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Price formation in monopolistic markets with endogenous diffusion of trading information: An experimental approach

Abstract:
This paper reports on price formation in experimental markets in which a single seller trades with four buyers. Transactions occur if either a buyer accepts an offer to sell from the seller, or the seller accepts an offer to buy from a buyer. The dissemination of such offers is endogenous in that the seller determines which buyer(s) should be informed about offers to sell, whereas each buyer may broadcast his offer to buy to any of the residual buyers. Complete dissemination of offers is consistent with conventional double-auction trading rules. The result is two-fold. First, the diffusion of trading information is incomplete, in that neither the single seller nor the buyers inform all market participants about offers. Second, observed prices and the number of transactions are in line with the competitive theoretic benchmark.

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1. Introduction

Standard monopoly theory assumes a single seller that is faced with a set of buyers. The monopolist knows his supply function, the market demand function and the implied marginal revenue schedule. All trades are conducted at the single price that maximizes the monopolist's profit. Hence, the single-price monopoly outcome is, in general, inefficient because the monopolistic trading volume deviates negatively from the competitive solution. Moreover, a positive mark-up relative to the competitive price level means that the monopolist accrues a comparatively larger share of the realized trade gains than buyers (see, e.g., Tirole, 1988).

A range of experiments has analyzed the empirical validity of monopoly theory using different trading institutions for price determination (Plott, 1989 and Holt, 1995 contain surveys of this literature)[1]. The double auction has attracted particular interest. It can be defined as a set of trading rules that enable buyers (the seller) to specify offers to buy (sell). Each offer is disseminated to all market participants. A transaction is triggered by an acceptance of an offer, and each contract (price) is common knowledge. Lastly, trading is sequential in the sense that traders negotiate and confirm prices continuously during real-time sequences (Friedman, 1993).

A stylized fact in the experimental economics literature is that the double-auction is a contracting institution that works to restrain a monopolist's market power (Davis and Holt, 1993). The principal reason is that buyers are actively engaged in bargaining with a single seller over terms of trade. Thus, buyers in such experiments are not neutral, but instead tend to actively coordinate their trading behavior against the seller. Specifically, Smith (1981) concluded that buyers appeared to engage in tacit collusion against the single seller, the effect of which was to render a single seller unable to implement the equilibrium monopoly price. Smith and Williams (1990) replicated this finding. Also, double-auction trading is sequential and need not be conducted at a single price. Hence, even if a single seller has managed to obtain the monopoly outcome, he has incentives to offer last-minute price concessions to buyers in order to realize gains from trade that still exist at the end of a trading period. Such price reductions tend to become public knowledge in experiments that lasts several consecutive trading periods, thereby causing the monopolist's market power to be eroded over time.

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[1] In most monopoly experiments the seller does not possess "true" demand information, only information about his own supply schedule and contract information that is forthcoming in the market under the governing trading institution. This

The purpose of this paper is to extend the experimental literature on monopoly and double-auction trading. Specifically, this paper reports on price formation in monopolistic markets characterized by a sequential trading process in which the diffusion of trading information is endogenous. Thus, after specifying an offer to buy from the seller, a buyer chooses which - if any - other buyer(s) should be informed about the offer as well. Similarly, the monopolist determines which buyer(s) shall receive his offer to sell. Complete dissemination of all offers produces information flows consistent with the double-auction trading institution. The research questions to be explored below are whether buyers and monopolists diffuse trading information in line with double-auction rules, and how the observed information flows affect the level of prices and quantity of transactions.

A priori, the monopolists may be conjectured to choose maximum dissemination of offers to sell. Intuition suggests that when faced with a given number of buyers, the probability of conducting a trade should increase with the quantity of buyers informed about the single seller's offer. Also, a related study by Kirchsteiger, Niederle and Potters (KNP) (1998) found strong evidence for similar behavior. They analyzed a competitive market environment characterized by six sellers and six buyers, each of which had the right to specify binding offers to sell and buy, respectively. In addition, the subjects had to determine the dissemination of their offers amongst the market participants. Acceptance of either type of offer triggered a transaction, and confirmation of this was communicated to all traders initially informed of the accepted offer. The results reported by KNP showed that traders consistently informed all traders on the other side of the market, but none of their competitors.

An interesting issue is whether the behavior of the buyers in KNP's study carries over to the experiments reported here. *Ceteris paribus*, collusion amongst buyers against the seller entails specifying bids below the single-price monopoly level and/or a negative correlation between level of offers and dissemination of offers. On the other hand, competition amongst buyers for trades with the seller may induce buyers to conceal their offers to buy from their competitors. Furthermore, assuming bids from buyers tend to be below the seller's offers to sell, the extent to which counterspeculation is successful increases with the degree to which prices stem from the acceptance of buyers' bids.

Experimental monopolistic markets tend to exhibit heterogeneous behavior because chances are that just one subject (i.e., the single seller) may to a large extent color a laboratory session. Specifically, market performance may depend upon the extent to which the seller (in comparison with the buyers)

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marks a deviation from theory, but arguably corresponds to situations in the real economy in which monopolists have information generated by the pricing process that is operative in a particular industry or market only.

are assertive or "rabbits" (see Ledyard and Szakaly-Moore, 1994). Thus, a focused data analysis of monopolistic price formation may require particular control for, and evaluation of, session effects. The remainder of the paper is organized as follows: Section 2 describes the experimental design; Section 3 reports the experimental results; and the final section offers concluding remarks.

2. Experimental design and procedures

2.1. Market environment

In each laboratory session one seller trades with four buyers. Endowing the four buyers with individual unit valuations for multiple units of a fictitious homogenous good induces market demand. The buyers are identical: Each buyer has an individual demand schedule for four units in which the marginal valuations are [800, 650, 500, 350]. A transaction gives a buyer a profit equal to the value of the difference between the induced value of the traded unit and the agreed price. On the other hand, assigning the seller unit costs over a range of units induces market supply. The seller's profit from any transaction equals the difference between price and assigned cost of the traded unit. Each buyer (the seller) has information about his own demand (supply) schedule only. The induced market demand and supply schedules are nominated in German Pfennig and are shown in Figure 1. Units are measured along the horizontal axis.

Figure 1. Market demand and supply

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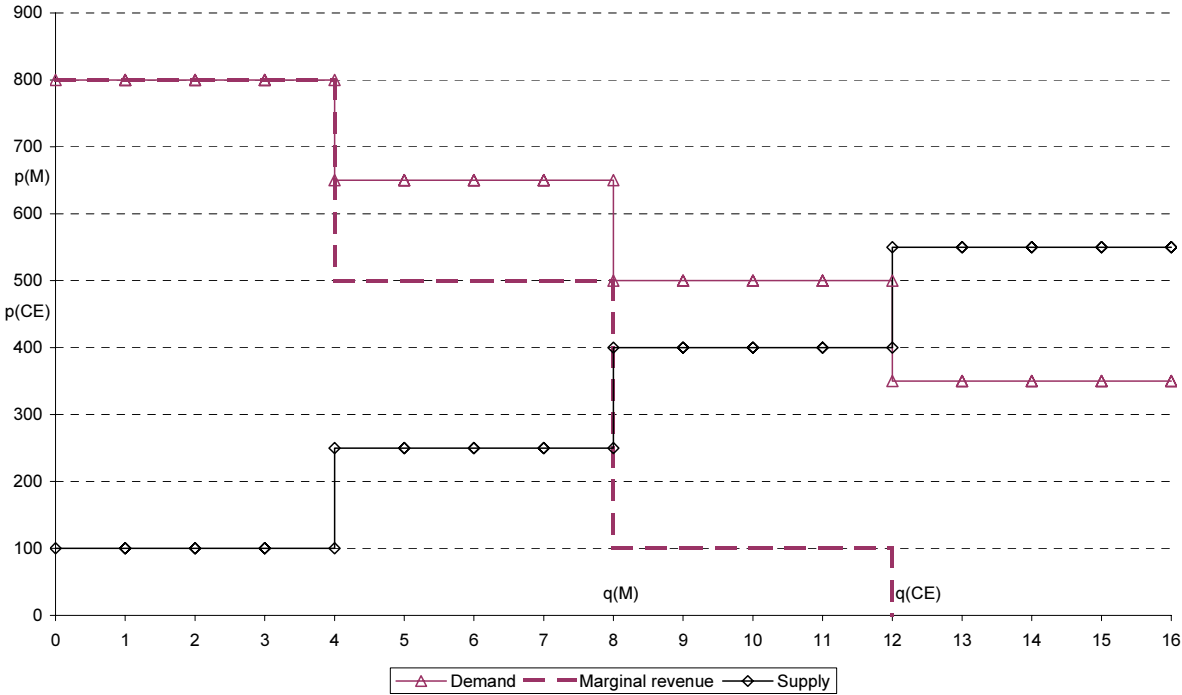
As can be seen from the figure, the competitive theoretic equilibrium price - p(CE) - is 450, and corresponds to the midpoint of the equilibrium price range [400, 500]. The efficient trading volume - q(CE) - is 12 units. Moreover, the price-quantity pair [p(M), q(M)] = [650,8] signifies the single-price monopoly outcome. These benchmark values are summarized in Table 1.

