A comparison of group-buying with fixed price mechanism under the effect of social media

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Abstract

With the development of mobile Internet and intelligent mobile, consumers spend more and more time on social media, which has caused the attention of the field of business and academic. Considering the impact of social media on consumer purchase behavior, this paper studies the selection and optimization of a seller's sales strategies. The results show that group-buying is optimal if two types of consumers have an information gap but have a great social interaction. Then, it further examines the problem of the selection and optimization of the seller's sales strategy when the seller uses its official social media to motivate consumers. To discover the effect of social media, the model with the official social media is compared with that without the official social media.

Keywords

Group-buying; fixed price; social media; optimal selling strategy.

1. Introduction

Group-buying, a e-commerce model that makes the same purchase intention of a product or service consumers together via the Internet, and apply for a low purchase price from the merchant. With the development of mobile Internet, the popularity of Smart Phones and OTO platform construction, group-buying has been widely accepted by merchants and customers in the e-commerce market. With the development of the Grouping Buying, it also attracts the attention of the academic community, which has studied the Group-buying from different perspectives. Many scholars compare group purchase and fixed price, and study the necessity and condition of group buying.

Chen, Chen and Song(2002) put the customer buying behavior as the online bidding process, and get the optimal price curve and product quantity curve when use the group-buying strategy, and gives the conditions when group-buying is superior to the fixed price. Anand and Aron put forward three conditions for group-buying over fixed price sales, and they are the coordination between requirement diversity, production scale and delay production. The optimal price is almost equivalent to the best fixed price, and only when the merchant considers the economies of scale and the business is the risk appetite group-buying is better than the fixed price (Chen, Chen and Song2007).If there is asymmetric information between customers, the information sharing is so high that group-buying is better than the fixed price (Jing and Xie2011). Researches show that when customers are independent, they are paid more for a fixed price. When there is information exchange between customers, group-buying is superior to fixed price (Reshef and Tyler2013). Based on the existing literature, this paper also compares the sales methods of group-buying and fixed price. In contrast to the existing literature, this paper considers the social media's influence on consumer buying behavior, including consumer personal social media and business official social media.

Empirical study found that the social benefit and economic incentives will affect consumers' behavior of sharing information. Businesses can use the price discount and the lowest limitation on the number of consumers of group-buying to let them share information with other customers to let more customers participate in group-buying, in order to improve the income (Thurau et al.2004).

Kankanhalli et al. (2005)studied the cost of customers to share information and the impact of information sharing from the perspective of knowledge sharing, and pointed out that it can encourage customers to share information with the group-buying price compensation to the customer to improve the business income. Whether or not a business openly participates in the group purchase process has a significant effect on the group purchase behavior of potential customers, which can be used to improve the benefits (Liang et al.2014).

Through the literatures, you can see that the uncertainty and asymmetry of information could suppress the customers' participation in group-buying intention and behavior and it can effectively motivate customers' buying behavior if open group-buying information and commodity information. In particular, with the development of social media, the aid of customer comments and share is helpful to the spread of high quality products and services and dispel the doubts of potential customers of uncertain information. Therefore, this paper intends to study the selection and optimization of the two types of sales methods in social media. The study of this article can answer the question: whether the merchant can incentive customers to exchange information with social media in different types of group-buying and then if the group-buying is always the best sales strategy? If not, then under what condition should the merchant choose group-buying?

Is it necessary for merchant to use official social media to motivate customers? At this point, what is the optimal sales strategy for the merchant? How do social media marketing effectiveness and cost, communication efficiency of different types of customers, valuation difference and other factors influence the selection and formulation of marketing strategies and sales strategies of merchants? Through the research of this paper, we hope to provide some theoretical reference of the social media influence for merchants to choose social marketing and sales methods.

