

## Chapter XIV

# Reputation, Reputation System and Reputation Distribution — An Explorative Study in Online Consumer-to- Consumer Auctions

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### ABSTRACT

*Reputation is an important organization asset, particularly in the era of e-commerce. In an online consumer-to-consumer (C2C) auction market, a trader's reputation sends an important signal to his trading partners in their decision-making, due to the nature of the anonymous transaction process. While prior research has shown that reputation systems, such as eBay's*

*Feedback Forum, facilitated buyer-seller transactions, several fundamental issues with these mechanisms remained unclear. Based on the empirical reputation data directly collected from eBay.com, we find that the distribution of reputation scores can be approximated in a geometric function. We analyze the formation of the distribution with a stochastic process model. The computer simulation using the Monte Carlo approach further validates the findings of the empirical study.*

## INTRODUCTION

The advent of e-commerce has brought about a new era, in which our daily life has undergone profound revolutions in social and economical aspects. However, Internet fraud in online marketplaces, rooted in the effect of information asymmetry (Akerlof, 1970), has been wearing away consumer benefits from the e-commerce. By the end of year 2000, about 31% of online American users participated in online auctions, and 41% of them encountered fraud-related problems. According to fraud.org (<http://www.fraud.org>), the total loss in 2001 from Internet fraud almost doubled that of 2000. The average loss per person increased about one third in the same period. In the last three years, online auction has remained the leader of 10 top scams. In particular, the fraud in “Nigerian money offers” increased nine times in 2001 (see AARP.org, 2002). As online auction traders have been faced with vital risks from frauds in online transactions, the vulnerable consumer trust could be easily hurt. This could be the main reason why 69% of American Internetters still keep a distance from online auctions (Selis, Ramasastry & Wright, 2001).

Because online trading allows anonymous transactions, an invisible, guileful trader may easily defraud his trading partners to exploit more benefits, and then may change his identity because of the cost in reputation damage. According to Friedman and Resnick (2001), the higher the reputation score, the higher the cheating cost, and the lower the probability a trader will cheat. Therefore, a trader’s reputation sends a critical signal to his trading partner in estimating the risk of trading. To promote safer online trades, some online market providers, such as eBay, have offered online reputation reporting services for its traders. This has led to the fast growth of C2C online businesses. In this chapter, we present the outcomes of an empirical research on online reputation and its distribution, using the data directly collected from eBay.com. The research is intended to examine the nature of reputation, such as its distribution and formation, in order to provide the empirical evidence and basis for further exploring the effect of reputation on perceived risk and trust.

The chapter is organized as follows. First, we present a brief literature review on reputation research; second, we summarize recent research progresses in the online reputation system — a key effort in promoting online markets; third, we report the findings from data analyses; finally, a stochastic process model explaining the

formation of reputation score distribution is derived with the supportive outcomes from the computer simulation using the Monte Carlo method.

## Reputation

Reputation is generally regarded as the impression and assessment of a social entity's esteem or desirability (e.g., Kollock, 1999; Standifird, 2001; Weiss et al., 1999). Although a social entity has many different ways to signal and build its reputation, e.g., through advertising or promotion, reputation is ultimately judged by some external entities rather than the entity itself (e.g., Fombrun & Shanley, 1990; Fombrun, 1996). Reputation signals the consistency of an entity's behavior over a certain period of time. It is a record of the history of an entity's interactions with others. Reputation also manifests whether an entity is willing and able to perform an activity in an expected fashion. This notion is supported by various studies on reputation building and continuous prisoner's dilemma game.

Reputation building is based on the sum of all the past behaviors of the entity, rather than a one-time effort. Reputation can be either positive or negative. A positive reputation manifests all the favorable assessment of an entity, while a negative reputation shows the unfavorable aspects. The potential sacrifice associated with a negative or bad reputation is so high that an entity with a positive reputation is predicted to behave consistently in a favorable manner in the future.

Reputation is a universal topic across many academic fields. A comprehensive summary of the roles of reputation can be found in several studies (e.g., Yoon et al., 1993; Mohamed et al., 2001). In business and marketing strategy studies, a firm's reputation resides in its brand name that carries the image of the firm. A brand name is relied on more heavily than other indicators (e.g., price, physical appearance, retailer's reputation) in judging the quality of a product (Dawar & Parker, 1994). A manufacturer with a more favorable reputation has a higher level of intention to use its own sales force and a lower level of intention to switch sale representatives (Weiss et al., 1999). On the other hand, the lower perception of a representative's reputation motivates a firm to switch to a new representative. A good reputation prevents a firm from being attacked when the potential attacker considers the firm as a minor competitor (Clark & Montgomery, 1998).

