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Rational bidding in a procurement auction with subjective evaluations☆

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ABSTRACT

In practice, procurement auctions often involve subjective evaluations of bids, especially when consisting of quality or design parameters which are hard to quantify. We formally define a notion of subjectivity in an auction environment and analyze the implications for rational bidding behavior. Our findings explain some observed bidding behaviors that are inconsistent with standard equilibrium predictions. Finally we examine the way subjectivity facilitates the practice of favoritism on part of the auctioneer.

1. Introduction

The Government of India carried out the Delhi and Mumbai Airport Privatization (DMAP) auctions during the years 2003–6 with the objective of modernizing the airports. The two critical dimensions along which the bids were evaluated consisted of quality and revenue. The main feature distinguishing these from a standard auction was the difficulty to precisely quantify the quality variable.

In the DMAP auction firms submitted their bids simultaneously. A bid consisted of a technical and a monetary part. The technical part included the proposed design of the airport as well as the bidder's characteristics (size, business history, experience in airport development etc.). These firm specific features were taken as good proxies for quality (for details see Jain et al. (2007)). The monetary part was the revenue accruing to the government.

The auctioneer publicly announced a minimum quality-score prior to the submission of bids. The bids were evaluated in two rounds. In the first round, technical bids were evaluated. Each item in the technical bid was graded. The overall quality-score of the bid was given by a weighted average of these grades. If a technical bid obtained the minimum quality-score, then the bidder qualified for the subsequent round. In this round, the monetary bids of the qualified bidders were compared. The winner was the bidder whose monetary bid was the highest among those who qualified for the second round.

Setting a quality cut-off is a pervasive practice in public procurements. The setting of a minimum quality standard has an obvious implication in standard auction environments. It is a dominant strategy for the bidders to offer the minimum quality level, and hence all bidders qualify. The winner is then effectively decided by a first-price auction with respect to the monetary dimension. However, in the DMAP auction many bidders did not qualify. We believe that the difficulty of quantifying the actual quality of a bid played an important role in leading to disqualified bidders.

For example, in the DMAP auction, even though the weighting scheme was common knowledge, the exact evaluation procedure i.e. the information about "what kind of technical bid would obtain what score", was not conveyed to the bidders prior to the submission of bids. This may be due to the inability of the auctioneer to completely specify all design aspects. It might also be the case that the auctioneer is not sure of what is the "exact" design she is looking for. This means that the evaluation of technical bids was indeed subjective, a phenomenon well documented in Jain et al. (2007). More precisely, we say that the evaluation of technical bids is subjective, if there are several methods, giving rise to different rankings, to evaluate a technical bid and the auctioneer cannot commit to use one particular method.

Examples of cut-off and subjectivity are quite common: one class of examples is defense procurement of supplies and services as it often

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involves a two-stage procedure where offers are first screened on the basis of a list of minimal standards and then ranked according to price and other parameters. The minimal requirements, while described, allow discretion on the part of the procurer leading to what we see as subjective evaluation. This is the case for the U.S. Department of Defense[1] as well as for the Australian[2]; another class is government procurement in general as is the case for the European Union[3] South Africa[4] and the Philippines.[5]

The issue of subjectivity in evaluation appears in some other contexts as well. For instance, while evaluating research proposals, a funding organization may usually use any method to evaluate the proposals submitted and need not commit to any specific one. When examining offers to operate a catering service, evaluating the quality of food is again subjective in the sense we defined.

In such subjective environments the standard auction model has to be modified to take account of the uncertainty faced by the bidders. We propose a procurement auction model allowing for uncertainty arising due to the subjectivity regarding the quality evaluation process. Bidders participating in the auction bid without knowing the precise evaluation method of the technical component. They entertain beliefs regarding the evaluation methods and the strategies of the other bidders, which may be false. We define rational bidding behavior in this context (following Kalai and Lehrer (1993)). We show that in the case of correct beliefs, either all or none of the bidders qualify. Furthermore, when beliefs are not correct we show that indeed some bidders may not qualify. We also show several other properties implied by rational bidding behavior.

We also observe that subjectivity makes it impossible to impose a legal requirement on the auctioneer to commit to a particular evaluation method. This makes it possible for a dishonest auctioneer to manipulate the evaluation so as to favor one of the bidders. To analyze this phenomenon of "favoritism", we formalize a manipulation scheme, and examine the resulting equilibrium bidding on part of favored and non-favored bidders. In particular, we show that this form of favoritism may lead to inefficiency.

1.1. Related literature

Che (1993) analyzed an auction with a bid-structure identical to ours with a different outcome function. While we used a lexicographic scoring rule to rank the different bids, Che (1993) used a quai-linear scoring rule for ranking. A scoring rule is a real valued function whose domain is the set of all two-tuples of technical and financial bids. The winner with the highest score wins the auction. The scoring auctions introduced by Che (1993) have been extended in different ways by Asker and Cantillon (2010), Branco (1997) and Naegelen (2002). However, none of these papers consider the implications of subjective scoring rules.

