No. 32

UNIVERSITY OF COLOGNE

WORKING PAPER SERIES IN ECONOMICS

HOW SOCIAL REPUTATION NETWORKS INTERACT WITH COMPETITION IN ANONYMOUS ONLINE TRADING: AN EXPERIMENTAL STUDY

GARY E BOLTON
CLAUDIA LOEBBECKE
AXEL OCKENFELS

Department of Economics
University of Cologne
Albertus-Magnus-Platz
D-50923 Köln
Germany

http://www.wiso.uni-koeln.de

How Social Reputation Networks Interact with Competition in Anonymous Online Trading: An Experimental Study

Gary E Bolton*
Penn State University, USA

Claudia Loebbecke
University of Cologne, Germany

Axel Ockenfels
University of Cologne, Germany

Many Internet markets rely on 'feedback systems', essentially social networks of reputation, to facilitate trust and trustworthiness in anonymous transactions. Market competition creates incentives that arguably may enhance or curb the effectiveness of these systems. We investigate how different forms of market competition and social reputation networks interact in a series of laboratory online markets, where sellers face a moral hazard. We find that competition in strangers networks (where market encounters are one-shot) most frequently enhances trust and trustworthiness, and always increases total gains-from-trade. One reason is that information about reputation trumps pricing in the sense that traders usually do not conduct business with someone having a bad reputation not even for a substantial price discount. We also find that a reliable reputation network can largely reduce the advantage of partners networks (where a buyer and a seller can maintain repeated exchange with each other) in promoting trust and trustworthiness if the market is sufficiently competitive. We conclude that, overall, competitive online markets have more effective social reputation networks.

* Gary Bolton, Smeal College of Business, Penn State University, University Park, PA 16802 USA, gbolton@psu.edu (http://www.personal.psu.edu/faculty/g/e/geb3/). Claudia Loebbecke, University of Cologne, Department of Business Administration and Media Management (http://www.mm.uni-koeln.de/mitarbeiter-loebbecke-home-engl.htm)., Axel Ockenfels, University of Cologne, Department of Economics, Albertus Magnus Platz, D-50923 Cologne, Germany, ockenfels@uni-koeln.de (http://ockenfels.uni-koeln.de/ao). Bolton gratefully acknowledges the support of the National Science Foundation. Ockenfels gratefully acknowledges the support of the Deutsche Forschungsgemeinschaft.

1 Introduction: Social Networks and Competitive Markets

This paper presents evidence on the relationship between market competition and the social networks used in many Internet markets to induce trusting and trustworthy behavior. Well functioning markets, be they Internet or brick-and-mortar, must strike a delicate balance between competition and cooperation. On the one hand, competition on factors such as price is a main driver of the social and business benefits associated with trade. On the other hand, these benefits can be realized only if traders cooperate by making good on the agreement (e.g., delivering the product as promised). It is on this latter score that social networks have proven critical (e.g., Dellarocas 2003, Gefen and Straub 2004).

All markets are embedded in social networks, and these networks facilitate the dissemination of information about reputations. Reputation information permits members, market traders in this instance, to implement cooperation through tit-for-tat strategies, bypassing what is often prohibitively costly legal action (e.g., Alexander 1987, Granovetter 1985).[1] In this way, social networks encourage trust and trustworthiness among traders.

The great advantage of Internet markets is that they enable traders to break through geographical constraints to trade in larger and more competitive pools (e.g., Malone et al. 1987; Granados et al. 2006). The social networks around Internet markets are structured differently than those around most brick-and-mortar markets. In brick-and-mortar markets, there tends to be more repeated exchange between traders with a *partners* relationship. Tit-for-tat here relies on a direct flow of reputation information; e.g., the buyer does business with the seller only if the seller has been reliable with the buyer in the past. Partnering to create trust and trustworthiness is known to work well even when there is little legal safety net (e.g., McMillan 2002). In Internet markets, transactions tend to be more one-shot, between *strangers*. For instance, Resnick and Zeckhauser (2002) found that 89 percent of all eBay trading encounters are one-shot. Tit-for-tat here relies on an indirect flow of reputation information; the buyer does business with the seller only if the seller has been reliable with third party buyers. To facilitate this strategy, many Internet markets

1 Or as Cornelius Vanderbilt put it to a former business associate he had a falling out with, "I won't sue you, for the law is too slow. I'll ruin you." (Kaplan 2006, p. 137).

(e.g., Amazon, Cnet, eBay, Half, and Yahoo) have formal 'feedback systems', allowing traders to post evaluations of those they exchange with for the benefit of other traders.[2]

In this paper, we examine laboratory versions of anonymous online markets where sellers face a moral hazard concerning *trustworthiness* - whether to ship to a trusting buyer or not. Market participants are presented with a series of trading opportunities, across a number of rounds. The market encounters are linked over time via social reputation networks: Prospective buyers are furnished with feedback information, a complete and accurate record of a seller's past shipping record within the market community.[3] The information flow allows buyers to better decide whether they should *trust* the seller by making a buy, and by the same token creates incentives for sellers to be trustworthy. In our laboratory study, we mainly focus on '*strangers network*' versions of the market, with indirect flows of reputation information as in many online markets. But following Bolton, Katok, and Ockenfels (2004a), we also investigate '*partners network*' versions of the market, as a way to benchmark the stranger network results. Because the amount of information that buyers have about the shipping history of sellers they are matched with is the same in both strangers and partners networks, economic theory implies that trading patterns should be independent of the kind of network. In essence, with the same information, buyers can implement the same tit-for-tat strategy (for the theory see Kreps et al. 1982; Bolton and Ockenfels 2006). The theory is independent of the amount of competition in the market. Bolton et al. (2004a) studied markets where there was little competition[4] and found that, contrary to reputation building theory, the volume of completed trade was substantially higher in the partners networks than in the strangers networks.

Reputation building behavior in both field and lab data is 'noisier' than what is implied by the theoretical reputation building models: Sellers sometimes fail to ship when building up a reputation of being trustworthy would have been the rational strategy, and they do not always defect when profit-maximizing dictates so. As a result, the predictive value of reputation

2 Brynjolfsson and Smith (2000), Dellarocas (2003), and Resnick and Zeckhauser (2002) provide comparisons of electronic and conventional dissemination of reputation information. There is a large literature showing that reputation mechanisms like those employed by eBay have merit, although reputation information is less than fully reliable. In particular, field data and experimental work indicate that reputable Internet sellers are more likely to sell their items (e.g., Resnick, Zeckhauser 2002), and can expect price premiums (e.g., Lucking-Reiley et al. 1999); see Resnick et al. (2002), Dellarocas (forthcoming), and Bolton, Katok, and Ockenfels (2004b) for discussions and surveys.

3 Hence our experiment looks at the performance of feedback systems under ideal conditions.

4 The study examined markets in which trading encounters were exogenously arranged, and the price of any transaction was fixed.

information differs in theory and practice. As a simple example, the fact that a seller failed to ship once in the past, does not mean, with probability one, that he will never ship again, as the equilibrium of the model would suggest. Hence reputation information, even when it is a complete and reliable history, is more a noisy *signal* than reputation building models typically anticipate. But when the predictive value of reputation information is low or not clear, it is difficult for buyers to deal with these signals in a rational way, which adds to the noise in actual reputation building.