In relationship marketing literature, a positive reputation will affect future short-term and long-term marketing success. Reputation has been found to be important, theoretically and empirically, in all business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C) transactions. Regarding the buyer-seller relationship, the seller's reputation has a positive effect on buyer's trust in the seller and buyer's long-term orientation with the seller (Ganesan, 1994). Reputation is positively associated with credible transactions between firms (Herbig et al., 1994). During the ongoing process of interactions, previous favorable transactions strengthen the perception of the firm's reputation in the next round of transactions.

Unlike a firm's reputation, the reputation of an individual person is based on the person's traits and past behaviors, which are usually studied as impression management. Researchers have found that impression is influenced more by the person's negative attributes than his positive attributes (Fiske, 1980). For example, unfavorable information was found to be more influential than favorable information in judging an individual's morality. The term of "negative bias" is used to reflect the effect of negative information on impression ratings (Yaniv & Kleingenger, 2000). According to Yaniv and Kleingenger, unfavorable information indicates conflict between general perception of social norms and a particular person's deviation behavior. The phenomenon of "negative bias" is consistent with "trust asymmetry" (Slovic, 1993), which means that negative events decrease trust far more than positive events serve to increase trust. Yaniv and Kleingenger (2000) suggest that it is easier to lose a good reputation than to gain it.

While people devote much to monitoring their own and others' reputation, they also act to manage their own reputation (Bromely, 1993). Both positive and negative reputations are managed in daily life. Reputation management need not occur in response to any problem related to unfavorable reputation. Social entities with good reputations also manage to maintain and enhance their standings. On the other hand, entities with bad reputations aim to change their present reputations or establish new reputations under new identities.

Researchers are drawn to reputation issues of electronic markets in recent years. In business-to-consumer electronic markets, Internet buyers are found to favor Websites that sell familiar products manufactured by familiar merchants (Quelch & Klein, 1996). The reputation of an online store is positively associated with an online consumer's trust in the store, which further influences the consumer's intention to buy (Javenppa et al., 2000). Unlike conventional reputation of a person or a firm, online reputation is difficult to be evaluated. Because the Internet allows anonymous transactions, traders cannot track the real identities of their transaction partners.

Internet technology is superior to traditional transmission media in several ways to promote the effectiveness and efficiency of business transactions. However, it cannot resolve the problem of information asymmetry. In online auction markets, a buyer does not always have the full knowledge of a business transaction, i.e., the product, the seller, or both. Similarly, a seller does not know the background of a buyer or his credit history. Thus, before a transaction is closed, a buyer does not know whether the products will be the same as described and be shipped with appropriate packaging (Resnick et al., 2000). Meanwhile, a seller does not know whether he can get correct payment from a buyer without errors. Whether a transaction can be successfully conducted depends on whether both parties have good reputation and whether they trust each other.

In the above scenarios, the online reputation associated with a pseudonym created by a trader will critically affect his trading partners' perceived risk in the

transaction and their trust toward the trader. The effect will result in the change of premium price and degree of willingness-to-buy (Kollock, 1999; Ba & Pavlou, 2001). Due to world-wide exposures, a trader's reputation becomes an important asset that is sensitive to the trader's online performance (Tadelis, 1999). An effective reputation system that can record and report traders' reputation scores in the online auction market is becoming a critical fraud-depressing mechanism in promoting and securing online trading.

## ONLINE REPUTATION SYSTEMS

### Reputation Systems

In a traditional context, the experience of interacting with an entity is the basis for judging the entity's reputation. If this experience is shared with other people who will interact with the entity, those people can be benefited. Likewise, if one trader's online transaction experience with another trader is shared it will benefit future traders. Promoting the share of transaction experience can be done through a reputation reporting system, or, in brief, a reputation system.

