Perceived Risk and Escrow Adoption: An Economic Analysis in Online Consumer-to-Consumer Auction Markets[1]

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Abstract

Online escrow is an emerging trust service in consumer-to-consumer auction markets for protecting online traders from Internet fraud. This paper is intended to study the effect of traders' perceived risk on the adoption of online escrow service. The paper establishes decision-making models for both the honest trader and the monopolist online escrow service provider. Perceived risk rate, a dynamic measure of perceived risk for online trades, is introduced to link two decision-making models together. A calculative model for PRR is proposed and the primary outcomes from the computer simulation for PRR measurement are presented.

1. Introduction

In the past several years, commercialized activity on the World Wide Web has brought about leaps in electronic commerce. In particular, customer-to-customer (C2C) online auction has virtually turned every Internet user to a potential trader. The fast growing revenue from C2C business, such as eBay, has shown a promising future of the e-commerce. However, the increasing number of Internet frauds is appearing as the key factor that prevents potential traders from trading online. According to the Internet Fraud Watch operated by the National Consumers League, online auction sales remained the number one aching for Internet fraud in 1999, increasing from 68% of the frauds reported to the Internet Fraud Watch in 1998 to an overwhelming 87% in 1999.[2] Although this figure dropped back to 79% in 2000, the average loss per person rose from $310 in 1999 to $412 in the first nine months of 2000, indicating the deterioration in online trading safety. The above statistics exerts two effects on online traders. First, it imposes a vital risk to them from the high likelihood of losses caused by fraud. Second, it could significantly hurt the "still vulnerable" consumer trust towards electronic markets. As a consequence, online auction is still an uncharted territory to many.

Recently, online escrow is emerging as an important type of trusted third party (TTP) in Internet-based auction marketplaces.[3] Online escrow service providers (OESP), such as Tradenable (www.tradenbale.com), have become major players in protecting online transactions from Internet fraud. Online escrow service provider acts as a TTP in

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[2] A figure from the Internet Fraud Watch (http://www.fraud.org/welcome.htm) operated by the National Consumers League under the incomplete statistics shows that consumers lost over $3.2 million to Internet fraud in 1999 in incident reports.

[3] See http://news.cnet.com/news//0-1007-200-344899.html?tag=st.ne.1.srchres.ni and http://news.cnet.com/news//0-1007-200-1639332.html?tag=st.cn.sr.ne.3

an online auction, providing secure methods for transferring items and payments to both parties. Therefore, online escrow services (OES) have drawn special attention from most C2C auction businesses.

Internet-based auction marketplaces are characterized by asymmetric information (Choi et al 1997), meaning that the transacting parties do not have the same information (Akerlof 1970). Among the many aspects of asymmetric information, two are closely related to online frauds: one is the uncertainty of the identity of the online trader; the other is the uncertainty of the merchandise quality. Online traders can easily remain anonymous or change identities. In online C2C auction markets where numerous individuals participate, it is nearly impossible to bind one identity to one trader. Fraud attempts are not directly observable to honest traders. Since honest traders are unable to observe the honesty of their trading partners, perceived risk (Cunningham 1967; Grewal 1994; Clemen 1996; Beach 1997) plays a critical role in trading decisions. In recent study on economic modeling of OES (Hu et al, 2000), perceived risk plays an important role in decision-making of online escrow service adoption. Complementary to perceived risk, trust has been extensively studied in the application of electronic commerce. For example, Kollock (1999) explores endogenous solutions (e.g., Feedback system in eBay) to the problems of risky trade in electronic markets. Lee and Yoo (1999) focus on the problem of quality discovery in electronic trading of physical goods. Ba et al (1999) design a TTP that can facilitate trust building in the online environment by binding trading agents' reputation with their online identities. Recently, the relationship between perceived risk and trust is becoming an important research topic. It has been argued that securing online transactions with trust services provided by TTP can eliminate the effect of perceived risk, and therefore increase the social welfare in Internet-based electronic markets (Chircu et al, 2000; Resnick et al, 2000; Friedman and Resnick, 2001).

This paper is intended to study the effect of perceived risk on OES adoption in Internet-based C2C auction market using both theoretical and experimental approaches. Section 2 defines perceived risk rate, a measure of honest trader's risk perception in C2C auction markets that involve traders, cheaters and online escrow service providers. In Section 3, an honest trader's decision-making problem is discussed and online escrow adoption criteria are derived. This then leads to a monopolist OESP profit maximization problem in Section 4, which leads to the issue of perceived risk rate estimation. Section 5 briefly introduces a PRR measurement model and presents primary outcomes from the simulation of PRR.