Thinking of reputation building in terms of signaling suggests an alternative conceptual framework, one where competition plays a central role. The economic theory of *signaling* suggests that, in principle, the combination of seller competition and noisy signals can lead to one of two very different types of outcomes (Riley 2001, Spence 1974, Cho and Kreps 1987). On the one hand, seller competition permits buyers to discriminate on the basis of seller signals. To the extent they do so, sellers have an incentive to invest in a good signal. In terms of the markets we study in this paper, sellers would have an incentive to maintain a reputation for trustworthiness because buyers reward trustworthiness with trust; the end result is a higher volume of transactions making for greater market efficiency. On the other hand, if buyers do not or only weakly discriminate on the basis of the reputation signal, sellers have little incentive to invest in greater trustworthiness. Competition, then, would have little merit, or, at the extreme, it could lead to a lemons problem (Akerlof 1970), where all sellers are basically treated the same by buyers. Competition may lead to sellers becoming less trustworthy, chasing out buying, thereby reducing the volume of trade. Thus, in principle, market competition may increase the effectiveness of social reputation networks to promote trust and trustworthiness – but it also might leave it unchanged or even reduce the efficiency of the market.

The experiment we present in this paper begins by examining strangers and partners networks with no competition. The partners network leads to higher levels of market efficiency than does the strangers network. This reproduces the main result of Bolton et al. (2004), and we take this result as a baseline for the rest of the experiment. We then introduce *matching competition* (each buyer gets to choose between two sellers; prices are fixed) and *price competition* (the two sellers compete on prices) to both the strangers and partners networks. The two kinds of competition, matching and price, plausibly have countervailing effects. In markets with matching competition, sellers can only attract buyers on the basis of reputation information, and this competitive focus

on competition may plausibly lead to more trustworthiness and larger gains-from-trade. Markets with price competition permit buyers to trade-off pricing and reputation in their seller selection (i.e., to take a chance on a seller with a less reputation but also a lower price), which weakens the focuse on reputation, and this might plausibly destabilize trade.

2 Experimental Design

2.1 Buyer-Seller Game

Our laboratory study centers on a simple buyer-seller game that captures the essence of moral hazard problems as they are present on any Internet market. We conceive of market transactions as taking place over a fixed number of rounds. At the beginning of each round, a potential buyer is matched (either exogenously or through selection by the buyer) with a seller. The ensuing encounter is laid out in Figure 1.

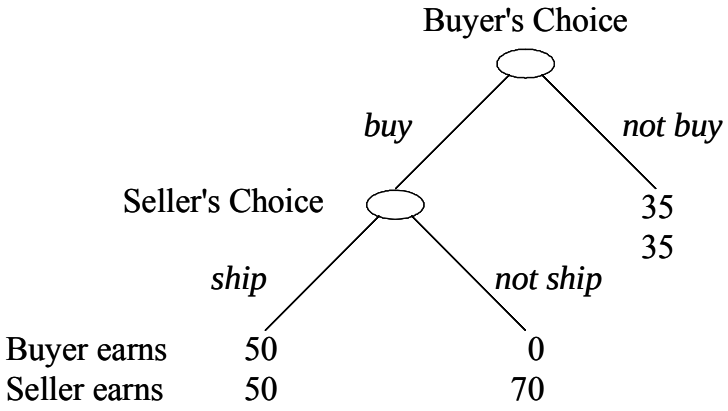


Figure 1. The Base Buyer-Seller Game with No Competition

The buyer chooses whether to purchase an item (in Figure 1, at a fixed price) or not. If not, both sides of the market receive a status quo payoff. If the purchase order is sent, the seller decides whether to ship or simply keep the buyer's money. The moral hazard is that, on receiving the money from the buyer, the seller has no immediate pecuniary incentive to ship the item. So a transaction that is in the interest of both parties may be thwarted either because the seller proves untrustworthy, or because the buyer, given this risk, chooses not to trust.

In the game in Figure 1, both the seller and the buyer are endowed with 35 (hence the payoff if no trade takes place). The seller offers an item for sale at a fixed price of 35 which has a value of 50 to the buyer. The seller's cost of providing the buyer with the item − costs associated with executing the trade, shipping, handling etc., as well as production costs − is 20.[5] So each successfully completed trade increases efficiency by creating a consumer surplus of 15 and a net profit of 15 for the seller. If the buyer chooses to *buy* the item, he sends his endowment of 35 to the seller, who then has to decide whether to ship the item. If the seller does not ship, he receives the price plus his endowment of 35 for a total of 70. If he ships, he receives the price minus the costs plus his endowment for a total of 50. If the buyer chooses not to buy the item, no trade occurs.

The experimental market is embedded in a social network of the market's trader population, which provides buyers with information about a seller's past behavior. That is, prior to choosing, the buyer is informed what choice (*ship* or *not ship*) the seller has made in each of the prior rounds he was given a chance to do so. In economics, reputation building theory indicates that this information is sufficient to induce reputation building over the course of the market. More specifically, Kreps and Wilson (1982) developed a (now standard) reputation building model applicable to our setting. The model supposes at the beginning of round 1 of the market that each buyer believes that a certain proportion of the sellers is intrinsically honest (that is, that they will ship even though the pecuniary incentive goes contrary to this decision). One of the hallmarks of the model is that this probability may be very small.[6] When a seller ships early in the market, this causes buyers to increase their assessment that the seller belongs to the honest sellers, and this, in turn, makes it more likely that the seller will be able to do business in the future. Alternatively, if the seller fails to ship, buyers can see the seller's dishonesty and no one will do business with the seller in the future. Hence, even sellers who are not intrinsically honest have an incentive to build a reputation for honesty. This incentive system insures successful trades (buyer buys, seller

5 These are production costs where either the seller produces the item after he knows the demand, or the product is produced before the buyer's decision is known but costs are not sunk (e.g., when the item can be resold at a price equal to production costs).

6 There is plenty of laboratory and field evidence that a non-negligible share of subjects and traders are, in fact, trustworthy and driven by social preferences (e.g., Bolton and Ockenfels 2000, Fehr and Schmidt 1999, Bolton et al. 2004b). Models that assume that it is common knowledge that all players are motivated only by their pecuniary interests, on the other hand, can support reputation building only if the market horizon is infinite (that is, there is no round maximum to player participation). One of the things that the models discussed in the text show, however, is that this restriction on reputation building activity is highly sensitive to the common knowledge assumption about motivation.

ships) at least until the last few rounds in the market, when there is no longer sufficient future incentive for sellers who are intrinsically honest to continue shipping. In *reputation building* theory, whether the interaction pattern in the market is of the stranger sort (one-shot trade) or the partner sort (long term relationships) does not matter. As long as buyers can see the history of the seller they are matched with prior to trade, reputation building should be independent of whether that information was supplied by a third party interaction (strangers network) or by first party interaction (partners network).[7] That is, in theory, reputation building is about information – not the pattern of social interaction.

2.2 Treatments

We examine six different treatments, each associated with specific market institutions (see Table 1). The treatments can be organized along two dimensions. The first is network: *partners* and *strangers network*. While in markets with partners networks, a buyer can maintain a cooperative relationship with a single seller, buyers and sellers in strangers networks interact at most once. The second dimension is competition: *no competition, matching competition,* and *price competition*. While in markets with no competition, buyers have no choice with whom they are matched with, competition involves buyers choosing between two sellers on the basis of reputation information only (matching competition), or on the basis of reputation information *and* price offers by sellers (price competition). Our treatments combine each of the two networks with each of the three competition forms, yielding six treatments in total.

