Designing On-Line Mediation Services for C2C Markets

Xia Zhao, Fang Fang, and Andrew B. Whinston

ABSTRACT: This paper proposes an on-line mediation services (OMS) mechanism to alleviate the consequences of asymmetric information for traders in C2C markets. In an adverse-selection setting, the mechanism facilitates on-line transactions by (1) inducing traders to negotiate efficiently in the presence of *ex post* discrepancy, and (2) enabling sellers with higher probability of selling a high-quality product to signal their superiority and enjoy a price premium. The mechanism can also be implemented as a profitable business model.

KEY WORDS AND PHRASES: C2C market; information asymmetry; negotiation; on-line mediation services.

The rapid development of information technology (IT) and wide accessibility of the Internet have provided the basis for the evolution of e-commerce. Online C2C markets, an important component of e-commerce, enable individuals to conduct convenient and economical "garage sales" of books, clothing, baseball cards, and even homemade artifacts [7, 10]. C2C market providers do not engage in conventional commercial activities, such as buying and selling, but generate wealth simply by offering transaction platforms and charging commission fees.

Despite their enormous growth, the performance of C2C markets is significantly undermined by their inherent information asymmetry, caused largely by the "shrinkwrap" phenomenon [6] and by the on-line anonymity of market participants. The shrinkwrap phenomenon refers to the fact that there is a time lag between the buyer and seller agreeing on a contract and the buyer directly experiencing the good. As a consequence, buyers bear tremendous quality uncertainty. Quality concerns are exacerbated by the ability of anonymous sellers to disappear without compensating unsatisfied buyers. Such concerns make buyers less willing to pay for items and, in consequence, reduce sellers' expected profits.

Information asymmetry leads to an adverse-selection problem in C2C markets. Sellers have private information, namely, the probability that they are selling high-quality items. This probability is referred to as the seller's type. Since buyers do not know the sellers' types, they tend to discount their bids based on the average quality in the marketplace, and this makes transactions unprofitable for sellers with higher types. As a result, sellers with higher types leave the marketplace earlier, which further reduces the expected value of the items to buyers. Information asymmetry of this kind adversely affects buyer expectations and impedes the growth and performance of C2C markets [1]. This paper proposes effective mechanisms that can alleviate the adverse consequences of information asymmetry.

The ability of on-line feedback mechanisms (also known as "reputation systems") to eliminate information asymmetry and build up trust has been

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extensively discussed in the electronic markets literature [2, 3, 8]. However, four latent problems, all of which impair the reliability and efficiency of reputation systems, remain unresolved. First, reputation scores are only connected to the name and (sometimes) e-mail account of the user. Since low-type sellers can secretly assume good names, this makes reputation an unreliable measure of seller types [9]. Second, malicious sellers may manipulate their reputation scores by shill bidding [11]. For example, traders may collude to trade worthless items and reciprocate by leaving positive feedback for each other. Third, as a bilateral disciplinary tool, dishonest buyers can exploit reputation systems by threatening sellers with negative feedback unless they give a price discount. Finally, it is difficult for users who do not trade frequently in C2C marketplaces to build solid reputations, but a reputation system is ineffective if it treats infrequent users the same as malicious users who have changed their identities.

On-line escrow services (OES) are another way to prevent opportunistic trader behavior when there is information asymmetry. However, the adoption rate of such services is surprisingly low [5], apparently because OES slows the transaction process and the fees entail an extra expenditure.

Although advanced IT can improve the performance of C2C markets, the elimination of asymmetric information is beyond its reach. The economic theory and principles of mechanism design provide valuable insights on how to alleviate the adverse consequences of information asymmetry in C2C markets. In traditional mechanism design problems, the principal (the party with less information) can determine an allocation rule based on reports by agents (the parties with better information) about their private information. A properly designed mechanism can truthfully elicit agents' private information and improve the system surplus. However, in the design problem discussed here, buyers play a passive role in C2C markets,[1] and consequently do not have the power or freedom to choose and configure a mechanism to elicit private information. This paper introduces a mechanism that facilitates trades in C2C markets by revealing the seller's private information and thereby reducing the buyer's risk. This mechanism can be implemented either by a C2C market provider (referred to as the third party) or by an independent "fourth" party. The profitability of implementing this mechanism will also be examined to validate its provider's incentive.

The mechanism design presented below is motivated by the emergence of on-line dispute resolutions (ODR). ODR providers are licensed, regulated companies that provide negotiation tools and services to help parties negotiate when conflicts arise. EBay has already built a partnership with an ODR provider, SquareTrade,[2] and encourages eBay participants to use it to resolve conflicts. Ideally, negotiation and compensation can relieve buyers' quality concerns and increase their willingness to pay. Higher-type sellers earn higher profits because they are less frequently involved in negotiations. However, sellers have no incentive to participate in costly negotiations because they can "take the money and run" in this anonymous environment. An effective mechanism would have to give sellers incentives to negotiate when the item quality is low. In addition, opening the door for negotiations may stimulate buyers to engage in strategic behavior. For example, a buyer can always ask to negotiate with the seller and get compensation even if the qualities are high. An effective mechanism should be able to preclude such opportunistic behavior.

This paper offers a systematic analysis of mechanism design issues in an on-line trading environment. In the setup it presents, there is a continuum of sellers differing in their probabilities to sell high-quality items. A novel business named On-line Mediation Services (OMS) is introduced that consists of ODR, a Trust Mark Program (TMP), and insurance. The business model functions as follows: The ODR offers on-line negotiation tools and services that enable traders to resolve disputes. In most cases the disputes are initiated by buyers who claim that they have received low-quality items. Since sellers generally have no incentive to negotiate because they are protected by anonymity, the OMS introduces a complementary service, the TMP. A seller can voluntarily apply for TMP membership by paying a membership fee. However, TMP marks are only issued to those who pass the TMP identity verification procedures.[3] TMP sellers can post a trust mark on their Web pages indicating that they are TMP members. The OMS offers insurance to buyers who trade with TMP sellers without any additional charge. If a buyer detects that an item purchased from a TMP seller is of low quality, and the seller refuses to negotiate, the buyer can appeal to the OMS by filing a claim. The OMS reviews the case and, if necessary, can revoke the seller's membership and give the buyer the insurance compensation. The initial identity verification enables the OMS to effectively ban revoked sellers from resubscribing to the TMP. Since TMP membership can increase sellers' profits, the possibility of losing their TMP membership will give them incentive to negotiate.

The discussion in this paper begins with a consideration of how the business model of the OMS can be configured so that the mechanism induces efficient negotiations. For the purposes of this paper, an efficient negotiation is defined as the outcome when negotiations occur if and only if the buyer receives a low-quality item. The paper then analyzes the seller's decision on whether to apply for TMP membership. Finally, it examines the profitability of an OMS provider.

The results show that

1. The OMS can induce efficient negotiations by setting an appropriate amount of insurance compensation.
2. For a certain range of subscription fees, there is a separating equilibrium in which only sellers whose types are higher than a threshold will subscribe to the TMP. TMP subscription can signal the sellers' better types and increase their transaction price. If the subscription fee is below this range, a pooling equilibrium is obtained in which sellers subscribe to the TMP regardless of their type. This equilibrium is supported by buyers' beliefs that only inferior sellers will not subscribe to the TMP. A buyer trading with a TMP member can expect an efficient negotiation outcome. If the subscription fee is above this range, however, there will be another pooling equilibrium in which no seller will ever subscribe because the profit from selling the item is too low to cover the subscription fee. As a consequence, no negotiation takes place.

