

## Association for Information Systems AIS Electronic Library (AISeL)

---

ICIS 1999 Proceedings

International Conference on Information Systems  
(ICIS)

---

December 1999

# Building Trust in the Electronic Market Through an Economic Incentive Mechanism

Sulin Ba

*University of Southern California*

Andrew Whinston

*University of Texas at Austin*

Hang Zhang

*University of Texas at Austin*

Follow this and additional works at: <http://aisel.aisnet.org/icis1999>

---

### Recommended Citation

Ba, Sulin; Whinston, Andrew; and Zhang, Hang, "Building Trust in the Electronic Market Through an Economic Incentive Mechanism" (1999). *ICIS 1999 Proceedings*. 19.

<http://aisel.aisnet.org/icis1999/19>

This material is brought to you by the International Conference on Information Systems (ICIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in ICIS 1999 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact [elibrary@aisnet.org](mailto:elibrary@aisnet.org).

# **BUILDING TRUST IN THE ELECTRONIC MARKET THROUGH AN ECONOMIC INCENTIVE MECHANISM**

**Sulin Ba**

Marshall School of Business  
University of Southern California  
U.S.A.

**Andrew B. Whinston**

**Hang Zhang**

Center for Research in Electronic Commerce  
University of Texas at Austin  
U.S.A.

## **1. INTRODUCTION**

Some of the most exciting developments in our economy right now are in the realm of electronic commerce. However, two major issues associated with asymmetric information in the online world still pose serious challenges to the growth of electronic commerce: one is the security concern on the Internet (Ford and Baum 1997; Garfinkel and Spafford 1997) and the other is the quality uncertainty problem (Choi, Stahl and Whinston 1997). While the former has been addressed by various technology developments such as digital signatures and digital certificates, the latter has not received much attention in the research community. Being more of a social and economic issue than a technology challenge, the quality uncertainty problem can severely cripple the development of electronic commerce. How can people promote the trust necessary for online exchange of products and services when individuals have short-run temptations to cheat? Using a game theoretic approach, we propose a design of an economic incentive mechanism that serves to encourage consumer confidence in conducting online business transactions.

## **2. ASYMMETRIC INFORMATION IN ELECTRONIC TRANSACTIONS**

In a traditional face-to-face business environment, eye contact, a handshake, and chatting help develop basic trust between vendors and customers. Customers get to know the quality of products by looking, touching, and feeling. However, such an interpersonal realm does not exist in the electronic market. With the global, but insecure, Internet being the primary carrier of electronic commerce transactions, web sites can be counterfeited, identities can be forged, and the nature of transactions can be altered. As a natural consequence, consumers and vendors alike want protection against such dishonest or even malicious behaviors.

Security is merely one concern. Another big problem for online transactions is related to information on product quality. Global networks in general and the Internet in particular have made information dissemination much easier and faster than ever before. However, under the disguise of information overflow, there is also information scarcity, a phenomenon that is affecting the market efficiency by creating information asymmetry: both parties do not have the same information (Akerlof 1970). For example, when a vendor offers products online, there is no easy way right now for consumers to know whether the vendor is a reputable one, what his product quality is, or whether it is really a legitimate business.

Due to the existence of asymmetric information, it is very difficult for buyers in the electronic market to have a full knowledge of the product quality prior to purchase. Conventional means to convey product quality, such as reputation and brand name, although still important, are less useful in the global electronic market with a vast array of sellers who may be in the market only for a short time. Therefore, consumers inevitably face many difficulties in selecting reliable, suitable vendors, which in turn produces the lemons problem (Akerlof 1970) where bad products drive out good products because of asymmetric information, particularly quality uncertainty. The lemons problem inevitably leads to a market failure and thus the need to use non-market corrective behavior to improve economic outcomes.