2. Basic model

We assume the number of customers in the market is n . According to their estimates of goods, this article divides them into two categories. We consider two types of customers: n_1 customers with a high nonnegative product valuation $v_0 + v_i$; and n_2 customers with a low valuation v_0 . Here $n_1 + n_2 = n$, assume $\lambda = n_2 / n_1$, where v_i ($v_i \geq 0$)is the information gap between the two segments. The information gap among potential customers generally exists in practice for various reasons, such as consumer heterogeneity in searching for and absorbing product information.

In traditional channels, businesses often determine the price of a commodity based on the valuation of a high evaluator, because they cannot give consideration to the benefit of both the high appraiser and the low appraiser. If the merchant know the valuation $v_0 + v_i$ and v_0 , p_f means the price of a commodity at a fixed price, so $p_f = v_0 + v_i$. At this time, the quantity of commodity the merchant can sell is $n_1 = n/(1+\lambda)$. Profit from the sale of the goods at a fixed price is Π_f^* , $\Pi_f^* = n_1 p_f = n(v_0 + v_i)/(1+\lambda)$.

In recent years, with the rapid development of the Internet, group-buying has become a popular way of sales because of small profits but quick returns. Merchants can adopt this way of sales between the effective utilization of valuation and information differences, through the lowest price discount, coupon number factors motivate high appraisal to the low valuation transmission commodity information, to improve the low valuation, cognition and value of goods. Every time a user posts a message through social media, it receives attention from their friends and even comments. Every time a user receives a product message from a friend, he or she has more or less promoted the value of the product. In general, the high the number of goods received, the high the user's level of evaluation will be. The price of goods sold in group-buying p_g , so $p_g < p_f$.

It takes some time and energy for users in their own personal social media transmit commodity information or group-buying information with text, images or video, and reply to friends interested in the goods or group-buying. On the other hand, users' efforts will also affect their friends' promotion of commodity valuation. The high appraiser's efforts to persuade a low appraiser to take part in the

group-buying c_{fs}, know one high appraiser face the number of low appraiser is λ, therefore, each high appraiser's group purchase communication cost is λc_{fs}.Low appraisers obtain information and their valuation increases αc_{fs}, give the same effort level c_{fs}, the bigger αc_{fs}, the better the persuasion effect of the high appraiser, the greater the increase in the valuation of the low appraiser.

Customers who participate in group-buying cannot get the goods immediately, participating in group purchase for customers' waiting costs c_g. So, only when $v_0 + v_i - p_g - \lambda c_{fs} - c_g \geq 0$, high appraisers will participate group-buying. Homoplastically, at least when $v_0 + \alpha c_{fs} - p_g - c_g = 0$, low appraisers will participate group-buying. In addition, by the group-buying rules, the goods are sold only at the end of group-buying, and the goods need to be stored during the whole group purchase, the storage cost of the unit commodity c_h. For simplicity, assume $v_0 \geq 2(c_g + c_h)$. In fact, this assumption is also reasonable. After all, the cost of waiting costs and the storage cost of unit products are low relative to the customer value. Therefore, when the merchants sell the goods by group-buying, the biggest gain is:

$$\max_{p_g} \Pi_g = (n_1 + n_2)(p_g - c_h)$$

$$s.t. \begin{cases} v_0 + v_i - p_g - \lambda c_{fs} - c_g \geq 0 \\ v_0 + \alpha c_{fs} - p_g - c_g = 0 \end{cases}$$

From above we can see, the optimal level of effort for each high appraiser to persuade the low appraiser to participate in group-buying and the optimal group-buying price respectively are:

$$c_{fs}^* = \frac{1}{(\alpha + \lambda)} v_i \tag{1}$$

and

$$p_g^* = v_0 + \frac{\alpha}{(\alpha + \lambda)} v_i - c_g. \tag{2}$$

At this time, the profit that the businessman obtains from a group-buying is

$$\Pi_g^* = (n_1 + n_2)(p_g^* - c_h) = n\left(v_0 + \frac{\alpha}{(\alpha + \lambda)} v_i - c_g - c_h\right). \tag{3}$$

