ISSN : 0974 - 7435 Volume 10 Issue 10

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(10), 2014 [4476-4483]

Group buying price mechanism based on transaction cost saving and customers' waiting-time

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ABSTRACT

Group buying is one of the major pricing mechanisms in which customers can buy goods in a low group rates due to a saving on transaction cost though they must wait for a certain time before they get the commodities. In this paper, a pricing mechanism is proposed to evaluate the impact of the waiting cost, competition, and the transaction cost saving on the profitability and efficiency of group buying. The results show that when a monopolistic seller operates a mixed channel, the seller will charge a relatively high individual price in the individual-buying channel to force most consumers to choose group buying and even close its individual-buying channel when the transaction cost saving of the group-buying channel compared with the individual channel is sufficiently high. The social welfares of mixed channels in monopolistic and duopolistic markets increase with the transaction costs saving and decrease with the level of time value. However, competition is good for social welfare when the level of time value is small enough or the cost saving is sufficiently high.

KEYWORDS

Group buying; Transaction costs saving; Customers' waiting-time.

INTRODUCTION

Due to the fierce competition and the development of e-commerce, many sellers offer a variety online purchasing to gain more revenues and online group buying (OGP)is one of the novel popular sales in recent years. Group buying is a mechanism that the sellers give a price discount to consumers when the purchase quantity exceeds a preset threshold and its difficulty is the aggregation of large purchasing group in early times. With the wide application of SNS and Microblog, consumers can be easily aggregated and form a group in a short time.

Under online group buying, because information technology plays an important role to drive the network externality and enable lower operation costs, consumers become more active in the price discovery processes and lead the purchasing group to reach a satisfactory price[1-3]. So online Group buying is one of the major pricing mechanisms in bulk, and the incentive for sellers to offer low group price in group buying channels comes from a saving on the transaction costs that may be variable to the group size.

While consumers have the advantage of getting goods at a lower group price via group buying, they also face the inconvenience for a group to be formed. People who participate in this kind of buying system are usually faced with uncertainty, waiting time, and risk issues, which are rarely seen in other e-retailing systems. Because formation costs increase with the number of consumers who join the purchasing group, most consumers would prefer purchasing from individual channels unless the group price is attractive enough for them. In this paper, we assume uncertainty risk can be transferred to time cost (i.e. the transaction will be completed but in delay) and use waiting time as the main formation cost. Li et al.[4] focus on bidders' waiting time in their pricing model. Waiting time is an inherent characteristic of the group-buying auction and can be very effective in customers' buying decision. Despite the existence of discounts in the group-buying, the waiting time may cause customers to prefer the fix-pricing system to the group-buying one. Therefore, Li et al. assume that all customers have a same value for the selling product and this value decreases according to the waiting time. According to this, they develop their pricing model in the monopolistic and duopolistic market. However, they consider a constant waiting time for all the participants in the auction, which is not the case in the real world most of the time, the waiting time could vary for each customer based on his entrance time in the auction.

Since the nature of group buying lowers transaction costs, the sellers operating group buying can utilize price difference as an incentive to gain more revenues. Group-buying models have two varieties: one is with a fixed price that is achieved only when enough consumers participate and the other is with a fixed time period to completion of an auction[1]. Here, we focus on the latter. In the current study, taking the varying waiting time into account, we focus on the pricing as a profit maximization tool and consider the scenario where sellers can sell the identical goods to consumers and develop a variety of pricing schemes, including an individual buying, a group buying, and a mixed strategy; subsequently, we discuss and compare them under monopolistic and duopolistic market structures.

THE PRIMARY PRICING MODEL IN MONOPOLISTIC MARKETS

In recent years, there have been several investigations done on online pricing systems[5,6,7,8,9]. However, very few works have been done on the pricing models of group-buying auction based on waiting cost[10,11]. For developing our primary pricing model, we first consider a monopolistic market and then extend our model to a duopolistic setting.

There are two ways for sellers to sell their goods: one is to sell single units by individual buying, whereas the other is to sell a large bundle of units by group buying. That is, each consumer can choose to buy the good from an individual-buying channel or join a purchasing group to buy the goods from a group-buying channel.

