

The Evaluation Model of Transaction Trust in online Group-buying Based on Transaction History Information

Yan Zou, Weijie Chen*, Shan Li, Yiyang Si

school of economics and management, Chongqing Normal University Chongqing, R.P. China

chwj721@163.com

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Abstract. Trust is an vital factor affecting online transaction. This paper presents an evaluation model of transaction trust based on transaction history information including past transaction amounts, transaction dates and rates of favorable comments, which can widen the applicability of the trust evaluation model. Some case studies are given to testify the effectiveness of the evaluation model presented in this paper. The results mainly show that (1) the new transaction with positive category difference of transaction amounts will have higher transaction risk than that with negative category difference of transaction amounts;(2) the bigger the absolute value of category difference of transaction amounts is, the higher the transaction risk is;(3)the farther the transaction date of the past transaction is from the new transaction, the smaller the impact on the risk of the new transaction is.

1 Introduction

Online group-buying mechanisms are being widely used for both business-to-business (B2B) and business-to-consumer (B2C) transactions. As a new way of consumption, online group-buying refers that a certain number of consumers buy the same goods at a certain discount through the Internet. Its basic feature lies in gathering money through the cohesive force of Internet, which can increase negotiation force of customers and make customers get a preferential transaction price. The organizers of online group-buying mainly include consumers themselves, sellers and professional purchasing associations. Group-buying websites have been developed rapidly in recent years, however, by the end of 2014, the failing rate of group-buying websites has reached to 90%. Thus online group-buying faces enormous risks with the rapid development. For customers, before deciding to joining group-buying, they need to know the transaction risk and then make purchase decisions. So the evaluation of transaction trust and risk is particularly necessary for online group-buying.

Due to the particularity of group-buying transactions, the measurement of trust and risk has attracted wide attention from scholars. Researchers have presented some classic evaluation models of trust, such as Beth trust management model^[1], subjective logic trust model^[2]. M. H. Hsu et al. presented a theoretical model to examine the antecedents of repurchase intention in online group-buying by integrating the D&M model and trust literature^[3]. The trust-based whole process e-commerce credit risk management model was proposed in [4] to enhance the trust between the sellers and buyers. In the next year, a coherent adaptive trust model for quantifying and comparing the trustworthiness of group-buying websites based on a transaction-based feedback system and social network are discussed in [5]. Trust is an vital factor affecting online transaction. Many factors can improve the trust of consumers to the sellers including scale of websites, reputation, customer satisfaction, product return and refund policy, and consumer's shopping experience^[6]. Y. Wang and V. Varadarajan^[7] proposed several trust metrics for the trust evaluation and pointed out that a constant good reputation leads to a series of good trust values. W. L. Shiau and M. M. Luo^[8] demonstrated that reciprocity, trust, satisfaction, and seller creativity provide considerable explanatory power for intention to engage in online group buying behavior. Z. Zhang and C. Gu^[9] indicated that social interaction has significant and normative influences on consumer trust by an

empirical study of online group-buying. The results from researches^[10] indicate that perceived usefulness, perceived ease of use and perceived risk all have a significant relationship with consumer attitudes. Some researchers focused on the relations between new transaction and existing transactions. R. J. Kauffman and B. Wang pointed that the number of existing orders has a significant positive effect on new orders placed during each three-hour period, indicating the presence of a positive participation externality effect^[11]. However, in most existing trust evaluation models, past transaction conditions and transaction history are usually ignored, so this paper introduces some characters of past transactions into the trust evaluation model of online group-buying.

To facilitate our discussion, we first present the correlative assumptions and definitions in Section 2. In section 3 an evaluation model of trust for online group-buying transactions based on transaction amounts is firstly presented in detail, then we extend the model by considering more factors, such as the transaction date and the rate of favorable comments. Some study cases are given to illuminating the effectiveness of our evaluation model in Section 4. At last, we conclude the paper with a summary and give some suggestions to reduce transaction risk in last section.

2 Preliminaries

For any new transaction between consumers and group-buying websites, assuming that the relative data of past transactions is public. So we consider that the difference between the old transaction amount and the new transaction amount is one of the important impact factors for evaluating transaction trust.