Take the derivative of λ in(1)-(3), we have

$$\frac{\partial c_{fs}^*}{\partial \lambda} = -\frac{1}{(\alpha + \lambda)^2} v_i < 0, \quad \frac{\partial p_g^*}{\partial \lambda} = -\frac{\alpha}{(\alpha + \lambda)^2} v_i < 0, \quad \frac{\partial \Pi_g^*}{\partial \lambda} = -\frac{n\alpha}{(\alpha + \lambda)^2} v_i < 0.$$

Therefore, when the number of customers is certain, with the increase of λ, namely the high appraiser has a smaller proportion of the total number of customers, and the lower appraiser becomes larger. The high valuation for low value each person to share the information with less, low valuation each person the valuation of the appreciation will also be reduced accordingly. The high appraiser shares less information with each of the low appraiser, and the valuation of each low appraiser has also decreased accordingly. At this point, in order to reach the bottom line of low appraiser, merchants have to reduce the price of group purchase. Accordingly, the profit that the businessman obtains will decrease accordingly.

We can know from (3),

$$\Pi_g^* - \Pi_f^* = n\left(\frac{\lambda}{1 + \lambda} v_0 + \frac{(\alpha - 1)\lambda}{(\alpha + \lambda)(1 + \lambda)} v_i - c_g - c_h\right). \tag{4}$$

Therefore, theorem 1 gives the choice between group-buying and fixed price as the conditions of optimal sales strategy. For simplicity, assume

$v_1 := \frac{(\alpha+\lambda)(1+\lambda)}{(\alpha-1)\lambda}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0\right)$.

Theorem 1. The choice of the best selling strategy between two types of customers depends mainly on the efficiency of communication α and the difference value of appraisal of goods v_i.

(1) $\alpha \geq 1$. If $\lambda \geq 1$, group-buying strategy is optimal; If $0 < \lambda < 1$, when $v_i > v_1$, group-buying strategy is optimal; otherwise, fixed price strategy is optimal.

(2) $0 < \alpha < 1$. When $v_i < v_1$, group-buying strategy is optimal; otherwise, fixed price strategy is optimal.

Demonstration. (1)When $\alpha \geq 1$, if $\lambda \geq 1$, have $\frac{1+\lambda}{\lambda} \leq 2$. From $v_0 > 2(c_g + c_h)$ know, $v_0 > \frac{1+\lambda}{\lambda}(c_g + c_h)$. So, $\Pi_g^* - \Pi_f^* > 0$ is obvious, group-buying strategy is optimal. If $0 < \lambda < 1$,so if $v_i > \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left[(c_g + c_h) - \frac{\lambda}{1+\lambda}v_0\right]$, $\Pi_g^* - \Pi_f^* > 0$; otherwise, $\Pi_g^* \leq \Pi_f^*$.

(2) When $0 < \alpha < 1$, get from (4), when $v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left[\frac{\lambda}{1+\lambda}v_0 - (c_g + c_h)\right]$, $\Pi_g^* > \Pi_f^*$; otherwise, $\Pi_g^* \leq \Pi_f^*$.

We can know from theorem 1, when two types of customers communicate more efficiently, the merchants adopt the group-buying method to gain more profit. Only when the high appraiser is more, and the value difference between the two types of customers is smaller, merchants can obtain more profit by adopting fixed price under the influence of group purchase cost. On the other hand, if two types of customers communicate less efficiently, high appraisals have little impact on the valuation of low appraisals through social media, so only if the two types of customers have a low valuation difference, the merchants can get more profit by using the group-buying strategy.

3. The best sales strategy for merchant using social media

In the previous section, we discussed the consumer's information about group-buying on personal social media, such as WeChat, QQ, etc. In reality, businesses will also use their official social media to post information to customers such as the information of the new products, the promotion information of the goods, and use its social media to serve customers. It is hoped that this will deepen the customer's understanding of its products from various aspects, and expand its market competitiveness. This section will study the selection and optimization of sales strategies for merchants using official social media to publish information on group-buying. The mathematical symbols and basic assumptions used in this section are the same as in the previous section.