2. Agents in Online Auction Marketplaces with Online Escrow Services

There are three types of agents in an Internet-based auction marketplace with online escrow services – two types of traders: honest type and cheating type - and OESP. An OESP's goal is to maximize the expected profit from the online escrow service by designing the best OES fee scheme that can leverage the usage of the OES. An honest trader (referred to as "she") maximizes her expected utility by deciding whether or not to adopt the OES to prevent possible Internet frauds. A cheater (referred to as "he") maximizes his expected utility by determining whether to cheat under different circumstances. Cheaters know that the OES can protect honest traders from Internet fraud.

An online escrow service provider operates by holding the buyer's payment. The seller ships the merchandise to the buyer only after the buyer has paid to the OESP, implying that a fraudulent payment can be detected. The payment is released to the seller when the buyer has inspected and accepted the seller's merchandise. If a buyer is unsatisfied with the merchandise, the merchandise will be returned to the seller, and the payment is refunded to the buyer from the OESP. Escrow service fee is usually based on the transaction amount and the method of payment used by the trader.

Table 1: How online escrow benefits traders

When the trader is a buyer	When the trader is a seller
1) Enables the buyers to inspect the merchandise before the seller is paid; 2) Gives the buyer the flexibility of multiple payment options and the access to a trusted source holding those payments.	1) Provides protection against fraudulent credit card, insufficient funds and credit card charge backs; 2) Allows to accept multiple forms of payment without the expense of a merchant account, such as credit cards, checks and money orders; 3) Attracts buyers who otherwise may be wary of conducting business with strangers.

In addition to the benefits of online escrow listed in Table 1, we assume that online escrow can effectively protect trades from fraud and facilitate transactions. This implies that *cheaters never initiate the OES, or, conversely, if a trader adopts online escrow, she must be an honest trader.*

An honest trader's decision to adopt an OES is dominantly affected by her risk perception in a trade since her objective is to maximize the expected utility. We define the risk level that a trader estimates the likelihood of fraud, before the type of trading partner is identified, as perceived risk rate (PRR). PRR is a subjective measure from a trader's perspective for the likelihood her trading partner may cheat. It depends on several mixed factors: the Internet fraud rate, a trader's experience on Internet losses, either direct or indirect, the trader's instinct feeling about the trading partner's honesty, the amount of the final trade transaction, etc. The Internet fraud rate is an objective factor and is uniformly informed among all traders. All other factors are trader- or trade-specific, and subjective to the trader's and/or the trade's specific characteristics. So, PRR varies from case to case, trader by trader, and is significantly affected by the information a trader possesses. It directly affects a trader's decision-making in buying or selling as well as in adopting online escrow.

Although PRR is deterministic to a trader involved in a given trade, it is a random variable to an OESP because the heterogeneity of traders imposes stochastic properties to PRR levels. Denote the trade set as I. Let ξ_i be the random variable for an arbitrary trader's PRR in trade $i \in I$ before the decision of OES adoption is made. The PRR distribution function in trade i from an OESP's viewpoint can be defined as:

$$F_i(x) = Prob\{\xi_i \geq x\} = \int_x^1 f_i(s)ds \qquad (1)$$

where $f_i(\bullet)$ is PRR's density function in trade i.

$F_i(x)$ is the probability that a trader's PRR regarding trade i is greater than x. Given a PRR distribution, as x increases, fewer traders will adopt OES for trade i, i.e. with less probability they will use OES for trade i.

3. An Honest Trader's Decision-Making Model

The following are notations to be used in the decision-making model for an honest trader:

p_i – trader's PRR when no online escrow is used

q_i –the likelihood that an honest trader believes that a cheater still cheats when she adopts online escrow

M_i – the transaction amount in trade *i*

V_i^b – buyer's net utility value of the property to be purchased in trade *i* excluding other costs, such as shipping

V_i^s – seller's reservation value of the property being sold in trade *i* excluding the shipping fee and other costs

U_{i0}– trader's expected utility from trade *i* without paying for online escrow

U_{i1}– trader's expected utility from trade *i* when paying for online escrow

r – the rate of escrow service fee, based on the percentage of the transaction amount.

Assumptions:

1) An honest trader's utility is defined as an expected net monetary value from the trade weighted by estimated PRR.

2) The honest trader is aware of that her trading partner could be an honest trader as well, or a cheater. The trader can opt for using or not using online escrow to optimize the expected utility from the trade.

3) If an OES is to be adopted in a trade, it must be under consensus of both traders involved in the trade. The payment accordingly sent to OESP covers the costs for both the merchandise and the OES.

4) If an Internet fraud happens, the loss is assumed to be completely unrecoverable in the transaction amount for an honest buyer or in the value an honest seller reserves at the time being, regardless whether the cheater is discovered or not, or whether the loss will be recovered later.

