Advances in Economics, Business and Management Research, volume 146
Fourth Asian B&R Conference on International Business Cooperation (ISBCD 2019)

Game Analysis on Online Reputation of Cross-Border E-Commerce

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***Abstract*—The development of Internet technology and e-commerce enables traders to find a wide variety of trading partners across geographical and national boundaries. Online trading has a significant role in promoting the development of One Belt and One Road business transactions. For transactions that cross geographical or national boundaries, the seller's reputation is an important decision basis for the buyer to decide whether to buy. In a virtual environment, without the reputation information of the sellers, low quality products and sellers will "expel" high-quality products and sellers. This paper adopts the game theory and uses the method of game analysis to analyze the influence of online reputation on the trading success rate, trading volume and trading price. Based on the game analysis, it is concluded that, there are strong positive relationship between seller's reputation and the buyer's purchase intention, the probability of transaction, the volume of transaction and the price of transaction.**

Keywords: online reputation, cross-border e-commerce, One Belt and One Road Initiative, game theory, game analysis

I. INTRODUCTION

In international trade, business activities often need to be carried out across regions and borders. The One Belt and One Road initiative promotes trade across borders and regions. The development of Internet technology and e-commerce enables traders to find a wide variety of trading partners across geographical and national boundaries. Online transactions have undermined the foundation of traditional market transactions, and promoted cross regional business transactions. Online trading has a significant role in promoting the development of One Belt and One Road business transactions. In traditional market transactions, the buyer can check the products before the transaction, and then decide whether to carry out the transaction. For transactions that cross geographical or national boundaries, it is too expensive and unrealistic for buyers to go to the seller's location to check the products before the transaction, as traditional transactions do. Therefore, the seller's reputation is an important decision basis for the buyer to decide whether to buy. In online transactions conducted through the Internet, the buyer does not know the seller's market position and integrity level. In a virtual and even anonymous environment, there is a huge temptation for sellers to exaggerate the quality of products, conceal the source of products, delay delivery and so on. This will reduce the willingness of buyers to transact over the internet, unless the seller can provide sufficient information about the quality of the products and performance as well as the reputation of themselves. Without the reputation information of the sellers, low quality products and sellers will "expel" high-quality products and sellers.

II. REPUTATION THEORY

The research on reputation has long history. The Longman Dictionary of Contemporary English defines the reputation as the opinion that people have about someone or something because of what has happened in the past.

A. Trading theory of Reputation

According to reputation trading theory, market regard reputation as an asset. If there is a dishonest behavior, it is possible to lose part of the customer. Therefore, the value of reputation is equal to the short-term gain obtained by deducting the loss of future transactions from the breach of trust. Reputation is an important asset of a business, which is gradually built up and disappeared. It needs investment and maintenance. The value of reputation is to increase the "high effort level" and avoid falling into the "low effort level". Mailath and Samuelson (2001) [1] interpreted reputation as "customers' prior expectation about the capability of the entity". They further emphasized that the equilibrium result of the game in the market is that High-capacity enterprises distinguish themselves from low-capacity enterprises by choosing high-effort enterprises.

B. Information theory of reputation

Information theory of reputation studies the value and transmission mechanism of reputation from the perspective of information theory. It regards reputation as information that contains historical records. Reputation information is exchanged and spread among stakeholders to form reputation flow, reputation system and reputation network. Information theory of reputation emphasizes the signal function of reputation. The value of reputation is to reduce information distortion and strengthen commitment so as to improve the efficiency of market transactions. The dissemination of reputation information can limit the opportunistic tendency of the actor and thus expand the market base of trading.

Reputation information helps market traders identify reliable trading partners in anonymous and unfamiliar Internet environment. The reputation system of online trading is a signaling mechanism, which concentrates and reports the past trading information of market participants. This links opportunistic behavior at this stage with lower reputation at the next stage. Reputation system is also a signal screening and information searching mechanism, which can always identify high-quality products and raise their prices. This mechanism helps the buyers to accurately find the sellers of such products.

However, reputation information theory does not solve the problem of how reputation information is collected, processed and reported in market transactions. In addition, it does not answer what kind of reputation transmission mechanism is the most effective and what factors affect the effectiveness of reputation information transmission mechanism.

C. The impact of reputation on market performance

First, reputation mechanism helps to improve market performance and establish a sustainable online trading market. Yang and Hu et al. (2007) [2] found that reputation feedback mechanism can improve the performance of online C2C market. Zhou and Dresner et al (2008) [3] proved that in the online auction market reputation feedback mechanism can form a sustainable online auction market. The empirical research of Przepiorka (2013) [4] confirms that reputation mechanism can solve the trust problem and reduce the transaction cost in anonymous online market.