Table 1. The Six Treatments

Competition	**Network**	
	Strangers	**Partners**
No	Strangers market with no competition	Partners market with no competition
Matching	Strangers market with matching competition	Partners market with matching competition
Price	Strangers market with price competition	Partners market with price competition

7 This statement holds as long as the information is equally reliable and complete across matching schemes. While this is not necessarily the case outside the laboratory, the experiments allow us to cleanly separate the impact of matching schemes and information content.

The two treatments with *no competition* look at the strangers versus partners result exhibited in Bolton et al. (2004a) in a slightly different market context.[8] At the beginning of the laboratory session, participants are assigned to buyer and seller roles, with an equal number in each role. The roles are fixed for the entire session. Traders interface by computer. Each round, a buyer and seller are matched to play the game as illustrated in Figure 1. A seller's history of actions - *ship*, *no ship*, or *no buy* - is recorded for each round within a market. The entire history within the market is displayed to the buyer with whom the seller is matched. Participants interact in a sequence of two separate markets of 15 rounds each. Upon completion of the first market, all reputation scores are deleted and traders start another market with blank records and identical market rules. Comparing behavior in the first and second market allows us to identify learning trends.

When the market is embedded in a strangers network, no buyer-seller pair interacted more than once (within this constraint, matches were random). In partners networks, the same buyer and seller are matched together for the duration of the entire market (but are randomly re-matched after the first and before the second market within a session). In both cases, the matching procedure is public information.

To investigate the impact of *matching competition*, we modify the basic game from Figure 1 to allow the buyer to choose between two sellers in each round on the basis of reputation histories (as before, the buyer can also choose not to buy at all in the round; see Figure 2).

8 In particular, the design of the experiment in Bolton et al. (2004a) had participants rotate between buyer and seller roles. Here we fix roles. Data from the present experiment will show that the stranger-partner gap identified in the earlier study is robust to this feature.

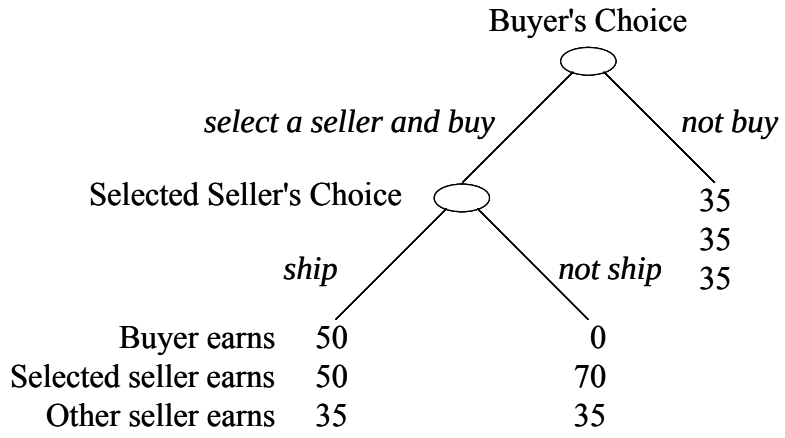


Figure 2. The Buyer-Seller Game with Matching Competition

In the partners network, after the first round, the buyer chooses between the seller he last bought from and a new seller he was not previously matched with. So the buyer can always choose to maintain a longer relationship with a seller; but in each new market period, he can also switch to match a new seller. Matching competition in the partners network does not necessarily *imply* a partners relationship, but it gives buyers the opportunity to build one.

In the corresponding strangers network, however, partner relationships cannot be developed. Here, after the first round, the buyer chooses between the seller he was last matched with but did not buy from and a new seller he was not previously matched with. So buyers cannot do repeated business with the same seller; they always have to choose between two sellers they have not selected previously. In all sessions for these two treatments with matching competition, two thirds of the participants are assigned roles as sellers and one-third assigned to be buyers. Otherwise the set-up and procedures for these treatments are the same as for the ones without matching competition.

To investigate the impact of *price competition* in strangers and partners networks, we follow the same procedure as above but now also allow sellers to post a selling price prior to the buyer choosing between them, as illustrated in Figure 3.

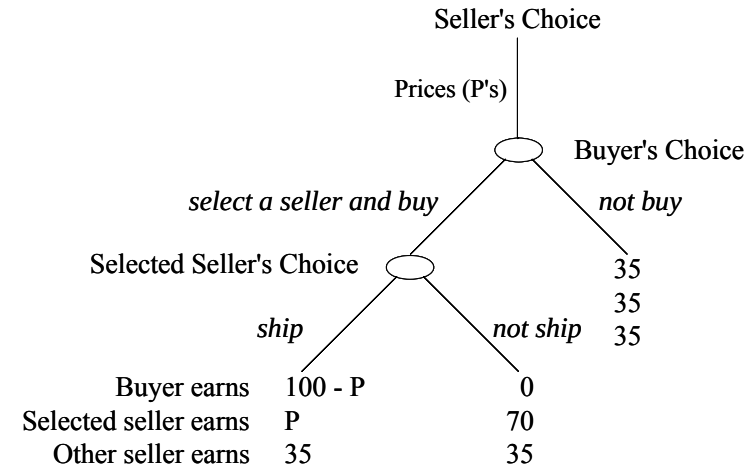


Figure 3: The Buyer-Seller Game with Price Competition

Sellers are free to set a price anywhere in the range from 0 to 100. As a result, a buyer can choose between two sellers (or not to buy at all) on the basis of both reputation *and* price information. Price competition always allows buyers to select sellers according to their reputation profiles, as in matching competition, but adds price as an additional dimension of the competition. Otherwise the set-up and procedures for these treatments are the same as for those with matching competition.

2.3 Laboratory Protocol

In all, 216 subjects participated in the experiment. There were 36 subjects in each treatment. No subject participated in more than one treatment. The written instructions given to participants, reproduced in the Appendix, describe the protocol for the experiment in detail. In brief, subjects were students, mostly undergraduates, from various fields of study who volunteered through an on-line recruitment system. Cash was the only incentive to participate. Upon arrival at the laboratory, participants were seated at the computers, separated by partitions. They were then asked to read the instructions. When subjects finished reading, the experimenter read the instructions out loud in order to enter them into public knowledge. To familiarize them with the software, subjects played several practice games, sometimes as buyer sometimes as seller, with the computer in the opposite role making its moves at random. (The Appendix includes a sample of screen shots.)

Once familiar with the interface, subjects played a sequence of two markets, both of the same treatment condition, and subjects taking the same role in both markets but trading encounters re-randomized. Payoffs were listed in laboratory 'francs' in the quantities given in Figures 1-3; the francs exchange rate of $0.02 per franc was presented to the subjects in the instructions. Upon completion of the session, one of the two markets played by each subject was chosen at random, and each subject was privately paid his or her earnings for that market in cash plus a $5 show-up fee. Total earnings per subject ranged from $5 to $20 with an average of $15.80.

3 Data Analysis: Market Efficiency and Trading Patterns

Subjects within each treatment engaged in a sequence of two markets (section 2.3), but there is no evidence of a statistically significant learning trends across the two. For this reason, in the following analysis, we do not distinguish between the first and second markets in each session but aggregate the data.