Table 1. Theoretical benchmarks

	Competitive theoretic equilibrium	Single-price monopoly outcome
Price	450	650
Trading volume	12	8

The described market environment is constant across trading periods in all laboratory sessions. Each session consists of eight trading periods, each of which lasts 300 seconds.

2.2. Trading process

Trading takes place on computerized networks. Communication amongst the experimental subjects is non-verbal and restricted to the transfer and acceptance of offers to buy and offers to sell via computer terminals. Trading is continuous-time insofar as trades may be conducted at any time during a trading period. The subsequent subsections contain detailed descriptions of the seller's and the buyers' trading roles.

2.2.1. Seller perspective

The seller can sell one unit at a time, starting with the first unit in his supply schedule. The supply function is depicted numerically at the top of his computer screen, as reproduced in Figure 2[2]. Above this schedule the seller is informed about the time remaining of the current trading period, as well as which trading period he is presently in. Below the supply function he sees the number of units traded and the associated profit accrued during the present trading period.

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[2] The experimental design was programmed in z-tree. This is a software package for economic experiments accessible from the Institute for Empirical Research in Economics at the University of Zurich: www.iew.zurich.ch/ztree.

Figure 2. Seller's computer screen

Trading can occur in two ways. First, the seller may choose to accept any bid from one of the four buyers. Such bids will be listed chronologically in order of appearance in the [Bids | Sender] box on the screen. A bid is the price a buyer is willing to pay in order to purchase one unit. The seller may only accept profitable bids, i.e., bids that are strictly greater than the marginal cost of the unit currently up for sale. The identity of each bidder (Buyer 1, 2, 3 or 4) is also listed in the [Bids | Sender] box. Second, the seller may formulate an ask, i.e. an offer to sell, and write this in the [Specify ask price] box on the screen. The value of the offer has to exceed the marginal cost of the actual unit. The seller then has to determine which buyer(s) will receive his offer to sell by marking the appropriate box(es) below the [Specify ask price] box. The ask has to be communicated to at least one buyer. The seller may specify as many asks as he wants. Additional offers do not render previous ask(s) invalid. A transaction occurs if an informed buyer accepts an offer to sell. Retraction of asks is prohibited.

Each outstanding ask is automatically cancelled and will disappear from the seller's and the informed buyer(s)'s computer screens when a transaction takes place. Transactions are listed in the [Price |

Traded with] box. Here the seller can see the price and the identity of the buyer involved in each transaction made during the present trading period. At the bottom of the screen the seller sees profit levels, trading volume and the mean price of transactions pertaining to preceding trading periods.

2.2.2. Buyer perspective

Each buyer's demand schedule is shown near the top of the buyer's computer screen, as is the identity of the buyer (1 or 2 or 3 or 4). As can be seen in Figure 3, below the demand function each buyer has access to information on the market trading volume (including his own trades), his trading volume only, as well as the continually updated profit.

Figure 3. A buyer's computer screen
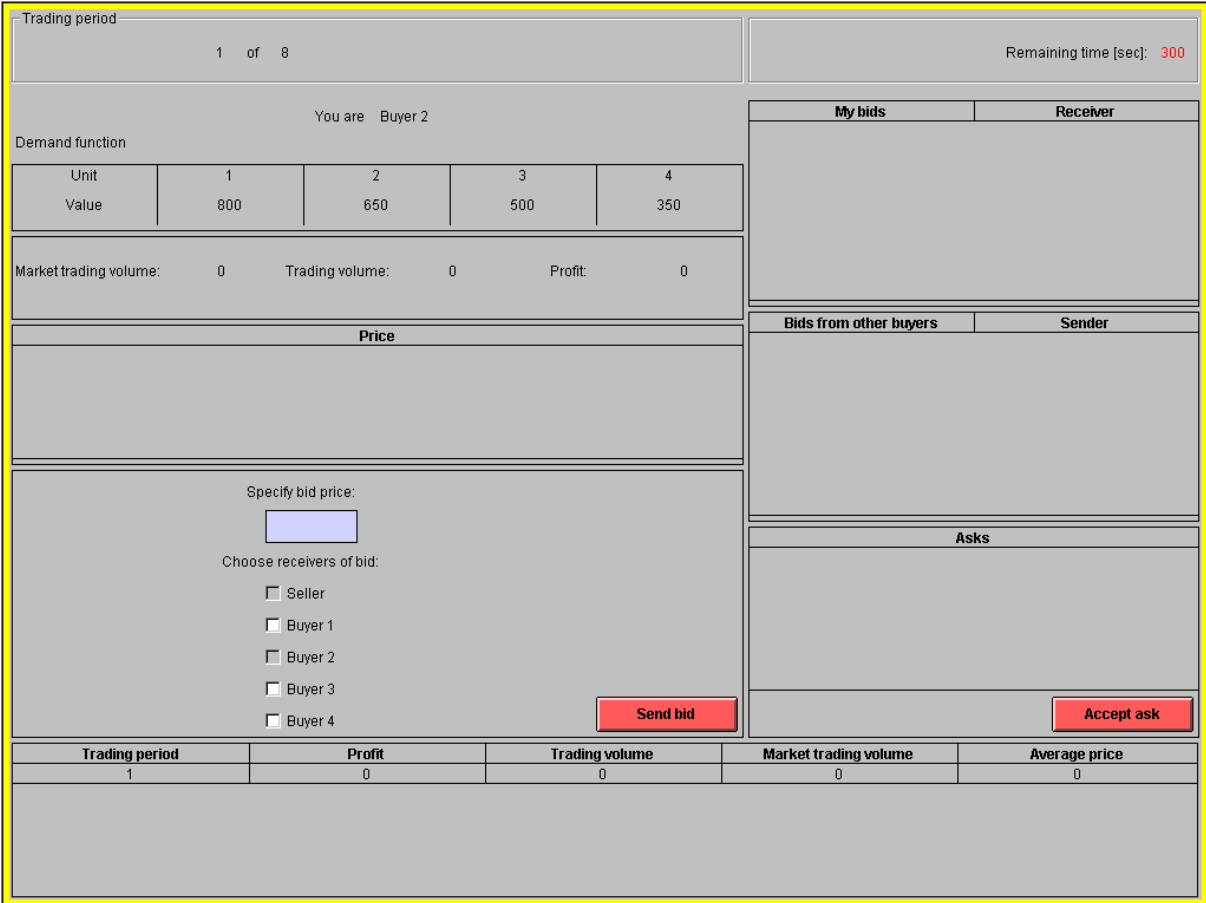
Offers to sell received from the seller are shown in the [Asks] screen. Conditional upon an ask being strictly lower than the buyer's marginal valuation, a transaction can take place if the buyer chooses to accept the ask. Acceptance is achieved by clicking on the [Accept ask] button.

Moreover, a buyer may specify a bid to buy in the [Specify bid box]. A bid is automatically sent to the seller when the [Send bid] button is pressed. In addition, a buyer may inform the residual buyer(s) about his bid. This is achieved by clicking the appropriate box(es) in front of the other buyer(s)[3]. The buyer determines how many bids he wants to specify for each unit. New bids do not make previous bids invalid. Each bid, along with information about the receivers of the bid, are shown in the [My bids | Receiver] box. A buyer may not retract any bid. Whenever a bid from the buyer is accepted, or the buyer accepts an ask, all other bids from the buyer are cancelled and disappear from his, the seller's and any informed buyer(s)'s computer screens. The buyer's transactions are listed in the [Price] box.

Information about bids from residual buyers is shown in the [Bids from other buyers | Sender] box. At the bottom of the screen there is a history box showing information on profit, market and individual trading volume, as well as the average price of the buyer's transactions from every preceding trading period.

2.3. Laboratory sessions: Practicalities

The sessions were run in February 2001 at the University of Mannheim. The participants were students of either economics and business administration or mathematics. The sessions plan and mean payoffs are shown in Table 2. The payoffs were tax-free and included a show-up fee equal to 10 DM.

Table 2. Laboratory sessions and payoffs

Session name	Mean payoff (buyer)	Payoff (seller)
010221J3	25 DM	320 DM
010221ME	70 DM	153 DM
010221OG	80 DM	100 DM
010222J1	38 DM	270 DM

Each experimental session ran as follows. Upon arriving in the laboratory, subjects were randomly assigned a trader role as either a buyer or a seller; roles they retained throughout the session. Then they were given the instructions to read and were allowed to practice trading over four test periods[4]. No profits were made during this part of the experiment. Lastly, subjects traded for eight periods and,

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[3] Automatic promulgation of bids to the seller means that each bid is binding. Thus, a buyer cannot broadcast fake bids to residual buyers.

[4] The instructions (both the English translation and the original German text) are reproduced in the appendix.

finally, were paid their total earnings in private. Each laboratory session lasted approximately 100 minutes.