5) No substitution effect is considered regarding other risk-reduction choices, such as insurance.

If the trading partner initiates the OES, the trade is therefore secured without the honest trader's cost in the OES. In an alternative case that the trading partner does not initiate online escrow, the honest trader must consider if she will use online escrow to protect her benefits from fraud. The honest trader has to take into account the extra escrow service fee charged by OESP. This is an opportunity cost: If the trading partner is also honest, using online escrow is unnecessary. However, if the trader does not adopt online escrow she will suffer a total loss if the trading partner is a cheater.

The trader's decision tree is shown in Figure 1 with the payoffs listed in Table 2. Although each trade may incur certain amount of overhead cost, such as trader's effort, we assume it is negligible to simplify the comparison between different payoffs. There are three decision-making points for the honest trader, the trading partner, and nature that controls the nodes under "uncertain point" (Kreps 1990). At the "uncertain point", the honest trader may confront a cheater with subjective probability p_i, which is her estimate of PRR. The dotted line connects two rectangular nodes for the trading partner if he is a cheater. It is obvious if the honest trader does not adopt the OES, a cheater will definitely cheat. If the honest trader adopts the OES, a cheater may continue to cheat with probability q_i if this will benefit him more than trading honestly.

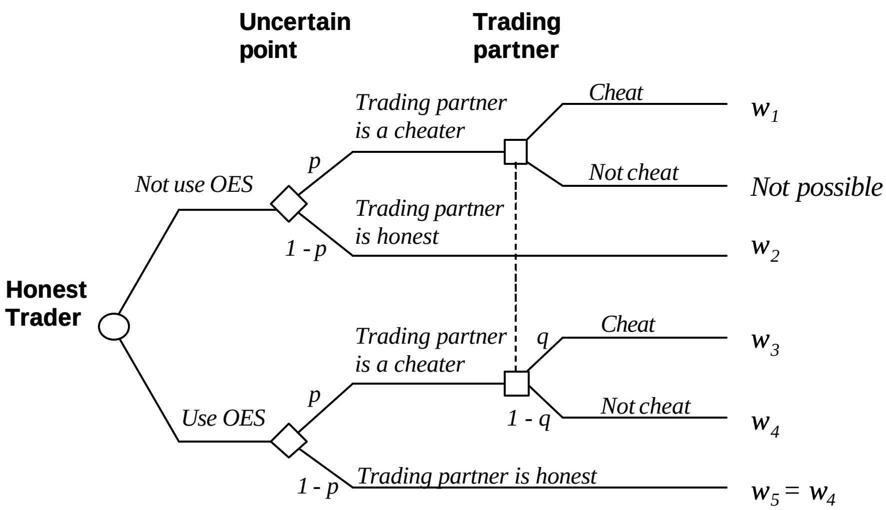

Figure 1. An honest trader's decision tree for OES adoption

Table 2: The honest trader's payoffs under different conditions

Payoffs	When the trader is a buyer	When the trader is a seller	Notes
w_1	$- M_i$	$- V_i^s$	When online escrow is not used, the trader is cheated.
w_2	$V_i^b – M_i$	$M_i – V^s{}_i$	No OES fee is paid.
w_3	$- rM_i$	$- rM_i$	The trader pays OES fee and the trading partner cheats.
w_4	$V_i^b – M_i – rM_i$	$M_i – V_i^s – rM_i$	The trader pays OES fee and the trading partner does not cheat.

Without losing the validity, the case that two traders jointly pay the OES fee can be skipped.[4] Therefore, the online escrow adoption decisions by the honest trader result in the following outcomes in three cases:

Case 1: No trader in the trade is to adopt online escrow.

The trader's expected utilities when she is in different trading roles are negatively affected by possible cheating by her trade partner:

For a buyer: $U_{i0} = (1 - p_i) (V_i^{\,b} - M_i) - p_i M_i$ (2a)

For a seller: $U_{i0} = (1 - p_i) (M_i - V_i^{\,s}) - p_i V_i^s$ (2b)

Case 2: The trading partner pays for the OES.

It signals the honest trader that her trading partner is honest. Therefore, her *PRR* equals 0. Her expected utilities are:

As a buyer: $U_{i0} = V_i^{\,b} - M_i$ (3a)

As a seller: $U_{i0} = M_i - V_i^{\,s}$ (3b)

Case 3: The honest trader pays for the OES.

