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Game Analysis on the Credit Model of Online Group Buying

Yongbo JIANG

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Abstract: In recent years, many positive factors (such as the cultivation of the market environment, the policy support, etc) have provided good development space for e-commerce. As a new mode of e-commerce, online group buying originated from American Groupon. But many problems have already exposed with its rapid development, such as the good and bad group buying websites being intermingled, the seller’s fraud operation, no guarantee after sales, and the consumer’s difficulty to maintain his right, etc. In this paper we first generalize the interests that online group buying brings to all the industry chain subjects. Then according to those exposed credit problems, we first analyze an individual seller’s behavior on the market using static game analysis and find out factors influencing the game subjects’ strategy choosing; then discuss the whole market’s gaming behavior using the dynamic game with imperfect information and find out its perfect Bayesian equilibrium by the backwards induction method. At last we put forward some measures to solving existing problems.

Keywords: online group buying, subject’s Interest, credit model; game analysis

1. INTRODUCTION

According to the draft of the twelfth five year planning, e-commerce will be listed as one of the important parts of strategic new industries during the twelfth five year planning. And as a new generation of information technology branch e-commerce should be taken as the core of the next informatization. So researching on issues about e-commerce has important practical significance.

As a new mode of e-commerce, online group buying (abbreviated as group buying sometimes) originated from American Groupon. In China, the time since it has appeared is not long. But group buying has grown rapidly recent years because its business model is easily copied and the admittance threshold is low. At the same time, the rapid development of the internet technology, the large base number of netizens and the strengthened credit in e-commerce market all has good accelerant effects on its growth. According to the Report of Chinese Online Group buying Market Research in 2011(iResearch, 2011), the group buying market’s sales in domestic in 2010 has reached 14.5 hundred millions, and it will reach 43.5 and 300 hundred millions in 2011 and 2015 respectively. But many problems have already exposed with its rapid development, such as the good and bad group buying websites being intermingled, the seller’s fraud operation, no guarantee after sales, and the consumer’s difficulty to maintain his right, etc. Many researchers have studied the topic in the view of game theory, such as static game analysis [1], dynamic game analysis [2] and cooperative game analysis [3].

Our works in this paper are as follows:

1) Introduce the elementary knowledge about online group buying;
2) Build the model of dynamic game with imperfect information about an individual seller on the online group buying market. And, we solve the mixed strategy Nash equilibrium through the static game model;
3) We also build the model of dynamic game with imperfect information about the whole online group buying market. Then we find out the perfect Bayesian equilibrium using the backwards induction method;
4) Discuss the corresponding phenomenon on the current market according to the above analysis and put forward some useful resolution strategies.
2. ONLINE GROUP BUYING

2.1 Online group buying

Online group buying is the main form of group buying. It means individual consumers with the same purchase intention are gathered together as a whole by the internet, and then they can make mass purchase from the seller with the lower price (Baidu Baike). Generally there are limitations about the time interval and the number of orders in group-buying. And the amount of payment is usually small.

Products of group buying can be classified as service class and real class generally. As a kind of promotion activities, one of the goals of group buying is to achieve the effect of advertisement to attract consumers. For the service class, the marginal cost of production is low or the gross profit is high, there is large space for the price to be discounted. So it is the main part of group-buying. And, the product’s discount ratio, the discounted price and the region all will influence the effect of group-buying.

Group buying has two main forms:

One form is group buying that the buyers are organized spontaneously by means of the internet. Here one of the buyers originates and organizes the deal. In this case the group’s scale is generally small and the bargaining power is low. And, the originator undertakes the task of organization and coordination, but he/she will receive the same interest with the other members in the group. His interest cannot cover his cost usually. So this form isn’t seen often.

