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Gift Exchange and Reciprocity in Competitive Experimental Markets

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Abstract

One of the outstanding results of three decades of laboratory market research is that under rather weak conditions prices and quantities in competitive experimental markets converge to the competitive equilibrium. Yet, the design of these experiments ruled out gift exchange or reciprocity motives, that is, subjects could not reciprocate for a gift. This paper reports the results of experiments which do not rule out reciprocal interactions between buyers and sellers.

Sellers have the opportunity to choose quality levels which are above the levels enforceable by buyers. In principle they can, therefore, reward buyers who offer them high prices. Yet, such reciprocating behaviour lowers sellers' monetary payoff and is, hence, not subgame perfect.

The data reveal that a majority of sellers behave reciprocally and that this behaviour is anticipated by buyers. As a result, buyers are willing to pay prices which are substantially above sellers' reservation prices. These results indicate that reciprocity motives may indeed be capable of driving a competitive experimental market permanently away from the competitive outcome. The data, therefore, support the gift exchange approach to the explanation of involuntary unemployment.

Keywords

Gift exchange, reciprocity, experiments

JEL-Classifications

J41, J64, C91, C92

Comments:

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I. Introduction

Most economic models are based on the assumption of rational and selfish agents. In these models it is ruled out that fairness motives can affect behaviour. During the last decade many researchers have, however, provided evidence which indicates that the behaviour of economic agents may well be affected by considerations of fairness (e.g. Kahneman, Knetsch and Thaler 1986). The most convincing evidence for the behavioural importance of fairness is provided by the results of simple one-shot ultimatum games (Güth, Schmittberger and Schwarze 1982; Ochs and Roth 1989; for surveys see Güth and Tietz 1990 and Roth 1995). For this bargaining game the standard game theoretic model predicts that proposers demand the whole bargaining cake while responders are willing to accept any positive share of the cake. Yet, responders usually reject positive offers which they consider as being too low. Most proposers seem to anticipate responders' behaviour and offer them approximately 40 percent of the available amount of money. This outcome is at odds with a model of rational and purely selfish behaviour but it can easily be explained in terms of fairness: Since responders are willing to reject unfairly low shares proposers, in general, offer them almost half of the available cake.

In principle, considerations of fairness might also affect the outcome of competitive markets. At the theoretical level many authors have claimed that fairness is also likely to affect market outcomes (e.g. Okun 1981, Akerlof 1982, Akerlof and Yellen 1988 and 1990, Fehr 1991, Fehr and Kirchsteiger 1994). At the empirical level, however, there does not seem to exist the kind of rigorous evidence that is available in the case of bargaining games. Quite the contrary. The results of competitive experimental markets show that the competitive equilibrium is usually reached within a few periods (Smith 1982, Davis and Holt 1993). Even if the equilibrium was very unfair by almost any conceivable definition of fairness, that is, if the whole market income was reaped by only one side (buyers or sellers) of the market, one could observe convergence to the competitive equilibrium (Smith 1976; Cason and Williams 1990; Roth et al.1991; Kachelmeier and Shehata 1992).

In the above mentioned competitive experimental markets subjects trade a well defined experimental good in the sense that buyers (sellers) know with certainty the monetary value (cost) of the good. In particular, the quality of the good is unambiguously determined before a pair of traders concludes a contract because the "delivery" of the quality is exogenously enforced by the experimenter. This paper reports the results of experiments which deviate in one important respect from the complete contracts design: The quality of the good is no longer exogenously enforced. Instead, buyers have to make price offers in a one-sided oral auction without knowing the quality they will receive from those sellers who accept their price offer. After a seller has accepted an offer he has to determine the quality of the good. Since our design rules out that a trader can build up a reputation and since sellers' costs are positively related to the quality delivered, money maximizing sellers will always choose the minimum quality q_0. Rational buyers will of course anticipate sellers' behaviour and, therefore, the market should operate as if only q_0 were enforceable. This means that a competitive experimental market with rational money maximizing agents should be expected to converge to the competitive equilibrium that corresponds to the quality level q_0.

The parameters of our experiments were chosen such that at this competitive equilibrium the whole market income is reaped by the buyers. Therefore, the competitive price coincides with sellers' (exogenously specified) reservation price. We hypothesized that sellers would be willing to respond to the payment of prices above their reservation level with quality choices above q_0. If this kind of reciprocation is sufficiently strong it is in the buyers' montary interest to pay more than the reservation price. Because of sellers' opportunity to reciprocate for a generous price offer we called this experiment the reciprocity treatment (henceforth RT).

The experimental data confirmed that sellers' quality choices vary positively with the price paid. Moreover, sellers' reciprocal responses were strong enough to render a high price policy profitable for the buyers. As a result, buyers offered prices which were more than twice as high as the sellers' reservation price. To check whether it is indeed sellers' reciprocal behaviour that induces buyers to offer high prices we implemented a control treatment (henceforth CT) in which sellers could not reciprocate because the quality q of the good was exogenously fixed. It turns out that the same buyers who pay rather high prices when sellers have an opportunity to reciprocate try to relentlessly push down prices to sellers' reservation levels when q is exogenously fixed.

These results challenge models which rely exclusively on rational and selfish agents. We show, however, that sellers' reciprocal behaviour need not be considered as irrational if one allows for interdependent preferences. If sellers value buyers' monetary payoff positively reciprocation can be perfectly rational. It is then possible to interpret the results of our reciprocity experiments as a noncooperative equilibrium of rational agents that entails a noncompetitive outcome.

One can give our design a labour market interpretation: Buyers are firms who make wage offers to the workers (sellers). After accepting an offer the worker has to determine his effort level. Due to incomplete supervision and verification technologies firms may be unable to enforce any desired effort (quality) level. The available technologies may only allow the enforcement of q_0. Since in our design buyers (firms) are price (wage) setters, and since the motivation problem is particularly important in employment relations, a labour market interpretation seems to be quite natural. When viewed from the labour market perspective our results provide support for equilibrium theories of involuntary unemployment that are based on the notion of fairness (Akerlof 1982, Akerlof and Yellen 1988 and 1990)[1].

The rest of the paper is organized as follows: In the next section we present the basic design of our experiments. In section III we discuss the predictions under the assumption that all subjects are selfish money maximizers whereas in section IV we determine the quality choice and reservation prices of sellers who have interdependent preferences. Section V presents the details of the experimental procedures and section VI documents the empirical regularities. Section VII summarizes the results and discusses them in the light of competing interpretations.

II. A Market with Reciprocation Opportunities

Consider a market with L sellers and N buyers with L>N. Each seller can sell at most one unit of the good traded. Likewise, each buyer can buy at most on unit. The costs of providing one unit of the good with quality $q \in [q_o, q^o]$, $0 < q_o < q^o$, , are given by

$$f + c(q); \qquad f > 0, \qquad c(q_o) = c'(q_o) = 0, \qquad c'(q) > 0 \ \ \forall q > q_o, \quad c'' \geq 0,$$

for each seller where c' and c" denote derivatives. q_o (q^o) is the exogenously given minimum (maximum) quality of the good while f represents a positive constant. Each seller's monetary payoff from a trade is defined by

$$S = p - f - c(q), \tag{1}$$

where p denotes the price at which the good is traded. Each buyer's monetary payoff is given by

$$B = (y - p)q; \tag{2}$$

where y is an exogenously given constant and y > f.

The RT consists of two stages. At the first stage buyers are allowed to propose prices in a one-sided oral auction. The essential feature of such an auction is that sellers can make no counteroffers. Buyers have, however, no opportunity to make bids to specific sellers because

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1 For an experimental investigation of another theory of involuntary unemployment see Fehr, Kirchsteiger and Riedl (1992).

every seller can accept every bid. Price bids have to be in the interval [f,y]. According to (2) buyers can, therefore, make no losses[2].

If a seller accepts a price bid p, a binding contract is concluded and stage one is completed for both the seller and the buyer. If a buyer's bid is not accepted she is free to change her bid, but the new bid has to be higher than the previous highest bid (possibly by another buyer) which has not yet been accepted.[3] The first stage ends if either all sellers have accepted an offer or if a prespecified amount of time has elapsed. The monetary payoffs of buyers and sellers who do not trade are zero. At the second stage those sellers who have accepted a bid have to determine the quality of the good.

The difference between the RT and the CT concerns only the second stage; in the CT there is no second stage because the experimenter ensures that all goods are traded at an exogenously specified quality level of q=1. The total cost of providing one unit of this good is f_c while the monetary value of such a good for the buyers is given by y_c. If p_c denotes the price at which the good is traded in the CT, the monetary payoffs are given by

(3) $$S_c = p_c - f_c$$

for the seller, and by

(4) $$B_c = y_c - p_c$$

for the buyer.

III. Predictions with Selfish Money Maximizers

What are the properties of the competitive equilibrium in the RT if it is common knowledge that all subjects are selfish money maximizers? For any given price a money maximising seller will choose $q = q_o$ because c(q) is strictly increasing in q. Rational buyers will of course anticipate that only q_o is enforceable and that f represents each seller's reservation price. Due to the

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2 The main reason why we wanted to rule out losses was that, due to loss aversion, the behaviour of experimental subjects may change considerably under conditions of potential losses (see Kahneman and Tversky 1992). Since our experiments aimed at isolating the impact of reciprocal behaviour on the outcome of competitive experimental markets we did not want our data to be polluted with loss aversion phenomena. It is a common requirement in experimental markets to forbid that buyers (sellers) trade at prices above (below) their redemption value y (cost f).

3 This bidding rule is sometimes called "improvement rule". The improvement rule is usually applied in experimental markets. Notice that it does not prevent underbidding. If a subject wants to make a lower bid than the highest "going" bid $\tilde{p}$ she has to wait until $\tilde{p}$ is accepted. After that she can bid a price below $\tilde{p}$.

excess supply of sellers (L>N) buyers will have no reason to offer more than f. Hence, the competitive equilibrium is characterised by N trades at $p = f$ and $q = q_o$. In the market with complete contracts a similar reasoning shows that the competitive equilibrium with money maximising agents exhibits N trades at a price of $p_c = f_c$.

Smith and Plott (1978) and Walker and Williams (1988) have conducted several one-sided oral auctions with a complete contracts design. Their results convincingly show that these markets converge to the competitive equilibrium. Yet, since contracts in these experimental markets were complete there were no possibilities for reciprocation.

We know of only one series of experiments in which reciprocal behaviour, as described in section I, permanently survived in competitive experimental markets (Fehr, Kirchsteiger and Riedl (FKR) 1993). In these experiments, which were similar to our RT, the market price did not converge towards f. Even after twelve trading periods the observed average price was significantly above f. The authors took this as evidence for (i) the impact of reciprocity on market prices and (ii) for the failure of the market to clear. This was, however, a premature conclusion.