### **3. LEGAL VS. EXTRALEGAL MECHANISMS**

When transaction disputes happen, one traditional approach of solving the problem is that people resort to the legal system. However, the legal mechanisms are not complete in the electronic market. First, legal regulation and control cannot keep pace with the development of electronic commerce and the extant laws in conventional commerce might not be strictly enforceable in electronic commerce. Second, resorting to legal enforcement in electronic commerce might be impracticably expensive or even impossible, such as in the case of micropayment transactions. There are many low-value transactions that might be worthy of only several dollars in the electronic market, which individually may not make economic sense for trading partners to settle in court.

Fortunately, research in the law community (Ellickson 1991) and the economics community (Kandori 1992; Milgrom, North and Weingast 1990) has argued that instead of solely relying on governments as the chief sources of rules and enforcement efforts, extralegal mechanisms can also help people interact to their mutual advantage. Extralegal mechanisms usually refer to systems governed by informal social norms (Charny 1996; Johnston 1996). These social norms identify the everyday behaviors that call for the informal administration of rewards and punishments. Macaulay (1963) points out that social pressure and reputation are perhaps even more widely used than formal contracts and law suits. As a matter of fact, people behave honestly in many cases because honesty is rewarded and/or deception is punished in future transactions or other social activities.

Because of the incompleteness of the current legal mechanisms for electronic commerce, we can foresee that in a certain time span people most likely will turn to extralegal mechanisms to help address the above mentioned problems and solve transaction disputes. For example, certification authorities (CAs) have emerged in recent years as an extralegal mechanism to protect security and privacy based on encryption technologies. While being an important element of the extralegal systems in terms of authenticating players, the current CAs can not solve the product quality problems: an authenticated vendor can still cheat a consumer by selling counterfeit products.

### **4. TRANSACTIONS IN THE ELECTRONIC MARKET**

As of today, almost all business transactions leave open the possibility of cheating. The temptation of cheating is that cheating normally has an immediate short-term return. Research on repeated games demonstrates how people manage to interact to their mutual advantage without the help of the legal enforcement (Axelrod 1984; Ellickson 1991; Johnston 1996). The theory of repeated games provides a perspective to understanding the role of extralegal mechanisms in the electronic market by pointing out that many business interactions are actually repeated, so that the threat of future retaliation by the cheated partner or the whole community may enforce cooperative behavior. In our analysis, each non-repeated transaction (the stage game) is assumed to be the Prisoner's Dilemma (PD) game described by Figure 1. By using the PD model, we will demonstrate why pure personal and/or community enforcement are not sufficient and why trusted third parties (TTPs) are needed to achieve market efficiency for the global online market.

Suppose that a seller and a buyer are engaged in a single exchange involving a digital product (Scenario 1). Each of them can choose to play one of two strategies: Honest or Cheat. Figure 1 presents the payoff structure of the PD game, where  $l$  and  $g$  are positive and  $g - l < 1$ . If both the buyer and the seller are honest, they each have a payoff of 1. If they both cheat, each has a payoff of 0. If one player decides to cheat while the other is honest, then the cheater has his highest payoff of  $1 + g$ , while the honest one gets his lowest of  $-l$ . This gives both sides an incentive to cheat, even though honest behavior maximizes the total payoff of the two players:  $1+1 > 1+g - l$  according to the assumption  $g - l < 1$ .

		Buyer	
		Honest	Cheat
Seller	Honest	1, 1	-l, 1+g
	Cheat	1+g, -l	0, 0

**Figure 1. The Prisoner’s Dilemma Game**

Obviously, if this transaction is conducted only once, it is to each player’s separate advantage to play Cheat, since that play yields a higher payoff regardless of what the other player does. Accordingly, the only Nash equilibrium of the game is for both players to play Cheat. The PD game demonstrates the idea that cheating might be profitable in a single business transaction. In the electronic market, for example, some sellers would find that a fly-by-night strategy of quality reduction would be profit maximizing.

