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Interfaces with Other Disciplines

The informational aspect of the group-buying mechanism

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ABSTRACT

This paper studies the group-buying mechanism from a dynamic perspective. We consider a seller that offers a product in the form of group buying (priced low but uncertain) and spot purchasing (priced high but guaranteed). In the case of group buying, the information associated with the number of participating customers is updated in the middle of the sale. Customers are assumed to be strategic with a time-dependent utility. In addition to choosing between spot purchasing and group buying, customers could choose to delay their decisions until the information update. We characterize the customer behavior within a rational expectations framework. We then consider the effect of information and demand dynamics. Our results show that whereas an improvement in information quality has a positive effect on customer surplus and the group-buying success rate, the effect of inter-temporal demand correlation is mixed. We also discuss the seller's profit maximization problem and derive the condition to be satisfied at the optimal group size.

1. Introduction

Group buying has emerged as a popular sales strategy in the new millennium. Also known as collective buying, it "offers products and services at significantly reduced prices on the condition that a minimum number of buyers would make the purchase."[1] Sellers usually offer group buying through third-party platform firms such as Groupon and LivingSocial.com. It is estimated that the total global group-buying market will reach nearly $4 billion by 2015.

The rationale behind the group-buying business model has attracted much interest (e.g., see Doukidis, Pramatari, & Lekakos, 2008, Dholakia, 2010, Edelman et al., 2012, Jing & Xie, 2011). One of the most distinctive features of the strategy is that group-buying customers receive products at a discount price *only if* the minimum number of the sales volume is reached. Due to this uncertainty, group buying could induce customer social interaction, which aligns the interests of participating customers with that of the seller (Jing & Xie, 2011). Group buying can therefore extract an effort from group-buying customers to help the seller boost its sales. Although it is debatable whether such an effort extraction is unique to group buying,[2] there is no doubt that the mutual influence among customers plays a key role in shaping the demand. Jing and Xie (2011) demonstrate this observation in a static setting, and we aim to study it in a dynamic framework. The shift from static to dynamic introduces some interesting problems. For example, in a dynamic setting, group buying must deal with inter-temporal demand shift, a condition further contingent on the information updated during its course (more specifically, the information that reveals the number of existing group-buying customers). The practical implications of this study have been confirmed by empirical work (Kauffman & Wang, 2001, 2002; Kauffman, Lai, & Ho, 2010a, Kauffman, Lai, & Lin, 2010b; Zhou, Xu, & Liao, 2013). The empirical work shows that group-buying demand is indeed influenced by customers' observation of the number of existing customers. In addition to discussing the effect of the information update, we also investigate the effectiveness of using group buying as a means for price discrimination. Due to the popularity of group-buying platforms such as Groupon and LivingSocial.com, sellers usually only pay attention to the advertising effect of group buying, and thus overlook that the strategy also serves the purpose of price discrimination. We study this overshadowed function of group buying and reveal the underlying tradeoff: On the one hand, sellers could make use of group buying to expand their customer bases; on the other hand, they do not want group buying to erode those high-margin customers who would otherwise purchase at a higher price in the spot sales.

To investigate how the mutual influence among group-buying customers takes effect in a *dynamic* way, we incorporate three key elements into our analysis: strategic customer behavior, information dynamics and demand dynamics. Strategic customer

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[1] Wikipedia, http://en.wikipedia.org/wiki/Group_buying/.

[2] The dynamic pricing strategy, for instance, may incorporate a dynamic diffusion among customers (Bass, 1969), which induces the seller to adopt a lower price at an early stage. This is one example of penetration pricing.

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behavior indicates that customers can shift their purchasing decisions inter-temporally. For instance, Kauffman and Wang (2001) observe that when the percentage of orders required to reach the next price drop is 25% or less, there is an average of 4.264 more orders per 3-hour time period (or 2.961 if limit orders are excluded). They refer to this as the *before-price drop effect* (BPDE) and provide a possible explanation: "When the numbers of orders needed are small enough to be within a potential buyer's perceived price threshold, the person will be more likely to act upon the expectation that the price will drop in the near future." Hence, to achieve information advantage, customers find it rational to delay their decisions. The informational concern brings out the second key element in our analysis: information dynamics. In this connection, we first consider a dichotomous-choice situation involving information revelation and then generalize our discussion to information quality. Our results show that information revelation or an improvement in information quality benefits customers and also increases the group-buying success rate. The third key element, i.e., demand dynamics, reveals how different inter-temporal realizations of demand affect customer behavior. Such dynamics are of interest because newly arrived customers choose whether to participate in the group buying based on the number of existing customers, thus offering a positive feedback. More specifically, in the case of group buying, the early influx of group-buying customers may induce more to follow, which accords with a positive-feedback pattern (see Shapiro & Varian, 1999). Nonetheless, we show that the effects of such positive feedback on customer surplus and group buying are both mixed. That is, positive feedback does not necessarily improve the customer surplus or the seller's profit. Positive feedback can work in two ways. First, it attracts more customers when the early demand realization is good. Second, when the early demand realization is bad, it works in the opposite way to depress future demand.[3] Hence, the overall effect is mixed.