Without a proper control experiment it is not possible to attribute the high prices in the FKR-experiments to the impact of reciprocity. Peculiar features of the design which may have the appearance of innocence may be responsible for prices above f. Moreover, if sellers in the RT choose $q > q_o$, they cannot be pure money maximizers because $q = q_o$ gives them a higher monetary payoff. Therefore, it could well be the case that they **prefer** to choose $q > q_o$, i.e., that they show a concern for their buyer's monetary payoff if they receive a "gift"? One can rationalise a reciprocal outcome in the RT by stipulating this kind of interdependent preferences.

However, if one assumes that the behaviour in the RT is governed by interdependent utility functions one runs into the following difficulty: In general, there is no reason to assume that the competitive equilibrium with money maximising agents coincides with the competitive equilibrium in case of interdependent utility functions. If sellers exhibit interdependent preferences their reservation prices may, for example, be higher than f. Therefore, a price above f is not in itself an indication of a non-competitive outcome.

IV. Quality Choice and Reservation Prices with Interdependent Preferences

In this section we discuss in more detail how interdependent preferences may give rise to reciprocal behaviour and what we can infer about sellers' preferences from certain experimental regularities that might occur. In addition, we present a solution to the problem of inferring from the experimental data whether the observed market outcome deviates from the competitive outcome when the preferences of a pair of traders are interdependent.

To allow for reciprocal behaviour we assume that sellers' preferences are given by

$$u = u(S, B) \qquad u_S > 0, \quad u_B \gtrless 0, \tag{5}$$

where B is the monetary payoff of the buyer with whom the seller is matched. If $u_B < 0$ ($u_B > 0$) for all feasible (S, B)-combinations we call a seller envious (altruistic). If $u_B = 0$ he is called selfish. It is obvious that a selfish or envious seller will never choose $q > q_o$ because nonminimum quality choices decrease S and increase B. Reciprocity means that a seller chooses "low" quality levels if p is "low" while if p is "high" he chooses a "high" q. Therefore, it may well be that a seller who behaves reciprocally exhibits locally selfish or envious preferences ($u_B \leq 0$) if p and, hence, S is "low", that is, he responds to a "low" price with $q = q_o$. Yet, if the price is sufficiently high he becomes locally altruistic ($u_B > 0$)and chooses $q > q_o$. It is of course possible that reciprocal behaviour is driven by preferences which exhibit $u_B > 0$ for all feasible (S, B)-combinations. Such a seller chooses $q' > q_o$ even if prices are low. As we will see, however, our experimental results indicate that only the former case (i.e. $u_B \leq 0$ for "low" prices) is empirically relevant.[4]

IV.1. Implications of Profitable Price Increases

Reciprocal sellers behave as if they value B positively at some combinations of S and B. Suppose that a seller responds to a p-increase by a q-increase which is sufficient to generate an overall rise in B. Does the observation of such profitable price increases allow us to characterise the sellers' preferences in more detail? Or more specifically: Does this seller value B as a normal or as an inferior "good"?

In order to answer this question it is useful to look more closely at the set of return combinations that can be attained for different values of p and q. Using (2) to substitute $q = B/(y - p)$ out of (1) yields

$$S = p - f - c[B/(y - p)] \tag{6}$$

Our assumptions about c(.) ensure that S is a decreasing and strictly concave function of B for $B > 0$ and $p < y$. For any given p a rational seller chooses q to maximise (5) subject to (6).

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4 In a former version of this paper we show that (under weak assumptions) each seller belongs to one and only one of the three following preference categories: (i) $u_B \leq 0$ for all feasible S and B values. (ii) $u_B > 0$ for all feasible S and B values. (iii) $u_B \leq 0$ for "low" prices and $u_B > 0$ for "high" prices. As already mentioned sellers of type (iiii) are of particular interest to us.

Any choice of $q = B/(y-p)$ determines a particular (S, B)-combination according to (6). Thus, by choosing q the seller is effectively choosing a particular (S, B)-combination on the constraint (6). The optimal choice of S and B (or q, respectively) can, therefore, be represented as a tangency point between a seller's indifference curves and the graph of the constraint (6)[5].

INSERT FIGURE 1 HERE

In Figure 1 point A represents the seller's choice that corresponds to a price p'. A rise in p, from p' to p" say, has two effects (see (6) and Figure 1). It shifts the constraint upwards, which gives rise to an income effect, and it renders the constraint steeper which gives rise to a substitution effect. Suppose now that B is **not** a normal "good", that is, as S rises, while B is equal to B', say, the indifference curves do not become steeper. Then, at point C, the indifference curve $\tilde{I}$ intersects the new (steeper) constraint, that corresponds to p" , from below. This implies that the seller will reduce B (see the movement from A to D in Figure 1). Thus, if B is non-normal a rise in p reduces B. This implies that if we observe a seller responding to a rise in p with an **increase** in B, he behaves as if B is a normal "good" for him.

IV.2. Reservation Prices

One of our main questions is whether sellers' reciprocal behaviour induces buyers to offer prices above sellers' reservation price p^r. p^r is defined as the lowest price in the feasible interval [f,y] for which the seller, if he accepts this price, is not worse off compared to a rejection. Therefore, prices above p^r make a seller strictly better off compared to a non-trade. This means that if trading sellers receive prices above the reservation price of non trading sellers, the latter are involuntarily rationed.

It is obvious that the p^r of **selfish** sellers coincides with f. Globally altruistic sellers are even willing to accept prices below f.[6] Only for those sellers who have (locally) **envious** preferences $p^r > f$ can occur. To see this, suppose that an envious seller gets an offer p=f. His monetary payoff from this offer is zero (because he chooses $q = q_o$) while his partner receives $B = (y-f)\,q_o$. Because he values B negatively he strictly prefers the monetary payoff combination

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5 This statement is, of course, only true if preferences are convex. In a former version of this paper we show that all relevant conclusions can also be drawn without the convexity assumption.

6 Let q (p) denote the utility maximizing quality choice while u(0,0) represents the seller's utility if he does not trade. If an altruistic seller accepts a price p=f his utility is $u = u[-c(q(f)), (y-f)\cdot q(f)] > u[-c(q_o), (y-f)\cdot q_o] > u[0,0]$. The first inequality holds because a globally altruistic seller prefers q(f) over q_o. The second inequality follows because $c(q_o) = 0$ and, by the definition of an altruistic seller, $u_B > 0$. Since f is a lower bound for p we set the p^r of altruistic sellers equal to f (for convenience).

[0,0], which follows from a rejection, over the combination $[0, (y-f)q_o]$. Therefore, to render him indifferent between acceptance and rejection he must be offered more than f.

The potential existence of envious subjects represents a major problem. Since it is impossible to observe subjects' preferences directly, we do not know the reservation prices of envious subjects. Therefore, observing prices above f is not in itself sufficient evidence for non-competitive prices, i.e. for $p > p^r$.

Recent empirical research by Loewenstein, Thompson and Bazerman (LTB, 1989) as well as the stylised facts which emerged from ultimatum game experiments also indicate that the existence of locally envious subjects is not just a theoretical possibility. The research results of LTB show that disadvantageous inequality, in general, causes a large utility loss. Since low prices imply a considerable amount of disadvantageous inequality for the seller, it may well be that sellers **prefer** to reject such offers. There is also ample evidence that in ultimatum games the responders reject low offers, although they would earn more money if they accepted these offers. This indicates that responders' reservation prices are higher than the reservation prices of selfish money maximizers which can be interpreted in terms of (our definition of) envy: responders are willing to give up money in order to reduce the income of the proposers. (see Bolton (1991) and Kirchsteiger (1994)).

To tackle the problem which arises if $p^r > f$, we have developed a method which allows us to infer upper bounds for sellers' reservation prices in the RT from the prices they have accepted in the CT. Let us define the seller's share of the (potential) surplus (y - f) in the RT by s = (p-f)/(y-f); $s_c = (p_c - f_c)/(y_c - f_c)$ denotes the share in the CT. Analogously, we define the reservation shares by $s^r = (p^r - f)/(y - f)$ and $s_c^r = (p_c^r - f_c)/(y_c - f_c)$ where p_c^r denotes the reservation price in the CT.

In the following we show that if the parameters of the RT and the CT meet the condition $y - f > y_c - f_c > (y - f)q_o$, for all types of sellers s_c^r will be larger than or equal to s^r. Before we prove this claim we comment shortly on its significance. How does the proposition help us to solve the problem mentioned above? If a seller accepts a certain share s_c in the CT, we have, of course, $s_c \geq s_c^r$. Together with $s_c^r \geq s^r$ we have, therefore, $s_c \geq s^r$. From this follows that a seller who accepted a certain share s_c in the CT will be strictly better off for all $s > s_c$ in the RT. Thus, if he cannot trade in the RT whereas other sellers trade at an s exceeding what he has accepted in the CT, he is involuntarily rationed. To prove the claim it is convenient to use Figure 2.

INSERT FIGURE 2 HERE

The figure shows the set of all feasible return combinations in the CT which are given by the straight line combining $S = y_c - f_c$ with $B = y_c - f_c$. In addition it depicts the positively sloped indifference curve I(0,0) of an envious[7] seller that starts in the origin. Thus, this seller rejects all prices p_c in the CT that lead to return combinations below I(0,0). The reservation price p_c^r and, hence, s_c^r are determined by the intersection between I(0,0) and the set of feasible return combinations (point β). Figure 2 shows, in addition, the set of all feasible return combinations in the RT for $q = q_o$. This set is given by the equation $S = y - f - (B/q_o)$. Since an envious seller always chooses $q = q_o$ this is the relevant set of return combinations. The reservation price p^r and, hence, s^r in the RT are determined by point α in Figure 2.

Notice that we have drawn Figure 2 in such a way that $p^r - f > p_c^r - f_c$. In case that the opposite inequality holds (i.e. if I(0,0) is very flat) the proposition is trivially true because $y - c > y_c - f_c$ by assumption. To prove the claim we must show that point β determines a larger share than point α. Since s_c^γ (i.e. the share s_c at point γ) is smaller than s_c^β (the share s_c at point β) it is sufficient to show that s_c^γ is larger than s^r. At points α and γ the buyer receives B' in both treatments. s^r is, therefore, given by

$$s^r = \frac{S}{y - f} = \frac{y - f - (B'/q_o)}{y - f} = 1 - \frac{B'}{(y - f)q_o}$$

whereas s_c^γ is given by

$$s_c^\gamma = \frac{S_c}{y_c - f_c} = \frac{y_c - f_c - B'}{y_c - f_c} = 1 - \frac{B'}{y_c - f_c}$$

By assumption, $y_c - f_c > (y - f)q_o$. Thus, $s_c^\gamma > s^r$ and, hence, $s_c^r > s^r$.