3.1 Gains-from-Trade

Figure 4 displays the efficiency of the markets in terms of the realized percentage of the maximum achievable gains-from-trade (= total payoff achieved if all possible transactions are successfully completed minus the amount achieved if there are no buys) for each of the six treatments. The gains are further broken down to amounts received by sellers and by buyers, as a percentage of the total gains possible *per trader*.

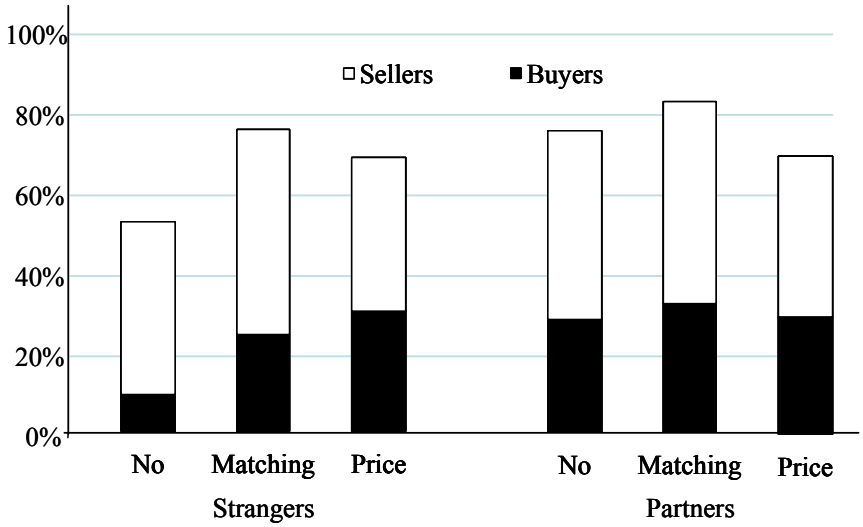


Figure 4. Gains from Trade as a Percentage of Potential Total Gains, by Type of Competition and Network

Table 2 provides the corresponding inferential statistics using Tobit regression analysis. Tobit estimation accounts for the censored nature of the data. There is no cross effects variable for PRICE and MATCH because, the the experiment's design, the former is nested in the latter. For our data, the estimated coefficients are equal to the marginal effects of the individual independent variables.[9]

9 The nonparametric Mann Whitney test, applied pair-wise to treatments, yields results comparable to those presented in Tables 2 and 4. The main advantage of the Tobit analysis is economy of exposition. For a detailed discussion of Tobit regression see, for example, Davidson and MacKinnon (1993).

Table 2. Gains-from-Trade (Proportion of Maximum Possible)

Tobit regression estimates (and standard errors)			
VARIABLES	**TOTAL[a]**	**BUYER**	**SELLER**
Independent \ Dependent	**GAINS**	**GAINS**	**GAINS**
CONSTANT	0.576***	0.095***	0.435***
= gains in strangers no competition market.	(.0248)	(.0239)	(.0434)
MATCH	0.237***	0.146***	0.073
= 1 if either match or price competition market, and 0 else.	(.0392)	(.0373)	(.0574)
PRICE	-0.035	0.060	-0.126***
= 1 if price competition market, and 0 else.	(.0429)	(.0407)	(.0531)
PARTNERS	0.216***	0.183***	0.034
= 1 if partner network, and 0 else.	(.0351)	(.0335)	(.0614)
PARTNERS x MATCH	-0.162***	-0.107	-0.047
= cross effects variable.	(.0554)	(.0527)	(.0813)
PARTNERS x PRICE	-0.091	-.071	0.028
= cross effects variable.	(.0607)	(.0575)	(.0753)
Number of observations	84	84	132
Log-likelihood	69.97	66.14	28.52

[a] Total gains tabulated by buyer. Regressing on data tabulated by seller yields similar results. Total gains in table differ slightly from buyer plus seller gains because buyer gains are tabulated by buyer, while seller gains are tabulated by seller.
*** Significant at .025 level, two-tailed.
** Significant at .05 level, two-tailed.
* Significant at .10 level, two-tailed.

There are three main observations to take from Figure 4 and Table 2:

(1) *In strangers markets, the introduction of competition increases the total gains-from-trade, with buyers primarily receiving the gains and sellers losing from price competition.*

Relative to the stranger market without competition, the introduction of matching competition significantly increases total gains-from-trade by 41% (=0.237/0.576). The further addition of price competition dampens these gains only by a small, insignificant amount. The total gains from price competition are significantly greater than for no competition (Wald test, two-tailed $p < 0.001$). The gains primarily go to buyers, the significant portion representing a 154% (=0.146/0.095) increase over no competition. Sellers are not hurt by matching competition but lose significant surplus from price competition, -29% (=-0.126/0.435). (Later, we will show that the average price sellers receive in price competitive markets is lower than what they receive in the fixed price markets, explaining this decrease.)

(2) Relative to strangers markets, in the partners markets the total gains-from-trade from matching competition are smaller, and they are erased by the addition of price competition.

The total gain from adding matching competition is just .075 (=0.237-0.162) but nevertheless weakly significant (Wald, two-tailed $p = 0.056$). There is no significant difference, however, for

total gains-from-trade in no competition and price competition markets (Wald, two-tailed p = 0.195). It is clear that buyers gain from both matching and price competition while sellers lose (see Table 2). So, unlike strangers markets, competition in partners markets leaves total efficiency little changed, but like strangers markets, it redistributes trade surplus from sellers to buyers.

(3) The efficiency-enhancing effect of partners networks is strongly reduced by competition.

Absent any competition, the total gains-from-trade in partners markets are 38% (=0.216/0.576) more efficient than in strangers markets (the coefficient of the PARTNERS variable shows the difference to be highly significant). The result can neither be explained by differences in the communication channel between traders (e.g., Daft, Lengel 1986; Dellarocas 2005; Rice 1992; Brosig et al. 2002), nor by the distances or anonymity between traders (Granovetter 1973), since these were kept constant across treatments. When we add matching competition, however, the total gains-from-trade in partners networks are only 5% (=0.216-0.162) higher than in strangers networks, but not significantly so (Wald test, two-tailed p = 0.207). When we add price competition, the difference completely disappears (Wald test, two-tailed p = 0.393). Hence competition erases the gap observed between non-competitive strangers and partners networks.

Table 3 explains why the difference vanishes: In the partners market with no competition, it is not possible for the buyer to switch away from his assigned seller partner. In competitive markets, the buyer can, and does switch – in about every fifth case under matching competition, and more than double this under price competition. So, with competition, (voluntary) partners networks look more and more like strangers networks.

Table 3. Buyer Choice Patterns in Partners Networks with Competition

	Frequency with which buyers switch seller partners when given the opportunity (%)	**Frequency buyers buy from a seller when given the opportunity (%)**
Matching competition	19	92
Price Competition	42	87

The next sub-section will make the point that the underlying changes in trust and trustworthy behaviors are the drivers for the fluctuations in gains-from-trade across treatments.

3.2 Trust and Trustworthiness in Trading

Figure 5 shows the frequency with which buyers trust their sellers across the rounds of the market. Figure 6 displays the frequency, conditional on receiving a buy, with which sellers are trustworthy and ship across the rounds of the market.