We conduct our analysis using a two-period model. Two options, i.e., group buying and spot buying, are provided in each period at different prices. For the spot-buying option, delivery is made immediately, and for the group-buying option, delivery is scheduled at the end of the second period. There are two customer segments in each period, labelled as high-end and low-end. High-end customers can choose either option and shift their purchasing decisions inter-temporally. The number of low-end customers in each period is random, which makes delaying their decisions to wait for the information update at the beginning of the second period (i.e., the revelation of the number of existing group-buying customers) meaningful for the high-end customers, who arrive early. However, utility loss occurs due to the delay. All of the results obtained in the analysis are based on the assumption of rational expectations (RE), i.e., customers have a true belief in the group-buying success rate.

The remainder of this paper is organized as follows. In Section 2, we review the related literature and identify our contributions. In Section 3, we present the model setup and derive the main results of the general model. We differentiate the general model in Section 4 according to the information and demand dynamics and provide a discussion of seller-side optimization. We carry out the numerical studies in Section 5. We conclude the paper with a discussion of future research topics in Section 6.

2. Literature review

Our work adds to the substantial literature on strategic customer behavior in the context of operations management. When customers are strategic, they are able to shift their demands inter-temporally to maximize their payoffs. Strategic customers can be either backward (Popescu & Wu, 2007; Ahn, Gümüş, & Kaminsky, 2007, 2009) or forward looking (Su, 2007; Aviv & Pazgal, 2008; Elmaghraby, Gümüş, & Keskinocak, 2008; Liu & van Ryzin, 2008; Su & Zhang, 2008, 2009; Cachon & Swinney, 2009; Yin, Aviv, Pazgal, & Tang, 2009; Lai, Debo, & Sycara, 2010; Su, 2010; Liu & van Ryzin, 2011; Mersereau & Zhang, 2012). Backward-looking customers recall a seller's past actions, and forward-looking customers form beliefs about a seller's future actions. The beliefs of forward-looking customers are usually assumed to be equal to their true statistical values, i.e., they are REs, (Cachon & Swinney, 2009). In this work, we restrict our attention to forward-looking customers.

Most of the literature focuses on the effect of strategic customer behavior on conventional strategies such as dynamic pricing. Liu and van Ryzin (2008) study the markdown strategy in the presence of risk-averse strategic customers. To curb speculation, the seller manipulates the rationing risk to induce customers to purchase early at a higher price. They derive the optimal inventory decision and investigate its sensitivity to factors such as the degree of risk aversion. Aviv and Pazgal (2008) consider the markdown problem in a continuous-time setting. A seller switches to a discount price at a fixed time, and strategic customers who choose to wait face the rationing risk. Two pricing strategies are discussed: contingent and pre-announced. They derive the conditions satisfied at possible equilibria, show the superiority of the pre-announced pricing strategy and indicate that the omission of strategic customer behavior can incur a huge revenue loss. Su (2007) considers the optimal pricing policy in a continuous-time setting where customers have heterogenous valuation and degrees of patience. He shows that whether the seller adopts a markdown or markup policy depends on the correlation between the valuation and degree of patience. He also finds that the seller may benefit from customers' waiting behavior through an increased rationing risk. Elmaghraby et al. (2008) consider the optimal markdown problem based on two information cases: a complete information (CI) case, in which the seller knows all of the customers' valuations, and an incomplete information (IV) case, in which the seller's knowledge about each customer's valuation is drawn from some distribution. In the CI case, the optimal markdown strategy is a simple two-step markdown, and the buyers bid *all-or-nothing* at some step. In the IV case, while the latter result holds, the simple structure of the optimal markdown strategy is absent.

As the literature surveyed, we consider informational benefits in addition to the group-buying discount. Strategic customers form beliefs about the group-buying success rate. The *accuracy* of their beliefs improves temporally as more uncertainty is resolved. Hence, this information dynamic induces customers to delay their decisions until more information is available.

Our work also complements the growing research on group buying that uses analytical approaches. There are commonly two forms of group buying: dynamic-price and fixed-price.[4] The final realized price in dynamic-price group buying is contingent on the final number of participants. In general, the more participants there are, the lower the final price. Fixed-price group buying adopts a simpler form, in which the final group-buying price is known in advance. This form of group buying is successful as long as the number of participants exceeds the preset threshold. In terms of dynamic-price group buying, Chen, Chen, and Song (2002) consider group buying as an online bidding process where the final price depends on the number of successful bidders. They prove that there exists a weakly dominant strategy according to which each bidder should bid the highest permitted price below his/her true valuation

[3] A similar discussion regarding the chilling/warming effect of network externalities on product growth can be found in the marketing literature (Goldenberg, Libai, & Muller, 2010; Tellis, 2010).

[4] We thank an anonymous referee for suggesting this classification.