A Structural Model of Sponsored Search Advertising Auctions

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Abstract

Sponsored links that appear beside internet search results on the major search engines are sold using real-time auctions, where advertisers place standing bids that are entered in an auction each time a user types in a search query. The ranking of advertisements and the prices paid depend on advertiser bids as well as "quality scores" that are assigned for each advertisement and user query. Existing models assume that bids are customized for a single user query; however, in practice queries arrive more quickly than advertisers can change their bids, and advertisers cannot perfectly predict quality scores. This paper develops a new model where bids apply to many user queries, while the quality scores and the set of competing advertisements may vary from query to query. In contrast to existing models that ignore uncertainty, which produce multiplicity of equilibria, we provide sufficient conditions for existence and uniqueness of equilibria. In addition, we propose a homotopy-based method for computing equilibria given advertiser valuations and the distribution of uncertainty.

We then propose a structural econometric model. With sufficient uncertainty in the environment, the valuations are point-identified, otherwise, we propose a bounds approach. We develop an estimator for bidder valuations, which we show is consistent and asymptotically normal, and we provide Monte Carlo analysis to assess the small sample properties of the estimator.

Finally, we apply the model to historical data for several keywords. Our model yields lower implied valuations and bidder profits than approaches that ignore uncertainty. Bidders have substantial strategic incentives to reduce their expressed demand in order to reduce the unit prices they pay in the auctions, and these incentives are asymmetric across bidders, leading to inefficient allocation. For the keywords we study, the auction mechanism used in practice is not only less efficient than a Vickrey auction, but it also raises less revenue.