In order to increase the customer's awareness of the commodity and raise the value of the goods, assume that the unit cost per customer is c_s when using social media. In general, the higher the cost per customer, the higher the customer satisfaction will be, and the higher the customer's value will be. Due to the valuation differences of the two types of customers with different initial information, so the merchants in the social media release of information to improve their cognition of the product range of ascension is not entirely different. $\eta_1 c_s$ and $\eta_2 c_s$ indicate that high appraisers and low appraisers raise the price of the product by the amount of marketing cost per customer. $\eta_i (i = 1,2)$ represents the level of motivation to consumer purchase behavior when using official social media. Bigger η_i is, the better the incentive for official social media is. Because the high appraiser has more product information, so this section assumes that official social media will have better incentives for low appraisers, that is $\eta_2 > \eta_1 > 1$. In addition, this article assumes that the new valuation of the high appraiser is still higher than that of the low appraiser due to the influence of the official social media.

p_{sf} and p_{sg} respectively represent the transaction price when the merchant uses fixed price and group-buying mode to sell goods, and Π_{sf} and Π_{sg} respectively represents the corresponding benefit. If a merchant sells goods in a fixed price, the optimal fixed price is the revaluation of a commodity after the impact of official social media, $p_{sf}^* = v_0 + v_i + \eta_1 c_s$. Thus, the profit that the merchant can obtain is

$$\Pi_{sf}^* = n_1 p_{sf}^* - nc_s = \frac{n}{1+\lambda}(v_0 + v_i + \eta_1 c_s) - nc_s \tag{5}$$

If merchants use official social media to publish information on their products, and use group-buying to sell goods, c_{is} is the cost of sharing information with low appraisers through individual social media. So, only when $v_0 + v_i + \eta_1 c_s - p_{sg} - \lambda c_{is} - c_g \geq 0$, high appraiser will participate in the group-buying activity. Influenced by the official social media and the high appraiser individual social media, only when the low appraiser's new appraisal of the commodity is not lower than the price of the group-buying price and the cost of participating in group-buying, that is $v_0 + \eta_2 c_s + \alpha c_{is} - p_{sg} - c_g = 0$, he will participate in group-buying. Similar to the previous calculation, we can get the optimal group-buying price and the optimal level of effort for high appraiser to convince the low appraiser:

$c_{is}^* = \frac{v_i - (\eta_2 - \eta_1)c_s}{\alpha + \lambda}$ and $p_{sg}^* = v_0 + \frac{\alpha}{\alpha+\lambda} v_i + \frac{\alpha\eta_1 + \lambda\eta_2}{\alpha+\lambda} c_s - c_g$.

At this time, the profit that the merchant obtains is

$$\Pi_{sg}^* = (n_1 + n_2)(p_{sg}^* - c_h) - nc_s = n\left(v_0 + \frac{\alpha}{\alpha+\lambda} v_i + \frac{\alpha\eta_1 + \lambda\eta_2}{\alpha+\lambda} c_s - c_g - c_h\right) - nc_s. \tag{6}$$

Take the derivative of λ, we have

$$\frac{\partial c_{is}^*}{\partial \lambda} = -\frac{v_i - (\eta_2 - \eta_1)c_{si}}{(\alpha+\lambda)^2} < 0, \quad \frac{\partial p_{sg}^*}{\partial \lambda} = -\frac{\alpha[v_i - (\eta_2 - \eta_1)c_{si}]}{(\alpha+\lambda)^2} < 0, \quad \frac{\partial \Pi_{sg}^*}{\partial \lambda} = -\frac{n\alpha[v_i - (\eta_2 - \eta_1)c_{si}]}{(\alpha+\lambda)^2} < 0.$$

