



Interfaces with Other Disciplines

Selecting optimal selling format of a product in B2C online auctions with boundedly rational customers

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ARTICLE INFO

Article history:

Received 3 August 2011

Accepted 1 October 2012

Available online 13 October 2012

Keywords:

E-commerce

Bounded rationality

Customer behavior

Online auctions

Revenue management

ABSTRACT

The advancement of Internet technology has enabled new formats for selling products in the B2C online auctions. At present, on the major online auction sites, there exist three popular selling formats, namely, the posted price, pure auction and buy-price auction formats. It is an important decision problem for a firm to select the most profitable format to sell its products through the Internet. The customer behavior is of course a crucial element of the decision process. To the best of our knowledge, most models available today assume that customers are perfectly rational. To better understand the decision process, in this paper, we incorporate the concept of bounded rationality into consideration. We first present a “behavior choice function” to characterize the behavior of the customers with bounded rationality. Then corresponding to each selling format, we construct a revenue model based on the bounded rationality for analysis. Finally, we conduct some elaborate computational experiments to investigate the performance of each revenue model for developing new managerial insights. Our computational results clearly demonstrate how the bounded rationality of customer behavior affects the choice of a preferable selling format for a B2C firm in an online auction.

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1. Introduction

In recent years, the pervasive spread of the high-speed Internet has led to a significant spurt in online trading. The business-to-consumer (B2C) online auction, along with the consumer-to-consumer (C2C) auction and business-to-business (B2B) auction, are the most popular manifestations of this trend (Bapna et al., 2003; Teich et al., 2004; Katehakis and Puranam, 2012). In fact, it can be argued that online auctions rank among the more successful uses of the Internet for commerce (Doukidis et al., 2008; Pinker et al., 2010). In the past, a product might be sold in a “posted price” format or a “pure auction” format. Recently, a new selling format, known as “buy-price auction”, has been introduced by several large online auction sites, including eBay.com, uBid.com and Bidz.com. The new format allows a customer (bidder) to immediately drop from an ongoing auction and purchase the item at a fixed buyout price set by the seller (or firm). Actually, both of eBay and uBid provide a buy-price auction besides the posted prices and pure auctions. Notice that there may exist some minor

difference in the implementations of the two sites—uBid offers a permanent buyout price (the buyout option remains until the end of the auction) whereas in eBay’s “Buy-It-Now” auctions, the buyout price is temporary (the buyout option disappears immediately after receiving the first bid above a predetermined price). The buyout features have become an important component of online auctions (Wang et al., 2008). More and more B2C firms regard the buy-price auction as an additional marketing channel complementing the posted price and pure auction formats (Pinker et al., 2010). This development also leads to an important and challenging decision problem for the firms to select a preferable selling format to sell a product through the Internet.

In a B2C online auction, the customer (bidder) behavior, a typology based on decisions that bidders have to make during an auction, makes a notable impact on the firm’s revenue (Ducarroz, 2007). In the research community, the significance of customer behavior has also been well recognized. But in most studies of online auctions, customers are assumed to behave in perfect rationality. This means each customer is a “perfect optimizer”, who always makes correct bidding decision to maximize his utility. Recently, this standard assumption of perfect rationality in online bidding behavior has been questioned by different authors in a variety of empirical settings. Particularly, Dholakia and Soltysinski (2001) report the evidence of “herd behavior bias,” and Kamins et al. (2004)

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find an effect of minimum bid on the final auction price. Furthermore, some fundamental aspects of customer's decision making, such as preference construction (Tversky and Kahneman, 1986), choice context (Bettman et al., 1998) and learning and expertise (Alba and Hutchinson, 1987), are likely to apply to auctions, as they do in regular purchase. These empirical studies indicate that it is hardly realistic to assume all individuals, especially the customers, are perfectly rational. Instead, customer behavior is always subject to psychological biases, heuristics or rules of thumb, and cognitive constraints. Shen and Su (2007) and Su (2008) collectively refer to this set of behavioral phenomena as the bounded rationality.

The above mentioned development leads to the following questions:

- (1) How the bounded rationality of customer behavior in the B2C online auctions can be characterized?
- (2) How will this bounded rationality of customer behavior impact on the selling firm's revenue?
- (3) Taking into account the bounded rationality of customer behavior, which selling format (posted price, pure auction and buy-price auction) is more favorable to a selling firm for a particular product to be sold online?

This paper first builds a revenue model for each of the three selling formats based on the perfect rationality assumption as a baseline study. Then a "behavior choice function" is proposed to model the bounded rationality of customer behavior in the B2C online auctions. Theoretical analysis and extensive computational experiments are conducted in hope to answer the three questions raised before.