V. Experimental Procedures[8]

In total we organised four experimental sessions.[9] In each session subjects participated in a RT as well as in a CT. There was an excess supply of sellers in all sessions. In S1 and S2 we had 9 sellers and 6 buyers, in S3 there were 10 sellers and 7 buyers, in S4 we had 12 sellers and 8 buyers.[10] In section II we described the features of one trading day of a RT or a CT, respectively. As it is common practise in experimental economics, we allowed subjects to learn

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7 We restrict the argument to a seller which is (locally) envious because for all other types we have $p^r = f$ and hence $s^r = 0 \leq s_c^r$.

8 The instructions for our experiments are available on request.

9 Session 1 (S1) was conducted at 18 November 1991, session 2 (S2) at 22 November 1991, session 3 (S3) at 16 January 1992 and session 4 (S4) at 17 January 1992.

10 All experimental subjects were volunteers. They were students of the University of Technology in Vienna and had no knowledge of experimental economics. They were not students of ours and most of them had never attended a course in economics. They were recruited with the promise that, dependent on their decisions, they could earn a considerable amount of money.

by repeating these trading days. Each session consisted of 16 trading days ("periods") and at least one trial period to allow the participants to become acquainted with the trading institution; these 16 periods were divided into two subsessions of 8 periods. In S1 and S3 we conducted the CT during the first 8 periods; in period 9 - 16 the RT took place. To control for spillovers between markets we changed the order in S2 and S4.[10]

In S1, S2 and S3 the prespecified time for the one-sided oral auction was 3 minutes. In S4 it was 4 minutes because of the larger number of participants. After three (four) minutes the market was closed and those parties which did not succeed in trading earned zero profits in this period. In the CT a trading day was over when the market was closed while in the RT the second stage of the trading day began. At this stage, sellers had to choose their quality **anonymously**, i.e. their choice was only revealed to "their" buyer. Moreover, their choice was completely unconstrained in the sense that there were no sanctions associated with it.

Before the beginning of a session each subject had to draw a card. If there was an "S" on the card he was a seller, if a "B", she was a buyer. Sellers and buyers were located in different rooms. During the experiment communication took place by means of a telephone. Four supervisors were engaged in each session, two in the buyers' room, two in the sellers' room. In each room, one supervisor transmitted the price (acceptance) and quality message over the telephone.

While price messages were public knowledge, the information about quality choices was coded. It was known only to the two parties involved. In addition, buyers and sellers did not know the identity of their trading partners. These information restrictions were chosen to exclude group pressure effects on quality choice and to reduce strategic spillovers between periods as much as possible. Since the traders did not know the identities of their partners it was impossible for buyers (sellers) to reward the past action of a **specific** seller (buyer). Moreover, we wanted to rule out the possibility of hidden side payments between parties after the experiment.

The monetary returns for those subjects who traded in the RT were given by the return functions (1) and (2). The returns of trading subjects in the CT were determined according to (3) and (4). For the RT the parameters were as follows: $y = 126$, $f = 30$, $q \in [0.1, 1]$. The c(q)-schedule was given by the following table:

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10 The subjects of a session did not know that we planned to conduct two different market experiments. At the beginning of each session they were informed that the experiment consisted of 8 periods. After 8 periods we told them that another market experiment would take place which would also take 8 rounds. This arrangement ensures that behaviour in the first treatment is not affected by the fact that there is a second treatment in a session.

q	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
c(q)	0	1	2	4	6	8	10	12	15	18

Table 1
[quality cost schedule]

This cost schedule is a discrete approximation of the function $c(q) = (10q-1)^{1.3}$, which exhibits the properties assumed in section II. For the CT we chose $y_c = 246$, $f_c = 210$. In all four sessions we paid a commission fee of 4 Austrian Schilling (4 AS ≅ 40 US-Cents) to the sellers to overcome the marginal unit problem which would arise if p=f=30. In S1 and S2 buyers' price offers had to be multiples of five. In S3 and S4 prices had to be multiples of 1. The reason for this change was that if prices have to be multiples of 5 it may be more difficult for buyers to enforce the market clearing price because sellers may not accept a price of 30 whereas a price of 32, for example, is acceptable for them.[11]

All parameters were common knowledge. This enabled subjects to compute the returns of their trading partners. Before the beginning of the experiments subjects had to solve several exercises which involved the computation of their own returns and the returns of a hypothetical trading partner. The experiment did not start until all subjects had solved these problems correctly.

VI. Experimental Results

The total number of possible trades in both the CT and the RT was 216. In the CT 211 trades were conducted; in the RT 213 trades took place. On average 1 experimental session (8 periods CT plus 8 periods RT) lasted for 3 hours and subjects earned AS 325 (approximately US$ 33). In the CT the lowest possible price of c = 210 was observed in 53 cases; the highest observed price was 229. The average price in the CT-experiments was 215 and sellers' average share was 0.14. In the RT-experiments trade at the lowest possible price of 30 was conducted in only 4 cases; the highest price offer was 110 (1 case). The average price in all RT-experiments was 74

11 In S1 and S2 we paid the commission fee "indirectly" by imposing costs of 26 AS in the RT (206 AS in the CT) if the seller delivered the good at minimum quality. Since prices had to be multiples of 5 the lowest price which could be offered was 30 (210) which yields an implicit commission fee of 4 AS in S3 and S4 the commission fee of 4 AS was paid explicitely and costs were 30 in the RT (210 in the CT).

and sellers' average share was 0.46. These data already indicate that sellers received a considerably larger part of the surplus (y - f) in the RT than of the surplus (y_c - f_c) in the CT. To organise the discussion of our experimental results, in the following we formulate some explicit hypotheses. One of our primary objectives concerns the occurrence of reciprocal behaviour. Is the majority of sellers behaving reciprocally? Do those who behave reciprocally dominate the aggregate price-quality relationship? These questions generate the following hypothesis:

Hypothesis 1: At the individual level reciprocal behaviour is the most frequent behavioural pattern. Moreover, the aggregate relationship between prices and quality levels is positive.

To test H1 at the individual level we have constructed the following measure of individual reciprocity. We computed the average price p_i that was paid to a seller during the RT. If the seller's average quality for prices above p_i exceeds his average quality for prices below p_i his behaviour was classified as reciprocal. Otherwise, his behaviour was not considered as reciprocal. In total we had 40 sellers in all sessions. 28 of these behaved reciprocally according to the above definition. Five sellers always chose q = 0.1. These five sellers may but need not be classified as purely selfish types because our data only show sellers' response to some wages but not to the whole range of wages.[12] From the remaining seven sellers three[13] always chose q > 0.1 while four exhibited a negative relation between q and p.

Due to the excess supply many sellers traded only between 4 and 6 times and some traded even less than 4 times. For those 20 sellers who behaved reciprocally according to the above measure and who traded more than 3 times we computed the Spearman Rank Correlation between prices and quality levels. For 15 of these 20 sellers the correlation is significantly positive at the 5 percent level, for 2 at the 10 percent level and 3 sellers do not have a significantly positive correlation. When judging these correlations one should keep in mind that the Spearman Rank Correlation is an extremely conservative measure of reciprocity.[14] Despite this conservatism 15 of these 20 sellers exhibit a significantly positive correlation between quality and prices.

The behaviour of sellers in the RT also gives rise to a positive aggregate relation between quality and prices. This is shown in Figure 3 which depicts the relation between prices and average (median) quality. It is obvious that the aggregate relation between p and q is

12 For example, one seller traded only two times. He got p = 46 two times and he chose q = 0.1 two times as well. Maybe, for p > 60 he would have chosen 0.5 which would have rendered his behavior reciprocal.

13 For these sellers the same remark as in footnote 12 applies. There was, for example, one seller who was able to catch only two offers: p = 92 and p = 100. He chose q = 0.5 two times but perhaps he would have chosen a lower q at a lower p.

14 For example, one of the three sellers who had no significantly positive correlation received wages of 80, 85, 90, 95 to which he responded with 0.5, 0.7, 0.8, 0.8. Although this behavior looks rather reciprocal the Spearman Rank Correlation is **not** significantly positive in this case.

positively sloped. For all 10 prices in the interval $30 \leq p < 40$, all of which have been accepted by different sellers, $q = 0.1$ was chosen. There were 22 offers in the interval $40 \leq p < 50$ which were accepted by 16 different subjects. In 16 out of these 22 cases sellers chose 0.1; in 4 cases 0.2. The average quality was 0.145. These data indicate that those sellers who received low offers did not make gifts to the buyer, that is, they were not globally altruistic.

INSERT FIGURE 3 HERE

Notice that our data about sellers' quality choice are two-sided censored. If a seller would have preferred to choose a quality level below 0.1, he could only choose 0.1 whereas if he would have preferred to choose a quality above 1, he had no other choice than 1. Hence, to investigate whether the positive relation between q and p is significant we ran a two-sided censored Tobit regression of the quality level on (p-f). The specification for our Tobit regression is given by

$$(7) \qquad q_i - 0.1 = \left\{ \begin{array}{cc} 0.9 & \text{if RHS} \geq 0.9 \\ \alpha + \beta(p_i\text{-}f) + \mu_i & \text{if } 0 < \text{RHS} < 0.9 \\ 0 & \text{if RHS} \leq 0 \end{array} \right\},$$

where $\text{RHS} \equiv \alpha + \beta(p_i - f) + \mu_i$. If the slope of this equation turns out to be significantly positive, q is an increasing function of p and Hypothesis 1 is confirmed at the aggregate level. If, in addition, the intercept is significantly negative or if we cannot reject the hypothesis that it is zero we have an indication that sellers are not globally altruistic. A nonpositive α together with a positive β thus means that, on average, sellers exhibit envious or selfish preferences for low prices while for high prices they have altruistic preferences.

In Table 2 the results of our Tobit regressions are presented. In all Tobit regressions α is negative. In the regression for S1, S2 and S3 α is significant at the 1 percent level while in S4 we cannot reject the hypothesis that $\alpha = 0$. This indicates that sellers were, on average, not globally altruistic. Low wages triggered low quality levels. For all Tobit regressions the slope is positive and highly significant. The p-value for β is below or equal to 0.03 percent. We also ran OLS and Tobit regressions with and without dummies for individual sellers. Again all β-coefficients were positive and highly significant. In addition, the inclusion of dummies increased the adjusted R^2 in the OLS regressions considerably. In the regressions without dummies the adjusted R^2 is between 0.21 and 0.47; with dummies the regressions explain between 49 and 69 percent of the variation in q. This increase in the adjusted R^2 confirms the presence of individual differences[15]. Taken together our regression results provide fairly strong evidence that, on average, q is an increasing function of p.

