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Information disclosure in auctions with downstream competition

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HIGHLIGHTS

- I present a model in which firm valuations depend on identities and rival's costs.
- When firms compete in a simultaneous auction, the lowest cost firms always win.
- However, sequential auctions are better at maximizing ex post valuations.

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ABSTRACT

When bidders' valuations are derived from a downstream market in which they may compete, the allocation to the firms with the lowest costs can differ from the allocation that maximizes the ex post valuations of the bidders. I consider the problem of auctioning two goods to bidders whose valuations for a good flexibly depend on their and their rival's costs as well as the identity of the rival. I show that revealing the identities of winners through a sequential auction procedure leads to allocations in which bidders tend to have higher ex post valuations but also higher costs when compared to a simultaneous auction.

1. Introduction

If firms in an auction for licenses vary in terms of how strongly they compete with one another in a post-auction market, their valuations in the auction can depend on the identities of the other winners. This can occur when consumers in the post-auction market incur costs to switch between incompatible products (Klemperer, 1995).

I present a model of such an environment that only places weak restrictions on the post-auction interaction and compare a simultaneous auction for two licenses to a sequential mechanism. Importantly, the latter reveals the first-round winner's identity. I show that the sequential mechanism is more likely to maximize bidder payoffs, while the simultaneous auction always selects the lowest cost bidders. The lowest cost allocation need not maximize the bidders' payoffs due to negative externalities, which if caused by increased competition in the downstream market may be offset by increases in consumer surplus. Intuitively, revealing the prior winner's identity in the sequential format causes the remaining bidders to update their values, leading to a higher likelihood of selecting the bidders with the highest valuations. On the other hand, when bidders update their values they become predictably asymmetric, making it less likely that the lowest cost firms win.

Jehiel and Moldovanu (2006) and the citations therein provide an overview of the consequences of introducing externalities into auction models. This paper is related to a series of papers that analyze a single-good environment in which bidders' payoffs depend on the identity of the winner (Das Varma, 2002a, b; Das Varma and Lopomo, 2010).[1] Das Varma (2002b) finds that revealing the identities of the bidders before an auction increases the auction efficiency (sum of bidder values). Similarly, I find that revealing the first-round winner's identity using a sequential mechanism is more effective at maximizing ex post valuations. On the other

[1] See Das Varma and Lopomo (2010) for more discussion of the related literature. Aseff and Chade (2008) study revenue-maximization in a similar setting. Katsenos (2008) considers a similar question in a setting in which there is no distinction between the identities of the bidders.

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hand, Das Varma and Lopomo (2010) study auctions involving entrants and incumbents, comparing simultaneous to dynamic formats. They find that a simultaneous format may be more efficient because the dynamic format in their model introduces a free riding incentive among incumbents causing strategic non-participation. I provide a different rationale for using a simultaneous format. I show that it is more effective than the sequential format at selecting the bidders with the lowest costs. Both Das Varma and Lopomo (2010) and my paper support the assertion that when bidders are concerned about increased competition in post-auction markets resulting from certain bidders winning a simultaneous format may be more effective at maximizing social surplus, once downstream consumers are considered.

I next describe the model. The following sections present the results for the simultaneous auction (Section 3) and the sequential mechanism (Section 4). Section 5 concludes. The proofs are in the Appendix.

2. Model

There are $2N$ ($N \geq 2$) bidders competing in an auction for two homogeneous goods. Each demands one unit and has a valuation that depends on the type of the other winner and both winners' cost parameters. Bidders may be one of two types, A and B. There are N bidders of each type.

Let $\pi_S(c_i, c_j)$ denote bidder i's reservation price for a unit of the good if bidder i with cost c_i wins with bidder j with c_j and the bidders are of the same type. Let $\pi_D(c_i, c_j)$ be bidder i's reservation price if bidder j is a different type. I assume that the payoff is zero to losing bidders. The payoff functions, π_S and π_D, are continuous, strictly decreasing in their first argument, and weakly increasing in their second argument.[2] I make the following assumptions for all c_i, c_j:

A1 $\pi_S(c_i, c_j) \leq \pi_D(c_i, c_j)$
A2 $\pi_t(c_i-d, c_j)-\pi_t(c_i, c_j) \geq \pi_t(c_i, c_j)-\pi_t(c_i, c_j-d),\ t \in \{S, D\}$.

Assumption A1 states that an A bidder would prefer to win against an B bidder over an A bidder with the same cost. This assumption is the source of the externality. A2 states that reducing a firm's own cost by d increases the payoff more that increasing that firm's opponent's cost by d. That is, one's own costs are more important than one's rival's.