The other form is the one organized by professional group buying organizations (here we mainly refer to group buying websites). In this form, group buying is originated by the professional website. The site will reach an arrangement with the seller in advance in which the seller agrees to push some product on the website with lower price and a certain level of service. Then the site is responsible for the advertisement and organizes the buyers to purchase. The site’s role is a professional agent. It will extract a certain proportion of the seller’s sales income as the commission. In this model, the “grouping” cost is relative low and the group’s scale is often large so that the margining power is high. It is the mainly form of the current group buying.

2.2 advantages of online group buying

Group buying has all the attributes of a deal, so all the industry chain subjects have theirs payoffs inevitably. Firstly, group buying can bring a lot of orders to the seller who can then realize small profits but quick turnover and recovering his cash flow quickly. At the same time, group buying helps the seller advertize their products with lower cost. Secondly, the site provides a platform to buyers to communicate easily and thoroughly. Then the buyers’ lose caused by information asymmetry in the deal process is eliminated as far as possible. And, they can enjoy more of the shopping benefits with the enhanced efficiency. Thirdly, the website takes commission from the deal, it need no production, logistics, etc. All it need are professionals to maintain the site, search for excellent products.

2.3 disadvantages of online group buying

Many problems have presented during the process of group buying. According to the Report of Chinese Online Group buying Research in 2011(DCCI, 2011), 51.5% of the users think the consumers’ profits can’t be promised; 43.1% thinks there are problems with the products’ qualities and 34.7% thinks the sellers’ credit degree is not high. Others such as that the website hasn’t explained the activity clearly are also responded frequently.

3. GAME MODEL OF ONLINE GROUP BUYING

3.1 model assumption

Game playing is a common society phenomenon. Game theory researches such decisional and balanced problem that when a subject’s choice is influenced by the other’s, how his choice influences the other’s in turn [4,5].
Here the decisional subject can be a person, an industry or an organization. A standard game consists of four key elements\(^1\): the participants or the subjects, strategies, the gaming order and their payoffs.

As a complex game phenomenon, online group buying mainly involves the seller, the group buying website and the consumers (iResearch Inc.). But the website and the seller have the same interests and are the community\(^2\). So in this paper we mainly discuss the game between the seller and the consumers. We make the following assumptions on the premise of not influencing the findings.

Assumption 1: there are only two participants in a deal or a gaming phenomenon: the consumers and the seller. And they are economic men with limited rationality: their purposes are to pursue the maximum self profits.

Assumption 2: the relevant information about market is complete. That is, the participants have accurate knowledge about the other’s characters, the strategy space and their payoffs.

Assumption 3: there is an order of the two participants’ action: first, the seller sponsors the group buying activity, and then the consumers decide whether to buy or not. But the consumers don’t know the seller’s choice completely before they make decisions, that is, they don’t know how is the seller’s product and they have imperfect information. So the game between them is a dynamic game with imperfect information.

### 3.2 game model of online group buying

Suppose all consumers wish to buy products which prices are consistent with their values. And the seller wants to sell his product anyhow and has the strong desire to sell seconds at best quality prices. For a group buying activity organized by the website, the seller (participant 1) can join in it (strategy J: join) or not join (strategy NJ: not join); if he chooses strategy J, then he can describe his product and the corresponding service truthfully and give the reasonable price (strategy G: good or credible). Or they can proper decorate it, exaggerate its quality to mark higher price (strategy B: bad or fraud). For the consumers, they can buy that product (strategy T: buy) or not buy (strategy NT: not buy) in spite of what the seller’s strategy is ahead. If the seller is fraud, the probability to be discovered is \(\lambda\) and the total cost he must pay is \(\Lambda\) (for example, reducing his credits, receiving fines, etc.). When the product’s quality is inferior and the seller wants to mark a higher price, he must cost \(K\) to decorate it. Because the following transaction happens only when the seller chooses strategy J (that is, the probability of J appearing is 100%), so the premise of the game analysis is that the consumers have already observed the seller’s strategy J.