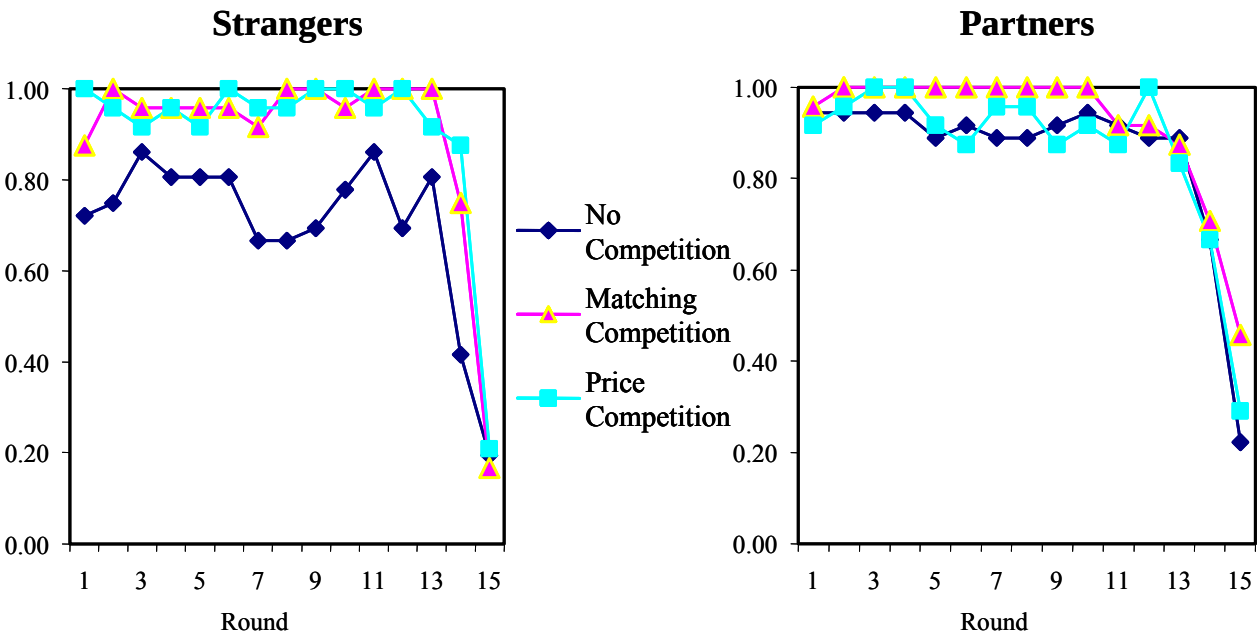


Figure 5. Trust: Buy Decisions (Frequency by Round)

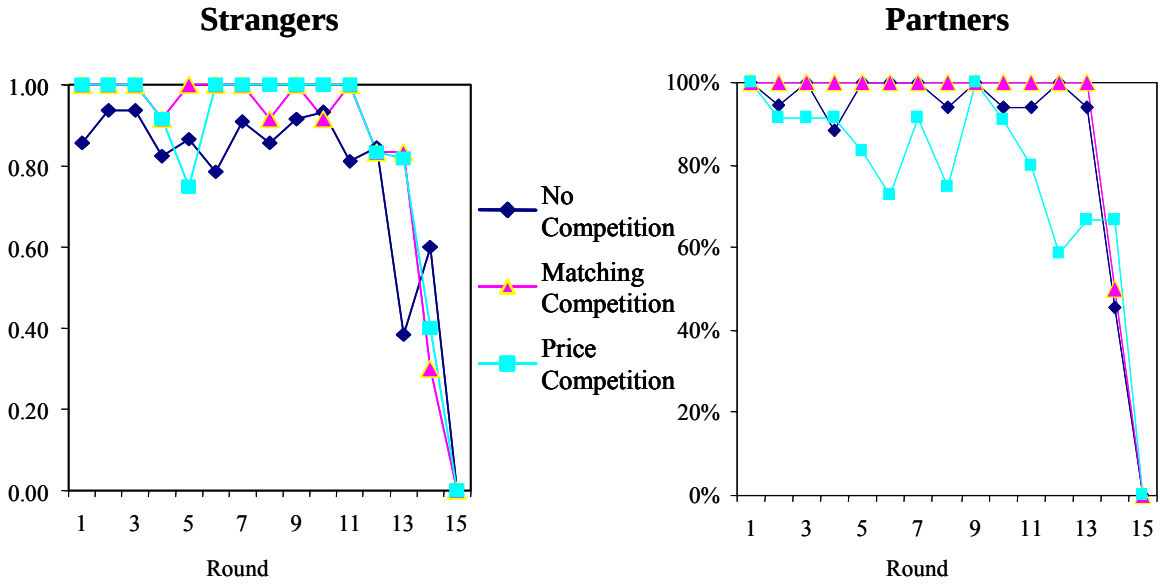


Figure 6. Trustworthiness: Ship Decisions - Conditional on Buying (Frequency by Round)

Notice in both Figures 5 and 6, the steep drop in buying and shipping in the final rounds of the markets. The consistency and magnitude of this behavior are striking evidence of the strategic nature of trader behavior in these markets: Sellers build reputation for profit; at the end of the market, a good reputation is no longer useful and so they stop. Likewise, buyers largely anticipate this behavior, and in this sense they too are behaving strategically. Table 4 shows the Tobit analysis for the data in Figures 5 and 6.

Table 4. Frequency of Trusting and Trustworthy Behavior

Tobit regression estimates (and standard errors)		
VARIABLES **Independent \ Dependent**	**BUY**	**SHIP**[a]
CONSTANT = frequency in strangers no competition market.	0.702*** (.0233)	0.754*** (.0548)
MATCH = 1 if either match or price competition market, and 0 else.	0.198*** (.0368)	0.155** (.0733)
PRICE = 1 if price competition market, and 0 else.	0.008 (.0403)	-0.117* (.0681)
PARTNERS = 1 if partner network, and 0 else.	0.154*** (.0330)	0.177*** (.0775)
PARTNERS x MATCH = cross effects variable.	-0.112** (.0528)	-0.259*** (.1039)
PARTNERS x PRICE = cross effects variable.	-0.078 (.0578)	0.074 (.0964)
Number of observations	84	132
Log-likelihood	63.86	-17.86

[a] Frequency conditional on buying.
*** Significant at .025 level, two-tailed.
** Significant at .05 level, two-tailed.
* Significant at .10 level, two-tailed.

There are two main observations to be made:

(1) In strangers markets, matching competition increases both trust and trustworthiness. The addition of price competition leaves trust unchanged, but diminishes trustworthiness.

Matching competition significantly raises trust by 28% (=0.198/0.702) and trustworthiness by 21% (=0.155/0.754). An important implication of the latter observation is that competition not only allows buyers to evade untrustworthy sellers, but also tends to lift the trustworthiness of all sellers relative to the market without competition. The addition of price competition, however, eliminates much of this gain in trustworthiness. Apparently, buyer trust remains high in price

competitive markets because buyers are able to evade untrustworthy sellers. The movements in trust and trustworthiness explain the increase in efficiency when competition is introduced to strangers markets (as observed in section 3.1).

(2) *Competition erases the advantage in trust and trustworthy behavior that partners networks have over strangers networks in markets without competition.*

The statement is true for both matching and price competition: With regard to Table 4, neither the hypothesis that the PARTNERS coefficient plus the first cross effect variable are equal to zero, nor the hypothesis that the PARTNERS coefficient plus both cross effect variables are equal to 0 can be rejected for either buyer behavior (Wald, two-tailed p = 0.303 and 0.387, respectively) or seller behavior (Wald, two-tailed p = 0.235 and 0.905, respectively). These changes in trust and trustworthiness explain why efficiency does not rise when competition is introduced into partners markets as observed in section 3.1. They also explain why efficiency in both matching and price competitive markets does not differ across strangers and partners networks.

