Bayesian Econometrics for Auction Models

Dong-Hyuk Kim
University of Arizona

Abstract

My research develops Bayesian methods to analyze data from auctions and produce policy recommendations for auction design. Specifically, I first propose a Bayesian decision method to choose a reserve price. For a given sample, this approach maximizes the seller's predictive revenue by considering the payoff structure and parameter uncertainty. Then, to analyze data from first price auctions, I develop a flexible method that fully exploits all the shape restrictions arising from economic theory, which may lead to more precise inference than current nonparametric methods. This method also provides a decision theoretic framework for auction design.

For choosing a reserve price, the previous literature estimates parameter values for a structural auction model and then uses the point estimates to infer the optimal reserve price. My first essay, "Auction Design Using Bayesian Methods," points out, however, that since the seller's payoff (expected revenue) function is generally not symmetric about the optimal reserve price, the seller can obtain a larger payoff by incorporating the payoff structure and parameter uncertainty into the decision procedure. To see this, consider a seller whose payoff increases slowly up to the optimal price, but then drops sharply thereafter. Then, the seller should avoid overestimation more than underestimation systematically taking into account the sampling error. For this purpose, I propose the Bayesian decision method that maximizes the seller's predictive payoff for a given sample by formally considering the payoff structure and parameter uncertainty. Monte Carlo experiments show that this Bayes rule is especially useful when the payoff is fairly asymmetric and there is a large amount of uncertainty (due to either small samples or flexible specifications).

For data analysis of first price auctions with affiliated private values, nonparametric indirect methods are widely used because they are fully flexible and computationally simple. However, these approaches are not well-suited to a formal decision framework. More importantly, since they do not fully consider the shape restrictions arising from economic theory, their inferences are often based on an estimated bid density that cannot be generated by an equilibrium. Addressing these issues, the essay, "Flexible Bayesian Analysis of First Price Auctions Using Simulated Likelihood," develops an empirical framework that satisfies all the theoretical shape conditions: bidding monotonicity and density affiliation. I directly parametrize the valuation density so that bidding monotonicity is automatically satisfied, and restrict the parameter space to rule out all the non-affiliated densities. My method uses a simulated likelihood to allow for a very flexible specification, but its posterior is exact for the chosen likelihood. This Bayesian framework allows for a formal decision analysis and controls the smoothness and tail behavior of the valuation density. I reanalyze a dataset of Outer Continental Shelf auctions that has been widely used. My approach chooses a much higher reserve price than the previous methods, suggesting the importance of the theoretical shape restrictions.