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Selective entry and auction design ☆

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ABSTRACT

This article examines how different auction designs perform when entry is endogenous and selective, by which we mean that bidders with higher values are more likely to enter. In a model where potential bidders are symmetric, we show that three alternative designs can significantly outperform the 'standard auction with simultaneous and free entry' when entry is selective. When bidders are asymmetric, we show that level of bid preference that maximizes a seller's revenues is significantly affected by the degree of selection. We also describe recent empirical and econometric work that shows that the degree of selection can be identified and estimated using standard types of auction data.

1. Introduction

This article examines the performance of different auction designs in a setting where bidders have independent private values but entry is endogenous and possibly *selective*. We will say that entry is selective when potential bidders with higher values are more likely to enter, as should happen when potential bidders have some information about their values prior to taking the entry decision. While it seems intuitive that entry should typically be selective, this has been ruled out by assumption in much of the theoretical and empirical auction literatures. In this article we will illustrate that allowing for selection can significantly affect the conclusions that a researcher would draw about the value of auction designs that differ from the standard auction with free entry, and that the exact degree of selection can also affect which design performs best. We also describe recent work that shows that the degree of selection is identified and can be estimated using types of data that are usually available in auction settings.

To develop our results, we consider an auction for a single unit of a good and assume that there is a well-defined set of risk-neutral potential bidders with independent private values. Throughout the article we will use the term 'player' to refer to a potential bidder, using 'bidder' to refer to a player that actually enters the auction and is able to submit a bid. The winning bidder is the one that is allocated the good at the end of the auction. We assume that it is costly for a player to enter the auction which she must do to submit a bid. We assume that a player learns her value of the object when she incurs the entry cost, so it is natural to interpret the entry cost as including the cost of doing research or 'due diligence' on the object being sold.[1]

As long as the entry cost is not too low or too high, entry will be endogenous in the sense that a player's entry decision will depend on what it expects other players to do, as well as what it believes about its own value. We model a player's belief about its value by assuming that, prior to taking the entry decision, it receives, for free, a signal that is positively correlated with its value. In equilibrium, players with signals above some threshold will enter, and the degree of correlation will, therefore, control the extent to which entry is selective. This provides us with a framework where we can examine how the degree of selection, determined by the informativeness of the signals, affects the absolute and relative performance of different mechanisms, measured either in terms of the seller's revenues or total surplus. The common assumption of no selection would involve players receiving no signals or, equivalently, signals that are completely uninformative.

We use a particular parameterization of our model to compare the performance, both in terms of revenues and efficiency, of different auction designs. Our baseline design is a 'standard auction with simultaneous and free (i.e., unrestricted) entry' (SASFE), which is the usual way that real-world auctions with endogenous entry are modeled. As

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[1] We will assume that a player has to incur the entry cost even if she discovers that her value is less than the seller's reserve price and so does not actually submit a bid. Therefore, at least when there is a positive reserve price, it is more appropriate to interpret the entry cost as the cost of gathering information, rather than some bureaucratic cost of submitting a bid.

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has been documented in the literature, one feature of this design that can be both inefficient and harmful for the seller is that entry decisions are not coordinated across players so that the realized number of bidders will be random. With symmetric players, we compare the SASFE with three designs that deal with this problem in different ways. In the 'entry rights auction' (ERA) of Ye (2007), the seller fixes the number of entrants in advance and conducts an initial auction for these entry 'slots' where players can bid based on their signals. We also consider two designs where players take entry decisions sequentially, which also allows for coordination, but also allows for the number of entrants to depend on the information that the players have and the seller does not. In one of these designs (a 'sequential entry auction'), players decide to enter sequentially but the entrants bid simultaneously. In the other design, the 'sequential bidding auction' of Bulow and Klemperer (2009) (BK hereafter), players make entry decisions sequentially and entrants can submit bids when they enter in order to signal information about their values to players that are taking entry decisions later in the sequence.

When there is no selection, as is typically assumed in the literature, the SASFE generates higher expected revenues than either of the sequential designs and its revenues are quite close to those of the ERA. However, once selection is introduced into the model, both sequential designs, and especially the sequential bidding auction, generate substantially higher revenues than the SASFE and the revenue advantage of the ERA over the SASFE also increases. The identity of the mechanism that performs best depends on the exact degree of selection that is assumed. The alternative designs generate higher total surplus than the SASFE whatever is assumed about selection, but the size of their advantage over the SASFE also tends to increase when entry is more selective. In our comparisons, we draw on results developed in Roberts and Sweeting (2013), who compare the SASFE and the sequential bidding auction, and Bhattacharya et al. (2014), who compare a SASFE and an ERA in a procurement setting. The new results in the present article come from using a single set of parameters, so that the sequential bidding auction and the ERA can also be compared; adding the sequential entry auction to the consideration set; considering how absolute and relative performance changes when we move from no selection to partial selection (the earlier papers only consider different degrees of partially selective entry); and, examining in more detail why the alternative mechanisms are more efficient and generate higher revenue.