A reputation system "collects, distributes, and aggregates feedbacks about participants' past behavior" (Resnick et al., 2000). It is built on the assumption that people in future transactions will look back at their partner's transaction history. The reputation system provides incentive for both parties to trust each other and encourages trustworthy behavior online. Because a future trader may lack personal interaction experience with a particular trader, he may rely on public archives of the particular trader to make decisions on transactions. A good reputation assures that a trader will continue to act in a favorable manner and minimize opportunistic behavior. The damaging effect of a bad reputation is so huge that both parties may not risk themselves by cheating the other party. Thus, both parties of a transaction may feel more secure even though the transaction requires a separation of delivery and payment.

Reputation systems can be classified as non-computational and computational (Zacharia et al., 2000). Better Business Bureau Online is an example of non-computational reputation systems, whose main functions are to handle disputes and track complaints. Computational systems range from rating of Web page to rating of peoples. The application domains of these computational systems range from auction sites, expert sites, to product review sites. Further, most retailer Websites provide functions for consumers to rate the products they have purchased. Based on how a reputation is represented, a reputation system can be either positive or negative (Whitmeyer, 2000). A positive reputation system records only a trader's positive reputation, which signals desirable or favorable comments. All the successful transactions are recorded under that trader's name. In a positive system, traders do not want to change their identities because the accumulated reputations cannot be

carried onto a new name (Kollock, 1999). A negative reputation system distributes information of untrustworthy parties and unsuccessful transactions. In such a system, people tend to change their identity as soon as they have negative or bad reputations and are marked as untrustworthy people. This also occurs in positive systems, in which people will change their identities whenever they get bad reputations or their reputations are damaged. Because people of a negative system often change their identities, it is seldom seen a long negative record under a name, and there is a lot of trash information in the system. Currently, most online reputation systems are positive.

### **eBay's Feedback Forum**

One of the most popular and successful reputation systems is eBay's Feedback Forum. Founded in 1995, eBay.com is the world's largest online C2C auction market. There are more than 10 million registered members and over four million items transacted a day. Unlike several other online auction Websites, eBay does not provide warranty or guarantee services for its traders. All the traders assume the inherent risks in the auction process. eBay just works as a central listing catalog of various items and products.

Contrary to common sense that there is a high risk in eBay's system, the fraud and deceit rate of transactions at eBay's site is very low. This could be partly attributed to the proper function of its Feedback Forum. With eBay's Feedback Forum, both buyers and sellers have the chance to rate each other after transactions are completed. The rating is generally related to a specific auction and is designated as a number. A positive comment from a unique trading partner adds one point to the accumulated score, a negative comment reduces one point from the accumulated score, and a neutral comment does not affect the overall score. Every buyer or seller has the overall score attached to his registered user name. Hence, a score of 100 might mean 100 positive comments and no negative comments, or 110 positive comments and 10 negative comments. At different threshold levels, a name is awarded a color star, which marks the number of net positive comments. For example, a yellow star means a rating of 10-99, and a red star means a rating of 1000-9000. To enforce the efficiency of the feedback system, eBay will not allow the existence of a trader with a net negative score of negative four or lower. In addition to the rating, traders can post some specific comments about a transaction, such as "good transaction" or "highly recommended." Future traders can see both feedback scores and written comments of a particular trader they want to transact with. A trader's overall reputation score and the statistics of different types of feedbacks in last six-month, one-month and one-week can be easily accessed from eBay.com (see Figure 1).

In general, a high feedback rating shows that a trader is experienced and has a track record. A low rating indicates either a new trader or an experienced trader who has changed his identity and registered again under a new name. Regarding a single score, a positive feedback score indicates a successful and satisfactory

Figure 1. A seller's reputation profile (the overall reputation score 61 is rated in a yellow star)



transaction. A neutral feedback score may suggest that one party hesitates to rate the other party because of various reasons. A neutral score may be related to slight problems, such as delays and poor communication (Resnick & Zeckhauser, 2001). A negative feedback score is used for very problematic transactions, such as products never shipped, broken products, or counterfeit. However, a negative score does not always indicate that the trader has a bad reputation. It may indicate an unresolved dispute or a fight-back occurred during the transaction process. Hence, a trader's reputation cannot be judged only based on a single negative feedback score. Instead, the ratio of overall negatives vs. overall positives, the situation under which the negative score occurs, or whether the feedback is related to the quality of the item, should be examined. The accumulation process of reputation scores is also interesting, which can be described by an attenuation model (Whitmeyer, 2000). In an attenuation model, each additional single point contributing to the overall rating score is less than the previous single point. The model suggests that the more positive ratings a trader has, the more trustworthy the trader is. However, the effect of each additional rating declines as the total reputation score increases.