As we can see from the above formula, when the total number of customers is fixed, λ is bigger, the smaller the ratio of the high appraiser in the total number of customers, the lower the level of effort the high appraiser will give to each low appraiser. As a result, the valuation of each low appraiser will be limited, and the price of its optimal group-buying will fall, thus reducing the gains for merchants. We can know from (5) and (6),

$$\Pi_{sg}^* - \Pi_{sf}^* = n\left(\frac{\lambda}{1+\lambda} v_0 + \frac{(\alpha-1)\lambda}{(\alpha+\lambda)(1+\lambda)} v_i + \frac{\lambda(\eta_2 - \eta_1) + \lambda(\alpha\eta_1 + \lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)} c_s - c_g - c_h\right) \tag{7}$$

assume

$\gamma_1 := \frac{\lambda(\eta_2 - \eta_1) + \lambda(\alpha\eta_1 + \lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}$ and $\gamma_2 := \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}$.

The following theorem shows the condition that the merchant chooses between fixed price and group-buying using the official social media to encourage consumers shopping behavior to achieve maximum profit.

Theorem 2. Merchant's optimal sales strategy is related to the communication efficiency α between the two types of customers, value difference v_i and incentive effect of official social media $\eta_i (i = 1,2)$ when using official social media to encourage the two types of consumers to buy.

(1) $\alpha \geq 1$. If $\lambda \geq 1$, group-buying strategy is optimal. If $0 < \lambda < 1$, when $v_i > v_1 - \gamma_1\gamma_2 c_s$, group-buying strategy is optimal; otherwise, fixed price strategy is optimal.

(2) $0 < \alpha < 1$. If $v_i < v_1 - \gamma_1\gamma_2 c_s$, group-buying strategy is optimal; otherwise, fixed price strategy is optimal.

Demonstration. (1) We can know from (7), if $\alpha \geq 1$, $\frac{(\alpha-1)\lambda}{(1+\lambda)(\alpha+\lambda)} \geq 0$. When $\lambda \geq 1$, because $v_0 > 2\left(c_g + c_h\right)$ so $v_0 \geq \frac{1+\lambda}{\lambda}\left(c_g + c_h - \gamma_1 c_s\right)$. Therefore, $\Pi_{sg}^* > \Pi_{sf}^*$. When $0 < \lambda < 1$, if $v_i > \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0 - \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right), \Pi_{sg}^* > \Pi_{sf}^*$; otherwise, $\Pi_{sg}^* \leq \Pi_{sf}^*$.

(2)When $0 < \alpha < 1$, we know from (7), when $v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{\lambda}{1+\lambda}v_0 - \left(c_g + c_h\right) + \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right)$, $\Pi_g^* > \Pi_f^*$; otherwise, $\Pi_g^* \leq \Pi_f^*$.

It can be seen that theorem 1 and 2 have many similarities. For example, if the two types of customer communication efficiency is very high, merchants can achieve maximum benefits using fixed price when low appraisers are larger than the high valuation appraisers. However, if the two types of customer communication efficiency is not high, businesses can gain more benefits through group-buying only when the value difference between the two types of customers is not very big.

Considering the merchants to create and maintain their social media takes a certain cost, we compare the merchant biggest profit under different conditions according to theorem 1 and 2 in this paper. We can get whether merchants use official social media and choose what way as the condition of the optimal sales strategy from theorem 3. If

$$\gamma_3 := \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}.$$

Theorem 3 . Merchant's optimal sales strategy hen using official social media to encourage the two types of consumers to buy. Whether the merchants use official social media motivate consumers to buy and use what way as the optimal sales strategy is related to the communication efficiency α between the two types of customers, value difference v_i, incentive effect of official social media η_i and the percentage of the high valuations λ.