	N	α	prob (α)	β	prob (β)
S1-S4	213	−.2233	.0005	.0087	.0000
S1	48	−.4844	.0041	.0152	.0000
S2	47	−.1566	.0059	.0102	.0000
S3	54	−.8916	.0018	.0147	.0003
S4	64	−.2017	.1414	.0110	.0000

N: number of observations

prob (.): p-values

Table 2
(Relation between quality and prices)

Due to the anonymity of the trading partners it was impossible for subjects to reward the past action of a specific subject. A buyer could, for example, not reward a high q in period t by a high wage offer in period t + 1 because she did not know the seller's identity in period t nor could she address her offer in t + 1 to any specific seller. Nonetheless, in case that buyers' – for whatever reason – respond to high quality in t with high wage offers in t + 1 sellers' quality choices could be interpreted as an investment in **group** reputation. A seller who chooses high quality levels would then provide a public good because he induces buyers to make generous offers to the group of sellers. This behaviour is, of course, also incompatible with conventional theory because it requires non-selfish co-operation among sellers. Yet, since we know from numerous public goods experiments (Ledyard.1995) that there is significantly less free-riding than predicted by conventional theory this possibility should be seriously taken into account.

In our view, the fact that sellers respond reciprocally to the **current** price is evidence against the group reputation hypothesis. Suppose, for a moment, that buyers respond positively to last

15 The existence of individual differences is also suggested by other tests. For example, the hypothesis that individual dummies are equal to the constant in Table 2 is clearly rejected by the data.

period's quality. Under these conditions sellers should **not** respond reciprocally to the current price if they want to induce high future prices. If they choose low quality levels in response to a low current price they cause low future prices which (in case of reciprocal q-choices) give rise to low future prices, etc. Thus, the desire to induce high future prices by high present quality levels requires **unconditionally** high quality levels. But these are not observed in the data. To further investigate whether there were strategic spillover across periods we ran two-sided censored Tobit regressions of prices in t on quality levels in t - 1:

(8)
$$p_t = \begin{cases} 126 & \text{if RHS} \geq 126 \\ \gamma + \delta q_{t-1} + \varepsilon_t & \text{if } 30 < \text{RHS} < 126 \\ 30 & \text{if RHS} \leq 30 \end{cases}$$

with RHS $\equiv \gamma + \delta q_{t-1} + \varepsilon_t$. If δ turns out to be significantly positive co-operatively motivated sellers would have had a rationale for high quality levels. In Table 3 the results of regression (8) are presented. The Table reveals that in S2, S3 and S4 q_{t-1} had no significant impact on p_t. For these sessions δ is clearly insignificant. It is also very small and has, in one case (S2), even the wrong sign. Moreover the adjusted R^2 of the OLS estimates (not shown here) of equation (8) show that q_{t-1} explains almost nothing of the variation in p_t. In all three cases in which δ is insignificant the adjusted R^2 is less than 2 percent.

	N	γ	prob (γ)	δ	prob (δ)
S1	42	62.6	.0000	33.7	.0002
S2	40	58.8	.0000	-9.3	.5847
S3	47	84.4	.0000	2.7	.814
S4	56	72.0	.0000	5.2	.5411

N: number of observations

prob (.): p-values

Table 3
(Relation between present quality and future prices)

These results show that even if sellers would have been motivated by a desire to induce high future prices they would have been unable to do so in S2, S3 and S4. Only in S1 δ is significantly positive. Yet, in S1 the α-coefficient of regression (7) is also significantly negative, that is, sellers did not choose unconditionally high quality levels.

Next we are interested in the question whether sellers' reciprocal responses rendered, on average, a high price policy individually profitable for the buyers. This question is related to the steepness of the $q(p)$ relationship. According to the buyers' monetary return function a rising $q(p)$-relationship is not sufficient for a rising $B(p)$-relationship. Neither is it sufficient that sellers value B as a normal good. As we have argued in section IV.1 the substitution effect of a rise in p causes a B-reduction. Only if the income effect of a p-rise is strong enough to overcompensate the negative substitution effect, a higher p will cause a higher B. In view of this result we stipulate

Hypothesis 2: On average, there is a range of prices in the interval $[f, y]$ of the RT over which B rises with p and, hence, sellers behave as if B is a normal good in this interval.

If both, sellers and buyers, are money maximizers and if this is known by the buyers the rational buyer will offer $p = 30$ in the RT because she anticipates that sellers will chose $q=0.1$. At this outcome sellers earn nothing while buyers reap $(126\text{-}30)\cdot 0.1$ = AS 9.6. Figure 4 shows however, that sellers' reciprocal actions enabled firms to earn considerably more than AS 9.6. The Figure depicts the relationship between prices and buyers' average profits in S1-4.

INSERT FIGURE 4 HERE

Figure 4 gives a first hint that buyers indeed could increase their average profits by increasing the price above f=30. According to the regression equation (7) the expected quality level q^e is given by

$$q^e = \left\{ \begin{array}{cc} 1 & \text{if RHS} \geq 1 \\ 0.1 + \alpha + \beta(p\text{-}30) & \text{if } 0.1 < \text{RHS} < 1 \\ 0.1 & \text{if RHS} \leq 0.1 \end{array} \right\},$$

where $\text{RHS} \equiv 0.1 + \alpha + \beta(p\text{-}30)$. Given the above equation for the expected quality level, it follows that q^e exceeds 0.1 if $p > p^o \equiv 30 - (\alpha/\beta)$. As long as $p^o < 126$ there exist feasible prices in the RT for which sellers will on average choose $q > 0.1$. In Table 4 we used the estimates of our Tobit regressions to compute p^o for each session. As we can see, p^o varies between 45.4

(S4) and 90.7 (S3), i.e. it is always below 126. For $p \geq p^o$, we can compute the expected monetary return for a buyer, B^e, by inserting q^e into the buyers' return function. This yields

(9)
$$B^e = (126 - p) \cdot \left(0.1 + \alpha + \beta(p - 30)\right)$$
$$= \left(12.6 + 126\alpha - 3780\beta\right) + \left(156\beta - 0.1 - \alpha\right)p - \beta p^2.$$

B^e as given in (9) is a strictly concave function of p. Differentiating (9) with respect to p yields

(10)
$$\delta B^e/\delta p \equiv B^e_p = (156\beta - 0.1 - \alpha) - 2\beta p$$

Substituting the results of our Tobit estimates into (10) and evaluating the resulting expression at p^o gives us $B^e_p(p^o)$. Table 4 shows the value of $B^e_p(p^o)$ for each session. As we can see, in each session a rise in p at p^o increases B^e. This, together with the fact that $B^e(p) = 0$ at $p = y = 126$, means that B^e has a maximum somewhere between p^o and p = 126. Moreover, since $B^e(p)$ is strictly concave the price which maximises B (subject to $p \geq p^o$) is unique. We denote this price by p*. Table 4 reports p* and $B^e(p^*)$ for each session. Since in the interval (p^o, p^*) the average behaviour of sellers generates a strictly increasing $B^e(p)$-function, B is, on average, a normal "good" in this interval. This validates Hypothesis 2.

	p^o	$B^e_p(p^o)$	p*	$B^e(p^*)$	B^a
S1	61.9	0.875	90.6	18.95	16.81
S2	45.4	0.723	80.8	20.84	16.34
S3	90.7	0.420	104.9	6.54	8.37
S4	48.3	0.754	82.6	20.70	20.82

p^o: price above which sellers chose on average $q > 0.1$
$B^e_p(p^o)$: increase in B^e at p^o if p increases
p*: price which maximises B^e subject to $p \geq p^o$
$B^e(p^*)$: buyers expected return iin RTs at p*
B^a: actual average profit per period in RTs

Table 4

(based on Tobit regressions of Table 2)

In general, buyers in the CT may have two reasons to offer positive shares s_c. They may anticipate that sellers are envious, that is, that $s_c^r > 0$ and/or they may be altruistic. Buyers in the RT may have the same reasons for shares s above 0. Yet, since $B(p)$ is a rising function of p over some feasible interval buyers in the RT have an additional reason to offer high prices. Therefore, if sellers' reciprocal behaviour is anticipated and affects buyers' price bids it shows up in the difference between s and s_c. This generates

Hypothesis 3: The average share per period in the CT, s_c^a, will be below the average share per period, s^a, in the RT. Moreover, s^a does not converge to s_c^a.

H3 can be examined with the help of Figure 5. In all periods of all 4 sessions s^a exceeded s_c^a which confirms the first part of Hypothesis 3. In addition, Figure 5 shows that there was no tendency for s^a to approach s_c^a which confirms the second part of Hypothesis 3.

INSERT FIGURE 5 HERE

Remember that in section IV.2. we have shown that for all types of sellers $s_c^r \geq s^r$. If we take, for a given population of sellers, the averages over the reservation shares, which we denote by s^{ra} and s_c^{ra}, $s_c^{ra} \geq s^{ra}$ must hold. Combining this with Hypothesis 3 yields $s^a > s_c^a \geq s_c^{ra} \geq s^{ra}$. Or in other words: The shares that have been paid to sellers in the RT were, on average, strictly above the sellers' reservation shares. This means that prices in the RT do not correspond to the competitive solution.

Beyond the possibility of examining whether the outcome in the RT deviates from the **competitive solution on average** we may also analyse whether specific sellers who could not trade in a certain period have been rationed involuntarily, that is, whether they would have strictly preferred to trade at the prevailing shares. The lowest share **which has been accepted by a certain seller in the CT** gives us an upper bound for his reservation share in the RT. By comparing this upper bound with the prevailing shares of those periods of the RT in which the seller could not trade we can infer whether the RT failed to clear in these periods for this specific seller. If the empirically observed upper bound on s^r is strictly below the prevailing shares the seller was involuntarily rationed.

One difficulty with the above method is that "the prevailing share" of a period is not a unique concept. Is it the highest, the average, or the lowest observed share? To overcome this problem we formulate the following hypothesis in several versions:

Hypothesis 4: The lowest s_c which is accepted by a seller in the CT is below (i) the highest, (ii) the average, (iii) the lowest share s offered in those periods of the RT in which the seller does not trade.

For the case of a "non-trade" for which versions (i) - (iii) of Hypothesis 4 hold the non-trading seller can be considered as involuntarily rationed. Notice, however, that even in those cases of a non-trade in which all versions of Hypothesis 4 do **not** hold the non-trading seller may be involuntarily rationed because his reservation share in the CT may be lower than the lowest observed share in the CT. Perhaps buyers did not offer lower shares in the CT or other, faster, sellers snatched away those offers with a lower s_c.