Resnick and Zeckhauser (2001) report several interesting findings about general characteristics of traders in eBay.com. First, the study has shown that sellers have higher feedback scores than buyers. Because sellers have more transactions than buyers, they seem to be more experienced traders than buyers. They may have stayed in the auction site longer than buyers do. They may also be professional traders, who make livings by conducting auction transactions. For buyers, the percentage of low feedback scores is much higher than that of high feedback scores. This may indicate that there are not many professional buyers. Further, experienced traders less frequently received negative feedbacks. Less experienced traders are likely to get negative feedbacks. This may imply that experienced traders are more careful with their reputation, because they have already built their reputation over a period of time.

Second, regarding the transactional relationship between buyers and sellers, only 17.9% of all sales involved a buyer and a seller who have done business with each other before. Most seller-buyer pairs have conducted just one transaction during the investigated time period. This may suggest that there is no long-term relationship formed between buyers and sellers, unlike conventional buyer-seller relationships. Buyers are also found to have less problematic feedbacks than sellers. This may be because buyers do not have much ambiguous information communicated with the seller. Sellers, on the other hand, must present information about their items, and may cause misunderstandings with buyers.

Third, over 99% of the feedbacks provided by buyers are positive. Regarding neutral and negative ratings, if an item does not match the description, or if the shipment is slow, neutral, rather than negative, feedback is given. If the item is not shipped after payment, negative rather than neutral feedback is given. Sellers are found to care about their reputation very much. They often write more detailed messages in resolving the dispute with buyers after buyers have issued their negative feedbacks.

Fourth, although some eBay traders do both selling and buying, most are primarily a seller or a buyer. Organizational sellers and buyers are also found in eBay's system. In this way, eBay.com is not only a consumer-to-consumer marketplace but also a business-to-consumer or business-to-business marketplace.

## Effects of Reputation Systems

In general, reputation systems help manage risks and promote cooperation (Kollock, 1999; Resnick et al., 2000). Whitmeyer (2000) reports that when the proportion of cooperators in a population is low, reputation obtained under a tough system will convey the most information for future traders to discriminate cooperator and non-cooperator. On the other hand, if the proportion of cooperators in the population is high, reputation earned in a lenient system will convey the most information. The proportion of honest and dishonest traders in a population must be also examined.

Further, reputation systems also impact transactional price and the formation of trust perception of one party toward the other. Both positive reputation and negative reputation scores have effects on sellers' abilities to command premium prices. Theoretically, the easier to get a reputation, the less the reputation is worth, and the more the price of a transaction is discounted (Whitmeyer, 2000). However, the effect of negative reputation seems to be more salient than that of positive reputation. Sellers with higher positive reputation scores are not found to be able to sell their products at higher prices than will sellers with lower positive reputation scores (Standifird, 2001). This is in consistency with the finding from the study by Resnick and Zeckhauser (2001), which found that it is easier for sellers with better reputations to sell their products but there is no significant boost in price for the two types of products examined in the study.

A strong positive reputation reduces buyers' risk perception and enhances their trust perception only when there is no negative feedback (Ba & Pavlou, 2002). With the introduction of negative feedback, the story is different. The effect of "negative bias" studied in conventional contexts is very significant in online transactions. People with negative feedback scores are at disadvantaged positions in electronic markets. Empirical studies shows that higher negative scores are significantly related to lower bidding auction price in the Internet auction (Lee et al., 2000), and that a negative reputation has a greater impact on the ability of sellers to sell their products at higher prices than a positive reputation (Standifird, 2001). Sellers with higher negative reputation scores are forced to sell their products at lower prices than will sellers with lower negative reputation scores (Standifird, 2001). Potential buyers are more sensitive to negative feedbacks than positive feedbacks when they plan to buy used or refurbished products (Lee et al., 2000). Negative ratings are found to have greater opposing effects than positive ratings in the formation of a buyer's trust perception toward a seller (Ba & Pavlou, 2002).