3. Experimental results

The experimental results are presented in three subsections. The first reports on observed bids and asks. Next prices *qua* accepted asks and bids are analyzed. The last subsection reports on the quantity of prices, i.e., trading volume. The findings of each subsection are summarized as observations.

3.1. Asks and bids

3.1.1. Level of asks and bids
Summary statistics of all asks and bids observed across the four sessions are shown in Table 3. On average, asks deviate positively from the competitive equilibrium price level of 450 Pfennig, and vice versa, with regard to the bids. However, at 561 and 569 Pfennig the mean and median ask appear to lie in the center of the interval between the competitive benchmark and the single-price monopoly prediction (650 Pfennig).

Average and median bids are below the corresponding ask values, and seem to be closer aligned to the competitive price level. Lastly, the experimental design restricts asks and bids to the interval [1,1000] Pfennig, and the maximum ask and the minimum bid correspond to these upper and lower constraints.

Table 3. Summary statistics of asks and bids

	Asks	Bids
Mean	561.53	385.91
Median	569	380
Standard deviation	154.86	146.53
Maximum	1000	730
Minimum	120	1
No. observations	443	2347

Time series of asks and bids across trading periods are depicted in Figure 4. The monopolistic and competitive price levels are depicted as p(M) and p(CM), respectively. The graph shows that the average ask level oscillates between 500 and 600 Pfennig. The bids swing in the vicinity of 400 Pfennig, but to a smaller extent.

Another visual impression is that the difference between average asks and average bids remain roughly constant throughout the sessions. Also, there is a slight tendency for the level of asks to decline during the final four trading periods.

Figure 4. Mean ask and mean bid, pooled across sessions, by trading period
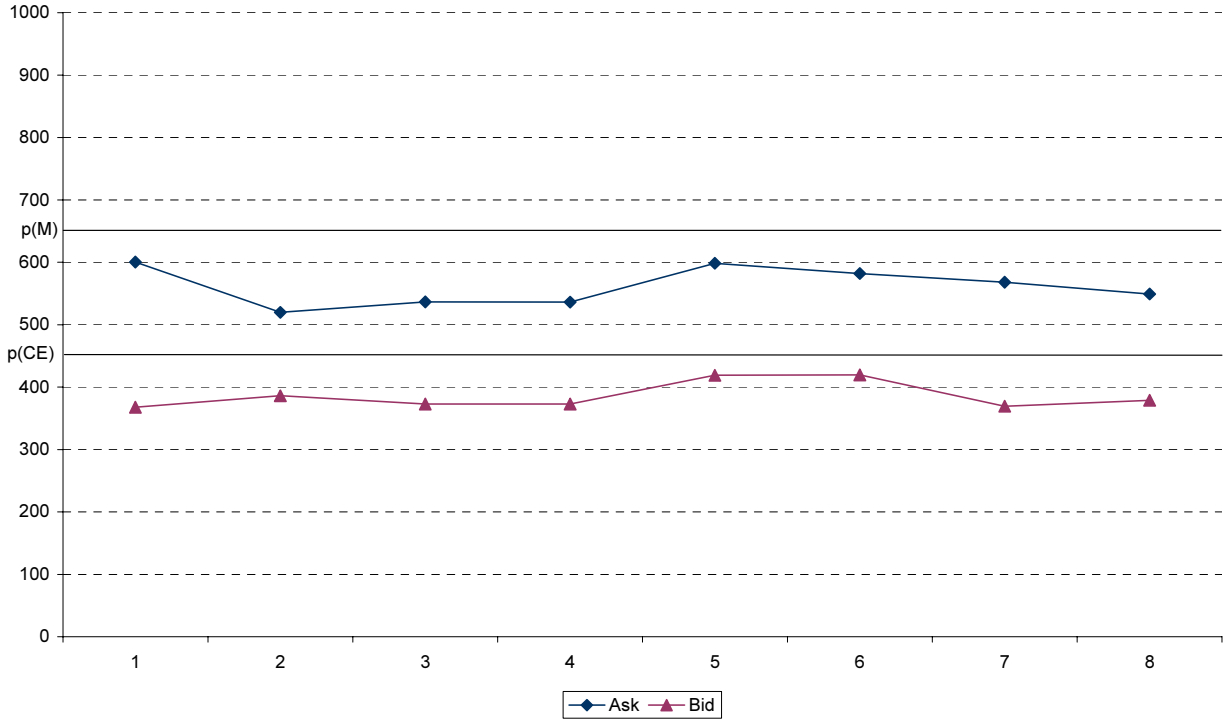
3.1.2. Dissemination of asks and bids

Information about an offer to sell - an ask - has to be communicated to at least one buyer ,and may be transmitted to, at most, four buyers. Let D(Ask) denote a variable that measures the dissemination of offers to sell; hence $D(Ask) \in \{1, 2, 3, 4\}$.

Similarly, let the variable D(Bid) measure of the spread of bids. A buyer may choose to inform no residual buyers and may broadcast his bid to, at most, three residual buyers about an offer to buy. Hence, the range of this variable is given by $D(Bid) \in \{0, 1, 2, 3\}$.

By implication, the pair of values (D(Ask), D(Bid)) = (4,3) is consistent with complete transparency of bids and asks, as implied by conventional double-auction trading rules[5].

Table 4 lists summary statistics pertaining to the variables D(Ask) and D(Bid). They reveal that the modal dissemination of asks and bids is consistent with double-auction rules. On average, a seller broadcasts asks to nearly three of the four buyers, whereas a buyer informs just one residual buyer about his bids.

Table 4. Summary statistics of dissemination of asks and bids

	D(Ask)	D(Bid)
Mean	2.69	1.06
Median	3	0
Mode	4	0
Standard deviation	1.31	1.39
Maximum	4	3
Minimum	1	0
No. observations	443	2347

Table 5 depicts the relative distributions of D(Ask) and D(Bid). Nearly half of all asks are broadcast to all four buyers. Also, buyers tend to inform either none or all residual buyers about their bids.

Table 5. Relative distributions of D(Ask) and D(Bid), pooled across sessions and trading periods

	D(Ask)				D(Bid)			
Value	1	2	3	4	0	1	2	3
%	23.77	22.12	3.61	46.50	61.95	2.45	5.16	32.38

Time series of D(Ask) and D(Bid) are depicted in Figure 5. The graph shows that the modal dissemination of bids is consistently zero, although the mean dissemination appears to exhibit a slight increase over time.

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[5] However, one subtle difference should be noted. In a double-auction context traders know for a fact that all asks and bids are transparent. Here, even if D(Ask) = 4 and D(Bid) = 3, then information flows correspond to double-auction rules without traders necessarily being aware of it.

The behavior of average D(Ask) is comparatively more variable. However, barring the sixth trading period, the modal dissemination of asks corresponds to complete promulgation of asks to buyers.

Figure 5. Mean and modal dissemination of asks and bids, pooled across sessions, by trading period
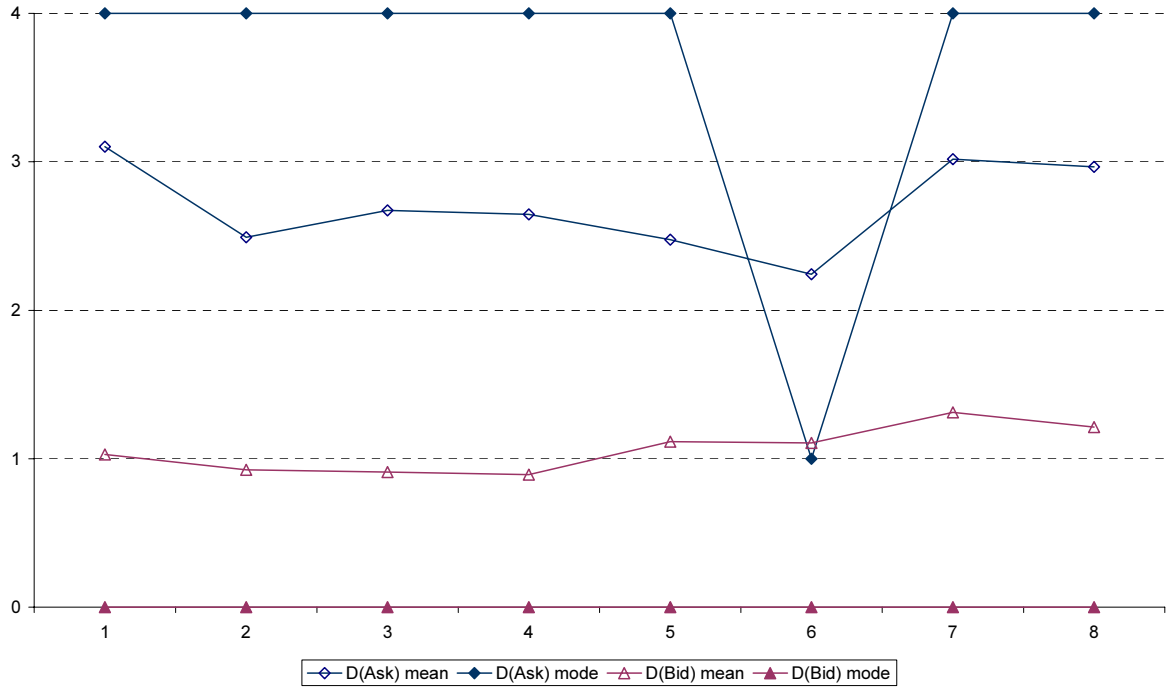
3.1.3. Level and dissemination of asks and bids