3. The OMS provider can make a profit. In addition, the profit can be increased by adopting a fixed rate ratio fee structure rather than a flat fee structure.[4] The profit increment comes from the ability of the OMS provider to adjust the subscription fees according to the sellers' profitability in the ratio fee structure.

Multistage Subscription Game Model

The discussion in this section uses a multistage game model to analyze traders' TMP subscription criteria and their on-line transaction strategies given a subscription fee. In subsequent sections, based on traders' decisions, the demand functions of the OMS are derived and OMS profit-maximization problems are analyzed.

Model Setup

A seller sells an item using English auction in a C2C market. The quality of the item can be either high or low. The probability that the seller is selling a high-quality item is influenced by the seller's inherent characteristics. For example, a seller with better reading habits has greater probability of selling a used book that looks brand-new. A seller who sells a high-quality item with probability q is said to be of type q. The seller's type is the seller's private information because the seller's inherent characteristics generally cannot be observed by others. Item quality is also the seller's private information before it is delivered to the buyer. These kinds of information asymmetry are typical in a C2C market. For example, the buyer cannot directly examine the quality of the item on-line and cannot infer the seller's type from previous experience or face-to-face interaction. However, the distribution function of sellers' types, $F(q)$, is common knowledge. Without loss of generality, the seller's reservation value of the item is assumed to be 0 regardless of quality.

In each auction, it is assumed that each prospective bidder i's valuation is w^i for a high-quality item and 0 for a low-quality item, where w^i is independently identically distributed between 0 and w. It is also assumed that this distribution is common knowledge and that the number of prospective bidders is large. Thus, the valuation of the buyer (i.e., the winning bidder) and the item price approach w infinitely close for a high-quality item. To simplify this price discovery process, we assume the value of the high-quality item is w.[5]

The game is divided into three periods (*see Figure 1*). In the first, the *pretransaction period*, the seller decides whether to join the TMP and obtain a trust mark. A seller who does will be charged a subscription fee t. The seller knows his own type but when making the subscription decision does not know the quality of the item. It is assumed that the seller, if indifferent, always subscribes to a TMP.

During the *transaction period*, the seller knows the quality of the item and lists the item in a C2C market. A seller who is a TMP member can post a trust mark indicating membership on the Web page where the item is listed. Bid-

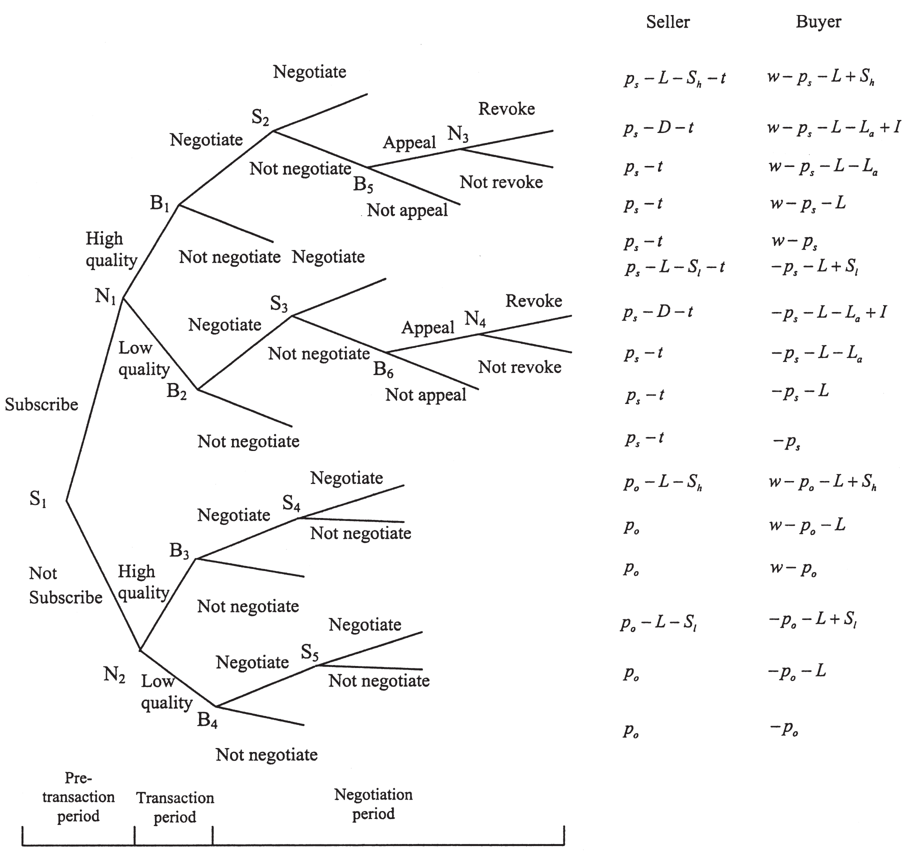

Figure 1. The Multistage Subscription Game

Notes: $S_i (i = 1 \ldots 5)$ beside the note indicates a seller's move; $B_j (j = 1 \ldots 6)$ beside the note indicates a buyer's move; $N_k (k = 1 \ldots 4)$ beside the note indicates nature's move.

ders observe whether the seller has a trust mark and decide how much they are willing to pay for the item. When the auction is complete, the buyer sends payment to the seller, who then delivers the item. The transaction price is contingent on the seller's possession of a trust mark: p_s denotes the expected price when the seller has a trust mark, and p_o denotes the expected price when the seller does not have a trust mark.

In the *negotiation period*, the buyer receives the item, examines its quality, and decides whether to negotiate with the seller. Now the seller and the buyer have shared knowledge about the quality of the item. The buyer incurs a negotiation cost L by initiating a negotiation. This cost includes the need to log in to SquareTrade and spend time submitting a negotiation request. The seller then decides whether to respond to the negotiation. For simplicity, it is assumed that the seller's response incurs the same negotiation cost as the buyer's.

The results of the negotiation depend on the bargaining power of seller and buyer. Since buyers are always the passive party in a C2C market, it is assumed here that the seller has all the bargaining power in a negotiation.

During the negotiation process, the seller makes a take-it-or-leave-it offer (hereinafter referred to as a settlement)[6] and the buyer decides whether to accept it. For present purposes, it is assumed that the buyer, if indifferent, always accepts the offer. $S_h(S_l)$ is the settlement the seller offers when the quality of the item is high (low).