If transactions are repeated between the same pair of buyer and seller (Scenario 2), for example, a consumer repeatedly orders books from Amazon.com, then both the buyer and the seller can conduct their business transactions based on

their previous interactions. In other words, they can use the history of past interactions as the basis to reward past honest behavior and to punish cheating because information on their trading history is complete and known to both agents. This kind of informal enforcement mechanism is personal enforcement, in which cheating triggers retaliation by the victim. This mechanism works best in frequent and long-term relationships (Axelrod 1984; Kandori 1992).

Electronic transactions can also happen in an electronic community (e-community) where people interact with multiple agents and share information among community members (Scenario 3). For example, people may sell or buy at eBay (www.ebay.com), an online auction company. Agents can change partners often and most relationships could be infrequent or one time only. Personal enforcement, therefore, becomes ineffective. There is, however, another form of enforcement, community enforcement, where agents change their partners over time but they will cooperate or coordinate their actions because dishonest behavior against one partner causes sanctions or retaliations by other members in the community (Kandori 1992; Milgrom, North and Weingast 1990). eBay’s “Feedback Forum,” although not completely effective, bears the idea of community enforcement in that consumers can use the forum to rate their satisfaction toward their trading partners. Other users are encouraged to check their trading partners’ ratings before transactions and leave feedback about their trading partners after their transactions.

The effectiveness of both personal and community enforcement depends on the assumption that the agents involved or the members of the community are well informed to know who has cheated and whom to punish. But this assumption most times can not be satisfied in the global electronic market where agents change trading partners often and may never have to face the same partner again (Scenario 4). In addition, gathering complete information on a trading partner’s past behavior becomes prohibitively expensive and even impossible. Obviously, unless we have other enforcement mechanisms to help information dissemination or to enforce honest behavior, honesty among self-interested agents in the global online market could be very hard to maintain. Each individual transaction thus becomes a PD game where it is never to the agent’s advantage to be honest. Therefore, we argue that we need extralegal mechanisms such as TTPs to help enforce honest behavior and to protect agents’ interest.

## 5. TRUSTED THIRD PARTIES AS AN ENFORCEMENT SYSTEM

Certification authorities serve as one form of trusted third party by authenticating the identity of each trading party in a transaction by issuing digital certificates. What is missing from the services provided by certification authorities is the certificate holder’s reputation: Is the certificate holder a reputable business entity? Has the holder ever cheated before? No information is conveyed regarding either the certificate holder’s past trading behavior or the legitimacy of the business. In short, even though certification authorities address security concerns for electronic transactions, the product quality uncertainty problem remains unsolved.

Given the incompleteness of the current structure of CAs, we propose a new design of a TTP. By building an information repository on trust, the TTP serves as both an information keeper and an information disseminator, through the issuance of digital certificates, which addresses the information asymmetry problem. The new design is built on the current models of CAs but has enriched functionality. That is, the digital certificate issued by a TTP serves not only as an authentication of the certificate holder, but also as a reputation indicator. Any one who holds a valid digital certificate should be regarded as a reputable agent who either has never been reported as a cheater or has paid all the fines adjudicated by the TTP. The TTP is not a legal institution that could

enforce rules. Therefore, paying fines adjudicated by the TTP is voluntary. However, if an online vendor sells fake products or products that are of a less quality than have been represented, unless the vendor paid off all the fines awarded to the cheated parties by the TTP, the vendor's digital certificate will be revoked by the issuing TTP. This will be an indication to any prospective buyers that this vendor doesn't behave honestly. On the other hand, if a buyer submits fake payment, the TTP can revoke the buyer's certificate as well if the fines are not paid. Here, we assume the TTP is fair and honest and it does not make mistakes.

In this design, we assume that agents are only concerned about their own interest. The new TTP would stimulate the formation of new types of social/business norms in the electronic market. However, we do not assume that people follow a social/business norm for its own sake. We investigate how such a rule is sustained by self-interested agents in the electronic market. In other words, we will investigate the sequential equilibria of the game played by buyers and sellers in the electronic market.

