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Econometric models of asymmetric ascending auctions

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Abstract

We develop econometric models of ascending (English) auctions which allow for both bidder asymmetries as well as common and/or private value components in bidders' underlying valuations. We show that the equilibrium inverse bid functions in each round of the auction are implicitly defined (pointwise) by a system of nonlinear equations, so that conditions for the existence and uniqueness of an increasing-strategy equilibrium are essentially identical to those which ensure a unique and increasing solution to the system of equations. We exploit the computational tractability of this characterization in order to develop an econometric model, thus extending the literature on structural estimation of auction models. Finally, an empirical example illustrates how equilibrium learning affects bidding during the course of the auction.

JEL classification: C51; D44; D82; L96

Keywords: Asymmetric auctions; Ascending (English) auctions; Simulation estimation

1. Introduction

We develop a framework for estimating structural models of asymmetric ascending (English) auctions. In these auctions, the bidding process is modeled as a multi-stage game in which bidders obtain more and more information during the course of the auctions as rivals drop out of the bidding. Equilibrium learning is a feature of these dynamic games, in contrast to static (first- or second-price) sealed-bid auctions which offer participants no opportunity to gain information during the course of the auction. In a common-value setting, information revelation during the auction reduces the effects of the winner's curse, thereby encouraging participants to bid more aggressively and

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raising expected seller revenue relative to a sealed-bid auction. Many real-world auction mechanisms—from art and collectible auctions to the Japanese "button" auction cited by Milgrom and Weber (1982, p. 1104)—resemble the auctions we study, and perhaps these mechanisms arose to allow for the possibility of information revelation.

The theoretical literature on ascending auctions (including the paradigmatic model presented in Milgrom and Weber (1982)) has focused primarily on symmetric models, in which the bidders' signals about the value of the object are assumed to be generated from identical distributions. However, recent applied research in auctions (e.g. work by Hendricks and Porter (1988) on offshore gas auctions, and by Klemperer (1998) on the PCS spectrum auctions) suggests that symmetry may not be a realistic assumption for many real-world situations. For these reasons, we develop an econometric framework for asymmetric ascending auctions which can be used in applied analyses.

We begin with a brief characterization of Bayesian–Nash equilibrium bidding behavior in asymmetric ascending auctions. This complements recent work (Maskin and Riley, 2000; Bulow et al., 1999; Bajari, 1998; Campo et al., 1998; Froeb et al., 2000) on asymmetric first-price auctions, and by Wilson (1998) and Maskin and Riley (2000) on asymmetric ascending auctions. We find that the increasing-strategy equilibrium bid functions in each round of an ascending auction exhibit an attractive analytic property: specifically, the *inverse bid functions* are implicitly defined by a system of nonlinear equations, pointwise in the bids. Therefore, conditions for the existence of an increasing-strategy equilibrium are essentially identical to those which ensure an increasing solution to the system of equations, given primitive model assumptions about the joint distribution of the bidders' underlying valuations and private signals.

This attractive analytic property also facilitates numerical calculation of the equilibrium bidding strategies, which makes the econometric implementation of these models feasible. This was recognized by Wilson (1998), who analytically derives the equilibrium bid functions for a log-additive log-normal asymmetric ascending auction model given a diffuse prior assumption on the distribution of the common value component. Following this cue, we develop an econometric model of the asymmetric ascending auction for this log-additive case which differs from Wilson's model in that we do not assume a diffuse prior for the common value distribution.[1] This extends the scope of the literature on the structural estimation of auction models (e.g. Paarsch, 1992; Laffont et al., 1995; Li et al., 2000) to asymmetric ascending auctions within the CV paradigm. Perhaps the closest antecedents of our work are papers by Donald et al. (1997) on bidding in simultaneous ascending auctions within the symmetric independent private values paradigm, and by Bajari and Hortacsu (1999) on bidding in symmetric common-value ascending auctions.

We provide an empirical illustration of this model by estimating it using data from the PCS spectrum auctions run by the U.S. Federal Communications Commission (FCC). While our model accommodates the multiple-round aspect of these auctions, it does not include other essential details, such as the simultaneous selling of multiple licenses, and the flexible eligibility rules. Therefore, we view the main purpose of this

[1] Furthermore, we show that the log-additive log-normal information structure satisfies a *diagonal dominance* condition which ensures the existence of an equilibrium in monotonic bidding strategies.