However, for group buying channel, seller has its own duration auction time and customers can buy the product for that specific duration. When the auction time for a product is finished, the product would not be available. The seller always defines a minimum quantity for the number of buying requests at the beginning of the auction and if the number of buying requests reaches that point during the auction. As a result, customers who want to buy from the group buying channel should face the waiting time, which could vary for each customer based on his entrance time in the auction. Continuous demand and customers' arrival time with uniform distribution are also considered, so in each time unit, just one customer enters the market and the interval between the customers' arrival to the market and his buying time is omitted[12,13]. The total number of consumers in a market is denoted as 1 and each consumer buys at most one unit of goods. Following prior study[14,15], we assume that consumers have homogenous valuation of v for the goods. While the setting is mainly for analytical convenience, it can be applied to some commodities on which the heterogeneity of individual valuation. We let p_I denote the individual price in an individual buying channel, and p_g as the group price in a group-buying channel with bundle size η_g (see TABLE 1 for a complete list of notations). A customer will buy from the group-buying seller when they are indifferent about which seller they should buy from. Customers face two different utility functions, which are as follows:

$$u_1 = v - p_I \quad \textit{if a customer chooses individual buyin} \tag{1}$$

$$u_2 = v - p_g - \beta(\tau - t) \quad \textit{if a customer chooses group buyin} \tag{2}$$

For a monopolistic market, we consider three types of channels that a monopolistic seller could offer: an individual-buying channel, a group-buying channel, and a mixed channel.

Individual-buying channel

If only an individual buying channel is provided, the utility of each consumer is $u_1 = v - p_I$,so the seller will set the individual price for a good to be $p_I^* = v$. Then all consumers buy the goods (i.e., $\eta_I = 1$) from individual channel. Therefore, the seller's profit is $\pi_m^{I*} = (v - c_I)$. All surplus of the consumers is extracted.

TABLE 1 : The symbols of the pricing models

Symbol	Description
v	The value each consumer receives if he/she does buy a good
p_I (p_g)	The individual price (group price)
β	The level of time value
τ	The time duration of the group-buying auction in a selling period.
c_I (c_g)	The unit cost of a good sold through an individual-buying (group-buying) channel
Δ	The transaction cost saving of the group buying channel compared with the individual channel
t	A customer's entrance time in the market.
u_i	the utility of a typical consumer i ($i = 1, 2$)
η_I (η_g)	The number of consumers in an individual-buying (a group-buying) channel
$s_I (s_g)$	The surplus in an individual-buying (a group-buying) channel
$\pi_m^I(\pi_m^g, \pi_m^{I+g})$	The profit of a monopolistic seller providing an individual-buying channel (a group-buying channel, a mixed channel)

$\pi_d^I(\pi_d^g)$	The profit of a seller providing an individual-buying channel (a group-buying channel) in a duopolistic market
$s_m^I(s_m^g)$	The social welfare of a monopolistic seller providing an individual-buying (a group-buying) channel
$s_m^{I+g}(s_d^{I+g})$	The social welfare of a monopolistic (duopolistic) seller providing a mixed channel

Group buying channel

If only a group buying channel is provided, the utility of each consumer is $u_2 = v - p_g - \beta(\tau - t)$,then the consumers with $u_2 \geq 0$ will buy the good, Hence, the customers who enter the market after time $t \leq \tau - (v - p_g)/\beta$ and before the ending time τ would prefer the buy the goods. Hence, the demand function of the group-buying channel is given by $\eta_g = \tau - t = (v - p_g)/\beta$. The seller's profit maximization problem is given by

$$\max_{p_g} \pi_m^g = (p_g - c_g)\eta_g = (p_g - (c_I - \Delta))(v - p_g)/\beta \quad \textbf{(3)}$$

Solving $\partial\pi_m^g / \partial p_g = 0$ yields the optimal group price, which is given by $p_g^* = (v + c_I - \Delta)/2$. Therefore, the demand and profit of the group-buying channel is given by

$$\eta_g^* = (v - c_I + \Delta)/2\beta \qquad \pi_m^{g*} = (v + \Delta - c_I)^2 / 4\beta \quad \textbf{(4)}$$

These results show that if the monopolistic seller only offers group buying, the group size will decrease with the value of time but increase with the value of goods.

