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Sang Yong Tom Lee

National University of Singapore, tlee@comp.nus.edu.sg

Zhaoli Meng

National University of Singapore, mengzhao@comp.nus.edu.sg

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CALCULATIVE-BASED TRUST AND SOCIAL WELFARE

Lee, Sang Yong Tom, National University of Singapore, SoC1-415, 3 Science Drive 2,
117543 Singapore, tlee@comp.nus.edu.sg

Meng, Zhaoli, National University of Singapore, SoC1-608, 3 Science Drive 2, 117543
Singapore, mengzhao@comp.nus.edu.sg

Abstract

Trust building has been acknowledged as one of the critical factor for the success of e-commerce. However, few sources of trust were identified in online transaction. This paper tries to fill the gap by investigating calculative-based trust. Specifically, an infinitely repeated game model is built to illustrate how strangers in online transaction build trust relationship based on the calculation of their own benefits. Furthermore, we relate the strategies of trading parties to social welfare and provide policy implications on how to control the cheating behaviors without jeopardizing social welfare.

Keywords: E-commerce, calculative-based trust, game theory, social welfare.

1 INTRODUCTION

Trust building has been deemed as one of the critical factors for the success of e-commerce. Trust is the major concern of online buyers (Business journal survey report 2002), and lack of trust has long been one of the greatest barriers for buyers and sellers participating in online transactions (Lee and Turban 2001, Hoffman et al. 1999). It is reported that 51% of companies would not trade with parties they do not trust in online transaction (Shankar et al. 2002). Trust is so important that it is the central factor for all transactions (Dasgupta 1988). Trust is believed to reduce the transaction costs (Handy 1995), to influence the coordination of institutional organizations (Shapiro 1987), to motivate the decisions (McAllister 1995), to propel the participation in transactions (Dasgupta 1988), to promote information exchanges (Earley 1986), and to sustain the markets (Akerlof 1970).

Because of the importance of the online trust building, a growing IS literature investigates how to initiate, build and sustain trust in online transactions (Davis et al. 1999, Smith et al. 2000, Urban et al. 2000, McKnight et. al 2002, Schneiderman 2000). One stream of studies focuses on investigating the antecedents of trust. Three attributes of trustee have been identified: ability, benevolence and integrity. And the attribute of trustor is the propensity to trust (Jarvenpaa et al. 1998, Ridings et al. 2002). Another stream of studies empirically tests the trust in e-commerce, which are reviewed by Grabner-Krauter and Kaluscha (2003). Others studies build concept model to explore the development of trust (McKnight et. al 2002).

Although trust building attracts the attention of IS scholars, the sources of trust have not yet been well understood in e-commerce context (Jones et al. 2000). There is, therefore, a need to recognize the sources of trust in online transaction, which can give a correct guide to initiate and maintain the trust. After reviewing sources of trust in traditional market that are summarized in Table1, we find that most of them are not really applicable in e-commerce context. For instance, affect-based trust, familiarity-based trust and cognition-based trust, which need personal contact, do not work in online transactions. Knowledge-based trust needs the repeated transactions between fixed pair of buyer and seller, which does not often happen in online transactions. Institutional-based trust and personality-based trust are also not so popular in online environment because online transactions are beyond the boundary of geographic distance and culture.

Author	Source of trust	Detail
Bowlby 1982	Personality-based trust	Trust can be traced to the infancy seeking and receiving help from caretakers.
Lewis and Wiegert 1985, McAllister 1995	Affect-based trust	The emotional bonds between individuals induce trust.
Lewis and Wiegert 1985, McAllister 1995	Cognition-based trust	Information gathered through the interaction sets the trust.
Dasgupta 1988, Williamson 1993	Calculative-based trust	Trust is the result of rational calculation of the cost and benefit.
Williamson 1993	Familiarity-based trust	Past interaction results in trust.
Lewicki and Bunker 1995	Knowledge-based trust	Trust is based on the accumulation of relevant knowledge
Lewicki and Bunker 1996	Deterrence-based trust	Trust is built because of consistency of the behavior. Consistency is sustained by the threat of punishment.
Coutu 1998	Institutional-based trust	Individual's trust is affected by the norms and rules of surrounding institution.