We also examine how the degree of selection in the entry process can affect the performance of bid preference programs, that are widely used by government agencies when selling assets or procuring services, in a model where bidders are asymmetric.[2] These programs are partly motivated by wanting to increase the probability that bidders of a particular type will win, but also, following the logic of optimal auctions (Myerson, 1981), by a desire to raise auction revenues by increasing the competition that strong bidders face. We show that while very large bid preferences maximize revenues when there is little selection, much smaller preferences are optimal when the degree of selection is high. These results are also new, and an additional contribution is that we use our analysis to illustrate how changing the degree of selection changes the level of entry costs required to rationalize a given amount of entry by weak bidders.

Our paper contributes to the enormous theoretical literature on auction design, summarized in the surveys of Klemperer (2004), Krishna (2002) and Milgrom (2004). When the seller has a single unit, and there is a fixed number of risk-neutral and symmetric bidders with independent private values, it is well-known that the optimal mechanism is a standard auction with a reserve price or entry fee.[3] Much of the theoretical auction literature has been concerned with exploring which mechanisms perform best when these assumptions are relaxed. We will focus on relaxing the assumption that the number of bidders is exogenous, and explore how particular assumptions about they way the entry process works affect the absolute and relative performance of different mechanisms. Milgrom (2004) uses endogenous entry as his leading illustration of why auctions need to be analyzed in their correct context, arguing that even auctions that are carefully designed can fail when too few bidders decide to participate (p. 209).[4]

We follow the existing literature in modeling the way that standard auctions work as a two-stage game, where, in the first stage, players simultaneously decide whether to enter, incurring a common entry cost, and, in the second stage, the entrants simultaneously submit bids. This is what we will label an SASFE. Entry decisions into an SASFE will be non-trivially endogenous when the entry cost is 'moderate' (Milgrom, p. 217) in the sense that it is low enough that, in equilibrium, some players may want to enter, while being high enough that some may not.

The cleanest set of theoretical results come from models in which players have no private information about their values until they have entered, so that entry is not selective. Assuming that players are symmetric, that the common entry cost is moderate and that the entry game is followed by a standard first price or second price auction (revenue equivalence holds in this context), Levin and Smith (1994) show that (i) the symmetric equilibrium involves players mixing over whether to enter, and making zero expected profits; (ii) the seller's optimal reserve price is equal to its value of keeping hold of the object, with revenue-maximization requiring no reserve price and no entry fees (see also McAfee and McMillan, 1987); (iii) an increase in the number of potential entrants will reduce expected revenues; and, (iv) when the reserve price is equal to the seller's value, equilibrium entry strategies are optimal in the sense that a social planner who also had to choose a symmetric entry rule would choose the same entry probability that the players themselves choose in equilibrium. In what follows, we will refer to the assumption that entry is not selective as "NS".[5] Of course, property (iv) does not imply that the mechanism is necessarily optimal when compared to mechanisms where the seller changes the entry process in some way, such as fixing the number of players that can enter or organizing players to move sequentially.

Assuming NS, BK compare outcomes in a SASFE with those in an alternative procedure where players take entry decisions and bid sequentially, which they argue is a stylized version of how corporations are often sold. They show that the alternative procedure raises total surplus but will almost always generate lower revenues for the seller, because of the ability of early movers to deter entry. We will show that their sequential bidding procedure can actually increase revenues quite significantly as soon as any degree of selection is introduced into the model.

A more limited literature has considered endogenous entry with selection. Samuelson (1985) and Menezes and Monteiro (2000) assume that players know their values when deciding whether to enter. This is the most extreme form of selection that we will consider, and we will call this the fully selective, "FS" assumption. A feature of this model is that bidders with high values tend to make positive profits in equilibrium. In the SASFE under FS, revenues may increase or decrease when additional players are added, and the seller-optimal reserve may be greater than the seller's value of holding onto the object

[2] Roberts and Sweeting (2013) allow for players to be asymmetric in the context of a second-price auction, while Bhattacharya et al. (2014) consider a low-bid auction with symmetric players. In the current article, we show that it is feasible to solve first-price auctions with asymmetric bidders and selective and endogenous entry. This framework is appropriate because bid preference programs are usually applied in the context of first-price or low-bid auctions.

[3] Bulow and Klemperer (1996) show that under these assumptions, adding an additional bidder in a standard auction will increase the seller's revenue by more than using the optimal design with a fixed number of bidders (which involves setting a reserve price). As our results illustrate, this conclusion does not necessarily hold when entry is endogenous and one considers the effects of adding a *potential* bidder.

[4] Milgrom's second illustration concerns asymmetries between bidders, which we also consider.

[5] The "not selective" assumption is sometimes called the "LS" assumption after Levin and Smith. Similarly, the "fully selective" assumption that we introduce as the opposite polar case below is often referred to as the "S" assumption following Samuelson (1985).

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