Mixed channel

If both channels coexist in a market, each customer computes his buying utilities at his entrance time then he selects the seller that provides a better utility. The market-segmentation condition is given by $v - p_I = v - p_g - \beta(\tau - t)$. The indifference entrance time for the customer is $\hat{t} = \tau - (p_I - p_g)/\beta$. Therefore, the customers who enter the market after $\hat{t}$ but before the auction ending time τ would prefer the group buying and otherwise they would choose the individual channel as it demonstrates in Figure 1. The market shares of these two channels are $\eta_g = \tau - \hat{t}$, and $\eta_I = 1 - \eta_g = 1 - \tau + \hat{t}$. As a result, the demand functions of the individual-buying channel and group buying one are given by

$$\eta_I = 1 - (p_I - p_g)/\beta \qquad \eta_g = (p_I - p_g)/\beta \quad \textbf{(5)}$$

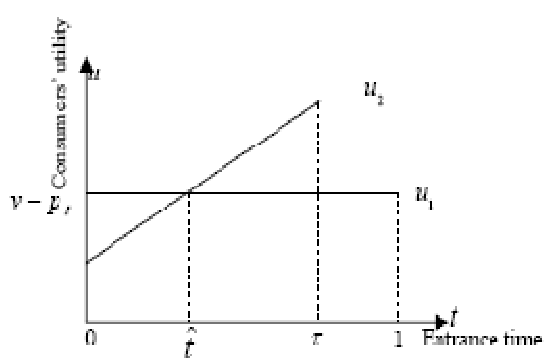

Figure 1 : The utility o the consumers in mixed channel

So the seller’s profit-maximizing problem is given by

$$\max_{p_I, pg} \pi_m^{I+g} = \pi_m^I + \pi_m^g = (p_I - c_I)(\beta - p_I + p_g)/\beta + (p_g - c_g)(p_I - p_g)/\beta \quad \textbf{(6)}$$

By checking first-order conditions, we find that $\partial\pi_m^{I+G}/\partial p_I = 1-(2p_I - 2p_G - \Delta)/\beta$ and $\partial\pi_m^{I+G}/\partial p_g = (2p_I - 2p_g - \Delta)/\beta$ can’t hold simultaneously. Therefore, by considering boundary conditions, $p_I^* = v$, solving formula (6) can yield $p_g^* = v - \Delta/2$.

Then, plugging the optimal price p_I^* and p_g^* into the demand function (5) and profit function (6) yields

$$\eta_I^* = 1 - \Delta/2\beta \qquad \eta_g^* = \Delta/2\beta \quad \textbf{(7)}$$

$$\pi_m^{I+g*} = v - c_I + \Delta^2/4\beta \quad \textbf{(8)}$$

Summarize the results of seller's three different sales strategy, the results are shown in TABLE 2.

TABLE 2 : The results of the pricing model

Item	individual buying channel	group buying channel	mixed channel	duopolistic channel
p_I^*	v	—	v	$(2\beta - \Delta + 3c_I)/3$
p_g^*	—	$(v + c_I - \Delta)/2$	$v - \Delta/2$	$(\beta - 2\Delta + 3c_I)/3$
π^{I+g*}	$v - c_I$	$(v + \Delta - c_I)^2/4\beta$	$v - c_I + \Delta^2/4\beta$	$(5\beta - 2\Delta + 2\Delta^2/\beta)/9$

Proposition 1 (Monopolistic market)

The mixed channel always dominates an individual-buying channel. If $\Delta > (-v + 4\beta + c_I)/2$ holds, then the monopolistic seller always generates more profit from the group buying channel than the other two channels; If $\Delta < (-v + 4\beta + c_I)/2$ holds, then the monopolistic seller always generates more profit from the mixed channel than the other pure channels, when $\Delta = (-v + 4\beta + c_I)/2$, the profits from group-buying channel is equal to that from the mixed channel.