1. Situation one: Consider an individual seller on the group buying market.

   The product’s price is \(P_1\) or \(P_6\) when the seller’s strategy is \(G\) or \(B\) respectively. For every completed transaction, suppose the seller’s processing fee is \(F\), the product’s production cost is \(C_p\), the website’s commission is \(Y\) and the consumers’ evaluation for the product utility is \(X\) (obviously, \(0 < P_1 < X < P_6\)). Then this dynamic game with imperfect information can be presented as the following extensive form (see figure 1).

   During the process of group buying, consumers can’t get full information about products under consideration even though they form a union because of the seller’s keeping secret about his products, information not transferred sufficiently and being asymmetric, etc. That is, they can’t know about thoroughly the other subject’s action information before their choosing. We can take this kind of the single-pass dynamic gaming as a static gaming (see table 1).

   In the payoff array, the first value represents the seller’s payoff and the second one is the consumer’s.

2. Situation two: Consider the whole group buying market.

   There are various sellers and products on the market. Suppose all products’ quality can be classified as good and bad and the consumers’ evaluation of their utilities are \(X_a\) and \(X_b\) respectively. When joining in the group buying activity, the seller can describe his product honestly and mark the price as \(P_1\), or be fraud and
mark the price as $P_h$. Other hypothesis is the same as that in situation one. Then the extensive model of this
dynamic game is as follows (figure 2). Where:

\[
(P_h - (C_3 + F + Y) - K - \lambda A, X - P_h)
\]

\[
(0,0)
\]

\[
(-K - \lambda A, 0)
\]

Figure 1 the dynamic game model involving an individual seller on the online group buying market

<table>
<thead>
<tr>
<th>seller</th>
<th>consumer</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good (G)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Pl - (CS + F + Y), X - Pl)</td>
<td>(0,0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bad (B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>((P_r - (C_3 + F + Y) - K - \lambda A, X - P_r)</td>
<td>(-K - \lambda A, 0)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 the static game model involving an individual seller on the online group buying

Figure 2 the dynamic game model of the whole group buying market
• GB: the product’s quality is superior.
• BB: the product’s quality is inferior.
• H: the sell is fraud and marks a product with a high price.
• LL: the seller is credible and marks a product with a low or an appropriate price.

4. GAME ANALYSIS OF THE GROUP BUYING MARKET

4.1 Situation One: Consider an Individual Seller on the Group Buying Market

According to the payment matrix in Table 3.1, when the seller chooses strategy G, the consumer will choose T in order to maximize his profit; and when the consumer chooses T, the seller’s choice depends on his exceptive payoff under different strategies.

1) If $P_l > (P_h - K - \lambda A)$, the seller will chooses G and the model has the only Nash equilibrium (G, T).
2) If $P_l < (P_h - K - \lambda A)$, the seller will chooses B and the consumer will chooses NT in turn, the seller then must chooses G. So the model has no Nash equilibrium of pure strategies. Now we can find its Nash equilibrium of mixed strategies.

Suppose the probability that the consumer chooses $T$ is $q$ and the seller chooses $G$ is $p$. Consider the two gaming subjects’ payoffs in a single-pass game.

The seller’s expected payoff is:

$$E(p) = (p, 1 - p) \begin{bmatrix} (P_l - (C_s + F + Y)) & 0 \\ P_h - (C_s + F + Y) - K - \lambda A & -K - \lambda A \end{bmatrix} \begin{bmatrix} q \\ 1 - q \end{bmatrix}$$

$$= pq((P_l - (C_s + F + Y)) + (1 - p)[(q(P_h - (C_s + F + Y) - K - \lambda A)) + (-K - \lambda A)(1 - q))]$$

(1)

Then in order to get his maximum expected payoff, there must be:

$$\frac{\partial E(p)}{\partial p} = \lambda A + K - q(P_h - P_l) = 0$$

(2)

and

$$q^* = \frac{(\lambda A + K) / (P_h - P_l)}.$$}

The consumer’s expected payoff is:

$$E(q) = (q, 1 - q) \begin{bmatrix} X - P_l & X - P_h \\ 0 & 0 \end{bmatrix} \begin{bmatrix} p \\ 1 - p \end{bmatrix}$$