Firstly, let $\Delta_a = cash_{new} - cash_{old}$ be the difference between the old transaction amount and the new transaction amount, where $cash_{new}$ and $cash_{old}$ are the amount of the new transaction and the amount of the old transaction, respectively. Let θ_a be the impact factor of Δ_a which shows how Δ_a influences the trust of the new transaction, and $0 < \theta_a < 1$. When $\Delta_a = 0$, we have $\theta_a = 1$, which means an old transaction having the same transaction amount with the new transaction has a maximum influence on the new transaction. When $\Delta_a \neq 0$, we have $0 < \theta_a < 1$.

Next, we consider two cases: $\Delta_a > 0$ and $\Delta_a < 0$. Considering the exponential function can reflect the property of θ_a pretty well, we define θ_a as

$$\theta_a = 1 / (\rho e^{\Delta_a^\alpha} + (1-\rho)e^{-\Delta_a^\alpha}) \quad \text{if } \Delta_a \geq 0, \quad (1)$$

where $\alpha \in (0,1]$ is the decay factor, $\rho \in [0.5,1)$ is the control factor which controls the impact of Δ_a with difference on the impact factor θ_a . The larger ρ is, the less the impact is.

Definition 1. Let $cash_{new}$ be the amount of the new transaction and $cash_{old}$ be the amount of the old transaction. Then the impact factor θ_a is defined as

$$\theta_a = \begin{cases} \frac{1}{\rho e^{\Delta_a^\alpha} + (1-\rho)e^{-\Delta_a^\alpha}} & \text{if } \Delta_a \geq 0, \\ \frac{1}{\rho e^{\Delta_a^\alpha} + (1-\rho)e^{-\Delta_a^\alpha}} \cdot (1-\beta) + \beta & \text{if } \Delta_a < 0 \end{cases} \quad (3)$$

where $\Delta_a = cash_{new} - cash_{old}$, $\alpha \in (0,1]$, $\rho \in [0.5,1)$ and $\beta \in (0,1)$.

In fact, for simplifying the computation, we can use the difference between the category of $cash_{new}$ and the category of $cash_{old}$ instead of detailed amounts. Here we can define a classification function of transaction amounts as follows.

Definition 2. Let $cash$ be the transaction amount of a transaction, so a classification function of transaction amounts is defined as

$$ca(cash) = \begin{cases} 1 & \text{if } cash \in [1, 100] \\ 2 & \text{if } cash \in [101, 500] \\ 3 & \text{if } cash \in [500, 2000] \\ \dots & \\ 9 & \text{if } cash \in [100001, 200000] \\ 10 & \text{if } cash \in [200001, +\infty) \end{cases}, \quad (4)$$

Given a transaction amount, we can compute the category of the transaction amount. For example, if $cash=1000$, then $ca(1000)=3$.

According to Definition 2, the Δ_a in Eq.(3) can be replaced with Δ_c where $\Delta_c = ca(cash_{new}) - ca(cash_{old})$. Of course, the classification function of transaction amounts in different industries should be different. So, we need to define different classification functions for different industries.

3 The Trust Evaluation Model in online group-buying

3.1 The Fundamental Model

Definition 3. Assume a set of trust values $T = \{T_1, T_2, \dots, T_n\}$ from a past transactions set $Purchase = \{P_1, P_2, \dots, P_n\}$ is known, then the trust value of the new transaction is:

$$T_{new} = \frac{1}{n} \sum_{i=1}^n (\theta_c(i) \cdot T_i), \quad (6)$$

where $T_i \in [0, 1]$ is the trust value of the old transaction P_i . $T_i = 0$ means the trust value of this transaction is very poor, while $T_i = 1$ means the trust value is very high, and $\theta_c(i)$ is the impact factor of $\Delta_c(i)$, $\Delta_c = ca(cash_{new}) - ca(cash_{old}(i))$ where $cash_{old}(i)$ is the transaction amount of the old transaction P_i . So, according to the above definitions, we define the transaction risk of a new transaction.

Definition 4. If the trust value of the new transaction lunched by group-buying websites is T_{new} , the transaction risk of a new transaction is defined as $R_{new} = 1 - T_{new}$.

So if customers know relative past transaction data before the new transaction begins, they can compute the risk value of the new transaction, which can provide the reference for customers to make purchase decisions.

3.2 The Extended Model Considering Transaction Dates of Past Transactions

In fact, different transaction dates of past transactions have different influences on the new transaction. To evaluate the trust of the new transaction more accurately, different weights should be assigned to past transactions taking place in disparate periods. We consider that a past transaction closing to the new one should get a bigger weight. Therefore, transaction dates of those past transactions are considered in the evaluation model.

