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Online advertisement service pricing and an option contract

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ABSTRACT

For the Internet advertisement market, we consider a contract problem between advertisers and publishers. Among several ways of pricing online advertisements, the methods based on cost-per-impression (CPM) and cost-per-click (CPC) are the two most popular. The CPC fee is proportional to the click-through rate (CTR), which is uncertain and makes decisions of advertisers and publishers difficult. In this paper, we suggest a hybrid pricing scheme: advertisers pay the minimum of CPM and CPC fees by purchasing an option from publishers. To determine the option price, we consider a Nash bargaining game for negotiation between an advertiser and a publisher and provide the solution. Further, we show that such option contracts will help the advertiser avoid high cost and the publisher generate more revenue. The option contract will also improve the contract feasibility, compared to CPM and CPC.

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1. Introduction

Over the last decade, the Internet has emerged as an important medium for advertising. According to a recent report of the Interactive Advertising Bureau (2008), over $23 billion has been spent in the US market alone. For the first 14 years of Internet advertising history after it first was introduced in 1995, the market increased by more than 400% in terms of total revenue. In 2008, the Internet advertising market was the third largest in the US after only television channels (including national, local and cable stations) and newspapers. The American Press Institute (2009) reported that the Internet advertising market took only 13 years to reach $20 billion in revenue, while newspapers took 127 years in the US. Without doubt, the Internet is the fastest growing marketing medium in history.

The Interactive Advertising Bureau (2008) also reported that search-based keyword advertising achieved 45% in revenue share in 2008, while the second on the list was display banner advertising with a 20% revenue share. Retailers and financial service providers spent 22% and 13% of the total revenue, respectively, which were the top two expenditures in the market.

Although the marketing media have been growing very fast, there is still much confusion over how advertisement publishers (e.g., web content providers) should charge for and how advertisers (e.g., retailers) should pay for their advertisement campaigns. When the market was first introduced, the traditional cost-per-impression method was used. It charges a fixed cost for a given number of displays of banner ads. As the biggest online advertisers are retailers, the actual benefit of advertisement campaigns usually comes from visits of customers to and purchases from the website of advertisers. In such cases, the number of displays does not reflect the benefit of advertising. Many advertisers believe that it is not reasonable to pay for advertisements that generate no value.

As the number of clicks likely reflects advertising effects, later in the history of the Internet marketing, payment based on the number of clicks has become very popular. This method is called cost-per-click, or CPC, while the traditional method based on the number of display is often called cost-per-mille, or CPM (*mille* is a Latin word meaning thousand). The CPC is possible, because the exact number of clicks is trackable due to the nature of information technology (Hoffman and Novak 2000). The CPC is one of several performance-based payment methods. Among other such methods, the cost-per-action, or CPA method is popular. This is based on the number of observable actions, for example, purchases, subscriptions, membership registrations, etc. In 2008, CPC pricing and other performance-based pricing made up 57% of the total revenue, while CPM pricing made up 39%. The CPC pricing is particularly popular in search-based advertising, while the CPM pricing is popular in banner display advertising. The market for CPA pricing is not yet mature, because the number of actions is neither controllable nor tractable by the publisher.

In CPC contracts, the click-through rate (CTR), which is the ratio of the number of clicks to the number of displays, plays an important role. The advertiser receives more marginal benefit from advertising when the CTR is higher. Although in CPC contracts the

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advertiser pays an advertising fee based on the number of clicks, which potentially reflects the actual advertising benefit, there is a significant drawback in CPC pricing. Click-frauds, which do not lead to purchases or subscriptions, will increase the CTR drastically without contributing to the profit of the advertiser. Many CPC contract providing publishers and agencies maintain click-fraud detection systems, but there is no perfect detection technology. Even without considering click-frauds, the CTR is never known *a priori*, hence both publishers and advertisers will be uncertain about it. Lahaie et al. (2007) noted that CTR can fluctuate dramatically even over small periods of time. In practice, if the same advertisement has been displayed by the same publisher, the historical estimate of CTR is used, while a forecast is used when the advertisement is completely new.

As we noted earlier, different types of contract schemes have been invented to generate more revenues or extract more advertisers' interests from the publisher's perspective. However, among those contracts, an advertiser has to select only one of them. As mentioned, since one contract can be more beneficial than the others, the contract choice might be crucial to the publisher's revenue. For example, suppose that an advertiser selects a CPC contract before she advertises when she is uncertain about the CTR. After its ads appear, if the CTR turns out to be high, then the advertisers might wish she had contracted to use CPM instead, since this will cost less.