If a TMP member does not negotiate, the buyer can appeal to the OMS by filing a claim. The cost of filing a claim is denoted as L_a (referred to as the appeal cost). The OMS will use all available evidence to judge whether the seller is at fault for delivering a low-quality item. If the OMS judges that the seller is at fault, it will revoke the seller's membership and pay the buyer insurance compensation, denoted as I. Because the OMS has only limited ability to collect evidence, the judgment is uncertain. The probability of judging the seller at fault is denoted as a when the quality is high, and as b when the quality is low ($a < b$). The OMS will permanently ban a seller whose TMP membership is revoked. It is assumed that a seller whose membership is revoked bears a loss D. That is to say, D is the difference between the seller's expected future profit when eligible to subscribe to the OMS and when permanently excluded by the OMS. It is assumed that D does not vary with respect to the seller's type and the value of the item. This assumption is valid in a C2C market because a seller in such a market usually sells different items in different periods, and thus the seller's type varies in different periods. Consequently the seller's expected future gain is independent of type and item value at any specific period.

All traders are assumed to be risk neutral and seeking to maximize their expected payoffs. Figure 1 shows the subscription game tree and marks the seller's and the buyer's payoffs. The solution concept used to derive the outcome is Perfect Bayesian Equilibrium (PBE) [4], which is commonly used to analyze multistage games with incomplete information. The notations used in the multistage game are listed in Table 1.

Results and Analysis

The multistage subscription game will now be solved using backward induction.

Negotiation Period

In the subgame beginning at node N_2, the seller does not subscribe to a TMP. A seller who does not respond to the negotiation faces no loss because the buyer and the OMS cannot take any disciplinary action. Knowing the seller's response, the buyer will never initiate negotiations in this subgame.

However, in the subgame beginning at N_1, the seller has subscribed to a TMP. The OMS can revoke the seller's membership as a punishment if the seller does not respond to the buyer's negotiation request and the buyer appeals to the OMS. Negotiations do not automatically take place, but grow from a complex decision-making process. The buyer uses intention-to-appeal

q	Seller's type
$F(q)(f(x))$	Distribution (density) function of seller's type
w	Value of a high-quality item
t	Subscription fee
$p_s(p_o)$	Price expected by seller who has (does not have) a trust mark
L	Negotiation cost
$S_h(S_l)$	Settlement seller offers when quality of item is high (low)
I	Insurance compensation
L_a	Appeal cost
$a(b)$	Probability of OMS judging seller at fault when quality is high (low)
D	Loss seller bears once membership is revoked
$q_s(q_o)$	Expected type of seller with (without) TMP mark

Table 1. Notations Used in Multistage Subscription Game.

as a threat to get the seller to negotiate. The credibility of the threat depends on whether the buyer's expected insurance will cover the appeal cost. If the expected insurance does not cover the appeal cost, the threat is not credible, and the seller will never respond to a negotiation in equilibrium. Consequently the buyer will not initiate negotiations at a cost. Even if the threat is credible, it cannot guarantee that negotiations will occur. The seller will not respond to negotiations if the loss from negotiations (i.e., the settlement plus the negotiation cost) is greater than the expected loss for not negotiating. Similarly, the buyer will not initiate negotiations if the settlement cannot cover the negotiation cost.

In this paper, efficient negotiation is the outcome when negotiations occur if and only if the buyer receives a low-quality item. Traders are said to negotiate efficiently if efficient negotiations occur. A properly designed mechanism should achieve an efficient negotiation outcome. The amount of insurance compensation offered by the OMS plays an important role in inducing efficient negotiations. Inefficiency occurs in four types of situations. The first two situations occur when the insurance compensation is set too high. In the first situation, the buyer initiates negotiations and forces the seller to negotiate but intends to appeal to the OMS even when the item quality is high. In the second situation, the seller of an item of low quality may not respond to a negotiation because the sum of the settlement and the negotiation cost is higher than the expected loss when he does not negotiate. The third and fourth types of situations occur when the insurance compensation is set too low. In the third situation, the buyer's expected insurance compensation is too low to cover the appeal cost. As a result, the buyer's intent to appeal after the failure of negotiations is not a credible threat to the seller, and thus the seller has no incentive to negotiate. Finally, in the fourth situation, the settlement derived from the insurance is too low to cover the buyer's negotiation cost, and this will frustrate the buyer's initial intention to negotiate. Proposition 1 shows the range of insurance compensation for the OMS to induce efficient negotiations.

Proposition 1*: Negotiation is efficient when the insurance is in the range*

$$\left[\frac{L+L_a}{b},\min\left(D+\frac{L_a-L}{b},\frac{L+L_a}{a}\right)\right].$$

Proof: See Appendix. QED

Proposition 1 shows that the amount of insurance compensation needed to induce efficient negotiation is independent of the item's value. Since the insurance is derived from the seller's revocation loss, the appeal cost, and the negotiation cost, all of which are independent of the item value, the insurance is independent of the item's value. In this range of insurance compensation, a seller negotiates with a buyer if and only if the item is of low quality. Thus, on the equilibrium path, the OMS never actually pays any insurance compensation to buyers. The insurance serves purely to give the traders incentives to negotiate. Proposition 1 has some managerial implications for the OMS on determining insurance compensation.

Transaction Period

The transaction price in the transaction period will now be derived. Since the buyer cannot judge the quality during this period, the price cannot be contingent on item quality. In addition, the price cannot be contingent on the seller's type, which is the seller's private information. However, the buyer forms different beliefs about the seller's type depending on whether the seller is a TMP member or not. Thus, the equilibrium transaction price, which is equal to the buyer's expected valuation of the item, is contingent on the seller's TMP subscription.

The payoff for a buyer who trades with a TMP member is $w - p_s$ when the item quality is high and $S_l - L - p_s$ when the item quality is low. $S_l = bI - L_a$ is the settlement when the item quality is low. The buyer's expected payoff while trading is

$$E\pi_s^b = q_s \times (\textit{payoff when quality is high}) + (1-q_s)\times (\textit{payoff when quality is low}) = q_s w + (1-q_s)(S_l - L) - p_s,$$

where $q_s = Pr(\textit{quality} = \textit{high} \mid \textit{subscription})$ is the buyer's belief about a TMP member's type. In a highly competitive English auction, the buyer's expected payoff approaches zero. Thus, $p_s = q_s w + (1 - q_s)(S_l - L)$.

If the buyer trades with a seller who has no trust mark, the payoff is $w - p_o$ when the item quality is high and $-p_o$ when the item quality is low. Similarly, the buyer's expected payoff while trading is

$$E\pi_o^b = q_o w - p_o,$$

where $q_o = Pr(quality = high \mid no\ subscription)$ is the buyer's belief about the type of a seller who has no trust mark. The price is $p_o = q_o w$.

Pre-Transaction Period

The seller's payoff in the pre-transaction period will now be discussed, and the seller's subscription criteria will be explored. The seller decides whether to subscribe to a TMP by comparing the expected payoff with a trust mark, $E\pi_s^s(q)$, and without one, $E\pi_o^s(q)$.

A seller with a trust mark earns $p_s - t$ when the quality is high and $p_s - (L + S_l) - t$ when the quality is low. A type q seller's expected payoff is

$$E\pi_s^s(q) = q \times (\text{profit when the quality is high}) + (1-q) \times (\text{profit when the quality is low}) = p_s - (1-q)(L + S_l) - t.$$

Correspondingly, a seller without a trust mark earns p_o when the quality is high and p_o when the quality is low. Hence, the seller's expected payoff is $E\pi_o^s(q) = qp_o + (1 - q)p_o = q_o w$ if the seller is of type q.