The reputation also affects traders' decisions to adopt online risk relief service. A risk relief service is provided by a trusted third party, via the Internet, to protect online transactions from fraud, such as online escrows and credit card protection programs (Selis, Ramasastry & Wright, 2001). A risk relief service does not increase trader's trustworthiness, but reduces or eliminates the risk in online trading (Sweeney, Soutar & Johnson, 1999). Hu et al. (2001) investigated the interactions between a seller and a buyer in a C2C online auction, and how an honest trader makes the decision to adopt online escrow service. They propose that reputation scores are significantly associated with perceived risk (Hawes & Lumpkin, 1986). Antony, Lin and Xu (2001) further test the model in a controlled laboratory experiment. In a computer-simulated C2C auction market, subjects conducted many rounds of transactions. With their trading partners' reputation scores constantly shown on the Website, subjects could refer to these scores to decide whether they needed to adopt online escrow service. The analysis shows that the higher the reputation score, the less the perceived risk in the dynamic process.

Although it has been well accepted that the reputation system plays an important role in electronic markets, the nature of reputation score distribution and how the distribution affects online traders' risk decisions have not been fully explored. Based on prior studies, the next section reports some preliminary research findings on these important issues.

## **AN EMPIRICAL STUDY OF ONLINE REPUTATION SCORES**

We randomly collected three sets of traders' reputation profile data from eBay.com. Two sets were for sellers and one set for buyers, all containing overall reputation credits of each account in a whole life cycle, and positive and negative

feedback scores respectively in a six-month window. There were 200 trader records in each set. A trader was classified as a seller (or buyer) when he was selling (or buying) an item in a trade, although he could be a buyer (seller) in another trade. Samples were randomly chosen from several different item categories, such as consumer electronics, clothes, antiques, toys, etc. Seller samples were collected from a few ongoing transactions in each category, and buyer samples were chosen from the ones currently leading the bid in each selected auctioned item. Seller data and buyer data were collected separately in different days without seeking for any connection between the data sets.

The current empirical study is focused more on reputation score distribution and the relationship between different types of feedbacks. Three main findings are reported below.

*Finding 1:* The reputation score can be approximated in a geometric distribution.

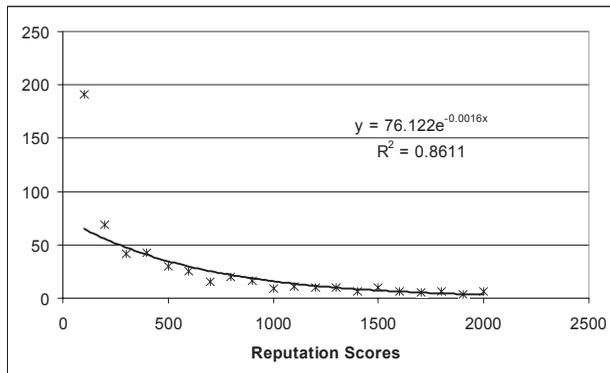
The trend curve of the histogram from reputation scores can be approximated in an exponential function  $y = Ae^{-Bx}$ .  $B = -0.0016$  ( $R^2 = 0.8611$ ) when the sample is classified in a 100-score increment (see Figure 2). This can be converted into a geometric function,  $y' = Ar^{x'}$ , a discrete form, where  $0 < r < 1$ ,  $x' = 0, 1, 2, \dots$ . The statistics from the three sets of data demonstrate the same distribution pattern.

Overall, about one third of traders have reputation scores less than 100; about two thirds of them less than 500; and about 90% of them under 2000 (see Table 1). The overall reputation scores of 534 traders, 89% of 600, range from 0 to 2000.

*Finding 2:* The positive feedbacks can be approximated in a geometric distribution

Figure 3 shows the histograms of positive reputation scores in last six-months for selected buyers and sellers who had less than 1000 positive scores. The trend curve of the histograms matches an exponential function with  $B = -0.0034$  ( $R^2 = 0.8386$ ) for buyers and  $B = -0.0031$  ( $R^2 = 0.8219$ ) for sellers. This outcome implies

Figure 2. A histogram of reputation scores from a pool of 600 traders



*Table 1: The statistics of overall reputation scores*

Data Set	<100	<500	<1000	<1500	<2000	<2500
Buyers	28.50%	61.00%	77.00%	86.50%	93.50%	95.00%
Sellers 1	28.50%	59.00%	75.50%	83.00%	86.50%	88.50%
Sellers 2	38.50%	67.50%	77.50%	84.00%	87.00%	89.00%
Average	31.83%	62.50%	76.67%	84.50%	89.00%	90.83%

that the distribution of positive feedbacks also fits a geometric function as discussed in Finding 1.