Table 1. *The various sources of trust in traditional market*

Calculative-based trust, believing that self-interested individuals build trust based on the rational calculation of the payoffs and costs, is thus suggested as the most prevalent source of trust in online transaction (Ba and Pavlou 2002). Personal interaction and repeated transaction of the same parties are

not necessary conditions for the form of calculative-based trust. Instead, trading parties build trust based on the calculation of the expected payoffs. If one party's expected incomes of cooperation exceeds the expenses, then he would choose cooperation. Knowing this calculation, the opponent (trading partner) will judge whether he is a trustable partner or not.

The concept of calculative-based trust has enjoyed widespread and growing acceptance (Williamson 1993). However, the theoretical foundation has received little attention. There are only two studies that build the theoretical model of calculative-based trust. Dasgupta (1988) specifies the calculative-based trust in a game theoretical context. He uses a one-shot game model to present when and why a self-interested agent will cooperate and show the trust. Although he claims that an infinitely repeated game might show how dishonest sellers go against their short-term interests to invest in the reputation and thus win the long term interests, he does not model and analyze an infinitely repeated game. Williamson (1993) also uses one-shot game to explain that trust is built in a calculative way.

This paper develops the work of the Dasgupta (1988). Considering trading parties in online transaction are more likely to transact repeatedly, we build a calculative-based trust model to analyze how strangers in online virtual community establish trust relationship in an infinitely repeated game setting. A consumer chooses one of the three strategies: transact honestly, transact dishonestly, and does not participate based on the calculation of the payoffs for each strategy. This paper also investigates the effect of these strategies on social welfare. These results give policy implications on how to control the cheating behavior of the communities without harming social welfare.

The rest of this paper is organized as following: Section 2 presents the model. Section 3 analyzes the comparative static of social welfare. Section 4 highlights our findings followed by the conclusion part in section 5.

2 INFINITELY REPEATED GAME MODEL

2.1 Online transaction model setting

Consider an online community where customers and sellers meet randomly for infinitely repeated transactions. From a consumer's point of view, some sellers are not honest and consumers may meet these sellers by chance. To capture this possibility, we assume that there are two types of sellers in this virtual community: type I sellers always play honestly, and type II sellers always play dishonestly. The proportions of type I and type II sellers in the population are β and $1 - \beta$ respectively. We assume that the value of β is common knowledge. Consumers have three choices: transact honestly (H), transact dishonestly (D) and quit the transaction (Q). They will do a once-and-for-all decision among the three strategies at the beginning of the game and do not change as long as the transactions continue. Customers do not know the exact type of the sellers in each encounter. A consumer makes his decision based on surplus calculation.

2.2 Payoffs of one-shot game

We begin with the consumers' payoffs in one-shot game. Figure 1 quantifies the amount of value that a consumer gains during the transaction. If a consumer gets the good without paying, he can gain the maximum payoffs, which is defined as l here. Suppose a is the payoffs of a consumer in normal transaction where the consumer pays the money and gets the good. Therefore it can be inferred that the transaction price is $l - a$. This transaction price is different according to different consumers because online community can use different rebates to differentiate the consumers. The production cost of the good to the seller is defined as c . As one can see from Figure 1, $0 < c < l$ and $0 < a < l$.

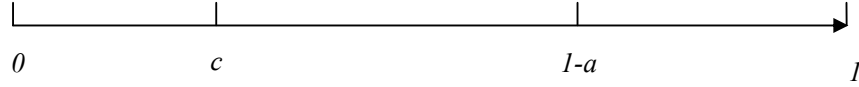


Figure 1. The payoffs during the transaction

Table 2 illustrates the payoffs for consumers and sellers. A consumer can choose H, D or Q, which are the three rows. And he may encounter a Type I or Type II seller, which are the two columns. Each cell in the table has two numbers which represents payoffs for consumers and sellers respectively.

		Seller	
		I (β)	II ($1-\beta$)
Consumer	H	$a, 1-a-c$	$-(1-a), (1-a)$
	D	$1, -c$	$0, 0$
	Q	$0, 0$	$0, 0$

Table 2. Payoffs matrix of consumers and sellers

2.3 Payoffs of infinitely repeated game

For the infinitely repeated game, suppose that the discount rate is δ and a consumer believes the probability of successful cheating is γ . The consumer expects that with the probability of $1-\gamma$, the dishonest behavior is caught and he is fined L . Since this is an online market, consumers can change their ID easily and play the game again with the same strategy. Some consumers are risk-aversion and others are risk-seeking. As a result, we assume that γ is evenly distributed between 0 and 1.