Subscribing to the TMP is costly because it forces the seller to negotiate when the quality of the item is low. A seller's subscription cost varies with the seller's type. Although the price, p_s, the settlement, S_l, and the subscription fee, t, are independent of the seller's type, the probability to negotiate and offer a settlement depends on the type. The higher the type, the lower the probability that the seller will sell a low-quality item and get involved in costly negotiations. For this reason, if a seller of type $\hat{q}$ subscribes to the TMP, a seller whose type is higher than $\hat{q}$ will also subscribe. Thus, there is a marginal type q^*: a seller whose type is higher than q^* will subscribe to the TMP and those whose types are lower than q^* will not.

A buyer's expectation of a seller's type with a TMP subscription is $q_s(q^*) = E(q \mid q \geq q^*)$, and the expected payoff of a subscribed seller of type q is $E\pi_s^s(q)$. A buyer's expectation of a seller's type without a trust mark is $q_o(q^*) = E(q \mid q < q^*)$, and the expected payoff of a non-subscribed seller of type q is $E\pi_o^s(q)$. A seller of marginal type should be indifferent about whether to subscribe or not. That is, $E\pi_s^s(q^*) = E\pi_o^s(q^*)$. q^* is the solution of Equation (1).

$$q_s(q)w + (1 - q_s(q))(S_l - L) - (1-q)(L + S_l) - t = q_o(q)w. \tag{1}$$

If $q^* \in (0, 1]$, there is a separating equilibrium in which only sellers whose types are higher than or equal to q^* subscribe. If $q^* = 0$, there is a pooling equilibrium in which all sellers subscribe to the TMP. In addition, if $q_s(q)w + (1 - q_s(q))(S_l - L) - (1 - q)(L + S_l) - t > q_o(q)w$ for $q = 0$, all sellers subscribe to the TMP. Therefore, we define $q^* = 0$. If $q_s(q)w + (1 - q_s(q))(S_l - L) - (1 - q)(L + S_l) - t < q_o(q)w$ for $q = 1$, no seller subscribes to the TMP. Since $F(q)$ is continuous, we can define $q^* = 1$. Note that the uniqueness of the marginal type cannot be guaranteed given any general distribution of $F(q)$. To retain the computational tractability, the results will be derived under the assumption that $F(q) \sim U[0, 1]$. Further on, the analysis will be extended to a more general distribution function $F(q) = q^n$, $q \in [0, 1]$ for any positive integer n.

***Lemma 1**: When* F(q) ~ U*[0, 1], a unique* q* *exists.*

$$q^* = \begin{cases} 0 & t < \dfrac{w-s}{2} \\ 1 - \dfrac{w-2t}{s} & \dfrac{w-s}{2} \le t \le \dfrac{w}{2} \\ 1 & t > \dfrac{w}{2} \end{cases},$$

where $s = S_1 + 3L$.

Proof: Solving Equation (1), we can directly derive the results. ***.*** *QED*

***Corollary 1**:* q* *decreases with* w *and increases with* t.

Proposition 2 characterizes the equilibria and describes the seller's subscription criteria.

***Proposition 2**: The equilibria of the subscription game and the seller's subscription criteria are as follows:*

(1) If $t \in [(w - s)/2, w/2]$*, there is a separating equilibrium in which only sellers whose types are higher than or equal to* q* *subscribe to the TMP. Subscription indicates that the seller has a higher type and is able to obtain a price premium.*

(2) If $t > w/2$*, there is a pooling equilibrium in which no seller subscribes to the TMP.*

(3) If $t < (w - s)/2$*, there is a pooling equilibrium in which all sellers subscribe to the TMP.*

Proof: See Appendix. QED

With the presence of the OMS, a seller cannot signal type q exactly but can subscribe to the TMP and thereby show possession of a type higher than the types of those who do not subscribe. Buyers are willing to pay more to sellers with trust marks for two reasons. First, sellers with trust marks have higher expected types. Second, sellers with TMP subscriptions will negotiate and compensate buyers when the item quality is low, thus hedging the buyers' risks.

When $t > w/2$, no seller will subscribe to the TMP. The subscription fee is so high that even sellers of type 1, who never have to negotiate, cannot benefit from subscribing to the TMP. In this case, the OMS does not play a role in C2C markets. When $t < (w - s)/2$, the subscription fee is so low that sellers of every type will subscribe to the TMP. Since $q_s = E(q \mid q \geq q^*) = E(q)$, membership in a TMP does not increase the buyer's belief in the subscribers' types, and thus all sellers get same price. However, their probabilities to negotiate are different, depending on their types. They finally obtain different payoffs in our mechanism.

OMS Profit-Maximization Problems

This section examines OMS profitability with two fee structures: a flat fee structure and a fixed rate ratio fee structure. The optimal flat fee, t^*, and optimal rate, γ^*, of the fixed rate ratio fee are derived, and OMS profits with these two fee structures are compared.

From the perspective of the OMS, there is a continuum of sellers selling items with different values in a C2C market. It is assumed that the value of the item, w, follows the distribution $G(w)$ with support $[w_l, w_h]$. G_w is differentiable, and the probability density function is $g(w)$. Without loss of generality, the marginal cost of the OMS to serve a member is assumed to be zero.

Given the seller's subscription criteria developed in Proposition 2, it is possible to determine the demand function of the OMS. The expected numbers of subscriptions in the flat fee structure given a flat fee, t, and in the fixed rate ratio fee structure given a rate, γ, are respectively

$$Q_f(t) = \int_{w_l}^{w_h} \left(1 - F\left(q^*(t, w)\right)\right) g(w)\, dw$$

and

$$Q_r(\gamma) = \int_{w_l}^{w_h} \left(1 - F\left(q^*(\gamma w, w)\right)\right) g(w)\, dw.$$

These two formulas can also be regarded as the demand functions of the OMS. The profit-maximization problems of the OMS based on these two demand functions will now be discussed.

To retain computational tractability, we assume $G(w) = U[0, 1]$. These assumptions (the uniform distribution and zero marginal cost) simplify the calculation without impairing the results. Given the subscription fee, the seller's type is the basis for choosing whether or not to subscribe to a TMP. If the subscription fee is low, a larger number of sellers will subscribe, but the profit per subscription is low. If the subscription fee is high, fewer sellers will subscribe to the TMP, but the profit per subscription is higher. Thus, an OMS provider must balance these two countervailing forces when setting the subscription fee. Proposition 3 characterizes the optimal parameters for the flat fee structure and the fixed rate ratio fee structure, and compares the OMS profits with these two fee structures.

Proposition 3: *The optimal pricing strategies of the OMS with the flat fee structure and the fixed rate ratio fee structure are as follows:*

(1) The optimal flat fee for the OMS is

$$t^* = \begin{cases} \frac{1}{6} & \text{if } s > \frac{2}{3} \\ \frac{1}{4} - \frac{s}{8} & \text{otherwise} \end{cases}.$$

(2) The optimal rate of the fixed rate ratio fee is $\gamma^* = 1/4$ *if* $s > 1/2$. *Otherwise, the OMS optimal rate satisfies*

$$\frac{1}{2} - \frac{s^2}{6(1-2\gamma)^2} - \frac{2\gamma s^2}{3(1-2\gamma)^3} = 0.$$

The OMS earns higher profit in the ratio fee structure than in the flat fee structure.