Paying OES fee incurs an extra cost to the honest trader, but reduces her risk from fraud. The trader's PRR may change after she decided to pay for online escrow. The utilities when she is in different trading roles are:

As a buyer:

$U_{i1} = (1 - p_i\, q_i) (V_i^b - M_i - r\, M_i) - p_i q_i\, r\, M_i$ (4a)

As a seller:

$U_{i1} = (1 - p_i\, q_i) (M_i - V_i^s - r\, M_i) - p_i q_i\, r\, M_i$ (4b)

[4] The case of "joint-payment" for the OES simply increases mathematical complexity with the same theoretical conclusions.

If the trading partner does not pay the online escrow, when $U_{i1} \geq U_{i0}$ and $U_{i1} \geq 0$, the trader will use online escrow because of higher expected utility. Solving (2) and (4), we obtain the criterion that the trader will pay for the OES:

$$p_i V_i^b / M_i - p_i q_i V_i^b / M_i + p_i q_i \geq r, \text{ if she is a buyer} \qquad (5a)$$

$$p_i - p_i q_i + p_i q_i V_i^s / M_i \geq r, \text{ if she is a seller} \qquad (5b)$$

Assume the honest trader believes the OES will totally block the possibility of Internet fraud. That is, $q_i = 0$. Thus, we have a pair of simplified OES adoption criteria:

$$p_i \geq r M_i / V_i^b, \text{ if she is a buyer} \qquad (6a)$$

$$p_i \geq r, \text{ if she is a seller} \qquad (6b)$$

Equation (6a) and (6b) reveal the important linear relationship between the adoption of OES and online escrow service price in regard to PRR. In particular, an honest seller will compare her PRR directly with the OES fee rate to assure if it is worth of using the online escrow.

Compare (6a) and (6b), since $M_i < V_i^b$, we can conclude that *an honest trader will be more likely to initiate an OES when she is a buyer rather than a seller.*

Alternatively, we could also assume $q_i = 1$, i.e. the trader believes online escrow will not change the cheater's mind in cheating. Although (6a) and (6b) will change the form, the above conclusion remains the same.

4. A Monopolist OESP's Optimum Pricing Problem

An OESP is assumed to be a monopolist in regard to an Internet-based auction site. This assumption is based on two facts: First, auction sites normally only ally to one designated OESP for their traders. [5] Under this setting, the OESP can dominate online escrow business in a cyber marketplace without considering other competitors. Second, a few OESPs have already occupied the majority of the market share. For example, Tradenable has taken 80% of online escrow market.

An OESP maximizes its total profits by designing a proper service fee scheme, poised between more demand for services and a higher income from each single service. The demand for the OES is defined as the number of trades that adopt online escrow, which is just the *OES adoption rate* times the total number of online trades. It can be derived from the PRR distribution following the preceding analyses in the decision-making models. With the combinations of a trader's role in a trade, the decision on using online escrow, and the fee payment arrangement, the OES adoption rate is a compound random variable of PRR that is characterized by density function $f_i(\bullet)$.

Denote the probability that a trader is honest as ρ. The probability that a seller is willing to pay the OES fee r alone in trade i can be expressed as:

$$Prob\{\xi_i \geq r, \text{"a trader is honest"}\} = \rho F_i(r). \qquad (7a)$$

Similarly, the probability that a buyer is willing to pay the OES fee r alone in trade i with determined M_i and V_i^b is:

$$Prob\{\xi_i \geq rM_i/V_i^b, \text{"a trader is honest"}\} = \rho F_i(rM_i/V_i^b). \qquad (7b)$$

Once two traders reach an agreement on a trade, M_i becomes common knowledge to both traders and V_i^b is known to the buyer. Then the two values are handled as constants referring to a specific trade. However, V_i^b and M_i become random variables to an OESP facing all trades because different trades may turn out different values of V_i^b and

[5] eBay has allied with Tradenable, previously i-Escrow; and agauction.com (www.agauction.com) has

M_i. Let us define random variables $\omega_i = V_i^b / M_i$ with a density function $w_i(\bullet)$ and ω_i is assumed independent of ξ_i. Given the assumption that trader's PRR distribution is independent of trader's honesty, the probability that a buyer is willing to pay OES fee r alone in trade i with unknown ratio V_i^b / M_i is:

$$Prob\{\theta_i \geq r, \text{“a trader is honest”}\}$$

$$= P\{\omega_i \xi_i \geq r\}\, P\{\text{“a trader is honest”}\}$$

$$= \rho \int_{-\infty}^{\infty} w_i(t)\, P\{\xi_i \geq r/t \mid \omega_i = t\} dt$$

$$= \rho \int_{-\infty}^{\infty} [\int_{r/t}^{1} f_i(s) ds] w_i(t) dt$$

$$= \rho\, G_i(r) \tag{8}$$

where $G_i(r) = \int_{-\infty}^{\infty} [\int_{r/t}^{1} f_i(s) ds] w_i(t) dt$ is the probability that a buyer is willing to pay the OES fee r alone under the condition she is honest.