With all these assumptions, a rational consumer calculates his payoffs at the beginning of the infinitely repeated game. He will choose the strategy that can bring the maximum benefits. The expected payoffs for different strategies are listed in Table 3.

Strategies	Expect payoffs
H	$H = \frac{\beta a - (1-\beta)(1-a)}{1-\delta}$
D	$D = \frac{\beta[\gamma - (1-\gamma)L]}{1-\delta}$
Q	$Q=0$

Table 3. Expected payoffs of different strategies

Let $H > Q$, we get $a > 1-\beta$. In this case, consumers would prefer H to Q.

Let $D > Q$, we get $\gamma > L/1+L$. In this case, consumers would prefer D to Q.

Let $H > D$, we get $\frac{\beta a - (1-\beta)(1-a)}{1-\delta} > \frac{\beta[\gamma - (1-\gamma)L]}{1-\delta}$. Solve this inequality, we can get that $a > \beta(1+L)(\gamma-1) + 1$. In this case, consumers would prefer H to D.

Since consumers are evenly distributed in two dimensions a and γ , we can see the population of consumers who choose different strategies in Figure 2.

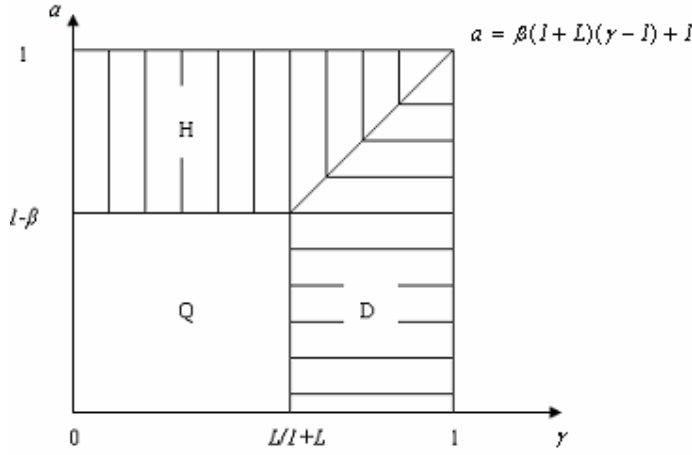


Figure 2. The strategy choices of consumers

Consumers in the area with vertical line choose to play H. Consumers in the area with horizon line choose to play D. Consumers in the area of blank choose to play Q.

3 SOCIAL WELFARE

Now we link consumers' strategies to social welfare. Social welfare in this model is the sum of consumers' surplus, the sellers' profits and the government revenue from the fine of the cheating consumers.

The calculation of consumers' surplus and the sellers' profits are straight forward. We state here how to calculate the government revenue. From the buyers' perspective, the probability of being caught for cheating is $1 - \gamma$. This is an endogenous variable which is different according to different buyers. However, the real probability of being caught for cheating is fixed in the society, which is an exogenous variable. Suppose the actual probability for a dishonest consumer to be caught is $1 - \hat{\gamma}$. The government revenue will be $L(1 - \hat{\gamma})$ multiplied by number of consumers playing D.

To calculate social welfare, we firstly sum up consumers' surplus, sellers' profits, and government revenue for each cell in Table 2. Then each sum is multiplied by the number of consumers and sellers playing that cell. The number of consumers of each cell is computed using Figure 2. Finally, the total welfare of the society is calculated as the sum of the welfare of each cell.