A related model is Ganuza and Pechlivanos (2000). In this model the buyer announces a design "a priori" and the firms compete on the cost parameter. They characterize optimal Bayesian incentive-compatible mechanisms. In our model the design is not specified a priori, nor is the bidding in terms of the cost parameters.

There is a large and growing literature on corruption/collusion in auctions. We only refer to some of the related papers on favoritism. In Laffont and Tirole (1991) an auctioneer, acting on behalf of a buyer, is asked to choose a firm to carry out a public project. Before the bids are submitted, the auctioneer receives a signal about the quality of the firms participating in the auction. The auctioneer can then transmit some information (not necessarily correct) to the buyer about their quality. Arozamena and Weinschelbaum (2009) consider corruption in first price auction when it is known among the other bidders that the auctioneer favors one of the bidders. The dishonest bidder is allowed to revise his bid upward or downward by the auctioneer. Burguet and Che (2004) consider a scoring auction where the relevant bids for the buyer are two dimensional, quality and price. They assume that both the bidders are dishonest — along with quality and price they bid a bribe. The auctioneer manipulates the quality bid in favor of the bidder submitting the larger bribe. In our model, the auctioneer does not manipulate the technical bid directly. Instead the evaluation procedure is manipulated to favor a preferred bidder. For further details on corruption in auctions we refer the reader to Wolfstetter and Lengwiler (2006).

The next section introduces the model. In Section 3 we define and analyze rational strategies. Favoritism is discussed in Section 4 and Section 5 concludes.

2. The model

The environment we consider can be described as follows: we assume that there is one auctioneer and two identical bidders (suppliers). The auctioneer wishes to procure a good, the quality of which, denoted by q, is variable. The auctioneer holds an auction where the bidders simultaneously submit a two-dimensional bid denoted by $(t, p) \in \Re^2_+$. The first component is the technical part of the bid and the second is the monetary part. The auctioneer evaluates the technical bid. The score that a technical bid obtains due to the evaluation is called the quality-score of that bid. The auctioneer specifies a cut-off level of the quality-score exogenously i.e. announced before the bids are submitted and this cut-off level is common knowledge. Let the cut-off quality-score be $\underline{q} > 0$. The winner of the auction is the bidder who bids the lowest monetary offer while satisfying the quality requirement. The winner carries out the project that corresponds to the winning technical bid and receives the monetary part of the bid.

The main feature distinguishing this environment from a standard procurement setting is the fact that the evaluation procedure cannot be precisely specified, which renders it subjective. The inability to specify it is due to the complexity of the typical evaluation procedure which tries to summarize a diverse set of hard to quantify technical attributes. That is, the bidders cannot be certain of the score of a given technical bid. We assume that the set of possible evaluation procedures consists of two functions, $q(t, \eta_1) = \eta_1 t$ and $q(t, \eta_2) = \eta_2 t$ with $0 < \eta_1 < \eta_2$. We let $\Omega = \{\eta_1, \eta_2\}$ with the auctioneer "unable"[6] to specify the actual η_k that will be used to evaluate technical bids and assume Ω is common knowledge. We assume that the uncertainty regarding the evaluation process is resolved only after bids are submitted. Since $\eta_1 < \eta_2$ we call the evaluation procedure using η_1 strict, as it increases the expected cost of any bidder to qualify.

Each bidder incurs a cost $c(t, \theta)$ if he bids t and is of type θ which is private information. The θ's are independently and identically distributed across the two bidders with support $[\underline{\alpha}, \overline{\alpha}] \subset \Re_{++}$ and a strictly increasing distribution function F with a continuously differentiable density function f. We assume that the first and second-order partial derivatives of the cost function satisfy $c_t > 0$, $c_\theta > 0$, $c_{tt} \geq 0$, $c_{t\theta} \geq 0$ and $c_{\theta\theta} \geq 0$. The utility of bidder i, of type θ_i, playing (bidding) (t_i, p_i), if he is the winner of the auction is given by $p_i - c(t_i, \theta_i)$ and zero otherwise.

This environment generalizes the procurement setting introduced in a seminal paper by Che (1993). Without uncertainty regarding the evaluation procedure, it is a dominant strategy for each agent to submit the lowest qualifying quality. Hence, effectively, the competition is just over the monetary part and our set-up reduces to a standard first-price

[1] See http://www.acq.osd.mil/dpap/cpic/cp/docs/BBP_2-0_Comp_Guidelines_Update_(3_Dec_2014).pdf (pages 13–14).
[2] See http://www.defence.gov.au/dmo/Multimedia/DPPM-9-5247.pdf (page 4.4–4).
[3] See Lundberg and Marklund (2011), Section 1 — Institutional settings.
[4] See https://www.environment.gov.za/sites/default/files/legislations/pppfa_guideline.pdf (pages 14–16).
[5] See http://www.treasury.gov.ph/wp-content/uploads/2015/04/RFEI-Auction-and-Registry-System-for-GS-Modernization.pdf.

[6] We emphasize that the evaluation method is not part of the auctioneer's private information.