Finally, given an OES fee rate r, the probability that traders adopt online escrow, namely the *OES adoption probability,* is a unified distribution of the above two cases:

$$S_i(r) = Prob\{\text{adoption of OES}\}$$

$$= Prob\{\text{“Buyer-Pay”} \cup \text{“Seller-Pay”}\}$$

$$= \rho\, [F_i(r) + G_i(r)] - \rho^2 F_i(r) G_i(r) \tag{9}$$

One of important pricing strategies for an OESP is to charge different fee rates $\mathbf{r} = \{r_j\}$ for different levels of transaction amounts having the same OES adoption probability distribution, where $j \in J$. A group of trades is defined as a *trade type* if they

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chosen TradeSafe to be its OESP.

are in the subset $I_j \subseteq I$ with $\overline{S}_j(r_j) = S_j(r_j)$, and have a transaction amount M_{ij} that falls in certain range called *category*. So, we use $S_j(r_j)$ to represent OES adoption rate for trades in category j. To simplify the derivation, assume there is only a single type of trades in a category.

Assume each online escrow service incurs a constant cost (C^e) to an OESP. An OESP is willing to service trade i only if $r_j M_{ij} - C^e \geq 0$, i.e. the transaction amount $M_{ij} \geq C^e / r_j$. Therefore, in the following discussion we exclude those trades with $r_j M_{ij} < C^e$ from trade set I_j in order to simplify the objective function. The OESP's profit maximization problem using differentiated service fee rates $\boldsymbol{r} = \{r_j\}$ is expressed as:

$$\mathbf{P}(\boldsymbol{r}) = \sum_{j\in J} \Pi_j(r_j) = \sum_{j\in J} \max_{r_j} \; [(r_j \sum_{i\in I_j} M_{ij} - I_j C^e) S_j(r_j)], \qquad (10)$$

where $\Pi_j(r_j)$ is the total profits from the OES for category-j trades. Maximizing each $\Pi_j(r_j)$ will eventually maximize $\mathbf{P}(\boldsymbol{r})$, providing r_j $(j = 1, \ldots, J)$ are independent of each other.

By intuition, we know $\Pi_j(1) = 0$ and $\Pi_j(0) = 0$. When $r_j \sum_{i\in I_j} M_{ij} > I_j C^e$, $\Pi_j(r_j)$ is non-negative. Therefore, it can be concluded that there exists at least an r_j^* such that

$$\Pi_j(r_j^*) = \max_{r_j} \; [(r_j \sum_{i\in I_j} M_{ij} - I_j C^e) S_j(r_j)] \qquad (11)$$

where $r_j M_{ij}$ is the OES price for trade i in category j in the amount of M_{ij}, and $I_j S_j(r_j)$ is the demand for the OES in transaction amount category j.

Define $\overline{M}_j = \sum_{i\in I_j} M_{ij} / I_j$ as the average trade amount for category-j trades, and $c_j = C^e / \overline{M}_j$ as the average marginal cost rate for category-j trades. The average OES price can be expressed as $r_j \overline{M}_j$. OESP's profit from the services for category-j trades can be normalized as $\pi_j(r_j) = \Pi_j(r_j)/\sum_{i \in I_j} M_{ij}$ and expressed in the following simplified form:

$$\pi_j(r_j) = (r_j - c_j)S_j(r_j) \tag{12}$$

where the normalized demand from category-j trades is $D_j(r_j) = S_j(r_j)$, the normalized price is r_j, and the normalized marginal cost is the average marginal cost rate c_j. It is obvious $\pi_j(c_j) = 0$. A graphical representation of OESP's profit from servicing category-j trades is shown in Figure 2.

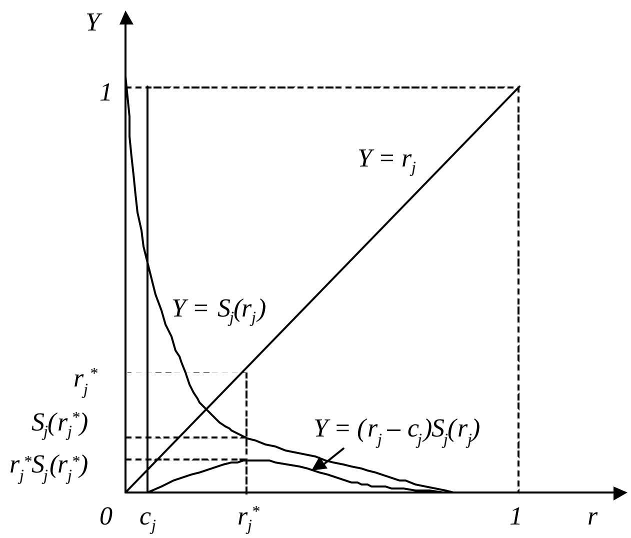

Figure 2. The Optimal OES Fee Rate

If the adoption rate distribution function $S_j(r_j)$ is known, a first-order condition can be derived from equation (12) and then be solved to obtain the optimal service fee rate r_j^*. A demand-supply diagram can be further obtained using a typical micro economic approach for a monopoly case (Hu et al, 2001).