3.3 The Impact of Price Competition

Looking at the trading encounter with price competition in Figure 2 in isolation and abstracting away from the reputation network, a seller should only ship at prices above 70. This is the seller profit from not shipping to a trusting buyer. But price offers above 70 will be rejected because they imply buyer payoffs below 30, while the buyer's outside option from not buying is 35. So, no trade can occur. However, as in the other markets, the social reputation network allows sellers to signal trustworthiness and at the same time to offer acceptable prices. The markets in the other treatments fixed the price at 50.

If buyers trade-off pricing and reputation information, sellers may have an incentive to undercut the competitor's price in order to be chosen by the buyer. As a result, there would be a downward pressure on prices. Reduced prices, however, create increased incentives not to ship, because the profit from shipping (=100 minus price; Figure 3) is negatively correlated with price whereas the profit from not shipping is fixed at 70. To the extent buyers are price-sensitive and are willing to trade-off reputation scores and price-offers, trade may be destabilized.

Figure 7 shows the average prices per round across the two price competition markets. The average chosen price across all rounds was 43 for the strangers market and 44.7 for the partners market. Average prices across strangers and partners networks are almost identical. The only difference to be observed in Figure 7, is that it takes longer for the strangers network to settle down. Save for this difference, pricing behavior is the same in strangers and partners networks.

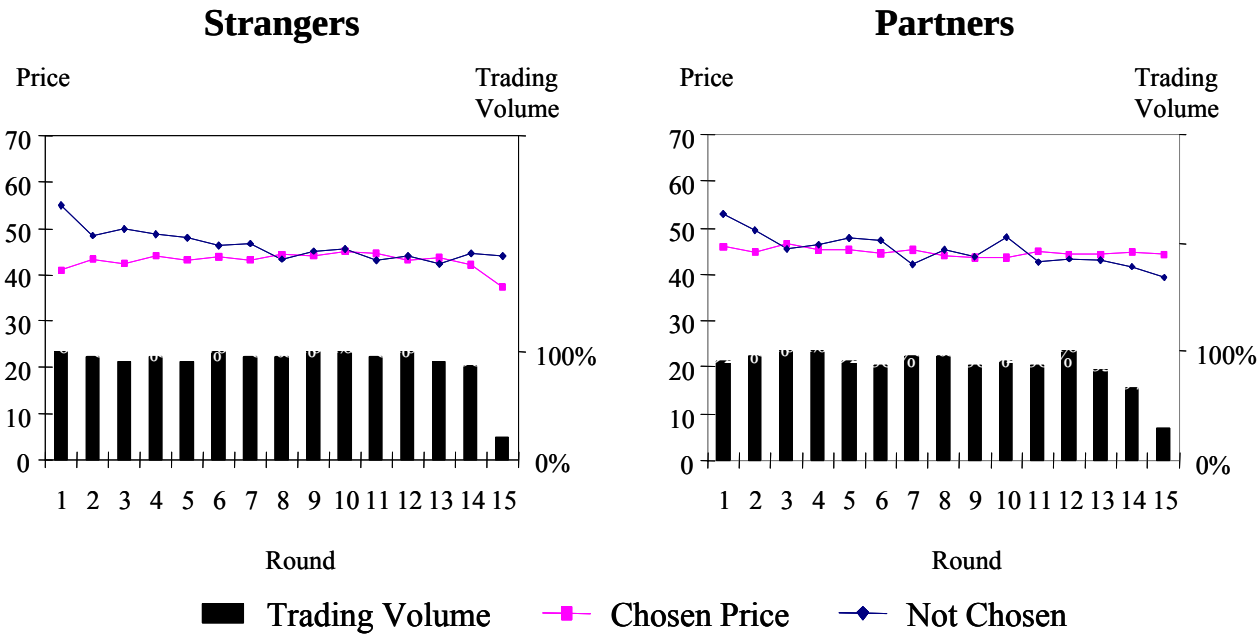


Figure 7. Price Movements with Price Competition

On average, prices in both markets are well above the competitive value of 35 (= marginal cost). If buyers chose primarily on price, we would expect the price to more closely reflect the fully competitive benchmark, or at least tend in this direction over time. But higher prices are rather stable over time.

Finally, as seen in Figure 7, once trading reputations have been established, in later market rounds, price is not much of an indicator of selection; the lines for chosen and rejected prices cross several times. This all suggests that reputation information – not price – determines seller selection.

Table 5 strengthens the view that reputation information trumps pricing. It indicates that, for the most part, buyer choice is lexicographic. Most selections of sellers are consistent with buyers

looking first at reputation, and if there is a difference, they select on this basis. If there is no difference in reputation, then and only then, do they select based on price.[10]

Table 5. Buyer Choice Frequencies in Games with Price Competition

Seller Reputation measured as $\frac{\textbf{Number of Ships}}{\textbf{Number of Buys}}$

STRANGERS NETWORK	**Seller chosen has a better reputation**	**… worse …**	**… same …**	**Sum**
Seller chosen offers a better price	0.214	0.113	0.168	0.495
… worse …	0.287	0.012	0.153	0.453
… same …	0.018	0.003	0.031	0.052
Sum	0.520	0.128	0.352	1.000

PARTNERS NETWORK	**Seller chosen has a better reputation**	**… worse …**	**… same …**	**Sum**
Seller chosen offers better price	0.166	0.019	0.166	0.351
… worse …	0.265	0.089	0.220	0.575
… same …	0.032	0.006	0.035	0.073
Sum	0.463	0.115	0.422	1.000

4 Summary and Discussion

Many Internet markets with anonymous trading implement social reputation networks to combat moral hazard problems. This paper investigates with the help of a laboratory experiment whether and how competition affects trading patterns and reputation building in such online markets. Our most important finding is that, when we restrict ourselves to strangers networks, the kind of networks which are predominant in large Internet markets, competition increases the

[10] While a quick read of the Table 5 would suggest that there is no clear tendency to choose the better price when the feedback score is the same, keep in mind that no single measure of reputation is likely to capture how every person judges the better reputation; for example, some people may weight recent seller behavior differently than earlier behavior - and people who do so may use different weighting schemes. Hence, what looks like indifference in the table, may not look precisely like that to everyone. That said, the basic results reported here are robust to other simple measures of reputation, such as the measure 'number of ships minus number of no ships', patterned after eBay's feedback number.

effectiveness of the electronic reputation mechanism in promoting trust and trustworthiness in trading.

In strangers markets, matching competition (sellers compete on reputation) yields significantly higher levels of buyer trust, seller trustworthiness and market efficiency compared to markets without any competition. The reason is that buyers can discriminate between sellers on the basis of the reputation information provided by the network, creating stronger incentives for sellers to be trustworthy. Price competition (sellers compete on reputation *and* prices) also does better than markets without any seller competition. Yet, the reason for the improvement is, ironically, that sellers do *not* engage in strong price competition. Price competition leaves sellers with less incentive to be trustworthy, the lower prices meaning lower gains from maintaining a good reputation. In fact, because there is some weak price competition, sellers are slightly less trustworthy compared to seller behavior with matching competition. This causes a negative, though not significant effect on the profitability and efficiency of trade. In this sense, price competition tends to undermine the merits of electronic feedback systems.

