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The Effect of Asymmetric Bidder Size on an Auction's Performance: Are More Bidders Always Better?

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One commonly held belief in designing auctions is that increasing the number of bidders makes an auction more competitive. Therefore, a buyer who wishes to minimize her procurement costs is better off inviting more suppliers to participate. In this paper, we question the validity of this belief by shedding light on bidders' behavior when bidders experience economies of scale in production and differ in their production capacity. We consider a setting with two different sized bidders, global and small. We assume that global bidders have a large production capacity (can win in more than one auction) and experience economies of scale in production, whereas small bidders can win in at most one auction. In this new setting, we focus on the impact of allowing both global and small suppliers to compete against each other on the performance of an auction.

Key words: sequential auctions; procurement; synergies; asymmetric bidders
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1. Introduction

Companies that are forced to buy and sell in an increasingly competitive environment are searching for methods to cut their costs. One particular method that has gained increased popularity, both online and offline in business-to-business (B2B) markets, is procurement auctions, where suppliers submit bids and compete for a buyer's business. The particularly interesting challenge posed by these B2B auctions is that they typically involve the exchange of multiple products/goods, whereas research in auction theory has traditionally focused on single-unit auctions. Unfortunately, many of the results for single-unit auctions do not generalize to multiunit settings (see Klemperer 1999 for an excellent survey of the literature).[1] In addition to multiple units being auctioned, suppliers (the bidders) in these B2B auctions differ from the standard bidder models in auction theory. The vast majority of auction models assume that bidders differ only in their valuations (real valuations in a private-values model and signal of valuation in a common-values model), and that a bidder's marginal valuation (for additional units/objects) is decreasing. However, many procurement settings differ from this basic model in two important ways: (1) suppliers may experience economies of scale in production, and (2) suppliers may differ in their production capacity (the number of units they can supply).

While the potential savings via procurement auctions are great, so are the challenges in realizing them. The biggest challenge lies in understanding how bidders will behave under different types of procurement settings. For example, one commonly held belief is that increasing the number of bidders makes an auction more competitive. Therefore, a buyer who wishes to minimize her procurement costs is better off inviting more suppliers to participate in her auction. In this paper, we question the validity of this belief by shedding light on bidders' behavior when bidders experience economies of scale in production and differ in their production capacity.

Our model builds on the novel paper by Krishna and Rosenthal (1996): Motivated by the Federal Communication Commission's sale of spectrum bandwidth via simultaneous ascending auctions, they study the bidding behavior of global and local bidders in a *simultaneous* multiunit second-price auction, where a local bidder has positive value for only one (particular) object and a global bidder has positive synergies associated with winning more than one object. The authors focus on a setting where

[1] Some governments and companies are exploring the use of combinatorial auctions to allow bidders to incorporate synergies in their bids and minimize perverse incentives such as exposure risk and the threshold problem (e.g., Ledyard et al. 2002, Elmaghraby and Keskinocak 2003). While the area of combinatorial auctions holds much promise for dealing with these problems, their use is still rare (see Pekec and Rothkopf 2003).

two objects are auctioned independently and assume that a global bidder's valuation from winning only one object is x, whereas his value from winning two objects is $2x + \alpha$, where x is independent and identically distributed (i.i.d.) and α is a known constant shared by all the global bidders. A key characteristic of their local bidders is that a local bidder participates in only one of the auctions, i.e., the global bidder faces a new set of locals in each auction. The second-price nature of the auction implies that it is a dominant strategy for the local to bid his true valuation in each auction.

In this paper, we consider a risk-neutral buyer who wishes to procure $Q = 2$ units of a good via two sequential second-price auctions.[2] Similar to Krishna and Rosenthal (1996), we also assume that there are two types of suppliers in the market; global bidders have a production capacity sufficiently large to supply both units and experience economies of scale in production, whereas small bidders can supply only one unit due to capacity constraints. In contrast to their paper, we assume that the same set of small bidders participates in each auction, subject to capacity availability. This fact implies that it may no longer be a dominant strategy for a small bidder to bid his true costs in both auctions.

Under this new setting, we focus on the impact of allowing both global and small suppliers to compete against each other on the performance of an auction. In particular, we seek to understand how suppliers bid in the presence of asymmetric-sized competitors. That is, do global (small) bidders bid more or less competitively in the face of small (global) bidders?

Buyers in B2B auctions typically have the discretion to invite (or reject) suppliers to participate in the auction. While a buyer may not (cannot) know a supplier's cost in advance, she can observe the supplier's production capacity and use that as a criterion in inviting bidders to participate. We suspect that a buyer would always want to invite globals to participate in the auction because of their larger production capacity and their economies of scale in production. However, it is not clear how inviting the small bidders will affect the performance of the auction. From our analysis, we seek to understand whether a buyer should invite both global and small suppliers to compete in her auction, or limit participation to only global bidders. That is, does inviting the small bidders to participate increase or decrease the buyer's expected procurement costs?

We give a brief overview of the literature in §2 and present our model in §3. In §4, we derive the equilibrium bidding strategies when only small bidders or only globals are present in the auction. We then formulate the optimization problem for both types of bidders when both are present in the auction, and present our theoretical results on their equilibrium behavior. In §6, we present our numerical results on the equilibrium bidding behavior and the performance of the auctions under different bidder pool types. For the remainder of the paper, we refer to an auction where both global and small bidders participate as *GS*, only global bidders participate as *GO*, and only small bidders participate as *SO*. Section 7 contains concluding remarks.

2. Literature Review

Kagel and Levin (2002) consider a variation of Krishna and Rosenthal's (1996) model by assuming a setting where two homogenous units are sold *together* in a single uniform-price auction, with the highest losing bid determining the price paid. Similar to Krishna and Rosenthal (1996), the authors assume that there is a global bidder who has positive valuation over two units and experiences a positive synergy when awarded both of them, whereas local bidders want at most one unit. As before, local bidders have a dominant strategy to bid truthfully in the auction. Using an experimental setting, Kagel and Levin (2002) analyze the opposing effects of exposure risk and demand reduction[3] on the globals' bidding behavior. Katok and Roth (2004) also adopt Kagel and Levin's (2002) experimental and bidder framework[4] and compare the performance of ascending and descending open auctions.

The impact of additional bidders on the expected selling price has been previously studied for common-valuation auctions (as opposed to a private-valuation

[2] Our auction format is inspired by the format adopted by FreeMarkets. When the buyer has multiple objects she wishes to procure, FreeMarkets opens bidding on all objects at the same time but then staggers the closing of the auctions. That is, FreeMarkets makes it publicly known that the auction for item 1 will close first, followed by the auction for item 2, etc. In essence, this staggered closing translates the auction into a sequential auction, because bidders tend to focus their attention on the auction with the closest closing time. Hence, we assume that the buyer conducts a sequential auction. In addition, FreeMarkets currently uses an open descending first-price auction format. With the open bidding format, bidders can iteratively update their bids until some predefined stopping criterion has been met and the auction closes. With private valuations and sufficiently small bid increments, bidding activity typically stops very close to the valuation of the second to last remainder bidder in the absence of signaling/collusion. Therefore, we are approximating the bidding behavior in these open auctions by assuming a sealed-bid second-price auction.

[3] Demand reduction occurs when bidders desire more than one unit, all the units are auctioned together, and the auction clears at a single (uniform) price; see Ausubel and Cramton (2002) and Engelbrecht-Wiggans and Kahn (1998) for further analysis and discussion.

[4] With one variation—they use human bidders to represent all of their bidders, whereas Kagel and Levin (2002) represent local bidders by a computer.