(3)

Let

$$\frac{\partial E(q)}{\partial q} = p(V_g - V_b) + (V_b - P) = 0$$

(4)

And

$$p^* = \frac{(P_h - X) / (P_h - P_l)}.$$

Then in this model the Nash equilibrium of mixed strategies of (seller, consumer) is
\[
\frac{(P_h - X)}{(P_h - P_l)} \cdot \frac{(\lambda A + K)}{(P_h - P_l)}.
\]

4.2 Situation Two: Consider the Whole Group Buying Market

From the above analysis we can see that factors Y, F and CS have no effect on the game subjects’ strategies. Then there is no influence if we ignore them in our following work. So the seller’s payoffs under different situations can be classified (see table 2).

<table>
<thead>
<tr>
<th>the consumer’s decision path</th>
<th>(GB,H,T)</th>
<th>(GB,L,T)</th>
<th>(BB,H,T)</th>
<th>(BB,L,T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>the seller’s payoff</td>
<td>(P_h)</td>
<td>(P_l^*)</td>
<td>(P_h^* - K \cdot \lambda A)</td>
<td>(P_l^*)</td>
</tr>
</tbody>
</table>

It is clear that \(X_h > X_l\), \(P_h > P_l\); and a superior product with the high price is better than an inferior one with the low price, but the payoff in the latter situation isn’t to such an extent that less than zero. But an inferior product with the high price will bring negative payoff. For the consumer, it is best to buy a good product with the low price. This is an event with little probability yet. That is:

\[
X_h - P_l^* > X_h - P_h > X_l - P_l^* > 0 > X_l - P_h
\]

In the model presented in figure 2, the seller can choose a low or high price in spite of the product’s quality. So consumers can’t make reasonable decision according to the price only. Now we adopt the backwards induction method to find out its perfect Bayesian equilibrium. Let \(M = K + \lambda A\) be the total cost when the seller asks a high price for his inferior product. There are two circumstances.

4.2.1 \(M > P_h\)

That is, the seller need high cost to sell an inferior product with a high price. Now the seller’s payoffs under paths \((BB, H, T)\) and \((GB, H, T)\) are \(P_h^* - K - \lambda A\) and \(P_l^*\) respectively.

Because \(P_h^* - K - \lambda A < 0 < P_h\), so the high price occurs only when the product is superior. Now the price is the mirror of the quality. Consumers will confer that:

\[
\begin{align*}
P(GB \mid H) &= 1 \quad & \text{the probability that a product with the high price is superior} \\
P(BB \mid H) &= 0 \quad & \text{the probability that a product with the high price is inferior} \\
P(GB \mid L) &= 0 \quad & \text{the probability that a product with the low price is superior} \\
P(BB \mid L) &= 1 \quad & \text{the probability that a product with the low price is inferior}
\end{align*}
\]

According to the above deduction, when the product is marked with a high price the consumer’s expected payoff of strategy T is:
\[ P(GB \mid H)(X_h - P_h) + P(BB \mid H)(X_l - P_h) = (X_h - P_h) > 0 \]

And his payoff of NT is 0. So T is his dominant strategy now.

Based on the consumer’s above deductions, When the product is superior the seller’s payoffs under H and L are \( P_h \) and \( P_l \) respectively, and he should choose the strategy H because \( P_h > P_l \); otherwise, if the product is inferior, he should choose the strategy L and mark a low price because of \( P_l > P_h - K - \lambda A \).

So the perfect Bayesian equilibrium of this model is:

1) The seller should marks high price when the product is superior, otherwise marks a low price.
2) Consumers will buy out all products sold on the group buying market.

That is to say: Consumers are full of confidence to the group buying market. They think all the sellers are credible and would like to buy out all their products.