Definition 5. Considering transaction dates of past transactions, the trust value of a new transaction

is defined as $T_{new} = \sum_{k=1}^l (w^k T_p^k)$, (7)

where (1) l is the number of periods we assign for all past transactions. (2) $w^{(k)}$ is the time-weight of a past transaction taking place in the period t_k ($k = 1, 2, \dots, l-1$) and the smaller k is, the farther the transaction date of the past transaction is from the date of the new transaction. So we have $w^{(k)} \leq w^{(k+1)}$ and $\sum w^{(k)} = 1$. (3) $T_p^{(k)} = (\sum_{j=1}^{m^{(k)}} (\theta_c^{(k)}(j) \cdot T_j^{(k)})) / m^{(k)}$ is the transaction trust value during the period t_k , $m^{(k)}$ is the number of transactions taking place in period t_k , and $T_j^{(k)}$ is the trust value of the past transaction with the transaction amount $cash_{old}^{(k)}(j)$ taking place in the period t_k . (4)

$\theta_c^{(k)}(j)$ is the impact factor of amounts category resulting from $\Delta_c^{(k)}(j) = ca(cash_{new}) - ca(cash_{old}^{(k)}(j))$, where $cash_{old}^{(k)}(j)$ is the transaction amount of the k th transaction in period t_k .

Specially, we build a simple weight distribution function to assign weights for past transactions. Given parameters λ ($0.5 < \lambda < 1$) and $\mu \in \{1, 2, 3, \dots\}$, the weight of period t_k can be computed by

$$w^{(k)} = v^{(k)} / \sum_{i=1}^l v^{(i)}, \text{ where } v^{(k)} = 1 - e^{-\lambda k^{(1/\mu)}}, \quad 0.5 < \lambda < 1, \mu \in \{1, 2, 3, \dots\}.$$

For example, let $l=10$, $\lambda=0.7$ and $\mu=2$, we have

$$W = \{0.0598, 0.0771, 0.0882, 0.0964, 0.1027, 0.1078, 0.1121, 0.1157, 0.1188, 0.1215\}.$$

3.3 The Extended Model Considering the rate of favorable comments

In this section, the rate of favorable comments will be introduced into the evaluation model of trust. Let $F_j^{(k)}$ be the rate of favorable comments for a past transaction with the amount transaction $cash_{old}^{(k)}(j)$ taking place in the period t_k , then the trust value of the new transaction is defined as

$$T_{new} = \sum_{k=1}^l (w^{(k)} \cdot T_F^{(k)}), \text{ Where } T_F^{(k)} = (\sum_{j=1}^{m^{(k)}} (\theta_i^{(k)}(j) \cdot F_j^{(k)} \cdot T_j^{(k)})) / m^{(k)} \text{ is the revised transaction trust value of the period } t_k.$$

4 Case Studies

4.1 Case 1

Specific statistical data are listed in Table I where the unit of transaction amount $cash_{old}^{(k)}(j)$ is ten thousand Chinese yuan. From Table 1, we know that there are 13 past transactions in total, where two transactions taking place in period t_1 and three transactions took place in period t_4 . Therefore, $k=10$, $m^{(1)}=2$, $m^{(4)}=3$ and $m^{(k)}=1$ ($k=2,3,5,6,7,8,9,10$). Assuming $cash_{new}=3$, $\alpha=0.5$, $\rho=0.5$, $\beta=0.85$, $\lambda=0.7$, $\mu=2$, we can get the results listed in Table II.

| k | 1 | 1 | 2 | 3 | 4 | 4 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| $cash_{old}^{(k)}(j)$ | 1 | 1.2 | 1.5 | 1.3 | 2 | 1.5 | 1.6 | 3 | 2 | 4 | 1.9 | 5 | 1.2 |
| $T_j^{(k)}$ | 0.85 | 0.83 | 0.74 | 0.80 | 0.69 | 0.77 | 0.90 | 0.81 | 0.78 | 0.77 | 0.63 | 0.50 | 0.91 |
| $F_j^{(k)}$ | 0.81 | 0.83 | 0.86 | 0.82 | 0.89 | 0.76 | 0.61 | 0.87 | 0.93 | 0.90 | 0.88 | 0.83 | 0.78 |

| k | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| $w^{(k)}$ | 0.0598 | 0.0771 | 0.0882 | 0.0964 | 0.1027 | 0.1078 | 0.1121 | 0.1157 | 0.1188 | 0.1215 |
| $T_F^{(k)}$ | 0.4518 | 0.5644 | 0.6448 | 0.4499 | 0.7047 | 0.6433 | 0.6930 | 0.4916 | 0.3931 | 0.6977 |

So we can get $T_{new}=0.5785$ and $r_{new}=1-T_{new}=0.4215$. These results can give customers a reference to make purchase decisions.