An econometric analysis will be employed in order to evaluate the relationship between the level and dissemination of asks and bids. First consider observed asks. The adopted approach is to estimate the fixed-effects panel-data model listed in equation (1):

$$(1) \quad Ask_{i,t(i)} = \alpha_i + \sum_{p=2}^{8} \delta_p T_{i,p} + \beta_2 D2_{i,t(i)} + \beta_3 D3_{i,t(i)} + \beta_4 D4_{i,t(i)} + \varepsilon_{i,t(i)}$$

The dependent variable - the level of observed asks - is indexed relative to session i, $i \in [010221J3, 010221ME, 010221OG, 010222J1]$ and observation number $t(i)$. The latter is session dependent because the number of asks varies across sessions. In particular, $\{t(010221J3), t(010221ME), t(010221OG), t(010222J1)\} = \{95, 142, 41, 165\}$. α_i is a session-specific constant term, and $T_{i,p}$ is a binary variable that in session i takes the value 1 during trading round p, $p \in \{2, 3, .. , 8\}$. The variables

D2, D3 and D4 are dummies that equal 1 when an ask has been transmitted to 2, 3 and 4 buyers, respectively. Lastly, ε is a classical disturbance term with $E[\varepsilon]=0$ and $Var[\varepsilon]=\sigma^2$, $\forall i \ \forall t$.

Table 6 lists the regression results. The estimates of the session-specific constants at the top of the table reveal marked behavioral differences across laboratory sessions. Correspondingly, the restriction of session effects is easily rejected ($F(3,439)=374.617$; p-value = 0.0000). Also, the data support statistically significant time effects during periods 2 - 4. Relative to the first trading round, asks are not markedly different from the fifth trading period onwards. After controlling for session and time effects, the regression estimates show that the degree of dissemination of asks does not affect the level of asks in a statistically significant manner.

Table 6. Level and dissemination of asks

1. Session effects							
Parameter	$\alpha_{010221J3}$		$\alpha_{010221ME}$		$\alpha_{010221OG}$		$\alpha_{010222J1}$
Estimate	689.75		440.05		382.72		673.86
P-value	0.0000		0.0000		0.0000		0.0000
2. Trading round (time) effects							
Parameter	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7	δ_8
Estimate	-51.25	-59.86	-47.43	10.60	-1.53	-12.88	-9.88
P-value	0.0010	0.0001	0.0035	0.4920	0.9211	0.4099	0.5237
3. Dissemination of ask effects							
Parameter	β_2		β_3		β_4		
Estimate	-2.07		-12.93		17.05		
P-value	0.8688		0.5490		0.1227		
Number of observations:			443	R^2:			0.75

Next, consider the relationship between the level and the dissemination of bids. The adopted approach is to estimate the model listed in equation (2). It is analogous to the one depicted in equation (1), apart from two differences. First, in this case the binary variables D1, D2 and D3 equal 1 when a bid has been broadcast to one, two or all three residual buyers, respectively. Second, the number of observations per session varies as follows: {t(010221J3), t(010221ME), t(010221OG), t(010222J1)}={742, 570, 450, 585}.

$$(2)\ Bid_{i,t(i)} = \alpha_i + \sum_{p=2}^{8} \delta_p T_{i,p} + \beta_1 D1_{i,t(i)} + \beta_2 D2_{i,t(i)} + \beta_3 D3_{i,t(i)} + \varepsilon_{i,t(i)}$$

Table 7 shows the regression estimates. The estimated session-specific constants expose considerable session heterogeneity, and the restriction of session effects can be rejected ($F(3,2343)=548.818$; p-value = 0.0000). Moreover, the estimates of the time-specific parameters reveal that during sessions bids increase relative to the initial trading periods, specifically in the fifth and sixth trading periods. Importantly, the estimates of the effects of the dissemination of bids indicate that, relative to bids that are transmitted to the seller only, buyers tend to inform other buyers about comparatively low bids. This is particularly evident with regard to bids that are completely disseminated. The highly significant point estimate of β_3 shows that fully transparent bids tend to be 69 Pfennig lower than bids that are hidden from residual buyers.

Table 7. Level and dissemination of bids

1. Session effects						
Parameter	$\alpha_{010221J3}$		$\alpha_{010221ME}$		$\alpha_{010221OG}$	$\alpha_{010222J1}$
Estimate	498.96		288.65		274.86	435.36
P-value	0.0000		0.0000		0.0000	0.0000

2. Trading round (time) effects							
Parameter	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7	δ_8
Estimate	10.03	10.66	9.39	52.73	59.19	10.21	9.02
P-value	0.2600	0.2277	0.2845	0.0000	0.0000	0.2579	0.3111

3. Dissemination of bid effects			
Parameter	β_1	β_2	β_3
Estimate	-33.08	-7.95	-69.08
P-value	0.0223	0.5323	0.0000
Number of observations:		2347 R^2:	0.48

Observation 1:

a. Single sellers specify asks that deviate positively (negatively) from the competitive theoretic (single-price monopoly) benchmark. Most asks are communicated to all buyers. There is no statistically significant correlation between the level and the degree of dissemination of asks.

b. Buyers announce bids that deviate negatively from the competitive theoretic benchmark. Close to 60% (30%) of bids are transmitted to the seller (the seller and all residual buyers). Completely disseminated bids tend to be manifestly lower than bids that are broadcast to the seller only.

3.2. Prices

Table 8 presents summary statistics on prices. The average value of accepted asks was 462 Pfennig, which is roughly equal to the mean value of accepted bids at 466 Pfennig. These values lie in the vicinity of the competitive theoretic benchmark equal to 450 Pfennig, and considerably below the single-price monopoly outcome of 650.

In total, 351 transactions occurred, 119 (232) of which stemmed from acceptances of asks (bids). Thus, accepted bids made up 66% of all prices.

Table 8. Summary statistics of prices

	Accepted asks	Accepted bids	All prices
Mean	462.38	466.14	464.87
Median	420	453	450
Standard deviation	132.63	127.65	129.19
Maximum	750	730	750
Minimum	120	200	120
No. observations	119	232	351

Time series of pooled average prices are depicted in Figure 6. The mean price appears to track the competitive level - p(CE) - quite consistently. However, a slightly surprising aspect is that the average level of accepted bids is greater than the mean accepted ask in four of the eight trading periods.

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Figure 6. Mean prices, pooled across sessions, by trading period

An econometric analysis facilitates a sharper impression of the effect of acceptance of ask versus the acceptance of bids on the level of prices. The adopted model is structurally similar to the ones depicted in equations (1)-(2) above. However, in equation (3) BID is a binary variable that equals 1 (0) in case the observed price stems from an accepted bid (ask). Also, the number of observations varies across sessions in the following manner: {t(010221J3), t(010221ME), t(010221OG), t(010222J1)}={83, 96, 88, 84}.

$$(3) \; Price_{i,t(i)} = \alpha_i + \sum_{p=2}^{8} \delta_p T_{i,p} + \beta BID_{i,t(i)} + \varepsilon_{i,t(i)}$$

The regression results are outlined in Table 9. The estimated session effects indicate marked differences in price levels across sessions, and the restriction of session effects is again rejected, (F(3,347)=215.5; p-value = 0.0000). The estimated time-specific effects primarily show that prices increased notably during the sixth and seventh trading periods.

However, after controlling for such effects, the estimate of β reveals that acceptance of bids imply significantly lower price levels than acceptances of asks.