5. A Simulation for PRR Measurement

The measure of perceived risk is empirically important to analyze the outcomes of decisions. Earlier perceived risk measurement models use the moments of a distribution and their transformations, such as mean, variance, skewness, range, etc. For example, the work by Coombs and Meyers (1969). Bawa (1975) and Jena (1975) introduce lower partial moments (LPMs) reflecting the negative meaning of risk from psychological point of view. It is a biased version compared to the previous moment-based approach. LPMs model has been tested by Unser (2000) in an experimental study with a favorable result. A different perceived risk measurement model is proposed by Jia et al (1999) using the mean and standard risk of a decomposed lottery, which is relevant to the axiomatization of the risk theory by Pollatsek and Tversky (1970). Whereas, the PRR addressed in this paper is dynamic and is case specific. For example, a trade only provides an opportunity to a pair of traders, while in a security market a financial product may be purchased by several traders at different moments. Therefore, our measurement model is dynamic and calculation-oriented.

In this calculative measurement model, the value of PRR is flavored by two ingredients: one is *base PRR* which is irrelevant to a specific trade, and another is *dynamic PRR* which is subject to change in accordance with each trader's information about the trade. Figure 3 is a conceptual model for calculating a trade-specific PRR depending on four factors in two-steps:[6]

1) *Average PRR* over base PRR of all traders under certain context. This is a measure of trader's overall perception of the risk in Internet fraud.

[6] The properties of merchandise should be one of the factors in PRR estimation. This model assumes that PRR is indifferent to this factor to reduce the complexity of analyses.

2) Trader's risk attitude. This factor is referred to the deviation of risk perception. It reflects the effect of trader's personality in risk assessment and is represented as the range in which the deviation is uniformly distributed.

3) Trader's experience of loss in online trades. This factor is to capture the effect of a trader's previous loss on the current PRR estimation. The longer the loss happened from the current trade, the less the effect it imposes.

4) Trading partner's reputation. Most auction sites provide the historical records of a trader. This is a useful source that can be used to estimate a trading partner's reputation.

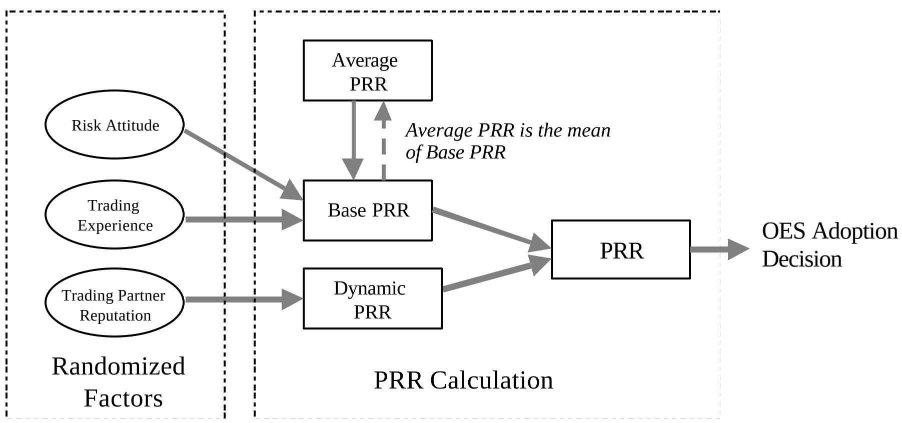

Figure 3. A Measurement Model for PRR

Denote $A\text{-}PRR_t$ $B\text{-}PRR_t$, and $D\text{-}PRR_t$ for average PRR, base PRR, and dynamic PRR respectively in trading time frame t. A trader's PRR in trade i in trading time frame t is formalized as:

$$PRR_i = \boldsymbol{F}_i[\,\boldsymbol{F}_t^B(A\text{-}PRR_{t-1},\ \boldsymbol{t},\ \boldsymbol{g}),\ \boldsymbol{F}_t^D(Repu)]$$

where $\boldsymbol{t}$ is the factor of personal trading loss factor, $\boldsymbol{g}$ is the trader's risk preference factor, $B\text{-}PRR_t = \boldsymbol{F}_t^B(A\text{-}PRR_{t-1},\ \boldsymbol{t},\ \boldsymbol{g})$ is a function of $A\text{-}PRR_{t-1}$, $\boldsymbol{t}$ and $\boldsymbol{g}$, $A\text{-}PRR_{t-1}$ is an average of