The statistics shows, based on current data sets, about a half of the traders have received positive feedbacks less than 150. About 90% sellers’ positive feedbacks fall in the interval from 0 to 1050 and 90% buyers’ positive feedbacks range from 0 to 900. The positive reputation scores of 95% traders (sellers and buyers together) are less than 1850.

*Finding 3:* The ratio of negative and positive feedbacks can be approximated in a geometric distribution.

How are trader’s negative scores distributed?. Data analysis shows that the trend curve of the histogram from negative reputation rate, i.e. the ratio of negative feedbacks and positive feedbacks, can be approximated in an exponential function (see Figure 4). This lines up with Findings 1 and 2 that the discrete form for the distribution of negative/positive feedback ratios is a geometric function.

*Figure 3. A histogram of trader’s positive feedbacks in a six-month period*

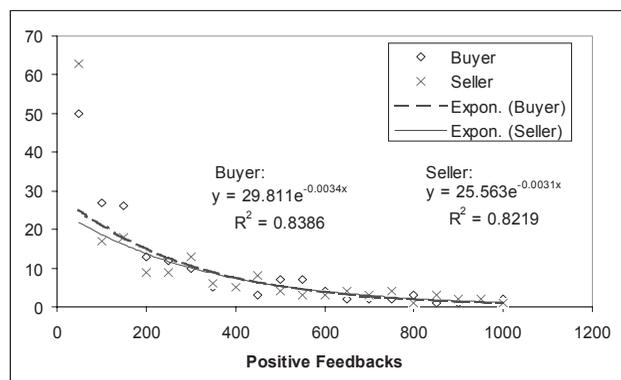
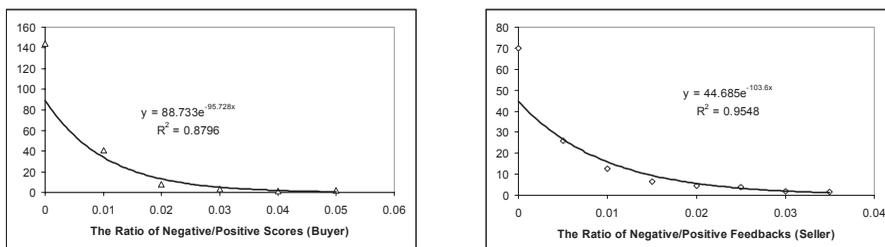


Figure 4. The histograms of negative/positive feedback ratios



(a) Buyers

(b) Sellers

## A STOCHASTIC PROCESS MODEL OF REPUTATION SCORING

In this section we propose a stochastic process model to further explain why the distribution of reputation scores is exponentially shaped, as found in the above empirical study. The model has been further tested in computer simulations using the Monte Carlo approach.

### Moral Traders Versus Opportunistic Traders

We assume that there are two types of traders in electronic markets, the *moral type* and the *opportunistic type*. These traders are distinctive with regard to their self-interest attitudes. This categorization of trader follows a similar scheme in economics literature (Kreps, 1990); traders are classified as the types with guile and without guile. In this study, we assume that a moral trader will never cheat under any circumstances, and an opportunistic trader will cheat when there is an opportunity that increases his benefits.

A trader's type, inherent as an ethical nature, can only be reflected through his trading strategy. The type is not identifiable without finalizing a transaction, because a potential opportunistic trader's trading strategy is subject to change in a specific transaction. Therefore, a trader's honesty is subject to change from trade to trade and can only be justified after a transaction is done.

A trader in a specific transaction can be an honest trader or a cheater according to their ethical behavior. In any transaction, a moral trader will always act honestly. An opportunity trader can choose between an honest trader and a cheater in different transactions, depending on which action benefits him the best. Here, the opportunistic trader has taken into account the opportunity cost being caught and punished. Fearing of the loss from the punishment, an opportunistic trader may have to behave honestly. In this way, a group of honest traders is composed of moral traders who are naturally honest, and opportunistic traders who decide to be honest because this will bring them better benefits.

