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Sponsored-Link Auction and Market Segmentation in Two-Sided Markets

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Abstract: This paper investigates how the sponsored-link auction for multiple positions influence the market structure under a duopoly setting. We utilize a model of position auction with consumer search in a duopoly setting and derive the consumer distribution, advertiser bidding, and market equilibrium in this game. We discover that there exists a segmentation equilibrium, in which a platform consists of high and low quality advertisers and consumers, while the other is composed of medium quality agents. The results regarding the agents' distribution could bring valuable insights for regulatory policies about interactions and cooperation between large digital platforms.

Keywords: Sponsored-link auction, Digital Advertising, Consumer Search, Duopoly, Market Structure

1. Introduction

Our paper mainly examines the phenomenon regarding platform auctioning advertisement positions to advertisers in a two-platform scenario. This practice is most prevalent in digital platforms. For example, when searching on Google or Amazon, there will always be sponsored advertisements that come before many other relevant search results. For consumers, this could appear somehow annoying. However, this will still happen even to the consumer's dismay since advertisers have paid the platforms to display their links at a high position.

There have been several previous pieces of literature investigating the equilibrium condition of a certain type of auction implemented by the platform, namely a general second-price auction. However, to our best knowledge, none of this literature has investigated the market effect of sponsored-link auctions and how it could influence the advertisers' and consumers' distribution when there are two platforms. This could be an important topic since we do not currently fully comprehend the market effects when platforms collaborate when it comes to sponsored-link auctions. By providing some insights into the market structure caused by the auction, we aim to provide useful ideas to help policymakers in refining their focus and policy when dealing with multiple platforms conducting sponsored-link auctions.

Our paper provided insights into the agents' distribution in a duopoly setting and we also took consumers' searching behavior into consideration. We modeled the situation as a duopoly model with consumer search and a general second-price auction. We utilized a Perfect Bayesian Equilibrium as our solution concept and solved it using backward induction. Our main result was that except from a general symmetric equilibrium that both advertisers and consumers distribute equally on both

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platforms caused by the auction, we also found that there exists a segmentation equilibrium where high and low-quality consumers and advertisers will search on the same platform, while medium-quality advertisers and consumers search on another platform.

Our results could advise policymakers in focusing on potentially increasing inner platform diversity considering the presence of a sponsored-link auction since a symmetrically distributed market could be more efficient than a segmented market in some situations. Moreover, the exchange of advertiser and consumer private information between platforms could be especially harmful to advertisers and consumers, which should be tightly restricted. Overall, our paper provided some new insights into the market structure of a duopoly under the circumstance where there are a generalized second price auction and consumer search involved.

2. Literature Review

2.1. Auction Design

Our paper relates to some of the aspects of the current studies regarding auction design in two-sided markets. Athey and Ellison relates the closest to our paper [1]. They also present a model on sponsored-link auction with consumer search, in which they investigated the consumer search behaviors, equilibrium in the bidding game, and welfare benefits in a single platform scenario. Our paper extends their position auction model and analyze it in a two-platform scenario, which we focus more on the auction's and consumer's implication on the two-sided market structure. Our work also connects to papers examining the optimal auctions on digital platform. Gomes applied a similar setting that advertiser position values depend on searchers' expectations and analyzed the revenue-maximizing auction for the platform [2]. Although they found that a revenue-maximizing auction in this setting is a scoring auction, we still put our focus on a generalized second price auction since it is currently most commonly used by digital platforms. They also analyzed a duopoly scenario when implementing a certain scoring auction and focused on competition between platforms.

Our work differs in that we analyzed the optimal behavior of advertisers and consumers considering consumer search cost, and we provided more insights on how advertisers' distribution could influence the consumer search process. Our paper also goes beyond their work since we considered where platforms post multiple advertising positions rather than only posting one. Some papers also explored related topics. Xu, Chen, and Whinston proposed a similar model and investigated how product pricing influenced the bidding process [3]. Best to our knowledge, we found that none of these related literatures paid attention to sponsored-link auction's influence on the two-sided market structure as we did.