(1) $\alpha \geq 1$. If $\lambda \geq 1$, merchants adopt official social media and group-buying strategy is optimal. If $0 < \lambda < 1$, (i) when $v_i \geq v_1$, merchants adopt official social media and group-buying strategy is optimal; (ii) when $v_1 - \gamma_1\gamma_2 c_s < v_i < v_1$, (a) if $\eta_1 > 1+\lambda$, merchants adopt official social media and group-buying strategy is optimal; (b) if $\eta_1 \leq 1+\lambda$, so when $v_1 - \gamma_2\gamma_3 c_s < v_i < v_1$, merchants adopt official social media and group-buying strategy is optimal; when $v_1 - \gamma_1\gamma_2 c_s < v_i < v_1 - \gamma_2\gamma_3 c_s$, merchants do not adopt official social media and fixed price strategy is optimal. (iii) when $v_i \leq v_1 - \gamma_1\gamma_2 c_s$, merchants adopt official social media and fixed price strategy is optimal.

(2) $0 < \alpha < 1$. (i) when $v_i < v_1$, merchants adopt official social media and group-buying strategy is optimal; (ii) when $v_1 < v_i < v_1 - \gamma_1\gamma_2 c_s$, (a) if $\eta_1 > 1+\lambda$, merchants adopt official social media and group-buying strategy is optimal; (b) if $\eta_1 \leq 1+\lambda$, so when $v_1 < v_i < v_1 - \gamma_2\gamma_3 c_s$, merchants adopt official social media and group-buying strategy is optimal; when $v_1 - \gamma_2\gamma_3 c_s \leq v_i \leq v_1 - \gamma_1\gamma_2 c_s$, merchants do not adopt official social media and fixed price strategy is optimal. (iii) when $v_i > v_1 - \gamma_1\gamma_2 c_s$ merchants adopt official social media and fixed price strategy is optimal.

Demonstration . (1) When $\alpha \geq 1$, if $\lambda > 1$, group-buying strategy is optimal no matter whether merchants adopting social media. Because

$$\Pi_{sg}^* - \Pi_g^* = \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha\lambda} n c_s > 0 \quad (8).$$

So, in this case merchants can gain more benefits when using its social media. If $0 < \lambda < 1$, One of the following three conditions will happen:

(i) when $v_i \geq \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0\right)$, we can know from theorem 1 and 2, group-buying strategy is optimal no matter whether merchants adopting social media. So we can know from (8), $\Pi_{sg}^* \geq \Pi_g^*$.

(ii) when $\frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0 - \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right) \leq v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{1+\lambda}{\lambda}v_0\right)$, we can know from theorem 1 and 2, fixed price strategy is optimal if merchants do not adopt official social media; grouping-buying strategy is optimal if merchants adopt official social media. So,

$$\Pi_{sg}^* - \Pi_f^* = n\left[\frac{\lambda}{1+\lambda}v_0 + \frac{\lambda(\alpha-1)}{(\alpha+\lambda)(1+\lambda)}v_i + \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}c_s - (c_g+c_h)\right] \quad (9)$$

Because $\frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)} - \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda} = \frac{(\alpha+\lambda)(1+\lambda-\eta_1)}{(\alpha+\lambda)(1+\lambda)}$, so when $\eta_1 > 1+\lambda$, (9) is greater than zero identically. At this time we have $\Pi_{sg}^* > \Pi_f^*$. Otherwise, when $\eta_1 \leq 1+\lambda$, under the circumstances, when $\frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0 - \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}c_s\right) \leq v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{1+\lambda}{\lambda}v_0\right)$, $\Pi_{sg}^* > \Pi_f^*$; when $\frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0 - \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right) \leq v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0 - \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}c_s\right)$, $\Pi_{sg}^* \leq \Pi_f^*$.

(iii) when $v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(\alpha-1)}\left(c_g + c_h - \frac{\lambda}{1+\lambda}v_0 - \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right)$, we can know from theorem 1 and 2, fixed priced strategy is optimal no matter whether merchants adopting social media, that is $\Pi_{sf}^* - \Pi_f^* = \frac{n}{1+\lambda}(\eta_1-1)c_s > 0$. At this time, merchants adopt official social media and fixed price strategy is optimal.