Proof: See Appendix. QED

Figure 2 shows the OMS profits with the flat fee structure and the fixed rate ratio fee structure. It illustrates that the fixed rate ratio fee structure produces a higher profit. In the flat fee structure, the optimal fee is relatively low for sellers who sell expensive items and earn higher profits. As a result, these sellers will definitely subscribe to the TMP. However, for sellers of inexpensive items, the optimal flat fee is too high to be an incentive to subscribe. Leveraging on the fixed rate ratio fee, the OMS can adjust subscription fees according to the value of sellers' items. The profit increment comes from the capability of the ratio fee to discriminate sellers based on their profitability, which, in turn, depends on the item value.

A More General Distribution of Seller Types

In this section, we use a more general distribution $F(q) = q^n$, $q \in [0, 1]$, $n = 1, 2, 3, \ldots$ to analyze the multistage subscription game and OMS' pricing strategies.[7] This assumption reflects the fact that the majority of sellers are of high quality to past experience from eBay.[8] With such a belief, a buyer's expectation of a seller's type with a trust mark is

$$q_s(q^*) = E(q \mid q \geq q^*) = \frac{n}{n+1} \frac{1-(q^*)^{n+1}}{1-(q^*)^n},$$

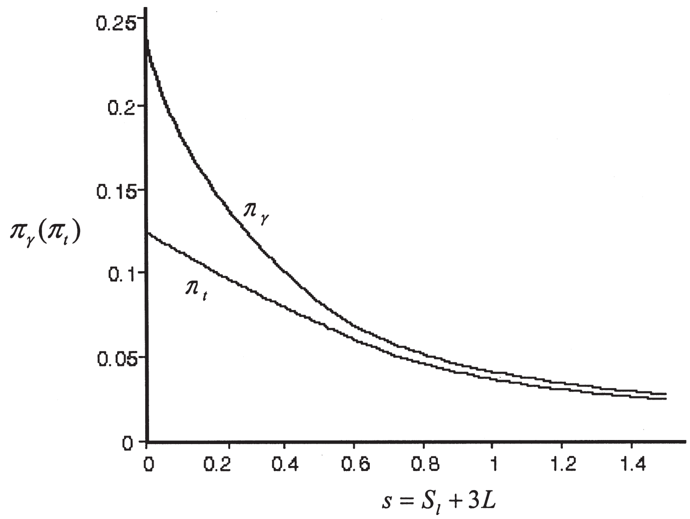

Figure 2. The Optimal Profits of the OMS with the Flat Fee Structure and the Fixed Rate Ratio Fee Structure

Notes: π_γ is the optimal profit of the OMS with the flat fee structure given different combinations of the settlement, S_l, and the negotiation cost, L; π_t is the optimal profit of the OMS with the fixed ratio fee structure given different combinations of the settlement, S_l, and the negotiation cost, L.

and a buyer's expectation of a seller's type without a trust mark is

$$q_o\left(q^*\right) = E\left(q \mid q < q^*\right) = \frac{n}{n+1} q^*,$$

where q^* is the marginal type. Equation (1) can then be rewritten as

$$\frac{n}{n+1}\frac{1-q^{n+1}}{1-q^n} w + \left(1 - \frac{n}{n+1}\frac{1-q^{n+1}}{1-q^n}\right)\left(S_l - L\right) - \left(1-q\right)\left(L + S_l\right) - t = \frac{n}{n+1} q w. \tag{2}$$

As in the analysis presented earlier, if $q^* \in (0, 1]$, there is a separating equilibrium in which only sellers whose types are higher than or equal to q^* subscribe. If $q^* = 0$, there is a pooling equilibrium in which all sellers subscribe to the TMP. In addition, if

$$\frac{n}{n+1}\frac{1-(q)^{n+1}}{1-(q)^{n}}w+\left(1-\frac{n}{n+1}\frac{1-(q)^{n+1}}{1-(q)^{n}}\right)(S_l-L)-(1-q)(L+S_l)$$
$$-t>\frac{n}{n+1}qw$$

for $q = 0$, we define $q^* = 0$ and a pooling equilibrium in which all sellers subscribe to the TMP exists. That is, the subscription fee is so low that sellers always obtain a higher profit by subscribing to the TMP. If

$$\frac{n}{n+1}\frac{1-(q)^{n+1}}{1-(q)^{n}}w+\left(1-\frac{n}{n+1}\frac{1-(q)^{n+1}}{1-(q)^{n}}\right)(S_l-L)-(1-q)(L+S_l)$$
$$-t<\frac{n}{n+1}qw$$

for $q = 1$, we define $q^* = 1$, and there is a pooling equilibrium in which no seller subscribes to the TMP. In this case, the OMS does not influence the C2C market and is not profitable.

Equation (2) can be solved by rewriting it as:

$$\frac{n}{n+1}\frac{1-q^{n+1}}{1-q^{n}}(w-S_l+L)=2L+t+\left(\frac{n}{n+1}w-L-S_l\right)q. \tag{3}$$

It is difficult to derive closed-form solutions for q^* from Equation (3). Proposition 4 summarizes the different equilibria and characterizes the marginal types given different combinations of the item value w, the settlement S_l, the negotiation cost L, and the subscription fee t.

***Proposition 4**: The equilibria can be summarized as follows:*

(1) When $t \le (n/(n+1))(w+L-S_l)-2L$, $q^* = 0$. *A pooling equilibrium exists in which all the sellers subscribe.*

(2) When $w - S_l + L > 0$, *a unique separating outcome exists if* $t \in ((n/(n+1))(w+L-S_l)-2L, (n/(n+1))w]$. *That is, a unique marginal type* $q^* \in (0, 1]$ *exists so that all sellers with types higher than or equal to* q^* *subscribe to the TMP, and those whose types are lower than* q^* *do not. When* $t > (n/(n+1))w$, *a pooling equilibrium exists in which no seller subscribes to the TMP.*

(3) When $w - S_l + L < 0$, *there is a* t' *such that two separating equilibria exist when* $t \in ((n/(n+1))(w+L-S_l)-2L, t']$. *Only the equilibrium with smaller marginal type is stable. When* $t > t'$, *there is a pooling equilibrium in*

which no seller subscribes to the TMP. t′ *is the solution of Equation (3) and Equation (4).*

$$\begin{cases} \dfrac{n}{n+1}\dfrac{1-q^{n+1}}{1-q^{n}}\left(w-S_l+L\right)=2L+t+\left(\dfrac{n}{n+1}w-L-S_l\right)q & (3) \\ \dfrac{\partial}{\partial q}\left(\dfrac{n}{n+1}\dfrac{1-q^{n+1}}{1-q^{n}}\left(w-S_l+L\right)\right)=\dfrac{\partial}{\partial q}\left(2L+t+\left(\dfrac{n}{n+1}w-L-S_l\right)q\right) & (4) \end{cases}$$

Proof: *Please see Appendix. QED*

Note that multiple equilibria of the subscription subgame may exist given a subscription fee t when $n > 1$. The discussion here focuses on the one with the largest subscription (i.e., smaller q^*) because it is the one that the OMS prefers. Thus, under the circumstance where a pooling equilibrium exists in which all sellers subscribe, the discussion here will ignore other equilibria.