In all sessions taken together it occurred 107 times that a seller could not trade in the RT. In **all** 107 cases the lowest s_c which has been accepted by the non-trading sellers in the CT was strictly smaller than (i) the highest and (ii) the average s of those periods of the RT in which the sellers were rationed. Therefore, in all 107 cases these sellers would have been better off at the highest and the average prices of that period. This confirms Hypothesis 4(i) and 4(ii). Moreover, in 72 out of 107 cases (67.3 percent) the rationed sellers would have preferred to trade even at the lowest price of the period; thus, for a majority of "non-trades" even Hypothesis 4(iii) holds true. Recall that in the remaining 35 cases rationing may also have been involuntary in the sense of Hypothesis 4(iii) because the lowest accepted offer in the CT provides only an upper bound for s_c^r. Perhaps rationed sellers would have accepted an s strictly less than this upper bound.

VII. Summary and Interpretation

The experimental results reported in this paper indicate that the existence of opportunities for reciprocation may significantly alter market outcomes. In our RT sellers persistently behaved reciprocally. They responded to low prices with minimum quality choices whereas if prices were raised they reciprocated by choosing non-minimum quality levels. At the individual level reciprocal actions represent the most frequent behavioural pattern. This contributes to a significantly positive relation between prices and quality levels at the aggregate level. Moreover, this relationship was sufficiently strong to render the payment of high prices individually profitable for buyers. The comparison of sellers' shares in the RT with their shares in the CT shows that sellers' reciprocal responses had a systematic impact on prices. In this respect the comparison between the last period of the CT (RT) and the first period of the RT (CT) is most telling. When subjects enter the RT after the CT (S1 and S3) there is a large **increase** in sellers' share in the first period of the RT (see Figure 3). When they enter the CT after the RT (S2 and S4) sellers' share **decreases** substantially in the first period of the CT. In our view these regularities provide strong evidence for a price raising effect of sellers' reciprocal behaviour. Buyers seem to have anticipated sellers' reciprocity in the RT and, as a consequence, offered sellers higher shares in the RT.

Our preferred interpretation of sellers' behaviour is based on the assumption that they are **conditionally** altruistic. In this view the behaviour of reciprocal sellers is fully rational. Low prices imply that sellers' monetary payoff is relatively low compared to the monetary payoff of "their" buyers. This renders them selfish or envious, that is, they choose a low quality. A high price implies that sellers are comparatively well off which renders them altruistic. As a result they respond with generous quality levels. In the theoretical part of this paper we have shown that on the basis of these assumptions on preferences, the positive relation between prices and buyers' expected profits implies that sellers value buyers' monetary payoff as a normal "good". Moreover, the prevailing prices in the RT are, in general, above sellers' reservation prices. This means that prices in the RT represent a non-competitive outcome. Notice that our interpretation of the RT-data does not mean that we consider the RT to be out of equilibrium. Quite the contrary, if sellers reciprocal responses are the result of rational preference maximisation and if buyers rationally anticipate sellers' behaviour persistently high prices may well reflect an underlying equilibrium. We "only" claim that the RT-outcome is non-competitive.

An alternative interpretation of our results might rely on the conjecture that subjects were hesitant to choose unfair actions because they knew that the experimenter could observe them. For several reasons we doubt that the observability of actions by the experimenter is behaviourally relevant in our context. First of all, sellers who received prices between 30 and 50 did in general not hesitate to choose minimum quality levels in our RT. Nor did buyers hesitate to offer prices close to f_c in the CT. Secondly, Berg et al. (1995) have conducted reciprocity experiments in which the experimenter could not observe the actions of individuals. Only aggregate results could be observed. They indicate a substantial amount of reciprocal behaviour. Thirdly, the results of Bolton and Zwick (1995), who conducted fully anonymous ultimatum games, also indicate that observability of actions by the experimenter does not change subjects' behaviour.

A more important objection against our interpretation concerns the fact that we had 8 market periods in each treatment. In principle, this may create opportunities for strategic and reputational spillovers across periods. However, we have taken great care in preventing such spillovers by enforcing strict anonymity between trading partners. Due to our anonymity requirements it was definitely not possible in our design that **individual** sellers or buyers developed a reputation. Nor was it possible that past actions of any **specific** buyer or seller could be rewarded. Therefore, in our view any reputational or strategic spillovers have to rely on group effects. Perhaps a majority of co-operative, group-oriented sellers wanted to induce high future wages by choosing high current quality levels. In the previous section we have, however, shown that reciprocal quality choices are incompatible with this view. Sellers who try to induce high future wages must not respond reciprocally to the **current** wage. They have to choose unconditionally high quality levels. In addition, in all but one session we could not detect any effect of current quality levels on future wages. In our view the data strongly indicate that the above mentioned spillover was not relevant in our RT.

The potential effect discussed in the previous paragraph is, of course, not the only possibility for group reputation to play a role. In principle there are many other possibilities and there seems only one method which rules them out with certainty: The conduct of one-shot experiments. In a recent paper by Fehr, Kirchler and Weichbold (FKW 1995) the results of a one-shot reciprocity treatment are reported. The FKW-design has the following features: Ten buyers interact with ten sellers over ten periods but each buyer is matched bilaterally with each seller only once. This matching procedure is common knowledge. A buyer makes a price proposal to a seller. If the seller accepts he has to choose q and bears costs $c(q)$ according to Table 1. If he rejects the offer, both players earn zero. This design combines features of the ultimatum game with features of our RT. Due to the one-shot nature of these experiments it never pays for a subject to invest anything in group reputation. FKW also conducted competitive market experiments with reciprocation opportunities (like our RT) to allow for a comparison of the bilateral one-shot experiments with the competitive market experiments. Their results indicate that sellers also respond reciprocally in a one-shot situation. Sellers' response pattern in the one-shot situation is rather similar compared to their behaviour in a competitive market with reciprocation opportunities. Moreover, as in our RT sellers' share both in the one-shot situation and in the market situation is, on average between 40 and 45 percent. The statistical tests conducted by FKW show that there is **no** significant difference between sellers' shares in the one-shot and the repeated market situation.

Our model in section IV and our interpretation of the RT-data imply that the amount of excess supply does not play a role in the formation of prices. If sellers' reciprocity is sufficiently strong buyers' expected profits are a strictly concave and rising function of prices. Therefore, as long as there is a non negative excess supply, i.e. as long as buyers can be sure to find at least one seller, they can set their prices irrespective of the extent of the excess supply. In our view, the fact, that in the FKW-experiments sellers received the same shares in the one-shot (bilateral) experiments as in the market experiments with an excess supply of sellers, supports our interpretation of the data.

Finally, we would like to relate our data and our interpretation to the approaches of Binmore and Samuelson (BS, 1994) and Roth and Erev (RE, 1995). These authors explain the stylised facts of ultimatum games in terms of evolutionary models (BS) or in terms of psychological learning models (RE). Both in BS and in RE subjects do not act rationally on the basis of consistent preferences. They follow, instead, behavioural patterns that are – at least initially – ill-adapted to the game being played. Their actions are ill-adapted in the sense that they do not maximise subjects monetary returns in the one-shot game. The simulations conducted by BS and RE show that these "mistakes" can survive even in the long run, i.e. adaptive forces need not cause convergence to the subgame perfect equilibrium of the ultimatum game.

We cannot rule out that the mechanisms that have been stipulated by BS and RE also play a role in our experiments. Perhaps the reciprocal responses of our sellers in the RT are not driven by the rational pursuit of consistent preferences but by a behavioural impulse to reciprocate that has been "inherited" from repeated interactions in the real world. If that were the case our task of proving that non trading sellers in our RT have been involuntarily rationed is much easier because we could identify sellers' reservation prices with the induced value f. The systematic and large gap between actual prices and the sellers' reservation price f in our RT would then be an unambiguous indicator for a non-competitive outcome.

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Data

ses: session#
per: period#
sel: seller#
buy: buyer#
p: price
q: quality
$c(q)$: quality costs
S: monetary payoff of the seller
B: monetary payoff of the buyer

ses	per	sel	buy	p	q	c(q)	S	B
1	1	1	8	225	-	-	19	21
1	1	2	6	220	-	-	14	26
1	1	3	7	225	-	-	19	21
1	1	4	2	225	-	-	19	21
1	1	5	1	215	-	-	9	31
1	1	6	5	210	-	-	4	36
1	2	1	6	215	-	-	9	31
1	2	2	2	220	-	-	14	26
1	2	3	1	220	-	-	14	26
1	2	4	5	220	-	-	14	26
1	2	5	7	210	-	-	4	36
1	2	6	8	220	-	-	14	26
1	3	1	5	210	-	-	4	36
1	3	2	8	215	-	-	9	31
1	3	3	2	215	-	-	9	31
1	3	4	1	215	-	-	9	31
1	3	5	3	220	-	-	14	26
1	3	6	9	210	-	-	4	36
1	4	1	8	210	-	-	4	36
1	4	2	7	210	-	-	4	36
1	4	3	9	210	-	-	4	36
1	4	4	4	215	-	-	9	31
1	4	5	5	215	-	-	9	31
1	4	6	2	215	-	-	9	31
1	5	1	2	210	-	-	4	36
1	5	2	3	210	-	-	4	36
1	5	3	4	210	-	-	4	36
1	5	4	1	210	-	-	4	36
1	5	5	5	215	-	-	9	31
1	5	6	7	210	-	-	4	36
1	6	1	1	210	-	-	4	36
1	6	2	3	210	-	-	4	36
1	6	3	8	210	-	-	4	36
1	6	4	2	210	-	-	4	36
1	6	5	5	215	-	-	9	31
1	6	6	9	210	-	-	4	36
1	7	1	8	210	-	-	4	36
1	7	2	3	210	-	-	4	36
1	7	3	7	210	-	-	4	36
1	7	4	2	210	-	-	4	36
1	7	5	4	210	-	-	4	36
1	7	6	5	210	-	-	4	36
1	8	1	7	210	-	-	4	36
1	8	2	3	210	-	-	4	36
1	8	3	2	210	-	-	4	36