Prove : Because $\pi_m^{g*} - \pi_m^{I*} = -v + (v + \Delta - c_I)^2/4\beta + c_I$

So when $\Delta > -v + c_I + 2\sqrt{v\beta - \beta c_1}$, $\pi_m^g > \pi_m^I$, $\pi_m^{g*} - \pi_m^{I+g*} = (v - c_1)(v - 4\beta + 2\Delta - c_I)/4\beta$

So when $\Delta > (-v + 4\beta + c_I)/2$, $\pi_m^{g*} > \pi_m^{I+g*}$ • because $(-v + 4\beta + c_I)/2 > -v + c_1 + 2\sqrt{v\beta - \beta c_I}$ holds, then When $\Delta > (-v + 4\beta + c_I)/2$, $\pi_m^{g*} > \max(\pi_m^{I*}, \pi_m^{I+g*})$ hold.

In addition, $\pi_m^{I+g*} - \pi_m^{I*} = \Delta^2/4\beta > 0$ holds without limitation. Because $\pi_m^{g*} - \pi_m^{I+g*} = (v - c_I)(v - 4\beta + 2\Delta - c_I)/4\beta$ When $\Delta < (-v + 4\beta + c_1)/2$, $\pi_m^{g*} < \pi_m^{I+g*}$ holds. So when $\Delta < (-v + 4\beta + c_1)/2$, $\pi_m^{I+g*} > \max(\pi_m^{I*}, \pi_m^{g*})$ hold.

Adding a group buying channel in the base of the individual channel to become a mixed channel is always superior to individual channel because the building and running costs of the group buying channel are not considered. We find that in the monopolistic market, the optimal bundle size of goods sold in a pure group-buying channel is larger than that in a mixed channel. Moreover, we find that the monopolistic seller would charge a relatively high individual price in the individual-buying channel to force most consumers to choose group buying. We also find that the monopolistic seller would close its individual-buying channel when the degree of reduction in transaction cost is sufficiently high because the saving of transaction cost in the group-buying channel dominates the additional benefit derived from offering an individual-buying channel. Also, because of the characteristics of a monopoly, the profit gained from the group-buying channel can be enhanced by reducing consumer's level of time value or decreasing the cost in group buying channel.

DUOPOLISTIC MARKETS

In this section, we extend the pricing model to a duopolistic market with two competitive sellers where one seller operates an individual-buying channel and the other operates a group buying channel. The demand functions of the individual-buying channel and group buying one are similar to section 2.3, so the individual seller's and group buying seller's profit-maximizing problem are given by

$$\max_{p_I, pg} \pi_d^I = (p_I - c_I)(1-(p_I - p_g)/\beta) \qquad \max_{p_I, pg} \pi_d^g = (p_g - (c_I - \Delta))(p_I - p_g)/\beta \tag{9}$$

Solving first-order conditions yields the optimal group price, which is given by

$$p_I^* = (2\beta - \Delta + 3c_I)/3 \qquad p_g^* = (\beta - 2\Delta + 3c_I)/3 \tag{10}$$

Plug the price in formula (9), then the optimal profits of the individual seller and the group buying seller would be:

$$\pi_d^{I*} = (-2\beta + \Delta)^2 / 9\beta \qquad \pi_d^{g*} = (\beta + \Delta)^2 / 9\beta \tag{11}$$

So the total profit is:

$$\pi_d^{I+g*} = \pi_d^{I*} + \pi_d^{g*} = (5\beta - 2\Delta + 2\Delta^2/\beta)/9 \tag{12}$$

These results show that the incentive $p_I^* - p_g^* = (\beta + \Delta)/3$ increases with both the consumer's level of time value and the transaction cost savings.

Proposition 2 (Duopolistic market)

(1) If one seller operates an individual-buying channel and the other operates a group-buying channel, both the prices increase with the level of β and decrease with the transaction cost saving Δ.

(2) The profit of the individual buying seller increase with the level of β, The profit of the group buying seller increase with the level of β when $\beta > \overline{\beta}$, and decreases with the level of β when $\beta < \overline{\beta}$,where $\overline{\beta} = \Delta$.