An OMS provider will set a subscription fee at which sellers choose whether to subscribe or not. It is difficult to derive the optimal flat fee and the optimal rate of the fixed rate ratio fee analytically. Thus, the OMS profits are compared using simulation. We still assume that w is uniformly distributed between 0 and 1. In addition, $S_l = 0.5$, $L = 0.1$. Figure 3 demonstrates the expected profits made by the OMS provider under different flat fees and different rates (in the fixed rate ratio fees structure). The maximal point of the dashed curve (i.e., the maximal profit of the OMS provider in the fixed rate ratio fee structure) is always higher than the maximal point of the solid curve (i.e., the maximal profit of the OMS provider in the flat fee structure). One may conclude that the OMS earns a higher profit in the fixed rate ratio fee structure than in the flat fee structure. This result is consistent with Proposition 3. The intuition is the same as the one given earlier in the discussion of OMS profit maximization problems—the ratio fee structure enables the OMS to discriminate sellers based on their profitability, which, in turn, depends on the item value.

Conclusions and Future Research

This paper demonstrates that properly designed OMS systems will alleviate the adverse consequences of information asymmetry. Such systems (1) allow sellers with higher types to signal their superiority and thus reduce buyer uncertainty about sellers' types, and (2) induce efficient negotiations between sellers and buyers, thereby alleviating buyer concerns about item quality. The paper shows that mechanism design has a significant impact on the profit reallocation of C2C markets—namely, that a third party can expropriate the market and make a profit if the original parties are not endowed with the rights or the abilities to design and implement a mechanism. The paper also studies the OMS provider's pricing schemes and illustrates that OMS profits are higher in fixed rate ratio fee structures than in simple flat fee structures.

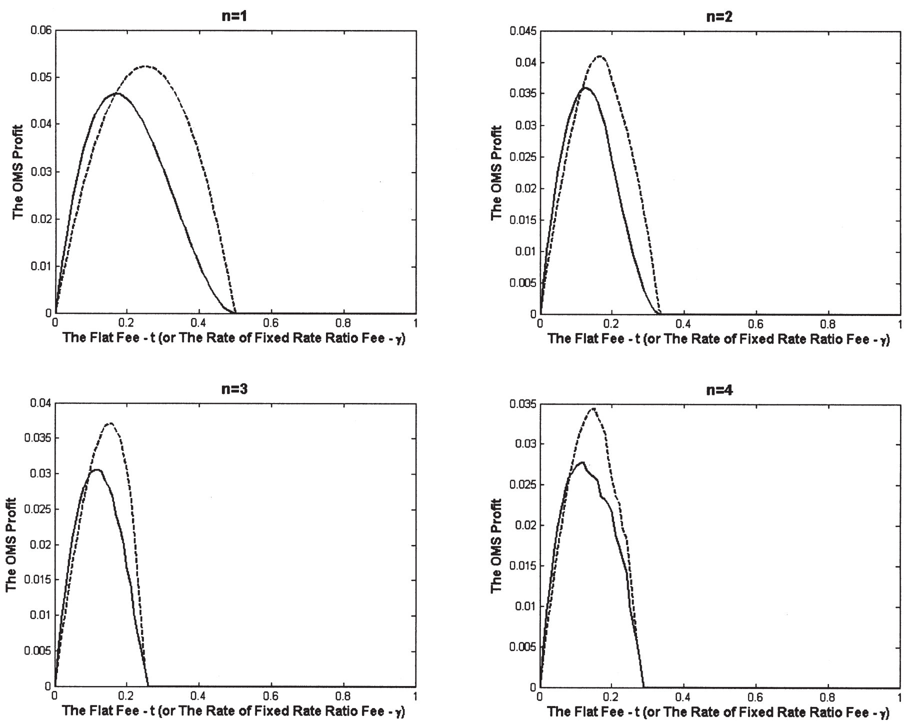

Figure 3. The OMS Profit with Different Flat Fees and Ratio Fees

Note: The solid line represents the OMS profit in the flat fee structure; the dashed line represents OMS profit in the fixed rate ratio fee structure.

The results presented here were first derived under a restrictive assumption that the seller's type follows the uniform distribution. Then the robustness of the proposed mechanism was shown by analyzing the model in a more general distribution function representing the reality that a majority of sellers in a C2C market are of high quality. The results provide valuable managerial implications for the operation of this mechanism as a business unit.

The mechanism discussed here can help a good seller without an enhanced reputation to signal superiority and earn a price premium. It prevents sellers with well-established names from consuming their reputation. These features complement the on-line reputation mechanism, effectively reduce information asymmetry, and alleviate the adverse consequences of information asymmetry in C2C markets.

The present research assumes that the loss from the revocation is exogenously given. Future research can look at a repeated setting and endogenize the loss. The loss can be derived by comparing the expected payoff of a seller eligible to subscribe to the OMS and the expected payoff of a seller permanently excluded by the OMS. However, extension of this kind would increase the computational complexity without generating any new insight.

The presentation in this paper derived OMS profit-maximization decisions in a flat fee structure and a fixed rate ratio fee structure and then compared their profitability. In reality, an OMS provider could implement a variety of fee structures. For example, the OMS can charge ratio fees with rates that depend on the item value. Other fee structures could be studied in future research to provide more concrete managerial guidelines for OMS providers.

NOTES

1. Most C2C markets are organized as auctions with established rules. Buyers must follow the rules and can only decide whether to join the auction and how much to bid.
2. www.SquareTrade.com.
3. TMP can verify an applicant's identity and address through a third-party identity-verification service provider (e.g., Equifax). It can also verify identity using current utility bills, credit card statements, insurance statements, or bank statements.
4. In the fixed rate ratio fee structure, the fee is proportional to the value of the item. In the flat fee structure, the fee is independent of the value of the item. We will not discuss the case in which the OMS charges traders a negotiation fee.
5. The classical results of English auction theory state that the bidder with the highest valuation wins and pays the bid (i.e., the price of the item), which is slightly higher than the second-highest valuation.
6. For the purposes of this paper, the settlement is the financial compensation the seller offers the buyer in a negotiation. This term is borrowed from civil law. In a civil lawsuit, "settlement offer" or "offer to settle" is a term that describes a communication from one party to the other suggesting a settlement: that is, an agreement to end the lawsuit before a judgment is rendered. The agreement specifies the obligations for the parties, such as financial compensation or a public apology.
7. When $n = 1$, q follows the uniform distribution.
8. We thank an anonymous referee for pointing out this fact and suggesting that we discuss our mechanism in a more general framework.

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Appendix

Proofs of Propositions

Sketch Proof of Proposition 1

Examine the game shown in Figure 1. At node B_5, a buyer chooses between "to appeal" and "not to appeal" by comparing $w - p_s - L - L_a + aI$ and $w - p_s - L$. A buyer at B_6 decides by comparing $-p_s - L - L_a + bI$ and $-p_s - L$.