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Table 9. Prices and acceptance of asks or bids

1. Session effects

Parameter	$\alpha_{010221J3}$	$\alpha_{010221ME}$	$\alpha_{010221OG}$	$\alpha_{010222J1}$
Estimate	614.81	402.19	353.17	553.81
P-value	0.0000	0.0000	0.0000	0.0000

2. Trading round (time) effects

Parameter	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7	δ_8
Estimate	-5.80	-4.93	-8.47	37.11	36.54	8.72	-0.97
P-value	0.7157	0.7602	0.5946	0.0227	0.0245	0.5757	0.9507

3. Effect of acceptance of bids

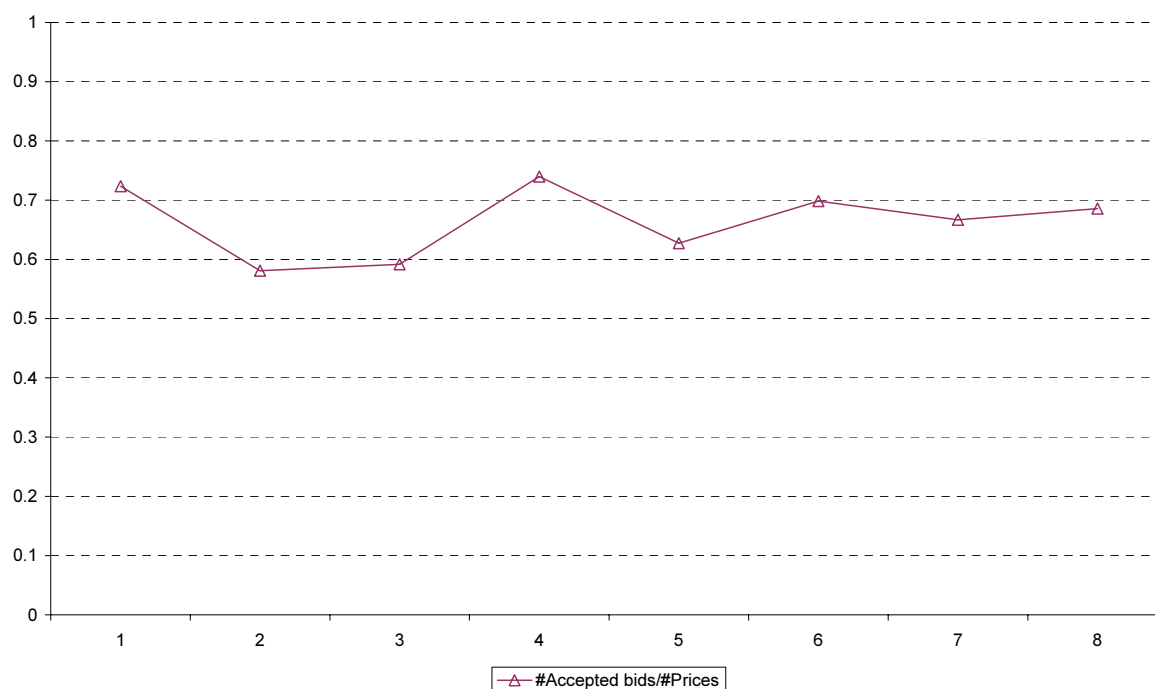| Parameter	β		
Estimate	-28.57		
P-value	0.0019		
P-value	0.0223	0.5323	0.0000
Number of observations:	351	R^2:	0.68

Now reconsider the number of accepted bids relative to the total quantity of prices. Time series of this ratio is depicted in Figure 9. A visual impression is that it, initially, oscillates between 60% and 70% and gradually converges towards 70% during the last trading periods.

The following regression analysis purports to evaluate how the ratio of accepted bids/number of prices depends upon the level of specified bids, the dissemination of bids, and the absolute number of bids relative to the quantity of asks. The adopted model is listed in equation (4). The observations of each variable is indexed relative to session i (i∈{010221J3, 010221ME, 010221OG, 010222J1}) and trading period t (t∈{1,2, .. , 8}).

$$(4) \quad \left(\# \, Accepted \; bids / \# \, Pr \, ices \right)_{i,t} = \alpha_i + \beta_1 BID_{i,t} + \beta_2 D(BID)_{i,t} + \beta_3 \left(\# \, BIDS / \# \, ASKS \right)_{i,t} + \varepsilon_{i,t}$$

Here the dependent variable simply measures the number of accepted bids relative to the quantity of prices. The variables BID and D(BID) denote the average bid and the average dissemination of bids, respectively. The third right-hand side variable measures the number of bids relative to the number of asks. Period-specific effects are excluded from the model. The rationale is that the restriction of these effects cannot be rejected at conventional levels of statistical significance ($F_{(7, 18)}=0.576$; p-value = 0.7664).

Figure 7. Number of accepted bids/number of prices, pooled across sessions, by trading period

The regression results are outlined in Table 10. The estimates of parameters β_1 and β_3 indicate that an increase in average bid levels, as well as the number of bids relative to the number of asks, exerts a significant and positive effect on the relative size of accepted bids. The estimate of β_2 reveals that a similar consequence derives from an increase in the average dissemination of bids.

Table 10. Ratio of accepted bids

1. Session effects					
Parameter	$\alpha_{010221J3}$	$\alpha_{010221ME}$	$\alpha_{010221OG}$	$\alpha_{010222J1}$	
Estimate	-3.77	-3.39	-3.52	-3.38	
P-value	0.0000	0.0000	0.0000	0.0000	
2. Effects of bid level, bid dissemination and ratio of number of bids/number of asks					
Parameter	β_1		β_2		β_3
Estimate	0.0015		0.3187		3.8742
P-value	0.0190		0.0122		0.0000
Number of observations:		32	R^2:		0.78

Observation 2:

a. The mean and median levels of prices are essentially consistent with the competitive theoretic equilibrium benchmark. However, prices that stem from acceptances of bids are significantly lower than accepted asks.

b. Accepted bids constitute two-thirds of all prices. The relative magnitude of accepted bids varies positively and statistically significantly with the level of bids, the dissemination of bids to residual buyers, and the number of bids relative to the quantity of asks.
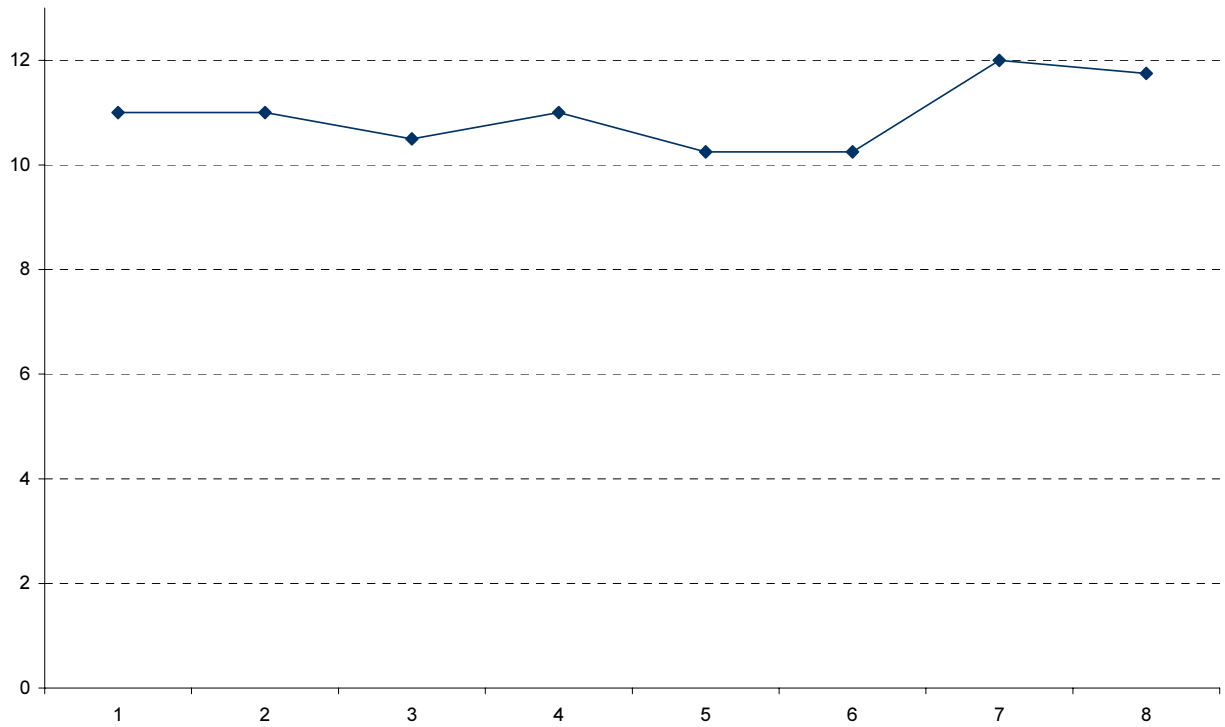
3.3. Trading volume

Summary statistics of periodic trading volume across the four sessions are depicted in Table 11. Both the modal and the median quantity are consistent with the competitive theoretic benchmark of 12 units. The average trading volume is lower at approximately 11 units, but it is still considerably above the single-price monopoly outcome equal to eight contracts per period.

Table 11. Summary statistics of trading volume

Mean	10.97
Median	12
Mode	12
Standard deviation	1.45
Maximum	12
Minimum	8
No. observations	32

A time series of the average number of contracts, pooled across sessions, is shown in Figure 8. A visual impression is that, halfway through the sessions, the mean trading volume first declines from the global average towards 10 units and then increases towards the competitive equilibrium level.

Figure 8. Trading volume, pooled across sessions, by trading period

Now consider the possible impact of session and period effects on observed trading volume. This is evaluated by means of the following econometric model:

$$(5)\ Trading\ volume_{i,t} = \alpha_i + \sum_{t=2}^{8} \delta_t T_t + \varepsilon_{i,t}$$

Here trading volume is indexed relative to session i and trading period t, whereas α_i denotes session specific constants and T_t is a binary variable that equals 1 in trading period t.

Table 12 shows the regression results. The immediate impression is that time effects are miniscule as well as dominated by session effects.