ses	per	sel	buy	p	q	c(q)	S	B
1	8	4	5	210	-	-	4	36
1	8	5	8	210	-	-	4	36
1	8	6	1	210	-	-	4	36
1	9	1	5	80	0.4	4	50	18
1	9	2	3	70	0.1	0	44	5.6
1	9	4	1	80	0.2	1	53	9.2
1	9	5	6	65	0.1	0	39	6.1
1	9	7	2	60	0.4	4	30	26
1	9	8	4	60	0.3	2	32	20
1	10	1	3	60	0.1	0	34	6.6
1	10	2	2	55	0.3	2	27	21
1	10	4	4	65	0.1	0	39	6.1
1	10	5	1	60	0.5	6	28	33
1	10	8	6	80	0.5	6	48	23
1	10	9	5	85	0.7	10	49	29
1	11	2	3	80	0.1	0	54	4.6
1	11	3	2	60	0.2	1	33	13
1	11	5	1	80	0.4	4	50	18
1	11	7	6	85	0.7	10	49	29
1	11	8	4	60	0.2	1	33	13
1	11	9	5	80	0.5	6	48	23
1	12	1	4	80	0.4	4	50	18
1	12	2	1	75	0.1	0	49	5.1
1	12	3	5	85	0.3	2	57	12
1	12	5	3	80	0.6	8	46	28
1	12	6	6	90	0.5	6	58	18
1	12	8	2	75	0.4	4	45	20
1	13	1	1	80	0.4	4	50	18
1	13	2	3	85	0.1	0	59	4.1
1	13	5	5	90	0.7	10	54	25
1	13	7	4	80	0.6	8	46	28
1	13	8	2	85	0.6	8	51	25
1	13	9	6	90	0.8	12	52	29
1	14	1	3	90	0.4	4	60	14
1	14	2	2	85	0.1	0	59	4.1
1	14	3	4	85	0.3	2	57	12
1	14	5	1	85	0.6	8	51	25
1	14	8	6	95	0.7	10	59	22
1	14	9	5	95	0.8	12	57	25
1	15	1	2	75	0.1	0	49	5.1
1	15	2	3	90	0.1	0	64	3.6
1	15	5	4	90	1	18	46	36
1	15	6	6	80	0.1	0	54	4.6
1	15	7	1	75	0.4	4	45	20
1	15	8	5	100	0.9	15	59	23

ses	per	sel	buy	p	q	c(q)	S	B
1	16	1	5	80	0.5	6	48	23
1	16	2	2	30	0.1	0	4	9.6
1	16	4	6	30	0.1	0	4	9.6
1	16	5	4	80	0.4	4	50	18
1	16	7	3	35	0.1	0	9	9.1
1	16	8	1	60	0.1	0	34	6.6
2	1	2	4	75	0.5	8	41	25.5
2	1	3	5	70	0.4	4	40	22.4
2	1	4	3	70	0.4	4	40	22.4
2	1	5	2	70	0.1	0	44	5.6
2	1	7	6	60	0.2	1	33	13.2
2	1	9	1	65	0.1	0	39	6.1
2	2	1	6	55	0.1	9	20	7.1
2	2	2	1	55	0.3	2	27	21.3
2	2	5	4	55	0.1	0	29	7.1
2	2	6	2	60	0.4	4	30	26.4
2	2	7	5	50	0.2	1	23	15.2
2	2	8	3	60	0.4	4	30	26.4
2	3	4	6	45	0.2	1	18	16.2
2	3	5	5	65	0.1	0	39	6.1
2	3	6	3	50	0.3	2	22	22.8
2	3	8	4	50	0.3	2	22	22.8
2	3	9	2	50	0.3	2	22	22.8
2	4	1	1	50	0.1	0	24	7.6
2	4	3	6	45	0.2	1	18	16.2
2	4	4	4	45	0.2	1	18	16.2
2	4	7	3	55	0.2	1	28	14.2
2	4	8	5	35	0.1	0	9	9.1
2	4	9	2	40	0.1	0	14	8.6
2	5	1	6	50	0.1	0	24	7.6
2	5	2	2	65	0.3	2	37	18.3
2	5	4	5	80	0.5	6	48	23
2	5	5	3	60	0.2	1	33	13.2
2	5	6	4	60	0.4	4	30	26.4
2	5	9	1	45	0.2	1	18	16.2
2	6	1	6	35	0.1	0	9	9.1
2	6	4	5	35	0.1	0	9	9.1
2	6	5	3	45	0.1	0	19	8.1
2	6	7	4	50	0.2	1	23	15.2
2	6	8	1	40	0.1	0	14	8.6
2	6	9	2	50	0.2	1	23	15.2
2	7	1	1	65	0.2	1	38	12.2
2	7	2	4	60	0.3	2	32	19.8
2	7	3	6	60	0.4	4	30	26.4
2	7	4	5	75	0.4	4	45	20.4
2	7	8	3	60	0.4	4	30	26.4
2	7	9	2	65	0.2	1	38	12.2
2	8	1	4	100	0.7	10	64	18.2
2	8	2	3	65	0.1	0	39	6.1
2	8	4	1	85	0.6	8	51	24.6
2	8	6	5	60	0.4	4	30	26.4
2	8	8	6	70	0.6	8	36	33.6
2	8	9	2	75	0.2	1	48	10.2
2	9	1	3	215	-	-	9	31
2	9	2	4	220	-	-	14	26
2	9	3	7	210	-	-	4	36

ses	per	sel	buy	p	q	c(q)	S	B
2	9	4	5	210	-	-	4	36
2	9	5	9	210	-	-	4	36
2	9	6	6	210	-	-	4	36
2	10	1	2	215	-	-	9	31
2	10	2	8	210	-	-	4	36
2	10	3	9	215	-	-	9	31
2	10	4	7	215	-	-	9	31
2	10	5	4	215	-	-	9	31
2	10	6	6	215	-	-	9	31
2	11	1	6	210	-	-	4	36
2	11	2	7	210	-	-	4	36
2	11	3	3	215	-	-	9	31
2	11	4	1	215	-	-	9	31
2	11	5	4	215	-	-	9	31
2	11	6	5	215	-	-	9	31
2	12	1	7	215	-	-	9	31
2	12	2	1	215	-	-	9	31
2	12	3	2	215	-	-	9	31
2	12	4	4	215	-	-	9	31
2	12	5	8	215	-	-	9	31
2	12	6	3	215	-	-	9	31
2	13	1	6	215	-	-	9	31
2	13	2	5	215	-	-	9	31
2	13	3	9	215	-	-	9	31
2	13	4	1	215	-	-	9	31
2	13	5	3	215	-	-	9	31
2	13	6	2	215	-	-	9	31
2	14	1	3	210	-	-	4	36
2	14	2	4	215	-	-	9	31
2	14	3	1	215	-	-	9	31
2	14	4	8	215	-	-	9	31
2	14	5	9	215	-	-	9	31
2	14	6	6	210	-	-	4	36
2	15	1	8	215	-	-	9	31
2	15	2	7	210	-	-	4	36
2	15	3	5	210	-	-	4	36
2	15	4	1	215	-	-	9	31
2	15	5	4	215	-	-	9	31
2	15	6	3	215	-	-	9	31
2	16	1	3	215	-	-	9	31
2	16	2	6	215	-	-	9	31
2	16	3	1	215	-	-	9	31
2	16	4	8	215	-	-	9	31
2	16	5	4	215	-	-	9	31
3	1	6	7	228	-	-	22	18
3	1	3	1	229	-	-	23	17
3	1	4	4	228	-	-	22	18
3	1	2	3	227	-	-	21	19
3	1	7	8	228	-	-	22	18
3	1	5	6	227	-	-	21	19
3	1	1	2	227	-	-	21	19
3	2	5	7	225	-	-	19	21
3	2	6	1	227	-	-	21	19
3	2	4	10	224	-	-	18	22
3	2	1	2	221	-	-	15	25
3	2	2	5	222	-	-	16	24

ses	per	sel	buy	p	q	c(q)	S	B
3	2	3	8	217	-	-	11	29
3	2	7	6	220	-	-	14	26
3	3	5	3	220	-	-	14	26
3	3	2	1	222	-	-	16	24
3	3	3	9	223	-	-	17	23
3	3	4	5	222	-	-	16	24
3	3	7	4	222	-	-	16	24
3	3	6	8	222	-	-	16	24
3	3	1	2	221	-	-	15	25
3	4	2	5	217	-	-	11	29
3	4	3	9	218	-	-	12	28
3	4	6	10	221	-	-	15	25
3	4	5	2	222	-	-	16	24
3	4	7	6	222	-	-	16	24
3	4	1	8	222	-	-	16	24
3	4	4	4	220	-	-	14	26
3	5	1	8	217	-	-	11	29
3	5	4	3	218	-	-	12	28
3	5	6	1	221	-	-	15	25
3	5	3	2	220	-	-	14	26
3	5	5	6	219	-	-	13	27
3	5	7	9	219	-	-	13	27
3	5	2	4	219	-	-	13	27
3	6	3	9	217	-	-	11	29
3	6	6	5	219	-	-	13	27
3	6	2	6	218	-	-	12	28
3	6	5	8	217	-	-	11	29
3	6	7	2	217	-	-	11	29
3	6	1	10	217	-	-	11	29
3	6	4	4	217	-	-	11	29
3	7	1	3	216	-	-	10	30
3	7	2	2	217	-	-	11	29
3	7	3	8	218	-	-	12	28
3	7	4	5	217	-	-	11	29
3	8	5	5	217	-	-	11	29
3	8	4	3	216	-	-	10	30
3	8	2	2	217	-	-	11	29
3	8	6	6	217	-	-	11	29
3	8	7	8	216	-	-	10	30
3	8	1	9	215	-	-	9	31
3	8	3	10	214	-	-	8	32
3	9	1	2	85	0.1	0	59	4.1
3	9	2	6	86	0.1	0	60	4
3	9	4	5	100	0.7	10	64	18.2
3	9	5	1	40	0.1	0	14	8.6
3	9	6	7	80	0.1	0	54	4.6
3	9	8	3	90	0.1	0	64	3.6
3	9	9	4	75	0.2	1	48	10.2
3	10	1	5	100	0.1	0	74	2.6
3	10	2	7	90	0.1	0	64	3.6
3	10	4	4	90	0.4	4	60	14.4
3	10	5	1	100	0.4	4	70	10.4
3	10	6	3	100	0.7	10	64	18.2
3	10	8	2	40	0.1	0	14	8.6
3	10	9	6	105	0.4	4	75	8.4
3	11	1	5	100	0.3	2	72	7.8
3	11	2	4	95	0.1	0	69	3.1
3	11	4	3	105	0.4	4	75	8.4
3	11	5	2	100	0.4	4	70	10.4
3	11	6	7	100	0.6	8	66	15.6
3	11	8	1	96	0.1	0	70	3
3	11	9	6	105	0.4	4	75	8.4
3	12	1	7	100	0.3	2	72	7.8
3	12	2	1	106	0.1	0	80	2
3	12	4	6	107	0.4	4	77	7.6
3	12	6	4	106	0.7	10	70	14
3	12	8	3	43	0.1	0	17	8.3
3	12	9	2	45	0.1	0	19	8.1
3	12	10	5	45	0.1	0	19	8.1
3	13	1	5	48	0.1	0	22	7.8
3	13	2	4	106	0.1	0	80	2
3	13	6	1	47	0.1	0	21	7.9
3	13	7	2	46	0.1	0	20	8
3	13	8	7	50	0.1	0	24	7.6
3	13	9	3	104	0.6	8	70	13.2
3	13	10	6	55	0.2	1	28	14.2
3	14	1	3	110	0.5	6	78	8
3	14	2	7	100	0.1	0	74	2.6
3	14	5	6	95	0.9	15	54	27.9
3	14	6	5	105	0.8	12	67	16.8
3	14	7	2	46	0.1	0	20	8
3	14	8	8	96	0.1	0	70	3
3	14	9	1	106	0.5	6	74	10
3	15	1	1	106	0.5	6	74	10
3	15	2	3	31	0.1	0	5	9.5
3	15	3	5	105	0.1	0	79	2.1
3	15	5	7	106	0.8	12	68	16
3	15	6	6	90	0.4	4	60	14.4
3	15	8	4	46	0.1	0	20	8
3	16	1	6	80	0.1	0	54	4.6
3	16	2	5	106	0.1	0	80	2
3	16	3	4	106	0.1	0	80	2
3	16	5	1	106	0.1	0	80	2
3	16	6	7	45	0.1	0	19	8.1
3	16	8	3	85	0.1	0	59	4.1
4	1	1	1	89	0.1	0	63	3.7
4	1	2	2	86	0.7	10	50	28
4	1	3	8	93	0.4	4	63	13.2
4	1	4	4	85	0.3	2	57	12.3
4	1	8	3	92	1	18	48	34
4	1	9	5	55	0.3	2	27	21.3
4	1	10	6	90	0.9	15	49	32.4
4	1	12	7	60	0.4	4	30	26.4
4	2	1	8	60	0.1	0	34	6.6
4	2	2	4	85	0.5	6	53	20.5
4	2	4	2	55	0.3	2	27	21.3
4	2	7	3	75	0.7	10	39	35.7
4	2	8	1	55	0.7	10	19	49.7
4	2	9	7	50	0.4	4	20	30.4
4	2	10	6	50	0.2	1	23	15.2
4	2	11	5	40	0.3	2	12	25.8
4	3	1	7	35	0.1	0	9	9.1