2.2. Platform Competition

Our content is also in the direction of literature regarding platform competition in two-sided markets. We have drawn great inspiration from Karle et al. [4]. They discussed how the degree of competition in the product market could influence the market composition. Their major discovery was that when there is high product market competition, sellers go to other platforms to avoid intense competition, which causes a market segmentation of many different platforms. Conversely, if product market competition is low, sellers stay on one platform and a market agglomeration occurs. We have also constructed a model examining how consumer and advertiser behavior influenced the market structure under a duopoly setting.

However, our model focuses more on the impact of sponsored-link auctions on the two-sided market structure, which is mainly due to advertisers expecting consumers to exhibit a searching behavior that they unevenly distribute among the two platforms caused by having varying search costs, and eventually advertisers and consumer both distribute optimally among the two platforms based on

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advertiser's quality and consumer's search cost. Although we did not explicitly consider the inherent platform competition and product pricing by advertisers, we are still able to derive meaningful results, without resorting to product pricing, regarding on how a position auction could influence the agents' market distribution. There are also several papers that guided the development of literature regarding two-sided markets. Caillaud and Jullien studied price competition between intermediate service providers and explored market equilibrium in the presence of indirect network externalities [5]. Rochet and Tirole explored payment cards and introduced a more refined two-sided market structure by using platform usage and membership charges [6]. Armstrong examined competition in two-sided markets and provided insights on the platform's equilibrium prices under different competing situations [7]. Jullien studied a Stackelberg price competition, which platforms will implement a divide and conquer strategy, and examined the optimal strategy taken by the leading and following platforms [8]. Our work contributes the most to these existing literature by presenting ideas on how sponsored-link auction in two-sided markets could shape the advertisers' and consumers' distribution, and the market structure in a duopoly setting.

2.3. Consumer Search

Lastly, our paper also ties with literature regarding the consumer search process in two-sided markets. De Corniere created a model on consumer search with a targeting mechanism and found that it brings consumer efficiency gains, but a monopoly platform tends to provide the consumer with an inferior matching quality, which this effect could be mitigated by platform competing with one another [9]. White provided a model that indicates a platform trade-off between attracting consumers and revenue earned from ads posted by advertisers [10]. Choi et al. considered an oligopoly model where consumer search sequentially and explored unique market equilibrium in this discrete-choice problem [11]. They also discovered that a reduction in search costs will drive-up market prices, since a reduction in search cost leads to an increase in consumer participation driving up the market price. Our work connects since we incorporated the consumer searching process into our model and specifically investigated on the case where consumer search cost is the dominant factor that influence consumer behaviors. Our paper filled in the gap where we considered searching process into both position auction and implicit competition in two-sided markets.

3. Analysis

In our research, we delved into the distribution of agents within a duopoly scenario while also accounting for consumers' search patterns. We approached the situation by constructing a duopoly model that incorporated consumer search and a general second-price auction [12]. Our solution concept was centered around a Perfect Bayesian Equilibrium, and we employed backward induction to successfully resolve it.

3.1. Model Setting

Our model included mathematical modeling utilizing game theory and setting different variables for each considered aspect in this game. For example, we modeled consumer search cost, advertiser's bidding price, quality of the advertiser, and the expected quality of the advertiser by the consumer. Also, since we constructed a duopoly model, there are two platforms, A and B, where each platform offers two sponsored-link positions.

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3.2. Consumer Search

According to our derivation of consumer decision based on the expected advertiser's quality, the model yields an interesting segmentation of digital platform in which both-high type and low-type consumers search on the same platform: the high-type prefers platform A because the expected quality of the firm link is higher than the consumer search cost and that's the only link they will search; In this case, consumer's search cost is so high that searching on lower quality platform B is not profitable. Consumer with a low search cost, only search on platform A because the conditional probability of meeting consumer's need, is so high that even when only adding a minimal amount of utility, derived from searching the lower quality link on platform A, platform A's combined utility is always greater than the combined utility of searching on platform B.