4.2.2 \( M < P_h \)

Consider an extreme case: \( M=0 \). No cost is needed to operate fraudulently. Now no one but a fool will mark a low price for the inferior product. The price can’t reflect the product’s quality. Consumers will make deductions that:

\[
\begin{align*}
P(GB \mid H) &= 0 \quad \text{the probability that a product with the high price is superior} \\
P(BB \mid H) &= 1 \quad \text{the probability that a product with the high price is inferior}
\end{align*}
\]

So when the product is marked with a high price:

The consumer’s expected payoff of the strategy T is \( P(GB \mid H)(X_h - P_h) + P(BB \mid H)(X_l - P_h) = X_l - P_h < 0 \).

And his expected payoff of strategy NT is 0 in any case. So NT is the dominant strategy.

When the product is marked with a low price:

The consumer’s expected payoff of the strategy T is: \( P(GB \mid L)(X_h - P_l) + P(BB \mid L)(X_l - P_l) > 0 \)

Now T is the dominant strategy. The market presents the invalid state. All consumers will buy products with low prices in spite of their quality. The ones with high prices are abandoned. And the phenomenon named adverse selection appears on the market.

5. CONCLUSIONS

5.1 analysis on the gaming results

Synthesize the above analysis we can see that the pricing space, the consumer’s utility loss, the deceive cost and the discovering probability when cheating are all playing important roles on the gaming subjects’ strategy selection.

5.1.1 Situation one: consider an individual seller on the group buying market.

1) The seller’s strategy is directed related to his unjust profit. The smaller the price difference \( (P_h - P_l) \) that can be set, the lower the seller’s unjust profit, and the larger the probability that the seller is credible.
2) When a fraud operation is found easily(that is: \( \lambda \) is larger), and the fine and other cost are substantial, the
probability that consumers choose $T$ will increase, which in turn impels the seller to choose $G$.

3) The consumers’ utility loss is also concerned. The larger the loss, the larger is the probability that the seller is credible, then the less the consumers choose to buy. And the cost depends on the seller’s behavior

5.1.2 Situation two: consider the whole group buying market.

Whether the market is effective or not depends on the cost to be fraud (involving $A$, $K$, $\lambda$). When fraud operation need high camouflage cost and even though it is easy to be find out, and then the seller must be faced with undertaking high fines, credit relegation, exposure, etc, most sellers won’t have the motive to operate fraudulently. On the market the price is consistent with the quality and consumers are optimistic to buy. The market is “with full success”; otherwise adverse selection will make the market become invalid.

5.2 Solving Strategies

Think about key factors that influence the market operation in the two cases: camouflage cost (involving $\lambda$, $A$, $K$), pricing space ($P_h - P_p$), utility loss ($P_h - X$). We must intensify efforts to punishment, compress the pricing space and decrease consumers’ utility loss so that we can cultivate the group buying market well. So, we prompt the following resolution strategies accordingly.

5.2.1 Perfect the relative laws and regulations, intensify efforts to law enforcement and punishment. It is the key to cultivate the integrity of the group buying market.

In the final analysis, many problems exposed on the group buying market are related to integrity. As one developing model of e-commerce, there is still much vulnerability in its supervision which makes the cost of fraud operation low during group buying. Firstly, perfect the legislation and the supervision mechanism. Then the probability of fraud operation being found will increase and the seller’s fluky psychology will be lowered. The third supervision institution and the credit authentication mechanism will specify the market’s behavior; secondly, we must reinforce the punishment efforts of fraud behavior to increase fraud cost. One is to adopt financial penalties; two is to expose such behavior by some means to increase the credit cost. At the same time, increase the reward efforts to credit behavior, such as enhance the credit degree, give preferential treatment to enterprises with good faith, etc.

5.2.2 Build a highly efficient information transferring system to solve information asymmetry during group buying and reduce the pricing space.

Information asymmetry can cause adverse selection and moral hazard. Highly efficient information transferring system makes all the gaming subjects’ data open timely to lessen the cost of getting information, especially to consumers. Then the more open the information, the letter the opportunity of fraud activity occurring and the larger the probability to cooperation, then the easier to build an effective credit mechanism.

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