In this paper, we propose a risk management method to deal with the uncertainty about the CTR and analyze the potential of this method to increase the likelihood of contract agreement. As a way to hedge against risk, we consider an instrument for the minimum price guarantee for the advertiser, with which she can choose between the CPM and CPC pricing after the CTR is realized. Of course the advertiser will choose the minimum of the CPM and CPC fees. To earn this privilege, the advertiser must pay an additional fee. Obviously if the additional fee is too high, the advertiser will not consider making the contract with the minimum price guarantee. The additional fee will be determined by a negotiation between the advertiser and the publisher. We call this contract type with the minimum price guarantee an option contract and call the additional fee for the guarantee the option price, following the theory of financial options (Wilmott et al. 1993). To determine the option price, we use an approach that is risk-neutral to both contract parties based on our analysis of a Nash bargaining game (Nash 1950). Furthermore, we investigate the potential of the option contract as a new hybrid pricing scheme. We make an assumption that the advertisement effect depends only on the number of clicks, which is not restrictive when we consider that the largest group of advertisers is retailers. In summary, the research objective of this paper is to propose a novel contract, option, and then investigate the potential of the contract.

The paper is organized as follows. In Section 2, we review the literature regarding online advertisements involving CPM and CPC contracts. We also discuss option contracts that have been suggested in other service industries. We define the option contract and formulate the option pricing model with the other two popular pricing contracts in Section 3. We show that the option contract has a better possibility of contract agreement compared to the standalone CPM and CPC contracts in Section 4. We provide managerial insights from the option contract in Section 5, and study the problem numerically in Section 6. We conclude in Section 7.

2. Literature review

With the radical growth of the Internet, researchers have been giving new attention to the theoretical problems associated with online advertising. For instance, they have studied how to optimally schedule advertisements with limited resources (Adler et al. 2002, Dawande et al. 2003, Amiri and Menon 2006). These papers presented a way to maximize revenue of a web site owner from advertising by determining the optimal sequencing of advertisements. Another stream of research analyzes bidding mechanisms and finds equilibria in search engine auctions (Aggarwal et al. 2007, Feng et al. 2007, Varian 2007, Liu et al. in press). For example, Athey and Ellison (2009) built models considering consumer search behavior and then analyzed the resulting equilibria for the design of sponsored keyword auctions.

However, relatively few studies regarding different contract types have been reported in the literature. Mangani (2004) addressed optimal decision making between CPM and CPC advertisements when the publishers are price-takers in the display advertisement market and later Fjell (2009) revisited the same problem. Both articles consider a revenue maximization problem with a deterministic CTR. Kwon (in press) also studied a capacity allocation problem between CPM and CPC advertisements with stochastic page-view and CTR. Kumar and Sethi (2009) considered a dynamic pricing problem considering subscription and advertising and Roels and Fridgeirsdottir (2009) studied a dynamic optimal customer selection and display scheduling problem considering only CPM contracts. Fridgeirsdottir and Najafi-Asadolahi (2009a,b) also studied revenue management problems with CPM contracts. In contrast to these approaches that were developed for existing pricing schemes, we propose a novel option contract in this paper.

Our option contract, as noted earlier, has a similar concept to financial options, in particular, European call options (Wilmott et al. 1993). With a European call, the option holder can purchase an asset with the minimum of the exercise price and the current market price, *after* the asset price is realized at the expiration date. For the option contract to be agreed on, the option holder should pay a certain amount of money, namely the option price, in advance. Options are widely used and traded in financial markets by investors who want to hedge their risk. The analogy behind these financial options is very similar to the option contract proposed in this paper in the sense that an option holder has flexibility in contract selection. However, unlike the asset price in a European option, we do not assume that CTR follows a dynamic stochastic process.

Utilization of option products or contracts, as suggested in our paper, has been highlighted as a good marketing or operational strategy in some other service industries. For example, Gallego and Phillips (2004) suggested the use of options thinking in the airline industry. They viewed the airline company as having a right to assign customers who purchase a flexible option product to take another flight at the end of a given period of time. Then, they showed that the flexible products have the advantage of increasing overall demand and using capacity more efficiently. Similarly, Gallego et al. (2008) proposed a callable service product which can be used for capacity expansion when full fare demand exceeds available capacity. Levin et al. (2007) introduced an option model to support a price assurance policy in service revenue management area to extract demand from the market.

There are other studies that apply real option theory to IS or e-commerce area (Campbell 2002, Kumar 2004), but they are a little different from our paper in the sense that the real option theory is used to evaluate an investment. To our knowledge, no attention has been paid to an option contract for online advertisement, even though it can be used as a good tool to hedge risk. To fill this gap, we propose an option contract and analyze its potential. Our model is based on game-theoretic approach.

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