If $I < L_a/b$, the buyer will choose "not to appeal" regardless of the quality level. Consequently, the seller has no incentive to negotiate, knowing the buyer will not appeal. Under these circumstances, a buyer will not bother to initiate a negotiation. Therefore, $I \geq L_a/b$ is needed to induce the buyer to use ODR.

If $I \geq L_a/a$, the buyer will always choose "to appeal" regardless of the item quality. The buyer's expected insurance compensation is aI. The seller's minimum offer to keep the buyer from appealing will be $S_h = aI - L_a$. The seller does not respond to negotiations if $p_s - aD - t > p_s - L - S_h - t$, (or $I > D + ((L_a - L)/a)$. Expecting the seller's response, the buyer does not initiate negotiations. Even if the seller is willing to negotiate, the buyer does not initiate negotiations if $W - p_s > w - p_s - L + S_h$, that is, if $I < ((L_a + L)/a)$. Thus, if $(L_a/a) \leq I < ((L_a + L)/a)$ or $I > \max(L_a/a, D + ((L_a - L)/a)$, there is no negotiation if the item quality is high.

When the item quality is low, the settlement should be $S_l = bI - L_a$. The seller responds to negotiation if $I < D + ((L_a - L)/b)$. The buyer is willing to initiate negotiation if $I > (L_a + L)/b$. If $\max(L_a/a, (L_a + L)/b) < I < (D + (L_a - L)/b)$ the seller and the buyer will negotiate when the item quality is low. In summary, efficient negotiation is induced when $\max(L_a/a, (L_a + L)/b) < I < \min((L_a + L)/a, D + (L_a - L)/b)$.

The buyer chooses "to appeal" if the item quality is low, and "not to appeal" when the item quality is high, if and only if $(L_a/b) \leq I \leq (L_a/a)$. When the item quality is high, the seller will choose "not to negotiate" because $p - t > p - L - S_h - t$. The buyer will choose "not to negotiate" because $w - p > w - p - L$. When the quality is low, the seller will choose "to negotiate" if $I \leq D + ((L_a - L)/b)$. The buyer will choose "to negotiate" if $I > ((L + L_a)/b)$. Overall, when

$(L + L_a)/b \leq I \leq \min(D + (L_a - L)/b, L_a/a)$, the traders negotiate and settle the dispute if and only if the quality is low.

In summary, if $(L + L_a)/b \leq I \leq \min(D + ((L_a - L)/b), (L + L_a)/a)$, the buyer and seller will negotiate and settle the dispute if and only if item quality is low. QED

Sketch Proof of Proposition 2

From Lemma 1, when $w \in [2t, 2t + s]$, $q^* = 1 - ((w - 2t)/s) \in [0, 1]$. When $q^* \in (0, 1]$, a separating equilibrium exists. We have $q_s > q_o$ and $p_s > p_o$. Subscription provides the seller a price premium. When $q^* = 0$, a pooling equilibrium exists in which all sellers subscribe to the TMP.

When $w \in [0, 2t)$, $q^* = 1$ by definition. Even type 1 sellers will not subscribe to a TMP. Thus, a pooling equilibrium exists in which no seller subscribes.

When $w \in (2t + s, +\infty)$, $q^* = 0$ by definition. Since the buyer believes that only an inferior seller will not subscribe to a TMP, all the sellers subscribe. QED

Sketch Proof of Proposition 3

In the flat fee structure, the OMS decision problem can be reformulated as follows:

$$\begin{aligned}&\max_t t\left(\int_{2t}^{1}\left(1-\left(1-\frac{w-2t}{s}\right)\right)g(w)\,dw\right)\\ &\text{s.t.}\quad 2t+s>1\end{aligned}$$

or

$$\begin{aligned}&\max_t t\left(\int_{2t}^{2t+s}\left(1-\left(1-\frac{w-2t}{s}\right)\right)g(w)\,dw+1-G(2t+s)\right)\\ &\text{s.t.}\quad 2t+s\leq 1\end{aligned}$$

Substitute q^*, w_1, w_2, and we get

$$\begin{aligned}&\max_t t\left(\int_{2t}^{1}\frac{w-2t}{s}g(w)dw\right)\\ &\text{s.t.}\quad 2t+s>1\end{aligned}$$

or

$$\max_t t\left(\int_{2t}^{2t+s} \frac{w-2t}{s} g(w)\,dw + 1 - 2t - s\right)$$
$$\text{s.t.} \quad 2t + s \le 1$$

when $s > 2/3$, the optimal flat fee $t = 1/6$ and the OMS profit is $\pi_t = 1/27s$. When $s \le 2/3$, $t = 1/4 - s/8$ and the OMS profit is $\pi_t = s^2/32 - s/8 + 1/8$.

In the fixed rate ratio fee structure, the OMS decision problem is reformed as

$$\max_\gamma \left(\int_0^1 \gamma w \left(1 - \left(1 - \frac{(1-2\gamma)w}{s}\right)\right) g(w)\,dw\right)$$
$$\text{s.t.} \quad \frac{s}{1-2\gamma} > 1$$

or (A.1)

$$\max_\gamma \left(\int_0^{\frac{s}{1-2\gamma}} \gamma w \left(1 - \left(1 - \frac{(1-2\gamma)w}{s}\right)\right) g(w)\,dw + \int_{\frac{s}{1-2\gamma}}^1 \gamma w g(w)\,dw\right)$$
$$\text{s.t.} \quad \frac{s}{1-2\gamma} \le 1.$$

When s > 1/2, the OMS optimal fixed rate for the ratio fee is $\gamma = 1/4$ and the profit is $\pi_\gamma = 1/24s$. When $s \le 1/2$, the OMS optimal fixed rate for the ratio fee satisfies

$$\frac{1}{2} - \frac{s^2}{6(1-2\gamma)^2} - \frac{2\gamma s^2}{3(1-2\gamma)^3} = 0.$$

The OMS profit can be calculated using (A.1). Using simulation to compare OMS profits, we conclude that an OMS provider earns a higher profit in the ratio fee structure than in the flat-fee structure. QED

Sketch Proof of Proposition 4

Figure 4 (a), (b), and (c) demonstrates three possible cases given different combinations of w, S_l, L, and t.

The case when $w > ((n + 1)/n)(L + S_l)$ is demonstrated in Figure 4 (a). The curve represents the left-hand side of Equation (3),