Intuitively, consumers with a medium search cost s < sj < ¯s search on platform B because they can search twice, both ¯qb1 and ¯qb2, which they can derive a higher combined conditional probability of meeting their needs than only searching on platform A for the first position, qa1 This sheds some insights into the observed real-world platform composition: there exist platforms with both high and low quality dispersion, such as Amazon, and platforms with more uniform product quality. The former platform attracts both sophisticated and unsophisticated consumers while the latter target a smaller range of medium typed consumers.

3.3. Advertiser Distribution

After analyzing consumer behavior based on their expected advertiser quality, we then analyze the possible advertiser distribution on platforms A or B based on their respective quality.

When assuming the consumers behavior is set as described, a high-quality advertiser would prefer to bid on platform A because they can capture the high type consumers on platform A. For a low-quality advertiser, they would also bid on platform A since no one will search them if they choose to bid on platform B. For a medium quality advertiser, they will choose to bid on platform B since they could capture more consumers than on platform A since there will be high search cost consumers on platform A that will not search any medium quality advertisements. Note that in our model setting, there are an infinite number of advertisers of q ~ [0, 1] choosing between two platforms. Therefore, when making the decision, advertisers neglect other advertisers' inherent quality. They only consider their own quality and the expected consumer behavior. Consequently, there will not be a case where medium quality advertisers choosing to bid on platform A because they know they have a higher quality than the low-quality advertisers bidding on platform A.

3.4. Advertiser's Revenue

The advertisers' revenue on each platform are composed sum of the probability of the advertiser being the second position times the expected payoff of the second position and the same product when the advertiser is in the first position. When we calculate the expected payoff of advertisers on each platform, we take the number of clicks on each platform and times that with the per-click profit they receive. Note that the number of clicks is the product of the expected probability of all previous clicks of the consumers are unsuccessful times the probability of consumer searching on this particular link.

3.5. Segmentation Equilibrium

We derived two cutoff lines for the different distribution of advertisers and consumers based on advertiser's quality and consumer search costs.

There is one cutoff line denoted by when certain consumer search cost equals to the quality of the second advertiser on platform B, and again equal to the expected quality consumers have for

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advertisers on the first position on platform B. The second cutoff line is when certain consumer search cost equals to the quality of the second advertiser on platform A, and again equal to the expected quality consumers have for advertisers on the first position on platform A, or is when a certain consumer search cost equal to the difference between the quality of the second advertiser on platform B and the quotient of the difference between the quality of the first position on platform A and the first position of platform B, and 1 minus the quality of the first position of platform B.

Our results provides a quantitative cutoff for certain consumer and advertiser distribution under a duopoly with the presence of a sponsored-link auction, and provided a more in depth understanding of the market effects of a sponsored-link auction.

4. Summary and Conclusion

Our paper discussed how could a sponsored-link auction with consumer search influence the market structure in a duopoly setting. Our base model consists of two equally efficient and competing platforms posting multiple positions for advertisers to choose to bid on a platform. Consumer behavior is a major factor that we incorporated in our model and directs our results. We proposed that every consumer each has an independent search cost when clicked on a certain sponsored link. By utilizing backward induction, we derived several consumer sub-game equilibria when advertiser distribution is set. Then, we confirm the optimal advertiser behavior correlates with the consumer distribution, and thus establish a segmentation equilibrium for the market. This means that in a duopoly setting, a sponsored-link auction will induce high type advertisers and consumers to interact on a certain platform, while medium type advertisers and consumers will interact on another platform.

However, we did not place any considerations on two-sided market interactions into our model since we only want to focus on the market implication of sponsored-link auctions. Therefore, future research regarding this literature could investigate on a duopoly auction model with, for example, product pricing or network externalities in two-sided market. Moreover, detailed platform interactions could be scrutinized in future researches, for instance, investigating a sponsored search auction in an oligopoly setting where platform entry and strategy decisions are more important than consumer behaviors, might provide more insights on regulatory policies regarding cooperation between multiple platforms in online advertising.

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