(2) when $0 < \alpha < 1$, we will have the following three condition according to the valuation difference in the two types of consumer:

(i) if $v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{\lambda}{1+\lambda}v_0 - c_g - c_h\right)$, we can know from theorem 1 and 2, group-buying strategy is optimal no matter whether merchants adopting social media. By the above prove to be seen, $\Pi_{sg}^* \geq \Pi_g^*$.

(ii) if $\frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{\lambda}{1+\lambda}v_0 - c_g - c_h\right) \leq v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{1+\lambda}{\lambda}v_0 - c_g - c_h + \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right)$, we can know from theorem 1 and 2, fixed price strategy is optimal if merchants do not adopt social media; group-buying strategy is optimal if merchants adopt social media. So, similar to the theorem proof of the first half section, we have

$$\Pi_{sg}^* - \Pi_f^* = n\left[\frac{\lambda}{1+\lambda}v_0 - \frac{\lambda(1-\alpha)}{(\alpha+\lambda)(1+\lambda)}v_i + \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}c_s - (c_g+c_h)\right]$$

Because $\frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)} - \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda} = \frac{(\alpha+\lambda)(1+\lambda-\eta_1)}{(\alpha+\lambda)(1+\lambda)}$, so when $\eta_1 > 1+\lambda$, the equation is less than zero. Here, we have $\Pi_{sg}^* > \Pi_f^*$. Otherwise, when $\eta_1 \leq 1+\lambda$ the equation is greater than zero. Under the circumstances,

when $\frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{\lambda}{1+\lambda}v_0 - c_g - c_h\right) \leq v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{1+\lambda}{\lambda}v_0 - c_g - c_h + \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}c_s\right)$, $\Pi_{sg}^* > \Pi_f^*$; when $\frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{\lambda}{1+\lambda}v_0 - c_g - c_h + \frac{\alpha(\eta_1-1)+\lambda(\eta_2-1)}{\alpha+\lambda}c_s\right) \leq v_i < \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{\lambda}{1+\lambda}v_0 - c_g - c_h + \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right)$. $\Pi_{sg}^* \leq \Pi_f^*$.

(iii) If $v_i \geq \frac{(\alpha+\lambda)(1+\lambda)}{\lambda(1-\alpha)}\left(\frac{1+\lambda}{\lambda}v_0 - c_g - c_h + \frac{\lambda(\eta_2-\eta_1)+\lambda(\alpha\eta_1+\lambda\eta_2)}{(\alpha+\lambda)(1+\lambda)}c_s\right)$, fixed price strategy is optimal no matter whether merchants adopting social media, that is $\Pi_{sf}^* - \Pi_f^* = \frac{n}{1+\lambda}(\eta_1-1)c_s > 0.$

It can be seen from theorem 3 that when communication efficiency is higher between the two types of consumers, merchants can gain maximum profit when use official social media to incentive two types of consumers and adopts the group-buying method. If the communication efficiency between the two kinds of customers is low, merchants can get more profit by its social media only when the official social media can motivate consumers.

4. Conclusion

This paper established two types of customers to use social media to share information about mathematical model of group-buying. We compare the merchant biggest profit under two kinds of sales way. Studies show that when two types of customers communication efficiency is high, group-buying strategy often can gain more profit; if the two types of customers communication efficiency is low, so only when valuation difference is small, merchants can gain more profit from the group-buying. On this basis, this paper further considers the choice of the optimal sales strategy and optimization problems when merchants use official social media to incentive two types of consumers. As is necessary for merchants to need certain cost to maintain official social media, so the paper discusses the conditions when merchants using official social media.

Based on the research work of this article, the following questions can be discussed. First, this paper assumes that the merchants know two types of customer value of goods. In fact, customer value is a random variable for merchants. At this time, we need to build a more complicated game model with incomplete information . Second, it is worth to study when merchants adopt the fixed price and group-buying at the same time.

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