Competing Demand-Side Intermediary Auctioneers in Online Advertising Exchanges

(Doctoral Consortium)

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ABSTRACT

We study the effects of competition among intermediary brokers that run local upstream auctions and participate at a central auction as bidders on behalf of their buyers. More specifically, we focus on the result of the choice of different mechanisms for the intermediaries on their profit, the central auctioneer's revenue and the buyers' surplus as well as the social welfare of all players both when the buyers are able to strategically select or not their intermediary broker. Our motivation stems from the area of online advertising with the introduction of ad exchanges, marketplaces that bring together buyers and sellers of advertising space and enable their trade by promoting the use of real-time auctions. However, our results are general and of relevance to the areas of procurement auctions with subcontracting, auctions with resale and auctions with colluding bidders.

Categories and Subject Descriptors

J.4 [**Social and Behavioral Sciences**]: Economics

General Terms

Economics, Theory

Keywords

Game Theory; Intermediary; Auction Theory; Ad Exchange; Competition

1. INTRODUCTION

The vast majority of publishers and online service providers on the web have online advertising as their main source of revenue. Only in the U.S., $ 37 billions [6] were spent in 2012 on advertising online. There are several categories of online advertising, however the dominant types comprise sponsored search and display advertising, i.e. text ads shown along with the organic results on search engine results and banner ads shown in any web page respectively. Auctions have been the dominant mechanism for trading sponsored search ads from the very beginning. In contrast, display ads were traditionally traded in bulk numbers, typically via exhaustive negotiations between the advertisers or publishers and specialized intermediaries, known as ad networks. The latter would try to balance their clients' demand and supply and, when this was not possible, they would contact other ad networks to send some of their demand or supply in excess. This created chains of intermediate ad networks that led to artificially increased prices and lack of transparency, with the ad networks taking a significant part of the surplus generated. Following the sponsored search paradigm, in order to deal with these issues and make use of the advanced targeting technologies, the first advertising exchanges [5] appeared in 2007. These are centralized marketplaces that enable the trade of online advertising space between buyers and sellers (or, most commonly, their brokers) with the use of real-time auctions.

Supply- and demand-side intermediary brokers constitute two of the most important players of these marketplaces, providing the technical infrastructure, tools and points of entrance to the ad exchanges, executing orders on behalf of their customers. The author's thesis focuses on the demand-side intermediaries, known as *demand-side platforms* (DSPs). These intermediaries have to submit a bid for each available impression in an ad exchange when typically tens or hundreds of advertisers are interested in the same impression. The most widespread mechanism for resolving this issue is to run a local internal auction that decides which bid to forward at the exchange, making a profit by keeping the difference between the local winning price in their market and the price paid at the exchange when they win at the exchange's auction. The fact that DSPs act both as auctioneers and bidders make the design of their auction extremely challenging. At the same time, the introduction of these intermediaries influence in a variety of ways the design of the auction for the exchange, as they essentially operate as bidding rings [4].

2. THESIS OBJECTIVE

The objective of this thesis is the analysis of the currently widespread use of auction mechanisms for the exchanges and the demand-side intermediaries as well as the design of new, appropriate mechanisms. This complex system of two-level auctions makes such a design and analysis quite challenging. More specifically, intermediaries have to design their mechanisms taking in consideration the respective design of their opponents so that they attract enough advertisers to maintain a sufficient level of profit, often balancing the trade-off of immediate versus long-term goals. Similarly, advertisers

Appears in: *Alessio Lomuscio, Paul Scerri, Ana Bazzan, and Michael Huhns (eds.), Proceedings of the 13th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2014), May 5-9, 2014, Paris, France.*

have to strategically decide which intermediary to select for their trades and the amount of bid to submit after considering the intermediaries' mechanisms and the corresponding decisions by competing advertisers. Finally, it is the exchanges' responsibility to select a mechanism that takes into account the existence of the intermediaries and promotes efficiency while at the same time guarantees enough revenue.

3. RELATED WORK

The most relevant to the current work is the paper by Feldman et al. [2] whose model forms the basis of the author's thesis. In this work, the authors focus on the design of dominant-strategy incentive-compatible and profit (revenue for the exchange) maximizing mechanisms for the intermediaries and the exchanges in a single-item, single-exchange setting where each intermediary has only a single advertiser that is captive (i.e. cannot move to another intermediary) in its market.

Our work is also relevant to the literature on competing auctions [1] that study the auction selection problem of bidders and the design of auctions whose auctioneers take this strategic selection into account when they design their mechanisms.

Finally, our work is related to the area of auctions with resale [3], where bidders participate at a central auction with the aim of reselling the item won, as well as to the field of procurement auctions with subcontractors [10], where large companies (called the contractors) participate in auctions and share the project with smaller companies, called the subcontractors.

4. CONTRIBUTIONS

The first part of our work until now has focused on the intermediary selection problem faced by the advertisers in a single-item single-exchange setting with two intermediaries, where each intermediary offers a Vickrey auction with a reserve price. The latter prices act as signals that the advertisers have to take into account along with their valuation and information about their opponent advertisers to select one of the two intermediaries. We have first studied this problem in a complete information setting where we have shown that this is a three-player game with a complex equilibrium strategy [7]. Moreover, in this scenario, we have shown that there is a symmetric subgame-perfect equilibrium for the intermediaries where they impose reserve prices equal to the second-highest valuation of the advertisers. Then, we have studied the same problem in a Bayesian setting, where we have shown that advertisers always select the low-reserve intermediary when the reserve prices are sufficiently different but otherwise follow a unique but complex symmetric mixed Bayes-Nash equilibrium intermediary selection strategy [8].

In the second part of our work, we have studied the revenue and efficiency effects of the intermediaries' choice of mechanism in a single-item setting [9]. More specifically, we have considered three commonly-used mechanisms for the intermediaries, namely a first-price sealed-bid auction and two variations of the Vickrey auction that we term *pre-* and *post-award* Vickrey auctions. We have shown that pre-award Vickrey auctions are less efficient than the other mechanisms and that the revenue/profit is not the same for the exchange and the intermediaries respectively for different mechanisms. Finally, we have shown that the optimal reserve price of the center (even when there is lack of competition between intermediaries) depends on the number of advertisers and/or intermediaries.

5. FUTURE RESEARCH

For future work, one of the most important questions we would like to answer is whether there is some mechanism that always performs better for the intermediaries when advertisers can act strategically on their selection of one ore more intermediaries and, if yes, how does this effect the exchange, i.e. what is a good mechanism for an exchange after knowing the mechanism that intermediaries might use. Moreover, all previous results are only for a single item. However, in reality billions of such auctions are conducted every day and advertisers usually set budgets. Hence, we would like to study the effects of budgets and repetition of auctions in the aforementioned design of mechanisms. Finally, one important issue in this market is the asymmetry of information. One of the most crucial roles of demand-side intermediaries is to provide additional information about each individual impression, such as first- or third-party data for the user and the publisher that are usually used to determine their advertisers' valuations for that impression. We would hence like to study the effect of this asymmetry in the advertisers' selection of DSPs and, consequently, the latter's profit.

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