Prove: By first order condition, we have $\partial\pi_d^{g*}/\partial\beta = 1/9 - \Delta^2/9\beta^2$. Therefore we know that $\frac{\partial\pi_d^{g*}}{\partial\beta}\begin{cases} >0 & \beta > \overline{\beta} \\ \le 0 & \beta < \overline{\beta} \end{cases}$, where $\overline{\beta} = \Delta$.

If one seller operates an individual-buying channel and the other operates a group-buying channel, we have an interesting finding as follows. When the saving of transaction cost in the group-buying channel is sufficiently small, both sellers' profits increase with β. Intuitively, the profit of the sellers operating the individual-buying channel increases with the level of β; however, it is counterintuitive that the profit of the sellers operating the group-buying channel also increases with the level of β.

COMPARE THE SOCIAL WELFARE OF MIXED CHANNELS IN MONOPOLISTIC AND DUOPOLISTIC MARKETS

In this section, we analyze the social welfare of mixed channels in monopolistic and duopolistic markets. The social welfare of a market is defined as a summation involving sellers' profits and consumers' surplus, which is given by $s = \pi_I + \pi_g + s_I + s_g$.

Since all related analytic results were derived from section 2 and section 3, we can list the social welfare levels with respect to corresponding cases as follows.

A MONOPOLISTIC SELLER OPERATING A MIXED CHANNEL

Because $\pi_m^{I+g^*} = v - c_I + \Delta^2 / 4\beta$, $s_I = 0$, $s_g = \int_t^{\tau} (v - p_g - \beta(\tau - \xi) d\xi = \Delta^2 / 8\beta$

So $s_m^{I+g} = \pi_m^{I+g^*} + s_I + s_g = v - c_1 + 3\Delta^2 / 8\beta$

ONE SELLER OPERATING AN INDIVIDUAL-BUYING CHANNEL AND THE OTHER OPERATING A GROUP-BUYING CHANNEL

Because $s_I = (v - P_1)(1 - \alpha) = (2\beta - \Delta)(3v - 2\beta + \Delta - 3c_I) / 9\beta$

$$s_g = \int_{\tau - \frac{\beta+\Delta}{3\beta}}^{\tau} (v - p_g - \beta(\tau - \xi) d\xi = (\beta + \Delta)(2v - \beta + \Delta - 2c_I) / 6\beta$$

So $s_d^{I+g} = \pi_m^{I+g^*} + s_I + s_g = v - c_I + (-\beta + 4\Delta + 5\Delta^2 / \beta) / 18$

Thus, we make proposition 3 to highlight our findings from the above results.

Proposition 3

(1)The social welfares of a mixed channel in a monopolistic market and duopolistic market would increase with the transaction cost saving Δ and decrease with the level of time value β.

(2) When $\Delta > 2\beta / 7$, The social welfare of mixed channel in duopolistic markets is greater than that in monopolistic.

Prove: by first order condition, we can obtain proposition 3.

It is apparently that the social welfares in both mixed channels increase with the transaction cost saving, but when the transaction costs saving is sufficiently small, monopolistic market is efficiency than duopolistic market, so when the level of time value is small enough or the cost saving is sufficiently high, competition is good for social welfare.

CONCLUSIONS

Group-buying is a new business model in e-commerce. This kind of mode has several unique characteristics that distinguish it from other sales models. In this paper, the main focus is on the pricing mechanism in a monopolistic and duopolistic market. Customers' waiting time is an inherent attribute in group buying. In a monopolistic market, we find that group buying is mainly used to reduce transaction costs; however, in a competitive market, the function of group buying is not significant when multiple sellers operate the same channels. In addition, due to the effect of competition, we suggest that sellers operating group-buying services may register on third party websites and maintain a relatively high price because they can monitor their competitors easily. Our pricing model also shows that economies of scale can be instrumental in the success of the group-buying seller. According to the model, not only the group-buying sellers can predict their demands and define the price reduction point more accurately, they can also determine appropriate auction duration.

ACKNOWLEDGEMENTS

This paper was supported by “the key project of the National Social Science Fund”, No. 12AZD102;“Funding of Jiangsu Innovation Program for Graduate Education,the Fundamental Research Funds for the Central Universities”, No.CXLX12_0177.

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