The reason that price competition is weak in these markets is that reputation information trumps pricing in buyer deliberations concerning which seller to do business with. That is, buyers usually do not do business with someone with a bad reputation even for a substantial price break. As a result, the downward pressure on prices is moderate, and average price offers are very stable over time. As a result, price competition is only a small threat - in strangers markets - to the increased trusting and trustworthy trading patterns observed with matching competition. Overall, the results imply that encouraging greater market competition may be a powerful tool for increasing trust and trustworthiness in Internet markets with reputation mechanisms.

Somewhat surprisingly, we also observe that competition largely erases the difference in market performance previously observed in strangers and partners networks. With either matching or price competition, there is virtually no difference in market efficiency and distribution of gains-from-trade in partners and strangers networks. This implies that, in our contexts, the opportunity to partner up with a seller for a longer bilateral relationship has only little value to traders in competitive markets. One might have expected just the opposite: that seller competition increases the value of stable, repeated bilateral exchange, e.g., because those sellers not chosen had no opportunity to prove their trustworthiness and thus have a smaller chance of being chosen in the future. In fact, however, buyers switch sellers quite often when given the chance. In price

competition markets with partners networks, for instance, the probability that the previous round seller is chosen again is not much smaller than the probability that a new seller is selected. The important implication of this finding for online markets is that a reliable reputation network in a competitive market can largely reduce the advantage of partner networks in promoting trust and trustworthiness.

While there is a large literature on the performance of reputation systems, there is as presently little field that complements the research here on competition and social networks. Part of the reason is that complex 'naturally occurring' field environments make it hard, if not impossible, to isolate the impact of competition in different kinds of social networks. In this regard, our findings of the subtle interplay between the working of the social reputation network and pricing system may help future field studies. For example, our study illuminates the subtle interplay between reputation information and pricing, and shows how both are important factors for analysis: On the one hand, reputation information trumps pricing in buyer decisions; on the other hand, pricing is an important variable in seller trustworthiness.

Finally, while the economic theory of reputation building yields important insights that guide our study, it does not illuminate the role competition plays in our findings. Instead, the basic intuition for our results, indeed for doing the experiment in the first place, comes from the market signaling literature. Presently there is little research to illuminate the connections between these two bodies of work. Our results suggest that a more thorough investigation of these links could be very fruitful for a deeper understanding of reputation building in general and for Internet markets in particular.

5 References

Akerlof, G. A. (1970) The Market for 'Lemons: Quality Uncertainty and the Market Mechanism, Quarterly Journal of Economic, 84(3), 488-500.

Alexander, R. D. (1987). The Biology of Moral Systems. New York, Aldine De Gruyter.

Bolton, G. E., Ockenfels, A. (2000) ERC: A Theory of Equity, Reciprocity and Competition, American Economic Review, 90(1), 166-193.

Bolton, G., Katok, E., Ockenfels, A. (2004a) How effective are electronic reputation mechanisms? An experimental investigation, Management Science, 50(11) 1587-1602.

Bolton, G. E., Katok, E., Ockenfels, A. (2004b) Trust among Internet Traders: A Behavioral Economics Approach, Analyse und Kritik, 26(2), 185-202.

Bolton, G., Ockenfels, A. (2006) The Influence of Information Externalities on the Value of Reputation Building. An Experiment. Working Paper, University of Cologne 2005

Brosig, J., Ockenfels, A., Weimann, J. (2002) The Effect of Communication Media on Cooperation, German Economic Review, 4(2), 217-241.

Brynjolfsson, E., Smith, M. (2000) Frictionless commerce? A Comparison of Internet and Conventional Retailers, Management Science, 46(4), 563-585.

Daft, R., Lengel, R. (1986) Organizational information requirements, media richness, and structural design, Management Science, 32(5), 554-571.

Davidson, R., MacKinnon, J. (1993) Estimation and Inference in Econometrics, Oxford, Oxford University Press.

Dellarocas, C. (2003) The Digitization of Word-of-Mouth: Promise and Challenges of Online Feedback Mechanisms. Management Science, 49(10), 1404-1427.

Dellarocas, C. (2005) Reputation Mechanism Design in Online Trading Environments with Pure Moral Hazard, Information Systems Research, 16(2), 209-230.

Dellarocas, C. (forthcoming) Reputation Mechanisms. Handbook on Economics and Information Systems, T. Hendershott, T. (ed.), Elsevier Publishing.

Fehr, E., Schmidt, K. (1999) A Theory of Fairness, Competition, and Cooperation. Quarterly Journal of Economics, 114(3), 817-868.

Gefen, D., Straub, D. (2004) Consumer trust in B2C e-Commerce and the importance of social presence: experiments in e-Products and e-Services, Omega, 32(6), 407-424.

Granados, N., Gupta, A., Kauffman, R. (2006) The Impact of IT on Market Information and Transparency: A Unified Theoretical Framework, Journal of the AIS (JAIS), 7(3), 148-178.

Granovetter, M. (1973) The Strength of Weak Ties, American Journal of Sociology, 78(6), 1360-1380.

Granovetter, M. (1985) Economic Action and Social Structure: The Problem of Embeddedness, American Journal of Sociology, 91(3), 481-510.

Kaplan, J. (2006) When the Astors owned New York, London, Viking.

Cho, I. K., Kreps, E. (1987), Signaling Games and Stable Equilibrium, Quarterly Journal of Economics, 102(2), 179-221.

Kreps, E., Wilson, R. (1982) Reputation and imperfect information, Journal of Economic Theory, 27(2), 253-279.

Lucking-Reiley, D., Bryan, D., Prasad, N., Reeves, D. (1999) Pennies from eBay: The Determinants of Price in Online Auctions, Working Paper, University of Arizona.

Malone, T., Yates, J., Benjamin, R. (1987) Electronic Markets and Electronic Hierarchies, Communications of the ACM, 30(6), 484-497.

McMillan, J. (2002) Reinventing the Bazaar: A Natural History of Markets, New York and London , W.W. Norton & Company, Inc.

Resnick, P., Zeckhauser, R. (2002) Trust Among Strangers in Internet Transactions: Empirical Analysis of eBay's Reputation System, in: The Economics of the Internet and E-Commerce, Baye, M. R. (ed.), Vol. 11 of Advances in Applied Microeconomics, Amsterdam, Elsevier Science.

Rice, R. (1992) Task Analyzability, use of new media, and effectiveness: A Multi-Site Exploration of Media Richness, Organization Science, 3(4), 475-500.

Riley, J. (2001) Silver Signals: Twenty-Five Years of Screening and Signaling, Journal of Economic Literature, 39(2), 432-478.

Spence, M. (1974) Market Signaling, Cambridge, Harvard University Press.

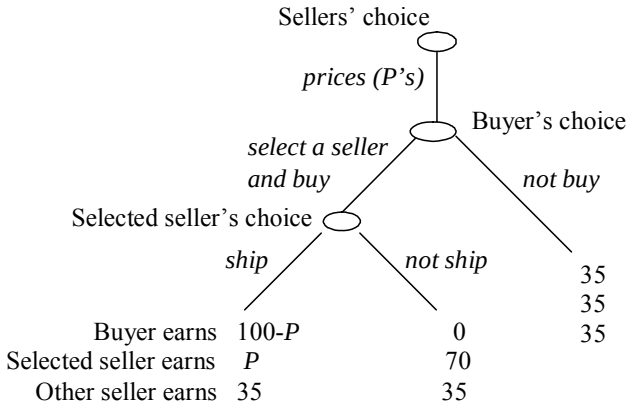
Appendix: Laboratory Materials

A.1 Written instructions given to subjects The instructions for the endogenous matching with price competition, strangers market are reprinted with changes made for other treatments in [brackets].

