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Large multi-unit auctions with a large bidder ☆

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Abstract

We compare equilibrium bidding in uniform-price and discriminatory auctions when a single large bidder (i.e., with multi-unit demand) competes against many small bidders, each with single-unit demands. We show that the large bidder prefers the discriminatory auction over the uniform-price auction, and we provide general conditions under which small bidders have the reverse preference. We use examples to show that the efficiency and revenue rankings of the two auctions are ambiguous.

JEL classification: C72; D44; D47; D61; D82

Keywords: Auctions; Multi-unit auctions; Market power; Large auctions; Asymmetric first price auctions

1. Introduction

Multi-unit auctions are often used to sell many units of a homogeneous good in markets with many buyers. Prominent examples include the markets for treasury bills, Initial Public Offerings of stock, and carbon emissions permits. Most of the multi-unit auctions used in practice are variants of the uniform-price (UP) or the discriminatory-price (DP) auction. While there is no explicit characterization of the equilibrium of either auction in a general setting, Swinkels (1999, 2001) shows that it is possible to characterize equilibrium bid behavior in each auction when the

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auction is large (i.e., it involves many bidders and objects) and all bidders demand a negligible amount of the total issuance. Asymptotically no bidder in Swinkels' model influences the market's clearing price (i.e., the lowest price at which goods are awarded) with her actions and hence no bidder has market power. Swinkels uses this observation to show that all bidders, as well as the seller, are approximately indifferent between the two formats.

Yet the presence of market power is an important feature in many large auction settings, and furthermore the degree of market power is not uniformly distributed across bidders. For example, Hortaçsu and Puller (2008) analyze the difference in bid behavior between small and large bidders in the Texas electricity spot market. While many bidders compete for the right to sell electricity, the largest bidder controls 24% of distribution. There is evidence that bidders have market power in U.S. Treasury auctions as well. Hortaçsu et al. (2015) report that primary dealers in U.S. Treasury auctions are allocated 46% to 76% of the competitive demand.

We take a first step in augmenting a large auctions model to allow for market power. In our benchmark model, a single large bidder demands a non-negligible measure of the total issuance and competes against a continuum of small bidders. Small bidders are heterogeneous and have negligible demand when considered as a fraction of the total issuance. All bidders have private values. If we think of Swinkels (1999, 2001) as modeling perfect competition in a multi-unit auction, then we model a market akin to a monopsony, since the small bidders' bids determine the large bidder's residual supply curve in the auction.

Although the revenue and efficiency rankings of the UP and DP auctions are generally ambiguous in our model, we obtain clear predictions for the bidders' preferences between the two formats. A straightforward argument establishes that the large bidder prefers the DP auction in this environment. Similar to the bidders in Swinkels' model, the small bidders' bids do not influence the clearing price in either format but their bids do affect the price they pay in the DP auction. They consequently shade their bids below their values in the DP auction but not the UP auction. On the other hand, any serious bid by the large bidder determines the clearing price in both formats. We use this to show that the large bidder's residual supply curve is always lower in the DP auction than in the UP auction when the small rivals bid according to an undominated strategy. Hence, the large bidder favors the DP auction. At the same time, we also provide conditions under which small bidders typically have the reverse preference over auction formats.

Bidder preferences over pricing rules have important practical implications. An immediate implication is that the bidder preferences can influence the choice of auction format. Maskin and Riley (2000a) report that "Similarly, in the lumber tract auctions in the Pacific Northwest, the local 'insiders' with neighboring tracts have forcefully (and successfully) lobbied for open auctions and the elimination of sealed high-bid auctions" (pg. 425). They suggest that this outcome was the result of a strong bidder's preference for a first-price auction over a second-price auction, where "strong" means that their distribution stochastically dominates their opponent's in the reverse hazard rate order (see Definition 1).

Our model suggests that when comparing the UP and DP formats in a multi-unit setting, size, not strength, determines bidder preferences. Instead, we show that the relative strength of bidders' distributions is important for comparing bidder preferences between the DP auction and the Vickrey auction. To do this, we reduce the problem of finding an equilibrium of the DP auction to that of finding an equilibrium of an asymmetric first-price auction with a reserve price. The argument proceeds in two steps. First, we argue that the large bidder optimally submits a flat bid. Then, using this result, we then show that the large and small bidders' payoffs are isomorphic to the payoffs in a certain asymmetric first-price auction between two bidders. We make this connection by expressing the quantity won by the large bidder as a fraction of the quantity of