The private cost parameters, $c_i \in [0, 1]$, are distributed independently according to the commonly known distribution, $F(c)$, which is assumed to have a strictly positive density for all $c \in [0, 1]$.

The following example shows that these assumptions hold in a market in which consumers have switching costs. It is a slight modification of Example 0 in Klemperer (1995).[3]

Example 1. Suppose that firms of type A manufacture products that are compatible with those of other type A firms but incompatible with products made by a type B firm. Assuming n consumers have a reservation price of R for one unit of a good. A fraction σ_A of consumers must pay a switching cost of s to buy from a B firm, while a fraction $\sigma_B = 1-\sigma_A$ pay s to buy from A. Symmetry requires $\sigma \equiv \sigma_A = \sigma_B$.

If an A and a B firm are in the market with marginal costs c_A and c_B, $s \geq R - c_A > 0$, and $s \geq R - c_B > 0$, then in the unique non-cooperative equilibrium the firms price the goods as if they were monopolists in their respective markets ($p_A = p_B = R$) and earn profits $\sigma n(R - c_A)$ and $\sigma n(R - c_B)$. If there are two As in the market with marginal costs $c_A^1 < c_A^2$, the firms compete for the share of customers in their segment (if $c_A^1 \geq R - s$, the B customers are not served). Under price competition the higher cost firm (firm 2) earns 0 and the lower cost firm (firm 2) earns $\sigma n(c_A^2 - c_A^1)$.

Therefore, for large enough switching costs we always have $\pi_D(c_i, c_j) = \sigma n(R - c_i)$ and $\pi_S(c_i, c_j) = \mathbf{1}\{c_i \leq c_j\}\sigma n(c_j - c_i)$, where $\mathbf{1}\{\cdot\}$ is an indicator function.

3. Simultaneous uniform-price auction

I first consider a sealed-bid auction that allocates the two goods to the two bidders with the highest bids and requires that each winner pays an amount equal to the highest rejected bid. The rationale for choosing this auction format derives from the fact that the highest-rejected-bid uniform-price auction shares allocation and payment rules with the Vickrey–Clarke–Groves (VCG) mechanism when all bidders demand a single good and values are private.[4] If values were private, the bidders would have a weakly dominant strategy to bid their valuation in this uniform-price auction due to the analogy with the VCG mechanism. In the current setting, bidders' values are interdependent and equilibrium strategies are no longer weakly dominant. However, they retain the feature that bidders bid their expected post-auction valuations conditional on winning an item, which allows for a closed-form description of equilibrium behavior.

Proposition 1 describes the unique symmetric equilibrium bidding strategies. The expression given is each firm's expected post-auction valuation conditional on winning, its cost, and the assumption that a symmetric equilibrium is played, meaning bids are independent of types. Note that when bids are independent of types the two lowest cost firms win the goods. The environment is symmetric because from every firm's perspective there are $N - 1$ firms of the same type and N firms of the other type.

Proposition 1. *In the unique symmetric equilibrium of the simultaneous highest-rejected-bid uniform-price auction, firms bid according to*

$$b^{SM}(c) = \int_0^1 ((N-1)\pi_S(c, x) + N\pi_D(c, x))f(x)(1 - F(\max(c, x)))^{2N-2}\, dx. \tag{1}$$

Although the auction allocates to the firms with the lowest cost, it does not always allocate to the firms with the largest ex post valuation, because the firms also care about the identity of the other winner. Suppose that $c_A^1 < c_A^2 < c_B^1$, but

$$\pi_S(c_A^1, c_A^2) + \pi_S(c_A^2, c_A^1) < \pi_D(c_A^1, c_B^1) + \pi_D(c_B^1, c_A^1). \tag{2}$$

Continuity of the payoff functions and the assumptions on the cost distribution imply that this event has positive probability when the inequality in A1 is strict.[5] In other words, the lowest cost firms may win the object without having the highest ex post valuations. However, if the auction allocates to an A and a B firm the allocation must also maximize the firms' ex post valuations. Suppose that $c_A^1 < c_B^1 < c_A^2$, and consider the following.

$$\pi_D(c_A^1, c_B^1) + \pi_D(c_B^1, c_A^1) > \pi_D(c_A^1, c_A^2) + \pi_D(c_A^2, c_A^1) \geq \pi_S(c_A^1, c_A^2) + \pi_S(c_A^2, c_A^1). \tag{3}$$

The first inequality follows from Assumption A2, and the second follows from A1.

2 Therefore, they are differentiable almost everywhere.

3 See Farrell and Klemperer (2007) for an overview of this literature.

4 See Krishna (2009, pg.75) for a general description of the VCG mechanism.

5 If A1 is strict consider the case where $c_B^1 = c_A^2 + \varepsilon$ for small $\varepsilon > 0$.