4.2 Case 2

Now assuming that there are only two transactions. We only consider how the latest transaction effect the new transaction, then $k=1$, $m^{(1)}=1$. Let the new transaction amount be 4 thousand Chinese yuan, and the parameters α , ρ , β , λ , μ are the same as case 1.

Table III. The statistical results of case 2

| Type | $cash_{old}^{(k)}(j)$ | $T_j^{(k)}$ | $F_j^{(k)}$ | $w^{(k)}$ | $\theta_c^{(k)}(j)$ | $T_F^{(k)}$ |
|------|-----------------------|-------------|-------------|-----------|---------------------|-------------|
| 1 | 0.4 | 0.87 | 0.91 | 1 | 0.4251 | 0.3587 |
| 2 | 3 | 0.88 | 0.92 | 1 | 1 | 0.8096 |
| 3 | 30 | 0.86 | 0.91 | 1 | 0.9138 | 0.7151 |

In Table III, Type 1 means the transaction amount of the past transaction is less than the new one, Type 2 means the transaction amount of the past transaction is roughly equal to the new one, and Type 3 means the transaction amount of the past transaction is extremely larger than the new one. Therefore, we can compute the trust and trust risk of three different types. The results are listed in Table 4.

Table IV. The trust and trust risk of three different types

| Type | T_{new} | r_{new} |
|------|-----------|-----------|
| 1 | 0.3587 | 0.6413 |
| 2 | 0.8096 | 0.1904 |
| 3 | 0.7151 | 0.2849 |

According to Table IV, if there is little difference between the amount of the past transaction and the new transaction, the trust risk of the new transaction will be very low. So when launching a new transaction, the group-buying website should not change the transaction amount rashly.

4.3 Case 3

This case discusses how the positive category difference of transaction amounts influence on the transaction trust and risk. The parameters values of $\alpha, \rho, \beta, \lambda, \mu$ are the same as case 1. In addition, let $k=1, T=0.88$ and $F=0.92$ for each transaction. Results are listed in Table V.

Table V. Influences of the positive category difference

| $\Delta_s^{(k)}(j)$ | 0 | 1 | 3 | 5 | 7 | 9 |
|---------------------|--------|--------|--------|--------|--------|--------|
| T_{new} | 0.8096 | 0.7180 | 0.3442 | 0.1320 | 0.0488 | 0.0180 |
| r_{new} | 0.1904 | 0.2820 | 0.6558 | 0.8680 | 0.9512 | 0.9820 |

From Table V, we know that the bigger the fluctuation scope of transaction amounts between the new transaction and its last transaction, the higher the transaction risk is, and the lower purchase intention of customers are. So if group-buying websites want to make deals, one of feasible methods is to add transactions amounts incrementally, which make the transaction risk value quite small, and the customer is likely to purchase goods.

5 Conclusions

In this paper, we present the evaluation model of risk based on transaction amounts, transaction dates and rates of favorable comments of those past transactions, and some case studies are given to demonstrate the validness of the evaluation model. The data the evaluation model needed are easy to get, and the evaluation model can be performed in each type of group-buying websites. However, the evaluation model only considered three notable factors. In future work, more factors, such as risk preference of customers, the social relationship between customers, can be considered to make the model universal in the practical application.

According to the trust evaluation model and case studies, we can see that the trust of the new transaction is related to category difference of transaction amounts, transaction dates and rates of favorable comments of those past transactions. If group-buying websites want to shows a good reputation for customers, in addition to deal honestly, they can also take necessary measures. For example, don not change the amount of transaction suddenly. If it is necessary, change gradually. Be sure to trade honestly and provide high quality products and services to customers for gaining a high rate of favorable comments. Be sure to provide complete and true past transaction information to customers to help them to make purchase decisions.

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