good, differ in their valuation, and hold second-price auctions. Buyers differ in their valuation (which is private information) and have single unit demand. Bids increase in discrete amounts. Their environment is frictionless in the sense that any buyer may participate in any auction.

In their paper, PS characterize a PBE in the competing auctions game. The PBE bidding strategies specify that buyers bid in the auction with the lowest standing price, using a simple tie breaking rule when relevant. Having identified the auction they will bid on, bidders bid the standing price plus the minimum bid increment. (See Section 2.2 for a full description of the game and the bidding rule.) This rule is appealing because it is based on observable market data. The only information that a bidder needs are the standing bid and whether the standing bid has changed since the last change of the winning bidder. This information is typically observable in buyer–seller trading platforms. In addition, their proposed bidding rule "constitutes a PBE in the bidding process independently of buyers' beliefs about other buyers' valuations, and even the number of other buyers. The outcome of this equilibrium is efficient provided that sellers set their reserve prices equal to their true costs. [...] The remarkable part [...] is that the outcome of the bidding process is efficient and sequentially

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rational (*i.e.* optimal at every information set given the traders' beliefs and their strategies), yet looks very much like a simple algorithmic price adjustment procedure'' (PS p. 223).

Because the PS strategies are simple and based on easily observed data, a branch of the empirical auctions literature has used some of the theoretical predictions of the bidding rule from PS to investigate bidder behavior in online competing auctions environments such as eBay. For example, Anwar et al. (2006), empirically investigate whether bidders' behavior in eBay corresponds to the equilibrium bidding rule in PS. Bapna et al. (2009), empirically investigate the prediction of the bidding rule in PS that bidders bid in multiple auctions and the resulting law of one price (*i.e.* no price dispersion). Hasker and Sickles (2010) use the incremental bidding prediction of the bidding rule in PS as a simple explanation for sniping in eBay. Zeithammer and Adams (2010) use data on eBay auctions to reject the hypothesis that these auctions resemble second-price sealed-bid auctions and use PS bidding rule as potential model consistent with some of their findings. Backus et al. (forthcoming) consider the case of two auctions with frictions using the framework of PS to investigate price dispersion using eBay data. A detailed discussion of the empirical evidence supporting the equilibrium bidding rule in PS can be found in the survey of online auctions by Ockenfels et al. (2006).

However, in internet platforms such as eBay it is costly for buyers to interact with all the sellers. Due to search costs, frictions in eBay are important.[1] Thus, it is unclear that the PS assumption of a frictionless market is appropriate when working with such data. In eBay, search frictions arise for two main reasons. First, two bidders that perform the exact same search query at a given time observe the same, say, 25 listings in the first page of results.[2] So certain sellers will rarely show up in the first page of results for most buyers. Second, buyers seldom perform the exact same search query. So the 25 products displayed in the first page will typically differ among buyers, depending on their search query and on the sellers' title for the product listing.[3] In this paper we show that when search frictions are present – so that buyers do not participate in all the auctions – the PS bidding rule is no longer guaranteed to be efficient nor a PBE of the competing auctions game of PS. Our results indicate that researchers should be cautious when using the PS bidding rule to make inference about the behavior of buyers and sellers in a market where frictions are present such as eBay.

We proceed as follows. In Section 2, we describe the game and the bidding rule of PS. In Section 3, we present a simple example where the bidding rule of PS produces an outcome that is no longer guaranteed to be efficient nor a PBE of the competing auctions game. Finally, in Section 4 we conclude.

2. The model

2.1. Setup

Consider a set of buyers and a set of sellers. Sellers differ in their valuation and offer one unit of an homogeneous good. Assume that sellers have no idiosyncratic preferences over the buyer they sell to. Buyers differ in their valuation and have single unit demand. A buyer with valuation v that buys from a seller at price p has utility $v - p$ and 0 otherwise. The seller's utility is the price, p, if they sell the good, and their valuation, b, if they do not.

To model search frictions in buyer–seller markets we find it useful to use the formalism of bipartite networks. We think of buyer–seller markets as a bipartite network that consists of a set of sellers, a set of buyers, and a set of links connecting buyers with sellers. A buyer can obtain a good from the seller only if the two are linked. The interpretation is that when a buyer is linked with a seller, the buyer may participate in the seller's auction. When the network is fully connected (*i.e.* when all buyers are linked with all sellers) we say that the market is frictionless. In that case, the bidding strategies in PS are a PBE of the sequential auctions game. In this paper we assume that the network is common knowledge, and focus on the case where the network is not (necessarily) fully connected (*i.e.* when search frictions are present in the market).

Definition (*Linked Auctions*)**.** The set of linked auctions of bidder j is the set of sellers i such that there is an edge (link) between seller i and bidder j in the network.

2.2. Peters and Severinov (2006)

PS sequential game

The PS sequential game is as follows. Consider the setup from Section 2.1. Sellers hold second-price auctions. Buyers (*i.e.* bidders) are ordered randomly in a queue and they arrive sequentially. When a new bidder arrives, the bidder can submit bids to one or more of the sellers to whom it is linked. After all bidders submit their bids (or decide not to bid), the bidding queue restarts. That is, bidders may sequentially update their bids (either in the same auction they bid before, or by bidding in different auctions), or decide not to. The process ends when all bidders in the queue decide not to place further bids. The buyers' valuations and sellers' valuations are distributed on the grid $\mathcal{D} \equiv \{\underline{p}, \underline{p}+\Delta, \underline{p}+2\Delta, \ldots, \overline{p}\}$ that has a step size $\Delta > 0$. The minimum bid increment is Δ.

For each seller, the standing bid is the second highest bid received (or the valuation if the seller received less than two bids). The standing bid is publicly observed for each seller at each moment. The highest bid is not publicly observed nor is the identity of the winner. If more than one bidder submits the same bid, the winner is the bidder who submitted the bid first. In this case, the standing bid coincides with the highest bid. Because sellers hold second-price auctions, the winner in each auction is the holder of the highest bid, but this bidder only pays the standing bid.

PS bidding rule

Now we focus on the bidding rule proposed by PS. Because these are second-price auctions, if bidder j bids the standing bid plus Δ (the minimum bid increment), two things could happen. First, it could be that the new bid exceeds the current highest bid. In this case, bidder j becomes the highest bidder (or winning bidder) displacing the previous highest bidder. But the standing bid does not change: the second highest bid is still the original standing bid. Second, the new bid may tie with the current highest bid. In this case, bidder j does not displace the previous highest bidder. But now the highest and second highest bid coincide. That is, the winning bid and highest bidder do not change, but the standing bid increases and matches the winning bid. Note that the new bid never falls short of the current winning bid. By definition the standing bid is either equal to the winning bid or Δ below it. Since the new bid exceeds the standing bid by Δ, whenever a new bid is placed it either matches the winning bid or exceeds it.

To identify which sellers have the lowest winning bid (recall that due to the second-price structure, winning bids are unobservable), it is convenient to identify auctions such as the ones

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[1] This is documented for the case of internet auctions by Bajari and Hortacsu (2004, p. 483) and for eBay by Backus et al. (forthcoming, p. 181).

[2] Twenty five is the default number of listings displayed by eBay in the first page.

[3] Bidders use these results to decide in which of the listed auctions to participate. Most users are reluctant to use other than the default settings in a search (Chau et al., 2005; Cone et al., 2005).