Secondly, reputation mechanism helps to promote the integrity of market participants. Yang and Hu et al. (2007) [2] found that reputation feedback mechanism can motivate sellers to choose honest behaviors. At the same time, it is proposed that in terms of promoting market performance, the punishment of seller's fraud is more effective than the reward of seller's honest behavior. Rice (2012) [5] found that reputation mechanism has a positive correlation with return of sellers.

D. The impact of reputation on transaction price

Some empirical studies show that seller's reputation has a significant impact on commodity price. McDonald and Slawson (2002) [6] found that there was a positive correlation between price and reputation score. The higher the seller's reputation, the higher the auction price. Przepiorka (2013) [7] confirmed that the higher the seller's reputation, the higher the product price and the price the buyer is willing to accept.

E. The impact of reputation on the number of transactions

The basic conclusion of the influence of reputation on the number of transactions is that reputation enhances the buyer's purchase intention and the number of transactions.

Li and Wu et al. (2008) [8] used online game prepaid card data from Taobao to study the role of seller's reputation in online sales in China. They found that seller's reputation had a positive effect on its sales volume, but this effect was non-linear. According to Rice (2012), the favorable comments of sellers are positively correlated with the Investment Level of buyers. "Buyer input level" is essentially the quantity that the buyer is willing to buy. Przepiorka (2013) [7] confirmed that the higher the seller's reputation, the higher the possibility of selling the product.

Since Resnick and Kuwabara (2000) [9], lots of considerable achievements have been made in online reputation mechanism and research. Previous studies on reputation mechanism are theoretical and empirical studies. Theoretical research focuses on the impact of reputation on the willingness of transaction, efficiency of market transactions and the success rate of transactions. The empirical research study the influence of online reputation on buyer's inclination to transact, transaction success rate, trading volume and transaction price. Unlike previous studies, this paper adopts the game theory and uses the method of game analysis to analyze the influence of online reputation on the trading success rate, trading volume and trading price in multistage games.

F. Online reputation game analysis

Suppose that the game of online shopping platform is a multi-stage game between long-term sellers and a series of short-term buyers. There are two types of sellers in the platform, they are high capacity sellers (H) and low capacity sellers (L) The seller sets up a reserve price or a minimum price (M). The seller has two behavioral choices of "Keeping honest" (Ht) and "fraud" (Ft) in stage t. High Quality Supplier (Seller) (H) chooses honesty behavior with the probability of θh. Therefore, the probability of fraud behaver of those High-Quality Supplier is 1-θh. Low Quality supplier (seller) (L) chooses honest behavior with the probability of θl. Therefore, the probability of fraud behaver of those Low-Quality supplier is 1-θl. High-quality suppliers are more likely to choose honest behavior than low-quality suppliers. Consequently $0 \leq \theta l \leq \theta h \leq 1$.

Buyers give feedback on sellers' behavior. If the seller chooses honest behavior (Ht), then the buyer gives a "good" comment as a feedback. If the seller chooses cheat behavior (Ft), then the buyer gives "bad" comment as a feedback. Further assume that buyers can always give objective and accurate feedback. In addition, buyers' feedback is only "good" and "bad". gt represents the number of positive comments "Good" received by sellers at the beginning of the t phase. bt is the number of "bad " comments received by the seller at the beginning of stage t. These feedbacks affect the buyer's beliefs about the seller type. p1 is the probability of buyers' subjective evaluation that the new seller is a high-quality supplier. pt represents the probability that the buyer updates the evaluation that the seller is a high-quality supplier at the beginning of stage t.

Consider the game between a group of buyers and sellers randomly selected. The equilibrium of the game is the buyer's optimum decision in each stage. Suppose that if the seller commits fraud (Ft), the value obtained by buyer a is 0. If the seller acts in good faith (Ht), the buyer gains a value of va. Therefore, the expected value obtained by buyer I after completing a transaction is：

$$e_t(v_a, p_t) = [p_t\theta_h + (1 - p_t)\theta_l]v_a \quad (1)$$

Buyers are willing to buy online only if the expected value they get is not lower than the reserve price or a minimum price (M) set by the seller. This is also the condition for online transactions to be completed.

$$e_t(v_a, p_t) = [p_t\theta_h + (1 - p_t)\theta_l]v_a \geq M \qquad (2)$$

Equations (1) and (2) determine that the equilibrium of the buyer is that pt has an important influence on the buyer's expected value and participation in decision-making. According to Equation (2), M affects buyer participation in decision-making. However, M has no effect on equation (1). According to the eBaye's rule, buyers adjust their beliefs about the type of seller (pt) by applying the previous stages of seller "good" and "bad" reviews. As long as the seller stays in the market (long-term seller), the posterior belief in the former game stage is equal to the prior belief in the present stage. In phase t, the buyer's belief about the seller's "high quality supplier" is updated to

$$p_t = \left[\theta_h^{g^t}(1-\theta_h)^{b^t}p_1\right] / \left[\theta_h^{g^t}(1-\theta_h)^{b^t}p_1 + \theta_h^{g^t}(1-\theta_l)^{b^t}(1-p_1)\right]$$