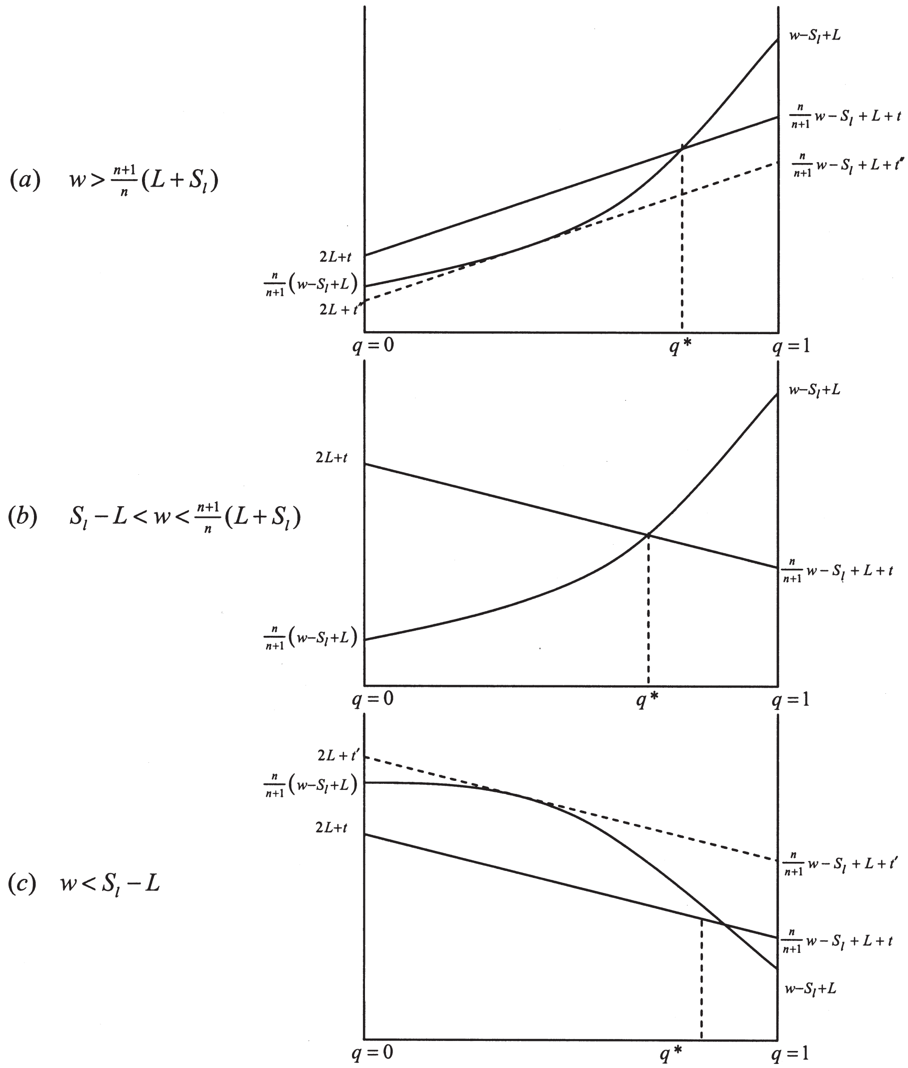

Figure 4. The Marginal Types Given Different Combinations of the Item Value, *w*, the Settlement, *S_l*, the Negotiation Cost, *L*, and the Subscription Fee, *t*

$$\frac{n}{n+1}\frac{1-(q)^{n+1}}{1-(q)^n}(w-S_l+L),$$

which is increasing and convex. The line represents the right-hand side of Equation (3),

$$2L+t+\left(\frac{n}{n+1}w-L-S_l\right)q.$$

The intersections between the curve and the line characterize q^*.

1. If $t < t''$, $q^* = 0$. A pooling equilibrium in which all sellers subscribe exists. And it is stable.
2. If $t'' \leq t < (n/(n+1))(w+L-S_l) - 2L$, $q_1^* = 0$, $q_2^*, q_3^* \in [0, 1]$ (we assume $q_2^* \leq q_3^*$). A pooling equilibrium in which all sellers subscribe and two separating equilibria exist. The pooling equilibrium and the separating equilibrium with larger q^* are stable.
3. If $t = (n/(n+1))(w+L-S_l) - 2L$, $q_1^* = 0$ and $q_2^* \in (0, 1)$. A pooling equilibrium in which all sellers subscribe and a separating equilibrium exist. Both are stable.
4. If $(n/(n+1))(w+L-S_l) - 2L < t \leq (1/(n+1))w$, $q^* \in (0, 1]$. A separating equilibrium exists. And it is stable.
5. If $t > (1/(n+1))w$, $q^* = 1$. A pooling equilibrium in which no seller subscribes exists. And it is stable.

t'' is the solution of both Equation (3) and Equation (4).

$$\begin{cases} \dfrac{n}{n+1}\dfrac{1-q^{n+1}}{1-q^n}(w-S_l+L) = 2L+t+\left(\dfrac{n}{n+1}w-L-S_l\right)q & (3) \\ \dfrac{\partial}{\partial q}\left(\dfrac{n}{n+1}\dfrac{1-q^{n+1}}{1-q^n}(w-S_l+L)\right) = \dfrac{\partial}{\partial q}\left(2L+t+\left(\dfrac{n}{n+1}w-L-S_l\right)q\right) & (4) \end{cases}$$

The case when $S_l - L < w < ((n+1)/n)(L+S_l)$ is illustrated in Figure 4 (b).

1. If $t \leq (n/(n+1))(w+L-S_l) - 2L$, $q^* = 0$. A pooling equilibrium in which all sellers subscribe exists. And it is stable.
2. If $(n/(n+1))(w+L-S_l) - 2L < t \leq (1/(n+1))w$, $q^* \in (0, 1]$. A separating equilibrium exists. And it is stable.
3. If $t > (1/(n+1))w$, $q^* = 1$. A pooling equilibrium in which no seller subscribes exists. And it is stable.

The case when $w < S_l - L$ is illustrated in Figure 4 (c).

1. If $t \leq (1/(n+1))w$, $q^* = 0$. A pooling equilibrium in which all sellers subscribe exists. And it is stable.
2. If $(1/(n+1))w < t \leq (n/(n+1))(w+L-S_l) - 2L$, q_1^* and $q_2^* \in (0, 1]$. A pooling equilibrium in which all sellers subscribe and a separating equilibrium exist. Only the pooling equilibrium is stable.
3. If $(n/(n+1))(w+L-S_l) - 2L < t \leq t'$, $q_1^*, q_2^* \in (0, 1]$ (we assume $q_1^* \leq q_2^*$). Two separating equilibria exist. And only the separating equilibrium with smaller q^* is stable.

4. If $t > t'$, $q^* = 1$. A pooling equilibrium in which no seller subscribes exists. And it is stable.

t' is a solution of both Equation (3) and Equation (4).

Only stable equilibrium is considered [4]. When multiple stable equilibria exist, it is assumed that a profit-maximizing OMS can influence sellers and induce the one with the largest demand. Thus, the results can be summarized in Proposition 4. QED

XIA ZHAO (xia.zhao@phd.mccombs.utexas.edu) is a Ph.D. candidate in information systems and a research assistant at the Center for Research in Electronic Commerce at the University of Texas, Austin. Her research interests include electronic commerce, Internet security, and the economics of open source.

FANG FANG (fangfang@csusm.edu) is an assistant professor in the College of Business Administration at California State University at San Marcos. Her research interests include knowledge markets, financial markets, and network finance.

ANDREW B. WHINSTON (abw@uts.cc.utexas.edu) is professor of information systems, economics, computer science, and library and information sciences, Hugh Roy Cullen Centennial Chair in Business Administration, and director of the Center for Research in Electronic Commerce at the University of Texas, Austin. He has published more than 300 papers in top-rated scientific journals and has recently co-authored the following books: *The Frontiers of Electronic Commerce, Electronic Commerce: A Manager's Guide, The Economics of Electronic Commerce, The Internet Economy: Technology and Practice,* and *Electronic Commerce and the Revolution in Financial Markets.*

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