We also assume that a reputation score has a value to its bearer. Opportunistic traders are fully aware of the consequences if they make a fraud. One of the costs to them is the damage of the reputation, because a good reputation score could bring them better benefits in future trades. Therefore, how to value their reputations becomes one of the key factors in opportunistic traders' decision-making. Once the reputation of an online identity has been damaged, a rational trader will naturally consider discarding the pseudonym and starting a new one. This causes the loss of previously accumulated reputation credits, but he may be compensated by the illegal income from the fraud.

In general, we define *irresolvable dispute* for the scenario that a severe negative feedback or even a lawsuit will substantially ruin a trader's reputation. This includes two cases: the trader defrauded his trading partner, or more broadly, any violations to the online contracts, such as breaking the contract by stopping payment or shipment without the consent from the trading partner; the trader did not commit any fraud, but his trading partner threw him in an adverse status that would damage his reputation totally. In either of these two cases, the trader will consider restarting a new account because his current reputation no longer brings him as good benefits as a new one.

### Stochastic Process Model for the Reputation Scoring System

Based on the above discussion, we propose a reputation-scoring model to explore the formation of the reputation score distribution. Consider a simplified reputation scoring system with only a positive score for a trader:

- When a trader initially participates in an online auction market, his score is 0;
- The trader's score increments one point after he has transacted honestly in a trade;
- The trader's score is reset to 0 if either he naturally quits from the market or he has cheated; and
- Assume that all traders have the same probability to abort their accounts at every level of reputation score.

This reputation scoring system can be modeled as a discrete-time Markov chain (Ross, 1997).

Define a stochastic process  $\{X_n, n = 0, 1, 2, \dots\}$  that takes on a countable number of possible values. Denote  $\{0, 1, 2, 3, \dots\}$  the score state set,  $\{p_0, p_1, p_2, \dots\}$  the distribution of the score, and  $q_i = P\{X_n = i | X_{n-1} = i-1\}$  the probability of the reputation score increments one, where  $i > 0$  and  $0 < q_i < 1$ . Then:

$$p_0 = \frac{1}{\sum_{i=1}^{\infty} (\prod_{j=1}^i q_j)} \text{ and } p_i = p_0 \prod_{j=1}^i q_j, \quad i = 1, 2, \dots$$

If  $q_i = q \forall i$ , i.e., the probability that a trader abort his current account is irrelevant to the reputation score, when  $n \rightarrow \infty$ :

$$p_0 = 1 - q \text{ and } p_i = q^i(1 - q), i = 1, 2, \dots$$

It clearly shows that  $X = \lim_{n \rightarrow \infty} X_n$  has a geometric distribution, the discrete form of exponential distribution.

When we assume that a trader's reputations score is naturally reset to 0 if he did not trade in last six months, this model can explain the distribution of reputation scores in a six-month window.

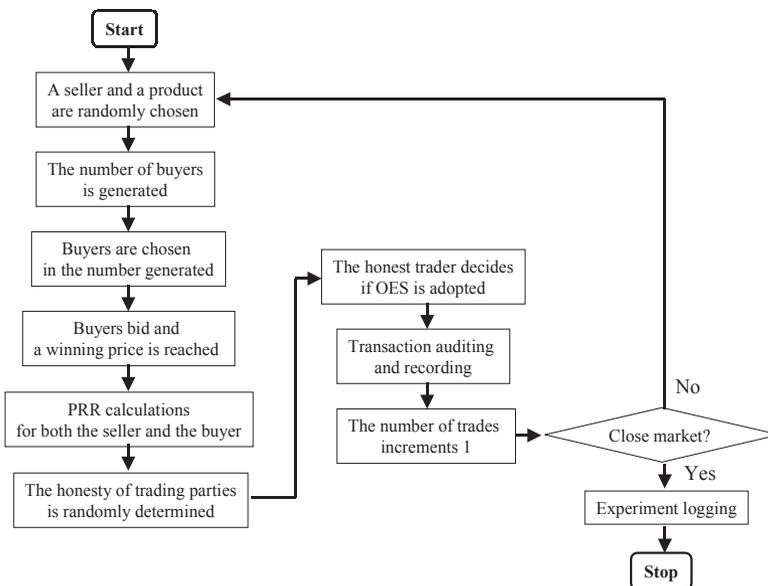
### A Monte Carlo Simulation of Reputation Scoring

We tested the above reputation model in a simulated C2C auction system, in which virtual traders were set up to use online escrow service (OES) to protect their transactions. In Figure 5, PRR is an abbreviation for *perceived risk rate* (Hu et al., 2001), a subjective probability evaluating the risk that a fraud may happen in a trade.