Now we formalize the online transaction process to illustrate the trusted third party's role by structuring the events with the following sequence of play, which we call the *Trusted Third Party system stage game*.

1. Before any agent (buyer and/or seller) is engaged in online transactions, he may apply to a TTP for a digital certificate by paying a one-time initiation fee:  $F$ . There may be multiple TTPs in the electronic market. We assume these TTPs are connected and will cooperate with each other, acting like one centralized TTP.
2. When two agents begin to do a transaction, they may ask each other to provide their digital certificate issued by the TTP. Agents may verify with the TTP the validity of the certificate at no cost.<sup>1</sup> The successful verification of a digital certificate means the certificate holder has not been reported to cheat in the past or he has paid all the fines. We assume that whatever transpires at this stage is common knowledge among the TTP and the two trading agents.
3. The two agents interact by playing the Prisoner's Dilemma game and get the outcome.
4. Either one of the two agents may appeal to the TTP at personal cost  $C > 0$ , but only if he has verified his partner's digital certificate with the TTP and known his partner's certificate is valid.
5. If either one makes an appeal, then the TTP investigates the case and awards a judgment,  $J$ , to the plaintiff if he has played Honest and his trading partner has played Cheat; otherwise, no award is made.
6. If a judgment,  $J$ , is decided, the defendant may pay the judgment, at cost,  $f(J)$ , or he may refuse to pay, at cost 0. The function  $f: \mathfrak{R}^+ \rightarrow \mathfrak{R}^+$  denotes the cost for a defendant to pay a given judgment. We assume that  $f$  is increasing and continuous. Therefore, the cost to the defendant is positively related to the amount of the judgment. Moreover, we assume  $f(x) \geq x$ , that is, what the cheater ends up paying is more than what the TTP awards to the plaintiff. Some of the difference goes to the TTP to cover the investigation cost.
7. All of the information about the unpaid judgments will be stored in the TTP's database and the TTP will revoke the cheating agent's digital certificate.

In the following part, we will describe a trading agent's strategy, *TTP System Strategy* (TTPSS), which is a complete contingent plan describing the actions he will take in each conceivable evolution of the game under the TTP system.

1. At the first step of the stage game, an agent buys a digital certificate from the TTP before he conducts any business transaction in the electronic market.
2. At the second step of the stage game, an agent verifies a trading partner's digital certificate with the TTP if he himself has a valid digital certificate.

---

<sup>1</sup>It is important to note that there are many online transactions involving micropayments. If certificate verification incurs a cost almost equaling or maybe even greater than the transaction amount, it is not likely for any player to query the TTP.

3. At the third step, if either agent does not have a digital certificate or if either agent fails to verify the digital certificate (e.g., the digital certificate is expired, has been revoked, or is a fake certificate), then both agents play Cheat<sup>2</sup>; otherwise, both play Honest.
4. At the fourth step, if both agents verified the digital certificates and learned the digital certificates were valid at step 2 and exactly one of the two agents cheated at step 3, then the cheated agent (victim) appeals to the TTP; otherwise, no appeal is filed.
5. At step five, if an appeal in step four was filed, the TTP awards judgment of  $J$  to the cheated agent.
6. At step six, the cheating agent (defendant) pays the judgment  $J$  if and only if he had a valid digital certificate before the trading.

*Theorem.* The Trusted Third Party System Strategy (TTPSS) is a sequential equilibrium strategy of the Trusted Third Party system stage game if and only if the following inequalities hold.<sup>3</sup>

$$\delta/(1 - \delta) \geq f(J) \geq \text{Max}[g, f(C)] \text{ and } F \leq 1/(1 - \delta)$$

If these conditions are satisfied, then the average payoff per period for each agent (at the equilibrium) is 1.