General. The purpose of this session is to study how people make decisions. If at any time you have questions, raise your hand and a monitor will happily assist you. From now until the end of the session, unauthorized communication of any nature with other participants is prohibited.

During the session you will participate in a market that gives you an opportunity to earn 'francs'. At the end of the session, your earnings in francs will be translated to US dollars, according to the rules stated below. You will be paid these earnings plus a $5 show-up fee. The decisions and payments you make will be treated as confidential.

Description of the game. You and the other participants in the room (but not the monitors) are the traders in the market. At the beginning of the market, you will be assigned to be either a Buyer or a Seller, and you will keep this role for the entire session.



The market proceeds in a series of rounds. Each round, each buyer is matched with two sellers to trade a (fictional) commodity.

At the beginning of the round, each Seller privately chooses a price in the range 0 to 100 francs. The Buyer sees these prices and then chooses to either *select a seller and buy* or *not buy*. If the Buyer chooses *not buy*, then there is no trade, and Buyer and both Sellers are paid 35 francs each. If the Buyer chooses to *select a seller and buy*, then the selected Seller makes a decision to *ship* or *not ship*. *Ship* pays the Buyer 100-*P* and the selected Seller *P* francs, where *P* is the price the selected Seller chose at the beginning of the round. *Not ship* pays the Buyer nothing and the selected Seller 70 francs. In all cases, the Other Seller, the one that was not selected, is paid 35 francs. *[For non-price competition treatments, the figure above was replaced with Figure 1 of the text, and the paragraph read:* At the beginning of the round, the Buyer chooses to either *select a seller and buy* or *not buy*. If the Buyer chooses *not buy*, then there is no trade, and Buyer and both Sellers are paid 35 francs each. If the Buyer chooses to *select a seller and buy*, then the selected Seller makes a decision to *ship* or *not ship*. *Ship* pays Buyer and the selected Seller 50 francs each while *not ship* pays the Buyer nothing and the selected Seller 70 francs; in either case, the Other Seller, the one that was not selected, is paid 35 francs.]

The market will last for 15 rounds.

In each round, the buyer is matched with the 'Previous Seller' and a 'New Seller'. The Previous Seller is a seller the buyer was matched with in the previous round but did not buy from. The New Seller is a seller that the buyer was

not matched with in the previous round. In round 1, both sellers are New Sellers (if neither is chosen then one is arbitrarily designated the Previous Seller in the succeeding round). [*For exogenous stranger markets this passage read:* You will never be matched with the same trading partner for more than one round. *For exogenous partner markets:* You will be matched with the same trading partner every round. *For endogenous partners:* In each round, the buyer is matched with the 'Previous Seller' and a 'New Seller'. The Previous Seller is the last seller the buyer chose to buy from in previous rounds. The New Seller is a seller that the buyer was not matched with in the previous round. In round 1, both sellers are New Sellers (if neither is chosen then one is arbitrarily designated the Previous Seller in the succeeding round).] All partner pairings are anonymous: Your identity will not be revealed to the person you are playing with either before, during or after the game.

Seller's feedback history. For each round, the computer will record whether selected Sellers chose *ship* or *not ship* (if the Seller did not get to decide, the computer records nothing). This feedback will then be made available to all future Buyers that are matched with this Seller. The feedback will include a summary of the number of times the Seller shipped in the past, as well as a round-by-round history of their shipping decisions, beginning with the most recent decision. Buyers will see this feedback history prior to making their buy decision.

Number of markets. You will participate in two markets, each with 15 rounds, one market played after the other. You will have the same role, buyer or seller, in both markets. But the order in which you interact with trading partners will be different in the second market than in the first. Information about seller decisions in the first market will not be available to participants during the second market.

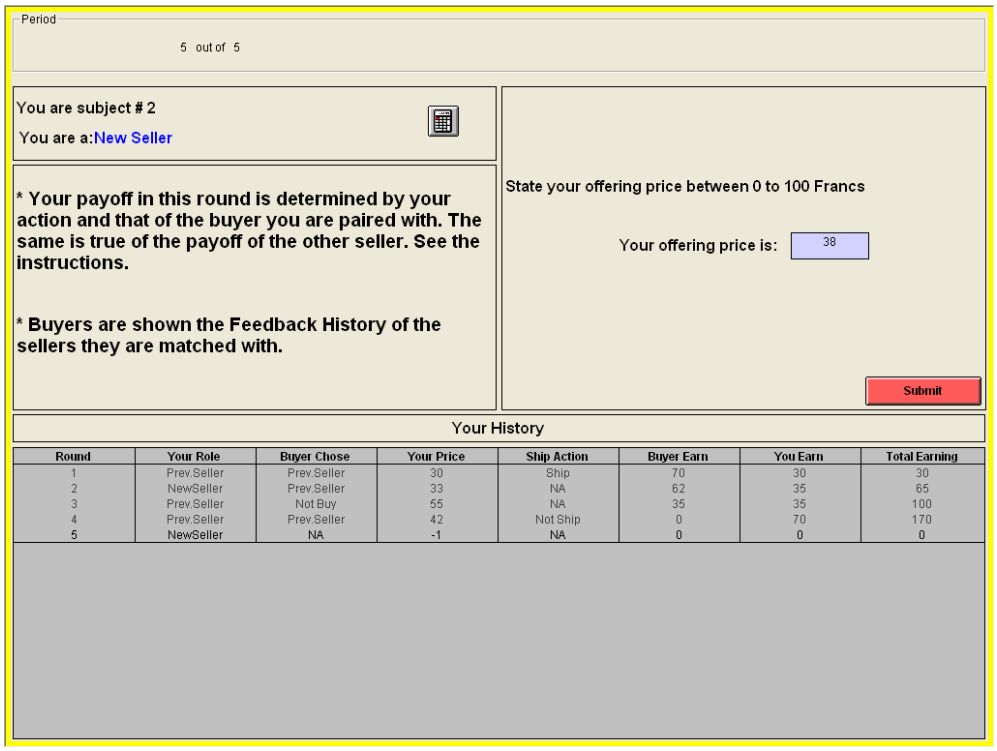
Money earnings. You will be paid your earnings for one market. The market to be paid will be selected by a random draw of a card at the end of the session. Each market has an equal chance of being selected, so you should do the best you can in both markets. The laboratory francs you earn for the selected market will be exchanged at a rate of $0.02 per franc. You will be paid the resulting sum plus a $5 show-up fee in cash.

Practice games. When the monitor gives the OK, play some practice games. Your partner for the practice games will be the computer. It has been programmed to choose its moves at random. The practice games will allow you to experience the game from both the Buyer and Seller's perspective. Practice until you feel comfortable with the game and its rules. Information about your decisions will not be used or displayed to other participants during the actual markets.

Consent Forms. If you wish to participate in this study, please read and sign the accompanying consent form. The consent form explains your rights as a subject as well as the rules of confidentiality that will be adhered to regarding your participation.

A.2 Screen shots Typical computer screens for both buyers and sellers in the endogenous matching with price competition, strangers market.

Sellers



Buyers