Moreover, neither the restriction of time effects (($F_{(7,21)}=0.875$, P-value = 0.5417) nor the restriction of session effects (($F_{(3,28)} = 2.356$, P-value = 0.0936) can be rejected at conventional levels of statistical significance.

Table 12. Trading volume and session/period effects

1. Session effects

Parameter	$\alpha_{010221J3}$	$\alpha_{010221ME}$	$\alpha_{010221OG}$	$\alpha_{010222J1}$
Estimate	10.41	12.03	11.03	10.53
P-value	0.0000	0.0000	0.0000	0.0000

2. Trading round (time) effects

Parameter	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7	δ_8
Estimate	0.0	-0.5	0.0	-0.75	-0.75	1.0	0.75
P-value	1.0000	0.6136	1.0000	0.4503	0.4503	0.3162	0.4503

Number of observations: 32 R^2:   0.38

Observation 3:

a. The modal and median trading volume is consistent with the competitive theoretic benchmark.

b. Observed trading volume does not vary in a statistically significant manner across neither sessions nor trading periods.

4. Concluding remarks

The double-auction trading institution implies complete dissemination of market information because each offer to buy or sell is public knowledge. Kirchsteiger et al. (KNP) (1998) showed that traders who choose the extent of dissemination of offers typically elect to inform the other side of the market, but none of their competitors. The experiments reported here implement a largely similar trading process, but differs from KNP by applying it to an asymmetric market environment characterized by a single-seller and four identical buyers. The principal result is that incomplete diffusion of trading information obtains. Neither sellers nor buyers consistently inform each residual trader about offers. Nevertheless, the modal behavior of sellers is to disseminate offers to sell to all buyers. This is in line with KNP's result. On the other hand, the buyers' performance is dichotomous in as much as they tend to inform either none or all of the residual buyers about offers to buy. Thus, in these experiments comparatively more competitors are informed than in KNP's case.

A second finding is that buyers - on average - succeed in abating the monopolists' market power. Specifically, the number of bids outweigh the quantity of asks, bids tend to be lower than asks and, more importantly, lower bids are more widely disseminated in the market. One reading of this pattern is that buyers attempt to collude against the seller. By spreading information on low bids, chances increase

that the buyers develop a shared perception of "acceptable" prices and consequently refuse to accept higher offers to sell from the monopolist. Lastly, the results reveal that buyers' bids do, in fact, influence price formation in two ways. First, accepted bids make up roughly two-thirds of all prices and, second, an accepted bid tends to be lower than an accepted ask. In addition, mean price levels and the number of contracts appear to be consistent with the competitive theoretic benchmark. Thus, neither the single-price monopoly outcome nor the implicit assumption that the monopolist dictates terms of trade is corroborated.

In summary, buyers in these experiments engage in a different type of counterspeculation compared to double-auction monopoly experiments, but they are nevertheless successful in terms of hindering prices and quantity from deviating systematically from the competitive equilibrium. Specifically, the experiments reported here indicate that complete diffusion of trading information is not a necessary condition for the ability of buyers to diminish monopoly power.

References

Davis, D. and C. Holt (1993): *Experimental economics*. Princeton University Press.

Friedman, D. (1994): The Double Auction Market Institution: A Survey, in Friedman and Rust (eds.): *The Double Auction Market*, Addison-Wesley, 3-25.

Friedman, D. and S. Sunder (1994): *Experimental Methods. A Primer for Economists*. Cambridge University Press.

Holt, C. (1995): Industrial Organization: A Survey of Laboratory Research, in Kagel and Roth (eds.): *Handbook of Experimental Economics*, Princeton University Press, 349-444.

Kirchsteiger, G., M. Niederle, and J. Potters (2001): Public versus Private Exchanges. Working paper, http://mailbox.univie.ac.at/~kirchsg8

Ledyard, J.O. and K. Szakaly-Moore (1994): Designing organizations for trading pollution rights, *Journal of Economic Behavior and Organization* **25** (2), 167-96.

Plott, Charles R. (1988): An updated review of industrial organization: Applications of experimental methods in Schmalensee and Willig (eds.): Handbook of Industrial Organization **2**, Elsevier.

Smith, V.L. (1981): "An Empirical Study of Decentralized Institutions of Monopoly Restraint" in J. Quirk and G. Horwich (eds.), *Essays in Contemporary Fields of Economics in honor of E.T. Weiler (1914-1979)*, West Lafayette: Purdue University Press, 83-106.

Smith, V.L. (1982): Microeconomic Systems as an Experimental Science, *American Economic Review* **72**, 923-955.

Smith, V.L. and A.W. Williams (1990): "The Boundaries of Competitive Price Theory: Convergence, Expectations, and Transactions Costs", in L. Green and J. Kagel (eds.), *Advances in Behavioral Economics, Vol. 2*, Norwood, New Jersey, 31-53.

Tirole, Jean (1988): The Theory of Industrial Organization, The MIT Press, Cambridge, Massachusetts.

Appendix

Instructions (buyers)

A.1. General

You are about to participate in an experiment in which you will have an opportunity to earn money. The experiment is estimated to last approximately 90 minutes. The money that you earn is tax-free and will be paid to you in cash immediately after the end of the experiment. The size of the payment depends upon the decisions you make during the experiment.

The plan for the experiment is as follows:

1. Read these instructions carefully. Try to finish reading within 40 minutes from now. If you have any questions, please be so kind as to raise your hand and the experimenter will assist you. *You are not allowed to speak to any of the other participants during this experiment.*

2. When everyone has finished reading the instructions you will practice your role in the experiment. You do not earn any money during this training session.

3. After the training session you will <u>participate in 8 experimental trading periods</u>. Your final payment equals the sum of your profits in these 8 trading periods plus a show-up fee equal to 10 DM.

A.2. Your trading role

In this experiment you are going to be a <u>buyer</u> of a fictitious good on a computerized market.

Apart from you there are 3 other buyers and 1 seller on this market.

In the experiment the buyers are called Buyer 1, Buyer 2, Buyer 3 and Buyer 4.

(Your buyer identity (number) will be shown on your computer screen.)

A.3. The computer screen

This is what the computer screen looks like:

Trading period

1 of 8

Remaining time [sec]: 300

You are Buyer 4

Demand function

Unit	1	2	3	4
Value	100	95	90	85

Market trading volume: 0   Trading volume: 0   Profit: 0

Price

My bids | Receiver

Bids from other buyers | Sender

Specify bid price:

Choose receivers of bid:
- Seller
- Buyer 1
- Buyer 2
- Buyer 3
- Buyer 4

Send bid

Asks

Accept ask

Trading period	Profit	Trading volume	Market trading volume	Average price
1	0	0	0	0

At the very top of the screen you see which trading period you are currently in, as well as how much time is left (in seconds) of the trading period.

Each trading period lasts 300 seconds.

Your buyer identity (number) is shown near the top of your computer screen.

The following pages contain information about each part of the screen and explain your role in the experiment, bit by bit.

A.4. Demand function and trade information

Your **demand function** for the good is shown <u>numerically</u> on your computer screen. This function describes how many units you can buy and the value associated with the buying of each unit.

You may buy one unit at a time, starting with unit 1 in your demand function. At most you can buy 4 units. <u>Your profit from a purchase equals the value of the unit you buy minus the price you pay for it</u>.

<u>Example</u>: If you purchase the first unit for a price equal to 50, your profit from this purchase becomes (100 minus 50 =) 50. If the second unit is bought for a price equal to 60, your profit in that case is (95 minus 60 =) 35. Therefore the combined profit from buying these two units becomes 50 + 35 = 85. Note that the demand function shown in the picture below, and used in this example, is different from the one you will see during the real experiment.

Demand function				
Unit	1	2	3	4
Value	100	95	90	85

Market trading volume: 0	Trading volume: 0	Profit: 0

Price

- **Market trading volume** counts the number of purchases made by all buyers (including yourself) in the current trading period.

- **Trading volume** shows how many units you have bought in the current trading period.

- **Profit** measures how much you have earned in the current trading period.

- **Price** lists the price of each purchase you have conducted in the current period (chronologically).