The rest of the paper is organized as follows. Section 2 contains a literature review on the selling formats and the concept of bounded rationality. The detailed problem description, assumptions and notation are given in Section 3. Then, using the results of the baseline study under perfect rationality, a behavior choice function is proposed in Section 4 to characterize the bounded rationality of customer behavior. On this basis, the revenue model of each of the three selling formats, i.e., the posted price, pure auction and buy-price auction, are then carefully studied. Section 5 conducts an extensive computational experiment to shed new insights for the managers of a firm to select the most favorable selling format. The conclusion and future research are given in Section 6. All technical details and proofs are put in the Appendix.

2. Literature review

In this section, we review two streams of research in the existing literature that are related to our study. We start with examining the selling formats in revenue management, and followed by the concept of bounded rationality in behavioral operations management.

2.1. Multiple selling formats

Auctions have been extensively studied in the economics literature (see, e.g., Klemperer, 1999; Krishna, 2002). Traditionally, researchers focus on analyzing the auction mechanism itself. In most analyses, an auction is fully characterized by the factors of "how the bidder valuations are revealed" and "how the actual goods are allocated." The rapidly developed online auction has brought to the forefront a new set of managerial problems. Pinker et al. (2003) survey the current state of research on the specific problems faced in the design of online auctions.

Online auctions are receiving considerable attentions in a revenue management perspective. (Chen et al., 2011; Li and Kuo, 2011) There are a few interesting papers studying the problem of

selecting a better selling format between the posted price and online auction formats to maximize a firm's revenue. Wang (1993, 1998) considers the impact of the dispersion in the distribution of buyer's valuation on the choice between the posted price format and pure auction format for a firm to sell one unit of a product. It is demonstrated that the pure auction format is preferred when the buyer's valuation becomes more disperse. Vulcano et al. (2002) extend Wang's work (1993, 1998) by considering multiple units of a product to sell, and multiple buyers arrive randomly during a selling period. They point out that a wider dispersion of buyer's valuation and more buyers per period make the format of pure auction more favorable. Kultti (1999) compares the two selling formats of posted price and pure auction in a game-theoretic setting in which multiple sellers and buyers are involved. It is demonstrated in his setting the two selling formats are practically equivalent through the existence of Nash equilibrium with co-existence of the two formats. van Ryzin and Vulcano (2004) study a joint inventory-pricing decision problem for an auction over an infinite horizon. They compare the optimal design of pure auctions to that of posted prices to show that the auction format significantly outperforms the list price format, when the number of buyers per period is moderately large, the holding cost is relatively high, or there exists a great uncertainty in demand. However, all these studies do not consider the selling format of buy-price auction.

As a new selling format, buy-price auctions are becoming more popular in many major online auction sites. Some empirical and theoretical studies also shed new lights on why the addition of a buyout option may increase the seller's revenue under various circumstance (Budish and Takeyama, 2001; Matthews, 2004; Hidvégi et al., 2006; Reynolds and Wooder, 2009; Gallien and Gupta, 2007). Yet, there has been little work analyzing the optimal choice among the three selling formats of posted price, pure auction and buy-price auction, from a firm's perspective. More recently, Wang et al. (2008) discuss the impact of the temporary buyout option when there is a participation cost, and they demonstrate that this feature of premature ending with buyout price may outperform the selling formats of pure auction and posted price under certain conditions. Sun et al. (2010) further extend Wang et al.'s work (2008) with a permanent buyout option and a general distribution of customer valuation. They find that, in their setting, the structure of the customer optimal bidding strategy remains the same, but the seller's expected profit becomes different, which is consistent with Gallien and Gupta's finding (2007).

It should be noted that some existing literature discusses a similar problem in terms of "Dual Channel", where a firm (retailer) offers two selling formats (posted price and pure auction) simultaneously (see, e.g., Etzion et al., 2006; Caldentey and Vulcano, 2007; Su, 2008). In the "Dual Channel", it is still possible for a customer to buy a product after some other customers already bought certain units of that product at a fixed price or made bids for auctions. Nevertheless, in the buyout price option, a customer needs to consider the fact that the product would not be available if another customer already exercised the buyout option.

2.2. Bounded rationality

Behavioral operations management (BOM) deals with the human behavior, cognition and their impacts on the operating systems and processes (Gino and Pisano, 2008). It has been evolving into a recognized domain of research in the past few years. Different from the traditional operations management (OM), BOM emphasizes the enduring importance of human behavior in operations and suggests that people may significantly influence how the operating systems work, perform, and respond to management interventions. Although the importance of people has always been acknowledged, at least in principle, most OM studies are heavily

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