ses	per	sel	buy	p	q	c(q)	S	B
4	3	2	6	70	0.5	6	38	28
4	3	3	2	45	0.1	0	19	8.1
4	3	4	1	50	0.1	0	24	7.6
4	3	7	5	100	1	18	56	26
4	3	8	8	96	1	18	52	30
4	3	9	3	45	0.5	6	13	40.5
4	3	10	4	100	1	18	56	26
4	4	1	2	86	0.1	0	60	4
4	4	2	8	96	0.8	12	58	24
4	4	4	6	80	0.1	0	54	4.6
4	4	6	5	100	0.5	6	68	13
4	4	8	1	65	0.8	12	27	48.8
4	4	9	3	60	0.4	4	30	26.4
4	4	10	7	90	1	18	46	36
4	4	12	4	100	0.9	15	59	23.4
4	5	1	7	80	0.1	0	54	4.6
4	5	2	8	96	0.8	12	58	24
4	5	4	1	65	0.3	2	37	18.3
4	5	5	3	45	0.1	0	19	8.1
4	5	6	6	92	0.5	4	62	17
4	5	7	2	90	1	18	46	36
4	5	10	4	76	0.8	12	38	40
4	5	11	5	100	1	18	56	26
4	6	1	8	96	0.1	0	70	3
4	6	2	1	66	0.1	0	40	6
4	6	4	6	95	0.2	1	68	6.2
4	6	5	5	76	0.1	0	50	5
4	6	9	3	65	0.4	4	35	24.4
4	6	10	7	85	1	18	41	41
4	6	11	2	86	0.5	6	54	20
4	6	12	4	76	0.4	4	46	20
4	7	1	1	76	0.1	0	50	5
4	7	2	4	91	0.8	12	53	28
4	7	4	8	30	0.1	0	4	9.6
4	7	5	7	85	0.6	8	51	24.6
4	7	7	6	75	0.7	10	39	35.7
4	7	8	3	70	0.9	15	29	50.4
4	7	10	2	86	1	18	42	40
4	7	11	5	99	0.7	10	63	18.9
4	8	1	2	86	0.1	0	60	4
4	8	2	1	76	0.1	0	50	5
4	8	3	4	101	0.4	4	71	10
4	8	4	6	80	0.1	0	54	4.6
4	8	5	8	96	0.7	10	60	21
4	8	7	5	30	0.1	0	4	9.6
4	8	9	3	50	0.4	4	20	30.4
4	8	10	7	86	0.1	0	60	4
4	9	7	5	210	-	-	4	36
4	9	6	2	220	-	-	14	26
4	9	3	1	226	-	-	20	20
4	9	4	7	216	-	-	10	30
4	9	8	4	217	-	-	11	29
4	9	1	9	214	-	-	8	32
4	9	2	8	212	-	-	6	34
4	9	5	10	210	-	-	4	36
4	10	4	1	216	-	-	10	30

ses	per	sel	buy	p	q	c(q)	S	B
4	10	8	11	211	-	-	5	35
4	10	1	5	212	-	-	6	34
4	10	2	9	211	-	-	5	35
4	10	3	8	215	-	-	9	31
4	10	5	4	211	-	-	5	35
4	10	7	3	211	-	-	5	35
4	10	6	2	211	-	-	5	35
4	11	3	1	215	-	-	9	31
4	11	1	4	212	-	-	6	34
4	11	2	9	212	-	-	6	34
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4	11	6	3	212	-	-	6	34
4	11	5	5	212	-	-	6	34
4	11	4	6	212	-	-	6	34
4	12	4	12	212	-	-	6	34
4	12	3	1	215	-	-	9	31
4	12	2	4	213	-	-	7	33
4	12	1	8	213	-	-	7	33
4	12	6	5	211	-	-	5	35
4	12	7	2	212	-	-	6	34
4	12	8	3	211	-	-	5	35
4	12	5	9	210	-	-	4	36
4	13	4	5	211	-	-	5	35
4	13	3	1	213	-	-	7	33
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4	13	5	3	212	-	-	6	34
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4	13	8	9	214	-	-	8	32
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4	16	2	5	210	-	-	4	36
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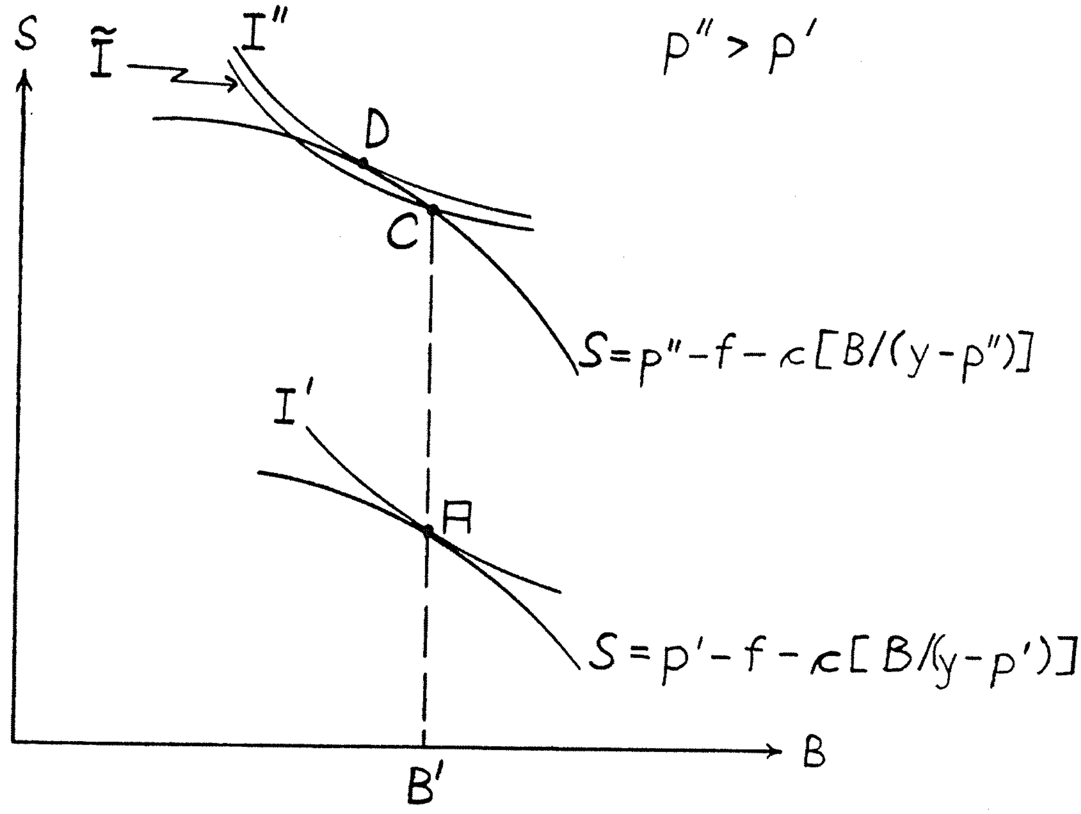