B-PRR$_{t-1}$ over traders, and *D-PRR* = $F_t^D(Repu)$ is a function of trading partner's reputation factor *Repu*. [7]

The simulation program accesses a pool of 160 traders. Each trader is assigned an initial base PRR ranging from 0.015 to 0.03, and the OES fee rate is preset as 2% of the transaction amount. That is, *B-PRR*$_0$ is uniformly distributed at the beginning. Internet frauds are randomly generated among trades. Traders, either sellers or buyers, decide the adoption of online escrow if they are of honest type. Then, *A-PRR*$_t$, *B-PRR*$_t$ *D-PRR*$_t$ and *PRR*$_i$ are recursively calculated. Figure 4 shows that *A-PRR*$_t$ converges from a lower bound to the OES fee rate. After performing 5000 trades, *A-PRR*$_t$'s value becomes close enough to the OES fee rate.

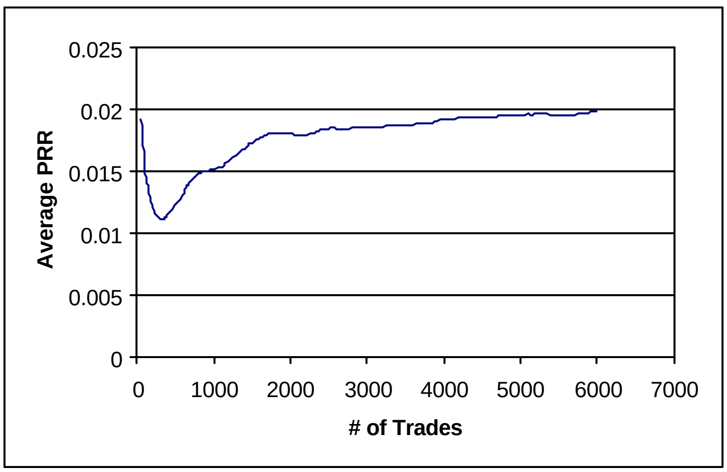

Figure 4. A converging average PRR (*A-PRR*$_t$)

Figure 5 depicts the distribution of *B-PRR*$_t$ at the end of the simulation when the value of *A-PRR*$_t$ is stable. The two histograms of *B-PRR*$_t$ over the trader pool demonstrate a similar shape of normal distribution. This gives the intuition that PRR could follow an asymmetric normal distribution in a finite interval *[0, 1]*.

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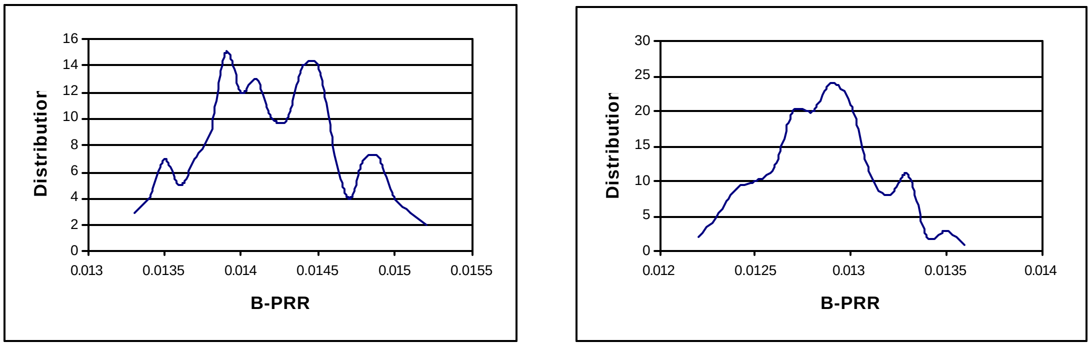
[7] Due to the limited size of the paper, detailed information about relations between components in Figure 3 has been omitted.



(a) (b)

Figure 5. Distributions of base PRR ($B\text{-}PRR_t$)

6. Summary and Future Prospects

This paper studies the OES adoption problem for the honest trader and the OES fee optimization problem for the monopolist OESP in Internet-based C2C auction markets. PRR, the subjective estimate of online trading risk, is used to link together the models for OES demand and supply sides. In adopting online services for electronic commerce, PPR becomes the driving factor in using the financial assurance service from a trusted third party, and the reduced risk under the protection of the service improves the trustworthiness of the online auction marketplace. We briefly introduce a calculative model for PRR with a two-step of recursive calculation. The converging PRR from the simulation shows a normal-like distribution in a stable status.