A.5. Trading rules
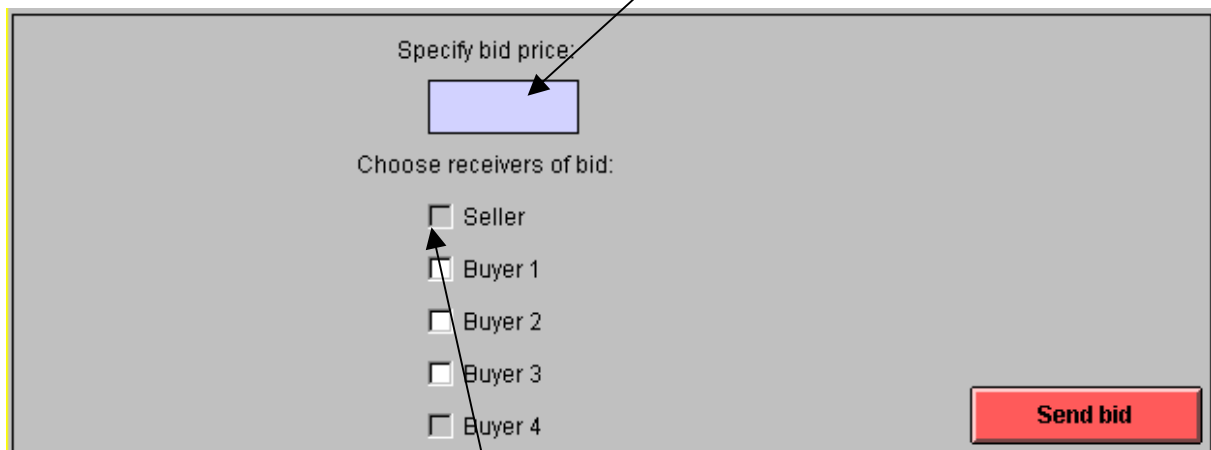
You can buy units of the good in two ways:

I. You make an offer to buy that the seller accepts, and/or

II. The seller makes an offer to sell that you accept.

Now we explain these trading rules in detail:

I. You can make an offer to buy, the seller accepts

Offers to buy are called **bids** and specify the price that you are willing to pay for a unit.

To make a bid you move the cursor with your mouse to the field below "Specify bid price". Here you enter the price at which you want to buy a unit.

Then you have to choose receivers of your bid. The seller automatically receives your bid. This is indicated in the box by a marked checkbox. But you can also choose to inform one or more of the other buyers about the bid.

In this example you are Buyer 4. Therefore your checkbox is already marked. This means that you could choose to inform Buyer 1 and/or Buyer 2 and/or Buyer 3 about your bid. To do this you must move the cursor to the checkbox in front of the chosen buyer(s) and mark them by clicking the left button on the mouse.

After you are finished choosing receivers of the bid, you need to move the cursor to the "Send bid" button. Press the left button on the mouse in order to send your bid.

The seller then gets to see your bid, as well as your buyer number, on his computer screen. The other buyers chosen to receive the bid also see the bid on their computer screens. They are also informed that you sent the bid.

A transaction takes place if the seller accepts your bid.

You can formulate more than just one bid for a unit. Each bid you send - and who received it - is shown on your computer screen in the "My bids Receiver" box.

If the seller accepts a bid from you, this bid disappears from your, the seller's and the informed buyer(s)' computer screens. Any other bids sent by you are also then cancelled and are no longer visible on the computer screens.

Any bid you specify has to be lower than the value of the unit you want to buy.
Example: If the value of the unit you want to buy is 100, you have to offer to pay less than 100 in order to make a profit.

| My bids	Receiver

Bids from other buyers	Sender
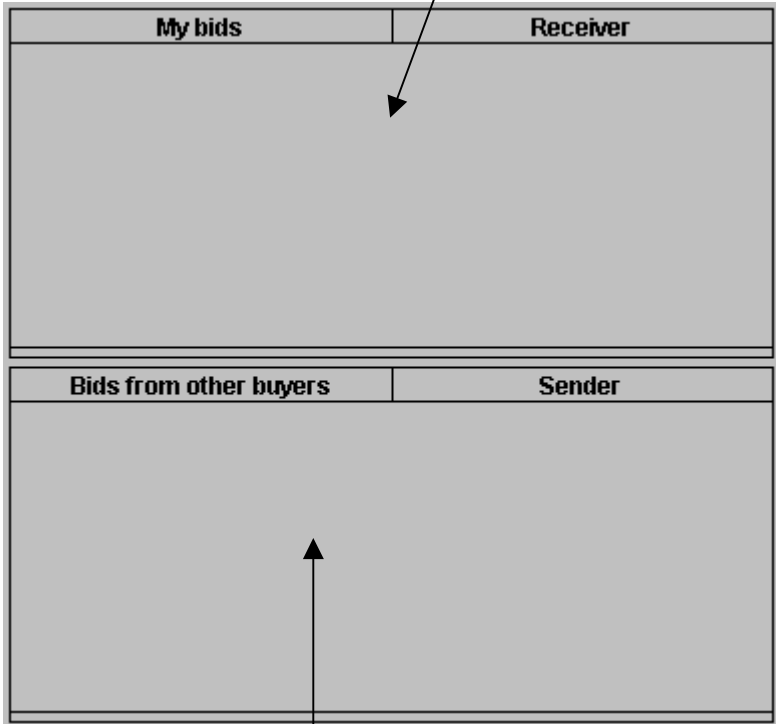
The bids that the other buyers have sent to the seller, but additionally have chosen to inform you about, are listed in the "Bids from other buyers | Sender" box. Here you can also see which of the other buyer(s) has sent bids to you.

II. The seller makes an offer to sell, you accept

Offers to sell are called **asks**. An ask specifies the price for which the seller wants to sell a unit.

The seller chooses which buyers are going to be informed about his ask. If you have been selected as a receiver of an ask, you are going to see this offer to sell in the "Asks" box on your computer screen.
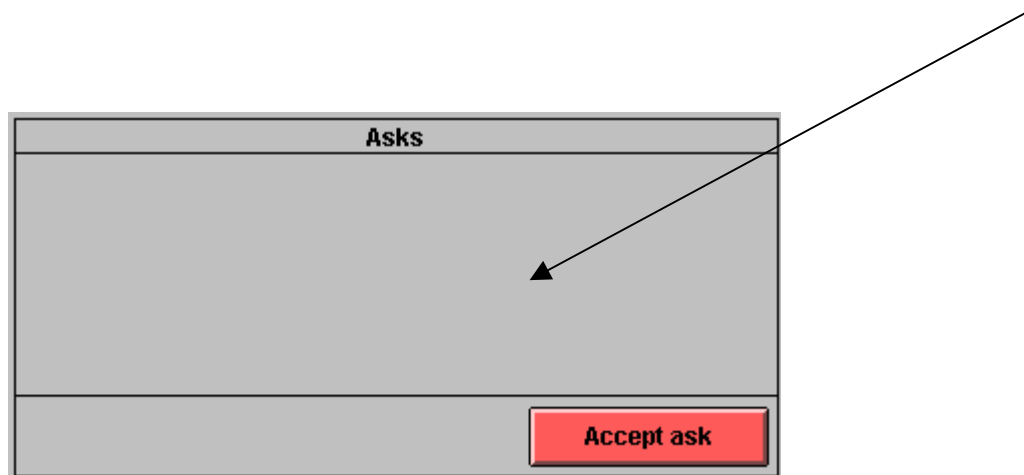
A transaction occurs if you choose to accept an ask.

To accept an ask you first have to use your mouse to move the cursor to the ask you want to accept.
Then click the left button on your mouse to highlight that ask.
Finally move the cursor to the "Accept ask" button and press it.

If you accept an ask, any bid you have sent to the seller and any of the other buyers is automatically cancelled and disappears from both your and the others' computer screens.

A.6. Trading history

At the bottom of your computer screen there is a box that contains information from previous trading periods.

Trading period	Profit	Trading volume	Market trading volume	Average price
1	0	0	0	0

The first column shows which trading period the provided information relates to.

The second column shows the profit you made.

The third column (Trading volume) shows how many units you bought.

Market trading volume shows how many units all buyers (including yourself) bought.

The fifth column lists the average price of your purchases.

Example: In trading period 4 you see information on these variables from trading periods 1, 2 and 3.

A.7. Profit and payment

The values in your demand function, all prices and profits in the 8 experimental trading periods are nominated in German Pfennig. Your aggregate profit in Deutsche Mark is automatically calculated by your computer and updated after each trading period.

Before the experiment ends you have to complete a questionnaire in which you are asked to write your name and address. Then your aggregated profit (including a show-up fee equal to 10 DM) is displayed on your computer screen only. Afterwards you will be paid this amount in cash by the experimenter.

Please raise your hand if you have any questions. Otherwise please wait until the experiment continues.

Erklärungen (Kaufer)

A.1. Einleitung

Sie nehmen nun an ein Experiment teil. In diesem Experiment können Sie Geld verdienen. Das Experiment wird etwa 90 Minuten dauern. Das Geld, das Sie verdienen, ist steuerfrei und wird an Sie unmittelbar am Ende des Experimentes in bar an Sie ausbezahlt. Wie viel Sie verdienen, hängt von Ihren Entscheidungen während des Experimentes ab.

Das Experiment wird vom "Ingegerd und Arne Skaug" Forschungsfonds, Norwegen, finanziert.

Der Ablauf des Experimentes ist, wie folgt:

1. Studieren Sie diese Erklärungen sorgfältig. Versuchen Sie bitte, die Erklärungen innerhalb von 40 Minuten zu lesen. Wenn Sie Fragen haben, heben Sie bitte die Hand. Der Experimentator wird dann zu Ihnen kommen. *Während dieses Experimentes ist es nicht gestattet, mit anderen Experimentteilnehmern zu reden.*

2. Nachdem alle die Erklärungen gelesen haben, werden Sie Ihre Rolle in einem Probeexperiment üben. Während des Probeexperimentes können Sie noch kein Geld verdienen.