## 6. DISCUSSION AND CONCLUSION

In this paper, we presented an analytical model for an extralegal institution that could be used in the absence of legal enforcement to address some of the issues impeding the growth of electronic commerce. The services of TTPs convert the private knowledge between a pair of business partners on their past trading behaviors to public knowledge in the dynamic electronic market. Due to the existence of this knowledge base, business agents have to maintain and protect their reputation if they want to continue their business in the global electronic market. The new design of TTPs has strong practical implications in the electronic marketplace, especially for small businesses with no brand names (Ba and Zhang 1999) and consumer-to-consumer transactions, such as most of the transactions conducted at online auction houses. For example, most online auction sites currently serve as matchmakers but their business model does not entail any control or guarantee over product quality or delivery of goods. Between May and August of 1997, eBay received reports of 27 fraudulent incidents (Caulfield 1998). A *Wall Street Journal* reporter surfed the online auction sites with five art experts and found many counterfeit products (*Wall Street Journal*, March 5, 1999). In the faceless electronic market, it is easy for people to commit fraud and misrepresent their products or services.

The “Feedback Forum” provided by eBay is a first step toward adopting a reputation mechanism to enforce honest behaviors. In the current model, the effectiveness of the forum is very limited for the following two reasons: First, the auction site does not enforce strong authentication, so a person with a bad reputation in the auction community can easily acquire a new e-mail address and then reregister with no trace of the earlier bad reputation. Second, feedback left at the forum does not go through any systematic check, therefore, it is subject to malicious manipulation. The TTP model we proposed addresses these problems and can be very effective in promoting small business online transactions and consumer-to-consumer transactions.

## 7. REFERENCES

Akerlof, G. “The Market for Lemons: Quality Uncertainty and the Market Mechanism,” *Quarterly Journal of Economics* (84), 1970, pp. 488-500.

---

<sup>2</sup>We may interpret this as a refusal by the honest agent to trade with a cheater.

<sup>3</sup> $\delta$  is the discount factor. The complete proof can be obtained from the authors directly.

- Axelrod, R. *The Evolution of Cooperation*, New York: Basic Books, 1984.
- Ba, S., and Zhang, H. "The Electronic Market: Not a Level Playing Field After All?" Working Paper, The Electronic Economy Research Program, University of Southern California, 1999.
- Caulfield, B. "Small Fees, Big Volume Are Keys for Auctioneer," *Internet World*, March 9, 1998 (<http://www.internetworld.com/print.../09/ecom/19980309-auctioneer.html>).
- Charny, D. "Illusions of a Spontaneous Order: 'Norms' in Contractual Relationships," *University of Pennsylvania Law Review* (144:5), 1996, pp. 1841-1858.
- Choi, S.-Y.; Stahl, D. O.; and Whinston, A. B. *The Economics of Electronic Commerce*, Indianapolis, IN: Macmillan Technical Publishing, 1997.
- Ellickson, R. C. *Order without Law*, Cambridge, MA: Harvard University Press, 1991.
- Ford, W., and Baum, M. S. *Secure Electronic Commerce: Building the Infrastructure for Digital Signatures and Encryption*, Englewood Cliffs, NJ: Prentice Hall, Inc., 1997.
- Garfinkel, S., and Spafford, G. *Web Security and Commerce*, Cambridge, MA: O'Reilly & Associates, Inc., 1997.
- Johnston, J. "The Statute of Frauds and Business Norms: A Testable Game-theoretic Model," *University of Pennsylvania Law Review* (144:5), 1996, pp. 1859-1912.
- Kandori, M. "Social Norms and Community Enforcement," *Review of Economic Studies* (59), 1992, pp. 63-80.
- Macaulay, S. "Non-Contractual Relations in Business: A Preliminary Study," *American Sociology Review* (28), 1963, pp. 55-67.
- Milgrom, P. R.; North, D. C.; and Weingast, B. R. "The Role of Institutions in the Revival of Trade: The Law Merchant, Private Judges, and the Champagne Fairs," *Economics and Politics* (2:1), 1990, pp. 1-23.
- Wall Street Journal*. "The Perils of Online Auctions," Friday, March 5, 1999, p. W1.