Denote W_{AB} to be partial welfare for the consumer plays A and encounters type B seller. For example W_{HI} , represents social welfare of consumer playing H while encountering a type I honest seller.

$$W_{HI} = \beta(1-c) \int_{1-\beta}^1 f_{(a)} da = \beta(1-c) \int_{1-\beta}^1 \frac{a + \beta + \beta L - 1}{\beta + \beta L} da = \beta(1-c) \frac{1+2L}{1+L} * \frac{\beta}{2}$$

$$W_{HII} = 0$$

$$W_{DI} = \beta[(1-\hat{\gamma})L + (1-c)] \int_{\frac{L}{1+L}}^1 f_{(\gamma)} d\gamma = \frac{2-\beta}{2(1+L)} \beta[(1-c) + (1+\hat{\gamma})L]$$

$$W_{DII} = 0$$

$$W_{QI} = 0$$

$$W_{QH} = 0$$

$$\begin{aligned} Totalwelfare &= W_{HI} + W_{HH} + W_{DI} + W_{DH} + W_{QI} + W_{QH} \\ &= \beta(1-c) \frac{1+2L}{1+L} * \frac{\beta}{2} + \frac{2-\beta}{2(1+L)} \beta[(1-c) + (1+\hat{\gamma})L] \end{aligned}$$

Now, we perform comparative statistic analysis as following:

$$(1) \frac{\partial Totalwelfare}{\partial \beta} = \frac{\beta(1+2L)(1-c)}{1+L} + \frac{(1-\beta)[(1-c) - (1-\hat{\gamma})L]}{1+L} > 0$$

With the increase of β , social welfare will increase.

$$(2) \frac{\partial Totalwelfare}{\partial L} = \frac{\beta^2(1-c) + (2-\beta)\beta(c-\hat{\gamma})}{2(1+L)^2}$$

Interestingly, when $\hat{\gamma} < \frac{\beta - 2\beta c + 2c}{2 - \beta}$, we can get $\frac{\partial Totalwelfare}{\partial L} > 0$, which means that social welfare increases with the increase of penalty L .

However, when $\hat{\gamma} > \frac{\beta - 2\beta c + 2c}{2 - \beta}$, we can get that $\frac{\partial Totalwelfare}{\partial L} < 0$, which means that social welfare decreases with the increase of penalty L . One can prove $0 < \frac{\beta - 2\beta c + 2c}{2 - \beta} < 1$ without much difficulty.

$$(3) \frac{\partial Totalwelfare}{\partial c} = -\frac{\beta^2(1+2L) + (2-\beta)\beta}{2(1+L)} < 0$$

With the increase of c , social welfare will decrease.

4 DISCUSSION

4.1 Finding 1: With the increase of β , social welfare will increase.

As shown in the comparative statics result 1, the increase of β will increase the social welfare. One can see the result in Figure 3, when β increases, the line $a = 1 - \beta$ moves down. This result is quite desirable for a society. Not only some players change from D to H, but also some players who quit the game previously choose to play H now, which will increase the welfare of the whole society.

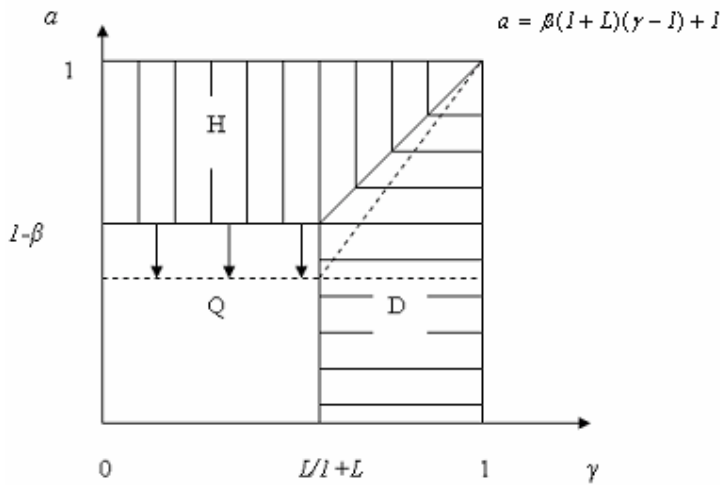


Figure 3. An increase of β

4.2 Finding 2: The increase of L will have opposite impact on the social welfare according to the value of $\hat{\gamma}$.

