Abstract: With the abundance of online big data and computing resources, as well as the rapid development and diversification of business models, programmatic advertising (PA) has emerged and become the mainstream and one of the most promising advertising channels in recent years. As an effective way to precision marketing, PA relies heavily on the information elicited from analyzing Web users and pages, which can help advertisers precisely identify their best-matched audiences and evaluate the ad impressions in a real-time fashion. In PA markets, publishers serve as the supplier of ad impressions, and have control on whether, what and how to reveal such key information to advertisers. These decisions play a central role in the information structure of data-driven PA markets, and attract intensive research interests. In this paper, we strive to investigate publishers’ rational preference over the symmetric and asymmetric information structures, with the aim of maximizing their revenues. Our model views publishers’ revenue as a function of the information structure among advertisers, and we hereby prove its convexity under an incentive compatible mechanism. This conclusion indicates that publishers prefer an asymmetric information structure rather than a symmetric one. Our research findings can help improve publishers’ revenue, and also can explain the underlying rationale for the hybrid PA markets mixed by public real-time bidding and private marketplaces.

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both the users and their own landing pages (Eső & Szentes, 2007). Once ad impressions arrive, publishers will elicit the useful information and make decisions on how much information will be revealed to individual advertisers when choosing the advertising channel, i.e., RTB or PMP, resulting in the corresponding information structures that describe how accurately advertisers formulate their private valuations by observing a signal (Hagedorn, 2009). As such, information structure can determine advertisers’ evaluation of ad impressions, their bidding strategies, and in turn publishers’ revenues (Hagedorn, 2009, and Bergemann & Pesendorfer, 2007). If publishers choose a single advertising channel of either RTB or PMP to sell the ad impressions, a symmetric information structure will be formed and the same information will be passed to all advertisers. On the contrary, if publishers use a hybrid advertising channel with both RTB and PMP, an asymmetric information structure occurs with different granularity of information passed to all advertisers. From the viewpoint of publishers, they prefer to allocate sufficient information to identify the advertiser with the highest valuation (Bergemann & Wambach, 2015), and their objective is to maximize revenue which is a function of advertisers’ information structures. As such, information structure is considered as a critical and challenging decision for publishers.

After publishers make their decision on the information structure, advertisers will submit their bids according to a specific auction mechanism, which determines advertisers’ probability of winning the ad impression and their monetary transfer to publishers. In the optimal mechanism of information revelation, each losing bidder will know his true valuation, while the winner only knows that his/her valuation is sufficiently high to win the auction. From a research perspective, many research efforts have been done to study the bidders’ instead of the auctioneer’s preferences over information in contractual relationships or auctions (Cremer & Khalil F, 1998; Persico, 2000; Athey & Levin, 2001). Generally speaking, an advertiser’s bid is affected by his/her valuation based on privately received information, and meanwhile, the bid of an ad impression is also a signal of its value (Ghosh et al., 2009). Advertisers can also adjust the bids based on the performance distribution in previous auctions (Lee et al., 2013) besides the received information. Cui et al. (2011) investigated the real-time prediction of the bid distribution for the RTB advertising campaign, since there is no accurate prior information for advertisers’ reference.

In PA markets, information-related topic is mainly studied as an important underlying problem in such research branches as auction mechanism design and bidding strategy optimization. Specially, in literature, research efforts on information structure are still far from enough. Gomes & Mirrokni (2014) studied the optimal mechanism design in settings plagued by competition and two-sided asymmetric information regarding the valuations of buyers, as well as the seller’s opportunity cost for the Ad Exchange. In the research of Liu & Viswanathan (2014), they highlighted the role of pricing schemes as a means of leveraging private information available to providers and advertisers.

Most of the above research efforts formulate the environment in PA markets with a single advertising channel or a specific information structure. However, the bidding scheme and revenue optimization under different information structures are essentially different in PA practice, which poses great challenges for publishers to assign information structure to individual advertisers. For instance, symmetric information structure gives equal information to all advertisers, and may result in averaged bids of both high-quality and low-quality ad impressions from advertisers, and in turn averaged revenues for publishers; On the contrary, an asymmetric information structure makes some advertiser more perfectly informed and others only roughly informed, which may lead to more revenues from high-quality ad impressions and less from low-quality ones. From the perspective of PA market practice, the information structure will not only affect the publishers’ revenues, but also in a system level plays a key role in improving the accuracy and performance of the PA advertising ecosystems. Therefore, there is a critical need to study the information structure problem emerged in PA markets.

Our research is targeted at studying publisher’s optimal decision on information structure to maximize their revenues. We establish a model to investigate the information structure related to quality information of the ad impression in PA market, explicitly considering that the information of target audiences is symmetric for all advertisers due to the attribute of precision targeting. We consider the publisher’s payment transferred from advertisers is maximized under the advertisers’ information structures. Then, we identify several important properties of the model and draw useful conclusions to support the publisher’s decision on information structures.

The remainder of this paper is organized as follows. In Section 2, we briefly state our research problem related to information structure in PA markets, establish a model under a direct revelation mechanism, and prove the important properties. Section 3 discusses the management insights of our research. Section 4 concludes.

2. THE MODEL

2.1 Problem Statement

Once a user visits a publisher’s Webpage, an ad impression is triggered, and the publisher will then forward the information behind the impression (especially information of the user and Webpage) to competing advertisers via intermediating platforms including an ad exchange (AdX) and multiple demand-side platforms (DSP). We consider two kinds of information, i.e., user (or audience) information denoted by $u$ and quality information of ad impression in the Web pages denoted by $q$. The former typically refers to user profiles (e.g., age, gender, intention, etc) elicited from the Web cookie data, while the latter includes URLs, Web context, ad slots, ad sizes and so on. In PA markets, advertisers rely on audience information to identify the best-matched audience and its corresponding ad impressions. As such, audience information can serve as the basis of the more fine-grained “impression-level buying” sale model in PA. On the contrary, quality information does not influence the audience-advertiser matching, but has a significant impact on advertisers’ valuations, and thus their bids of the ad impressions.
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