The system starts from a given number of traders. At the very beginning, every trader's reputation score is initialized as a zero. The following parameters are randomized in each trade:

- The item to be sold, which is a specific merchandise chosen from a set of products;
- The seller chosen from a trader pool;

Figure 5. A flow chart for the C2C auction simulation



- The number of buyers bidding for the item;
- The perceived value of the underlying product for the buyer and the seller;
- The winning price; and
- The type of traders, either the moral type or the opportunistic type.

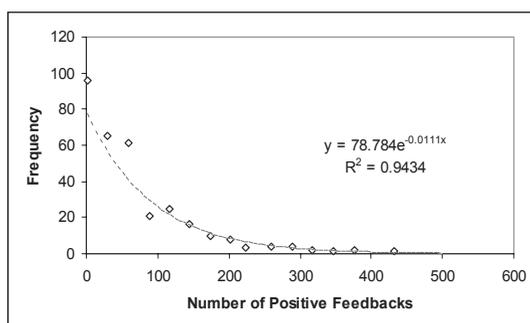
Honest traders make decision on how they trade and whether they need a trusted third party's protection for online frauds, which are randomly generated. A trader is scored regarding whether he behaves honestly or not. If a trader cheats, his score will be reset to zero, meaning he will escape and restart with a new appearance. If he trades honestly, his score will be increased by one. There is no negative reputation scoring in this simplified simulation system, because negative scores are considered as resolvable disputes not as frauds.

Figure 6 is a histogram of reputation scores from 320 traders after 200,000 trades were run in the simulation system. The trend curve in Figure 6 is consistent with the one as shown in Figure 2. An adjusted logarithm of reputation scores,  $y = \ln(x + 1)$ , has a linear-like decreasing curve and further supports the distribution. Although  $A = 78.784$ ,  $B = 0.0111$  in Figure 6, they can be calibrated by changing a few parameters. Therefore, the reputation scores can be approximated in a geometric distribution.

## CONCLUSIVE REMARKS

This chapter is based on our previous research work (Lin, Li & Huang, 2002). The findings in the reputation score distribution support the study in the game-theoretic model between moral traders and opportunistic traders as conducted by Hu et al. (2001). With the approximated distribution of reputation scores, further computer experiments will have a solid background to calibrate other important parameters, such as those for the calculation of perceived risk.

Figure 6. Histogram of reputation scores after 200,000 transactions (trader samples: 320 virtual traders including buyers and sellers)



While reputation systems provide significant benefits to the development of online transaction markets, there are various inherent problems regarding the reliability of these systems (Dellarocas, 2001; Zacharia et al., 2000). Resnick et al. (2000) summarize several problems in reputation expression, distribution, and aggregation. Online traders may not have the incentive and intention to spend extra time providing feedbacks. They may also have the apprehension of being evaluated and evaluating others, so they do not post any negative feedback. Traders may also intentionally provide unfairly high or low ratings (Dellarocas, 2001) toward a specific person. The sellers may also perform “discriminatory behavior,” providing favorable services for one group of buyers and unfavorable services for another to get inflated ratings from the favorable group of buyers (Dellarocas, 2001). Additional insights are expected to explain the important issues of the reputation distribution with the imperfections of current reputation systems.

Further research can emphasize on the validation of the research findings from consumer behavior perspectives, with the aim to study the theoretical implications of the reputation distribution with mathematic modeling techniques. Specifically, the properties of negative feedback scores are not well studied. Negative feedbacks are actually not negative enough in eBay.com. In fact, if we look into the comments and the final settledown associated to each negative feedback we can find that most of negative feedbacks are finally resolved and many were caused by third parties, such as a shipping company which did not deliver the item on time. Since the experience and risk attitude vary from trader to trader, the real effect of negative feedbacks may also change. Furthermore the correlation of negative feedbacks with other factors, such as overall reputation credits, is to be studied for better understanding of the nature of negative feedbacks.

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