One can see from the comparative statics result 2: when the actual successful cheating probability $\hat{\gamma}$ is relatively small ($\hat{\gamma} < \frac{\beta - 2\beta c + 2c}{2 - \beta}$), increasing the penalty L of cheating consumers will increase social welfare. However, when $\hat{\gamma}$ is relatively large ($\hat{\gamma} > \frac{\beta - 2\beta c + 2c}{2 - \beta}$), increasing the penalty L of cheating consumers will decrease social welfare. This result is very interesting. As shown in Figure 4, when L increases, the line $\gamma = \frac{L}{1+L}$ moves to the right. Although some consumers playing D change to play H, the total number of consumers participating in the game (H and D) will decrease. When $\hat{\gamma}$ is relatively large, the government revenue is low because only small portion of cheating consumers are caught. At the same time many consumers are forced to quit the game because of the high penalty. As a result, social welfare will decrease as L increases. When $\hat{\gamma}$ is relatively small, most of cheating consumers will be caught and fined L , thus the government revenue will increase which compensates the decrease of welfare caused by consumers quitting the game. Consequently, the higher the level of L , the higher the social welfare will be.

This has an important policy implication to manage the online communities. In the real world, $\hat{\gamma}$ is comparatively high, it is difficult to punish majority of cheating consumers because of the anonymous online transaction environment and the lack of relevant law or policy. If we simply increase the penalty L to forestall the cheating behavior of consumers, social welfare will be lowered because some consumers will quit the transaction. Only when most cheating behaviors of consumers are caught, can the increased L benefit social welfare.

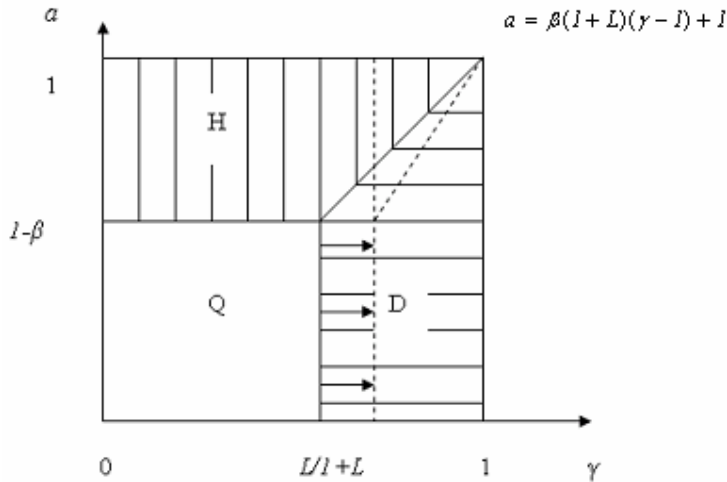


Figure 4. An increase of L

4.3 Finding 3: Combining the real world competition with the first result, we can explain how a positive feedback is formed in big online communities.

In the real world, the honest ratio of sellers in different online communities is decided by the visiting volume. For a same seller in different communities, the seller is more likely to transact honestly in communities with more potential consumers because the long term profits of behaving honestly are increasing according to the number of potential buyers. In other words, the reputation is more precious in a bigger community. Therefore, we can say that the size of the community is related the value of β . Furthermore, our first result proves that the increase of β will result in more consumers participating the transactions. This triggers the positive feedback: the increase of the visitors cause the increase of β , the increased β in turn attract more people to participate in the transaction. Though consumers enter the transaction for their own benefits, it will increase the payoffs of sellers. Meanwhile, the sellers choose to transact honestly for their own benefits, but it will increase the payoffs of consumers. As a result, the positive feedback forms and the strong become stronger and the weak becomes weaker.

5 CONCLUSION

This paper used a game-theory model to present how strangers in online virtual community build trust relationship based on the calculation of their own benefits. After calculating their own benefits, some consumers choose to transact honestly. Sellers trust that consumers will do so based on the same calculations. In the online transaction environment where buyers have no idea of sellers' type, calculation of one's own benefit seems to be the only possible source of trust. Understanding the calculative-based trust can help establishing and maintaining trust relationship between buyers and sellers. The calculative-based trust is the basic motivation for the participation of online transaction where two strangers meet randomly.

Relating the buyers and sellers' strategies to social welfare, we find that encouraging consumers to enter the transaction is more important than forestalling their cheating behavior. A desirable solution to keep the effectiveness of the online community is to increase the percentage of honest sellers, which can both decrease the cheating behavior of the consumers and increase the welfare of the community. Furthermore, our results showed that when it is hard to catch the majority cheating consumers, the increase of fine may lower social welfare.

This study contributes to the understanding of the trust build in e-commerce. Academically, a calculative-based trust model was built in the e-commerce environment. Practically, we provided some policy implications to manage the online community.

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