Figure 1

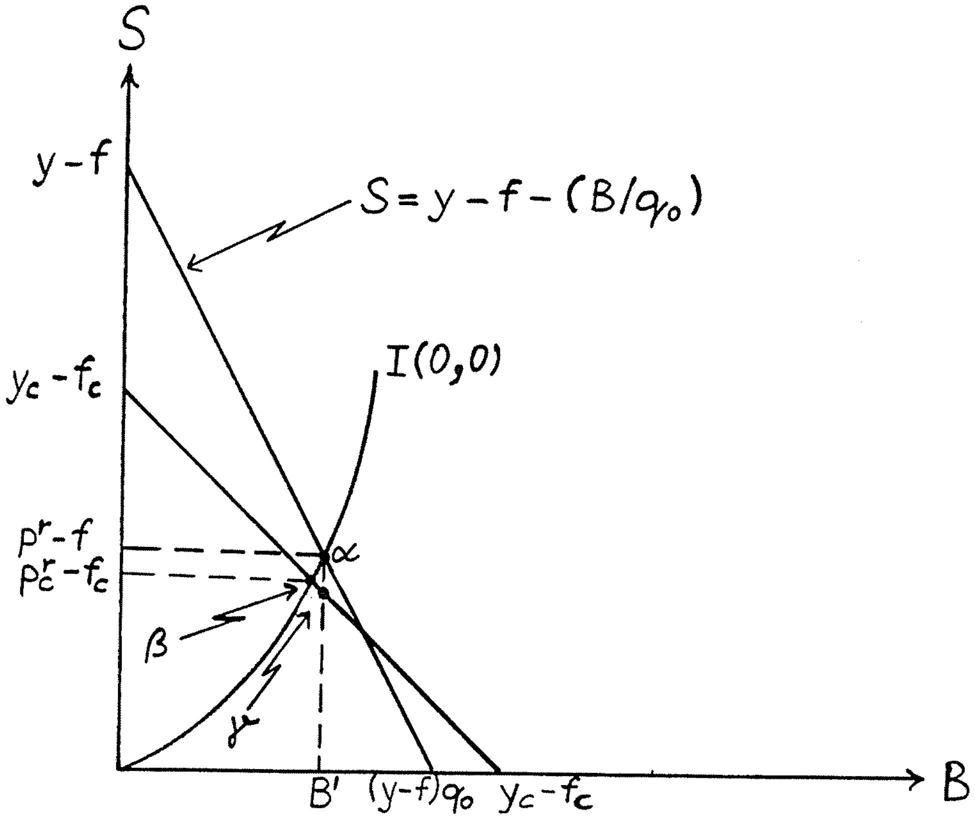

Figure 2

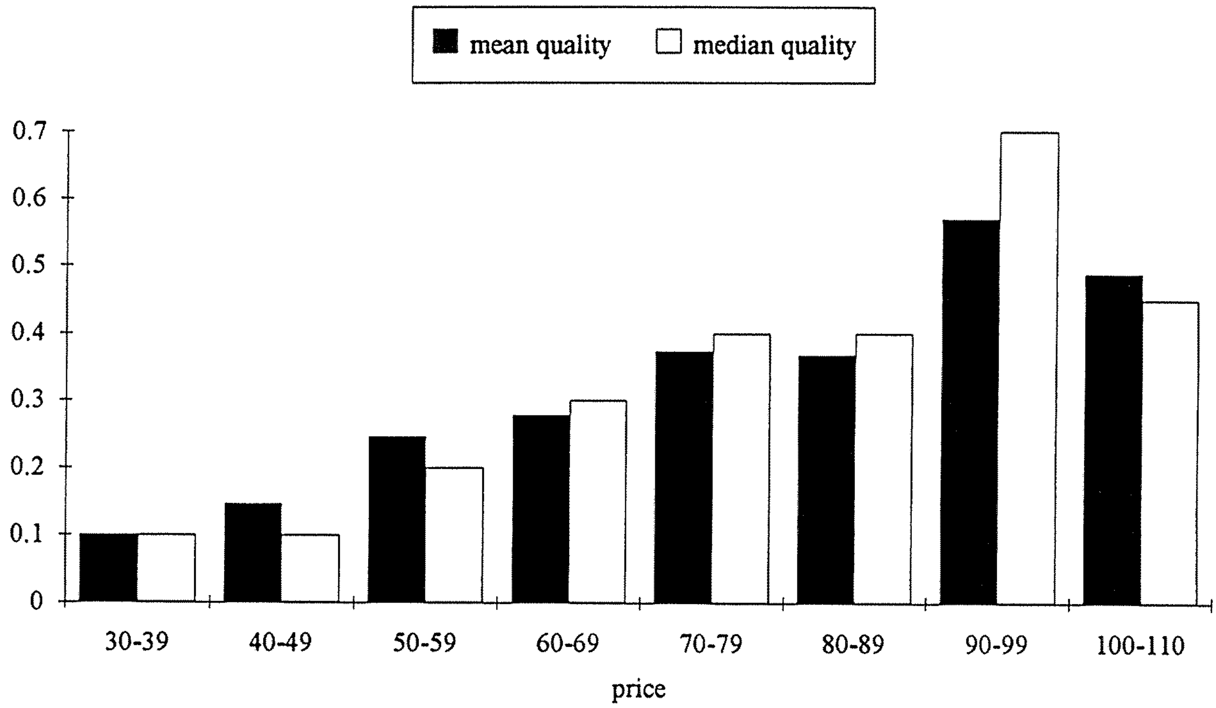

Figure 3:
The Price-Quality Relation

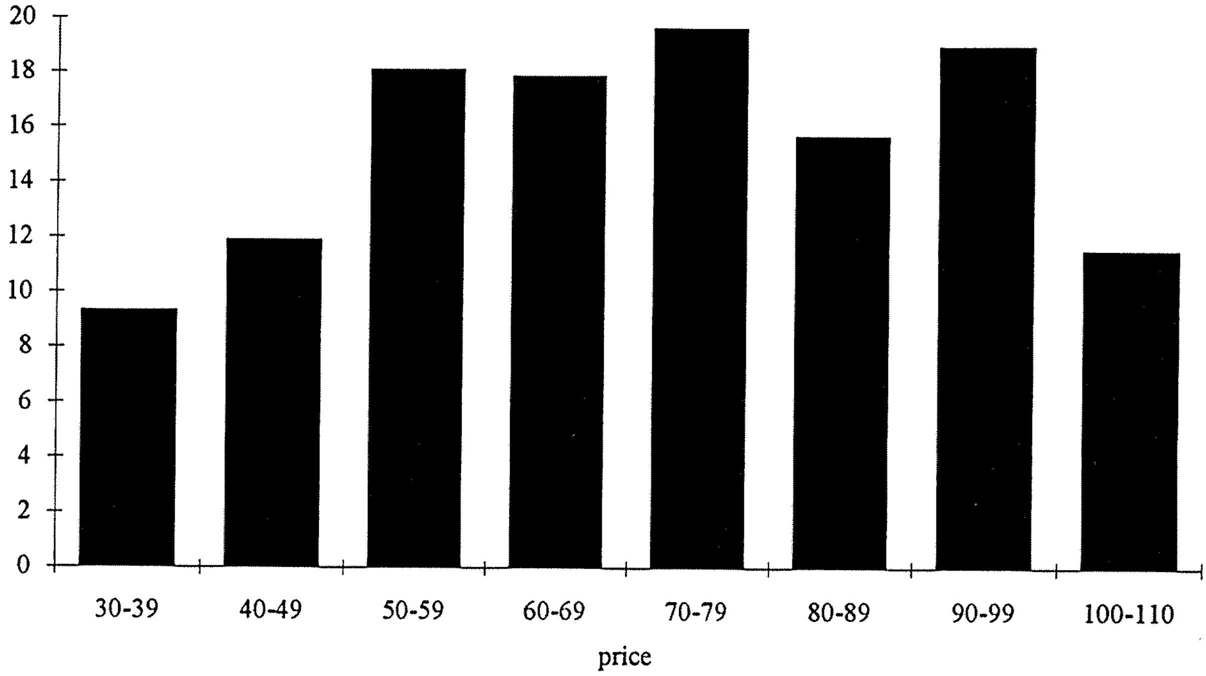

Figure 4:

The Relation between Price and Buyers´ Profit

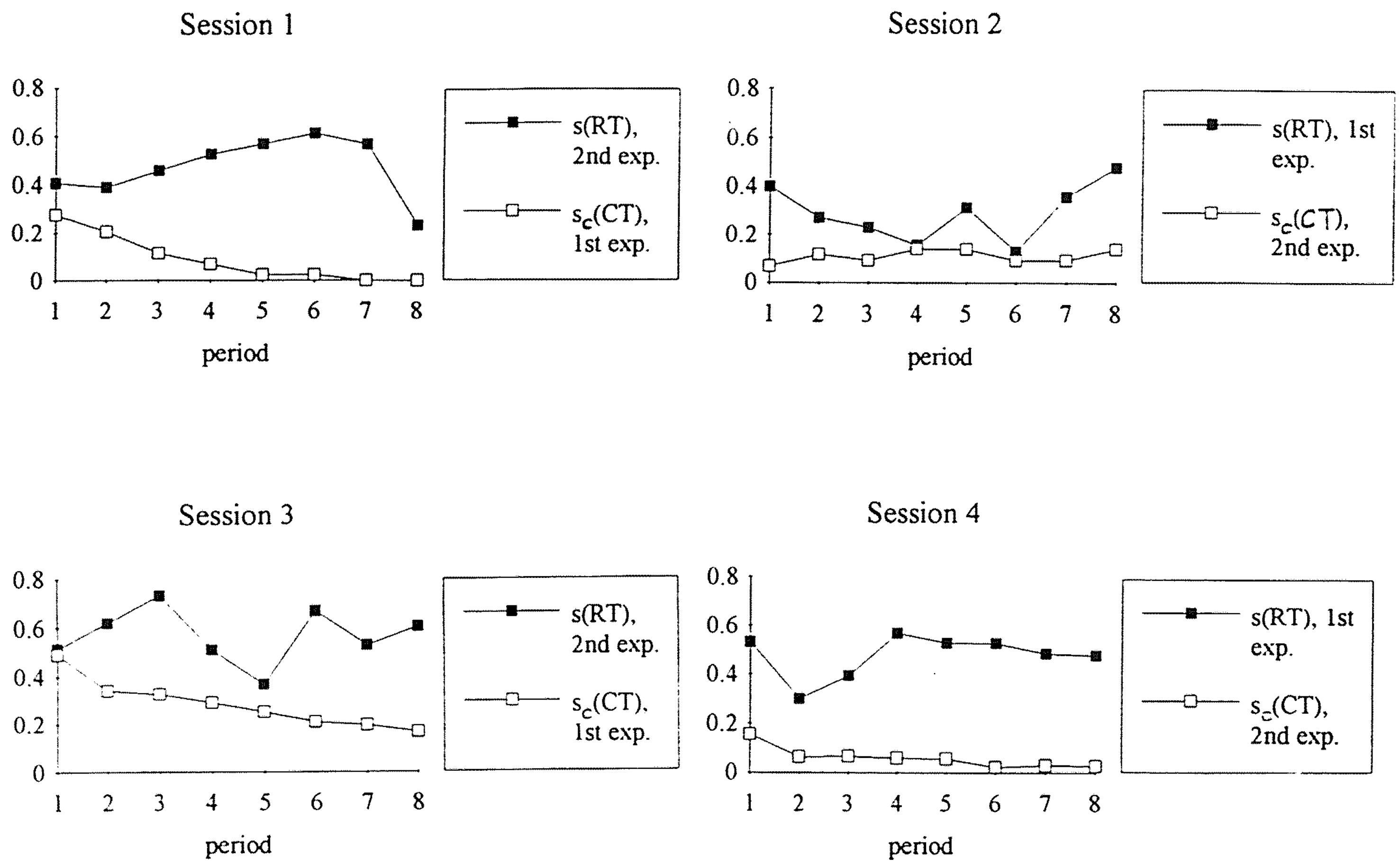

Figure 5:
Average Share per Period

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