Further theoretical research is to be focused on two aspects. The first one is to complete a game theoretic model by introducing a cheater-based decision-making process. This will be a sequential signaling game model with extensive subgame perfect Nash equilibrium analyses. The second aspect is to further explore the relationship between perceived risk in using an online facility and the facility's trustworthiness (e.g.

Kim and Prabhakar, 2000). The OES provides a good setup to explore that relationship when a TTP is present.

Promising outcomes may come from the empirical study. One aspect is to conduct comprehensive computer experiments to study the relationship among PRR, OES adoption rate, fraud rate and OES fee rate. Both computer simulation and human-based experiments are to be carried out. In addition, from behavioral point of view, the relationship between the causal factors and PRR sheds the light as an interesting research issue in next stage.

References:

Akerlof, G. “The Market for Lemons: Quality Uncertainty and the Market Mechanism,” *Quarterly Journal of Economics* (84), 1970.

Ba, S., Whinston, A. B., and Zhang, H. “Building Trust in the Electronic Market through an Economic Incentive Mechanism,” *Proceedings of ICIS 1999*, Charlotte, North Carolina, Dec. 12-15, 1999.

Bawa, V.S. “Optimal Rules for Ordering Uncertain Prospects,” *Journal of Financial Economics* (2), 1975, pp.95-121.

Beach, L. R. “The Psychology of Decision Making,” SAGE Publications, 1997.

Chircu, A., Davis, G., and Kauffman, R. “The Role of Trust and Expertise in the Adoption of Electronic Commerce Intermediaries,” MISRC Working paper, University of Minnesota, March 2000.

Choi, S.-Y., Stahl, D. O., and Whinston, A. B. “*The Economics of Electronic Commerce*,” Indiana: Macmillan Technical Publishing, 1997.

Clemen, R. T. “Making Hard Decisions – An Introduction to Decision Analysis,” Duxbury Press, 1996.

Coombs, C. H., and Meyer, D. E. “Risk Preference in Coin-Toss Games,” *Journal of Mathematical Psychology* (6), 1969, pp.514-527.

Cunningham, S. M. “The Major Dimensions of Perceived Risk,” in *Risk Taking and Information Handling in Consumer Behavior*, Cox D. F. (ed.), Harvard University Press, Boston, MA, 1967, pp.82-108.

Friedman, E., and Resnick, P. "The Social Cost of Cheap Pseudonyms," Forthcoming in *Journal of Economics and Management Strategy*, 2001.

Grewal, D., Gotlieb, J., and Marmorstein, H. "The Moderating Effects of Message Framing and Source Credibility on the Price-perceived Risk Relationship," *Journal of Consumer Research* (21:1), June 1994, pp.145-153.

Hu, X., Lin, Z., Whinston, A. B., and Zhang, H. "Escrow Services in Online Auction Markets: Decision Making and Profit Maximization," presented in *WISE 2000*, Brisbane, Australia, Dec. 14-15, 2000.

Hu, X., Lin, Z., Whinston, A. B., and Zhang, H. "Trick or Treat? — Escrow Services in Online Consumer-to-Consumer Auction Markets," working paper, 2001.

Jean, W. H. "Comparison of Moment and Stochastic Dominance Ranking Methods," *Journal of Financial and Quantitative Analysts* (10), 1975, pp.151-161.

Jia, J., Dyer, J. S., and Butler J. C. "Measures of perceived risk," *Management Science* (45:4), April, 1999, pp.519-532.

Kim, K., and Prabhakar, B. "Initial Trust, Perceived Risk, and the Adoption of Internet Banking," *Proceedings of ICIS 2000*, Brisbane, Australia, Dec. 10-13, 2000.

Kollock, P. "The Production of Trust in Online Markets," In Lawler, E. J., M. Macy, S. Thyne, and H. A. Walker (Eds), *Advances in Group Processes* (16), Greenwich, CT: JAI Press, 1999.

Kreps, D. M. "A Course in Microeconomic Theory," Princeton University Press, 1990.

Lee, B., and Yoo, B. "Internalization of Electronic Auction Market and Information Asymmetry in Electronic Commerce," presented in *WISE 1999*, Charlotte, North Carolina, Dec. 16-17, 1999.

Pollatsek, A., and Tversky, A. "A Theory of Risk," *Journal of Mathematical Psychology* (7), 1970, pp.540-553.

Resnick, P., Zeckhauser, R., Friedman, E., and Kuwabara K. "Reputation Systems," *Communications of the ACM* (43:12), December, 2000, pp.45-48.

Unser, M. "Lower Partial Moments as Measure of Perceived Risk: An Experimental Study," *Journal of Economic Psychology* (21), 2000, pp.253-280.