By investigating the first partial derivatives of p_t with respect to g^t and b^t, it can be concluded that:

$$\frac{\partial p_t}{\partial g^t} = p_t(1-p_t)(\ln\theta_h - \ln\theta_l) > 0$$

$$\frac{\partial p_t}{\partial b^t} = p_t(1-p_t)(\ln(1-\theta_h) - \ln(1-\theta_l) < 0$$

This means that the comment of "good " can enhance buyers' belief that sellers are high-quality suppliers. On the contrary, the comment of "bad " will reduce this belief. Furthermore, first partial derivatives of e_t with respect to g^t and b^t shows that

$$\frac{\partial e_t(v_a, p_t)}{\partial g^t} = (\theta_h - \theta_l)v_a p_t(1-p_t)(\ln\theta_h - \ln\theta_l) > 0$$

$$\frac{\partial e_t(v_a, p_t)}{\partial b^t} = (\theta_h - \theta_l)v_a p_t(1-p_t)[\ln(1-\theta_h) - \ln(1-\theta_l)] < 0$$

This suggests that as the number of "good" comments increase, the higher the expected value received by the buyers. Therefore, the buyer has a higher purchase intention, that means there can be a higher transaction price as well as a higher probability of transaction. On the contrary, as the number of "bad" comments increase, expected value perceived by buyers will decrease. Therefore, the buyer has a lower purchase intention, which means there can be a lower transaction price as well as a lower probability of transaction. In addition, the investigation on the second partial derivatives of et with respect to gt and bt shows that:

$$\frac{\partial^2 e_t(v_a, p_t)}{\partial g_t^2} = [(\theta_h - \theta_l)v_a(\ln\theta_h - \ln\theta_l)(\partial p_t/\partial g_t)](1-2p_t)$$

$$\frac{\partial^2 e_t(v_a, p_t)}{\partial b_t^2} \quad (\theta_h - \theta_l)v_a(ln\,\theta_h - ln\,\theta_l)(1-2p_t)$$

$[(\theta_h - \theta_l)v_a(ln\,\theta_h - ln\,\theta_l)(\partial p_t/\partial g^t)]$ and $[(\theta_h - \theta_l)v_a(ln(1-\theta_h) - ln(1-\theta_l))(\partial p_t/\partial b_t)]$

are greater than zero. If $p_t < 1/2$, $\partial^2 e_t(v_a, p_t)/\partial g_t^2 > 0$, $\partial^2 e_t(v_a, p_t)/\partial b_t^2 > 0$. This indicates that the number of "good" comments and "bad" comments has an increasing marginal impact on the buyer's expected value. (This shows that the number of "good" comment and "bad" comment has an increasing marginal impact on the buyer's expected value.) In other words, when the seller's reputation is low ($p_t < 1/2$), the influence of credit evaluation feedback on trading is marginal increasing. When the seller's reputation is high ($p_t > 1/2$), the impact of credit feedback evaluation on trading is marginal decreasing.

Based on the above game analysis, it is concluded that, there are strong positive relationship between seller's reputation and the buyer's purchase intention, the probability of transaction, the volume of transaction and the price of transaction. The better seller's reputation is, the stronger buyer's

purchase intention is, the higher probability of transaction success is, and the higher transaction price is.

III. CONCLUSION

The development of Internet technology and e-commerce has promoted cross-border business transactions. There is uncertainty in the cross-border e-commerce transaction since the transaction is carried out in a virtual environment. In order for transactions to take place, reputation-based trust needs to be established. Online reputation mechanism has become an indispensable part of online cross-border transactions. It improves the efficiency of online trading market. The research find that a good reputation of the seller has a positive impact on the buyer's purchase intention, the success rate of the transaction, the volume of the transaction and the transaction price, especial for Cross-border e-commerce transactions.

This paper can be improved and expanded from the following aspects. The number of rating scale used in this paper has only two, that is, "good" and "bad". However, in practice, the number of rating scale may be three or even five. Whether the conclusion will be different, if the number of rating scale is greater than two. The impact of different information sources as well as different market participants on the effectiveness of reputation mechanism needs further study.

ACKNOWLEDGMENT

I would like to express my gratitude to my supervisor Professor Song Guangxing. He provided me with considerable suggestions and comments during the writing. This study was financially supported by National Natural Science Foundation of China (2014, No.71362016).

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