3. Nach dem Probeexperiment werden Sie in 8 experimentellen Handelsperioden in einem Markt teilnehmen. Ihre abschließende Auszahlung entspricht der Summe Ihrer Gewinne in diesen 8 Handelsperioden zuzüglich den 10 DM für Ihr pünktliches Erscheinen.

A.2. Ihre Rolle im Markt

In diesem Experiment sind Sie ein Käufer von einem fiktiven Gut auf einem computerisierten Markt.

Außer Ihnen gibt es noch 3 Käufer und 1 Verkäufer auf dem Markt.

Im Experiment werden die Käufer "Buyer 1", "Buyer 2", "Buyer 3" und "Buyer 4" genannt.

(Ihr Käuferkennzeichen (Nummer) wird am Computerbildschirm angezeigt.)

A.3. Der Computerbildschirm

So sieht der Bildschirm während einer Handelsperiode aus:

Ganz oben am Schirm sehen Sie, in welcher Handelsperiode (Trading period) Sie jetzt sind, und wie viel Zeit (in Sekunden) in dieser Periode noch bleibt.

Jede Handelsperiode dauert 300 Sekunden.

Ihr Käuferkennzeichen (Nummer) wird oben am Schirm gezeigt.

Auf den nächsten Seiten erhalten Sie Information über jeden Bereich des Bildschirms, und wir erklären schrittweise Ihre Rolle im Experiment.

A.4. Nachfragefunktion (Demand function) und Information zum Handel

Ihre **Nachfragefrunktion** nach dem Gut ist in Zahlen auf dem Bildschirm angegeben. Diese Funktion erklärt, wie viele Einheiten des Gutes Sie kaufen können, und welcher Wert (Value) für jede Einheit (Unit) des Gutes für Sie mit dem Kauf verbunden ist.

Sie können Ihre Einheiten nur eine nach der anderen kaufen und fangen dabei mit der Einheit Nummer 1 in Ihrer Nachfragefunktion an. Sie können insgesamt nicht mehr als 4 Einheiten kaufen. Der Gewinn, den Sie mit einer Transaktion machen, entspricht der Differenz zwischen dem Wert der aktuellen Einheit und dem Preis, den Sie für diese Einheit bezahlen.

Beispiel: Wenn Sie die erste Einheit für einen Preis von 50 kaufen, würde Ihr Profit aus dieser Transaktion (100 abzüglich 50 =) 50 sein. Kaufen Sie die zweite Einheit für einen Preis von 60, würde der Profit (95 abzüglich 60 =) 35 sein. Folglich würde der gesamte Profit aus dem Kauf dieser 2 Einheiten 50 + 35 = 85 betragen.
Beachten Sie bitte, dass sich die hier im Beispiel gezeigte Nachfragefunktion von Ihrer Nachfragefunktion im wirklichen Experiment unterscheidet.

Demand function

Unit	1	2	3	4
Value	100	95	90	85

Market trading volume: 0   Trading volume: 0   Profit: 0

Price

- **Market trading volume** (Transaktionsvolumen am Markt) zeigt die Menge der insgesamt gekauften Einheiten (einschließlich der von Ihnen gekauften Einheiten) während der aktuellen Periode an.

- **Trading volume** (Transaktionsvolumen) zeigt wie viele Einheiten Sie persönlich in der aktuellen Periode gekauft haben.

- **Profit** (Gewinn) misst, wie viel Sie in der aktuellen Periode verdient haben.

- **Price** (Preis) zeigt den Preis für jeden Kauf, den Sie in der aktuellen Periode getätigt haben (chronologisch).

A.5. Handelsregeln

Sie können auf 2 unterschiedliche Arten Einheiten kaufen:

I.   Sie machen ein Kaufangebot, das der Verkäufer annimmt, und/oder

II.   Der Verkäufer macht ein Verkaufsangebot, das Sie annehmen.

Im folgenden erklären wir diese Handelsregeln näher:

I. Sie machen ein Kaufangebot, das der Verkäufer annimmt

Kaufangebote werden "**bids**" genannt, und spezifizieren, zu welchem Preis Sie bereit sind, die Einheit zu kaufen.

Um ein Angebot (bid) zu machen, bewegen Sie der Cursor mit der Maus zum Feld unter "Specify bid price". Hier tragen Sie den Preis ein, zu dem Sie die Einheit kaufen wollen.

Danach müssen Sie die Empfänger für Ihr bid auswählen. Der Verkäufer erhält Ihr bid automatisch. Dies wird mit einem markierten Kästchen im obigen Feld angezeigt. Sie können darüber hinaus auch einen oder mehrere andere Käufer auswählen, um Sie über Ihr bid zu informieren.

In diesem Beispiel sind Sie Käufer 4 (Buyer 4). Folglich ist Ihr Kästchen schon markiert. Also können Sie noch Buyer 1, Buyer 2 und/oder Buyer 3 über Ihr bid informieren. Um das zu tun, bewegen Sie den Cursor zum Kästchen eines Käufers und markieren es durch ein Drücken auf die linke Maustaste.


Wenn Sie mit der Auswahl der Empfänger für Ihr bid fertig sind, bewegen Sie den Cursor zum "Send bid" Knopf. Drücken Sie mit der linken Maustaste auf diesen Knopf, um das bid abzusenden.

Der Verkäufer wird in der Folge Ihr Angebot und Ihr Käufernummer auf seinem Bildschirm sehen. Die Käufer, die Sie ausgewählt haben, über Ihr bid informiert zu werden, werden ebenfalls das Angebot auf ihren Bildschirmen sehen. Diese Käufer werden auch darüber informiert, dass das Angebot von Ihnen stammt. Eine Transaktion entsteht, wenn der Verkäufer Ihr Angebot annimmt.

Sie können mehr als nur ein Angebot für eine Einheit machen. Jedes von Ihnen abgesendete Angebot und die Information, zu wem es geschickt worden ist, wird auf Ihrem Schirm im Feld "My bids | Receiver" angezeigt.

Wenn der Verkäufer ein Angebot von Ihnen annimmt, wird dieses Angebot in den Anzeigen auf Ihrem, jenem des Verkäufers sowie den Bildschirmen der von Ihnen informierten Käufer gelöscht. Auch alle anderen von Ihnen abgeschickten Angebote werden gelöscht und sind nicht mehr am Bildschirm zu sehen.

Jedes Ihrer Angebote muss niedriger als der Wert der Einheit sein, die Sie zu kaufen wünschen. Beispiel: Bei einem Wert von 100 für die Einheit, die Sie kaufen wollen, müssen Ihre Angebote unter 100 liegen, um einen Gewinn zu machen.

My bids	Receiver

| Bids from other buyers	Sender
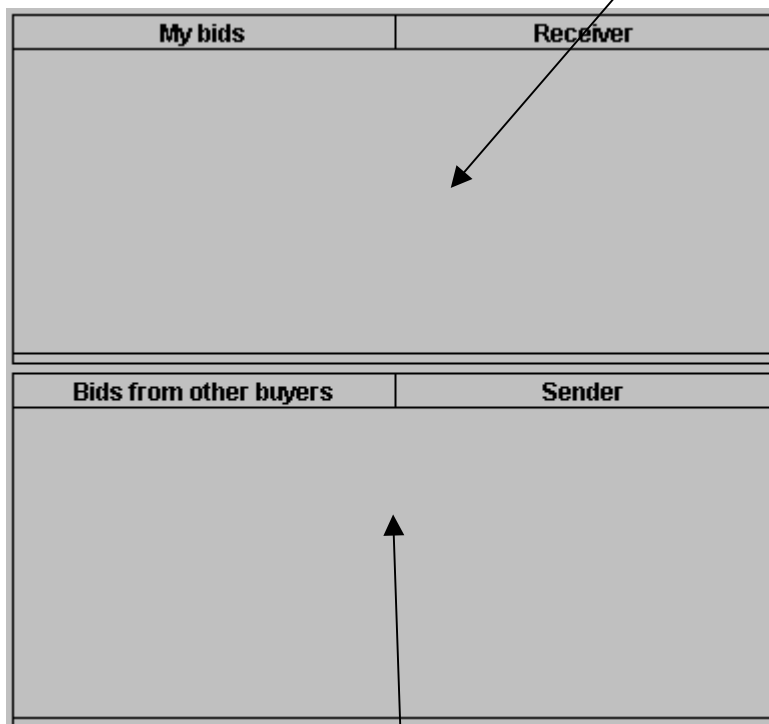
Auch die anderen Käufer schicken ihre bids an den Verkäufer. Wenn Sie von einem dieser Käufer ausgewählt wurden, über ein bid informiert zu werden, wird Ihnen das im Feld "Bids from other

buyers | Sender" angezeigt. Hier können Sie darüber hinaus sehen, welcher der anderen Käufer ein bid an Sie geschickt hat.

II. Der Verkäufer macht ein Verkaufsangebot, das Sie annehmen

Verkaufsangebote werden **"asks"** genannt. Ein ask spezifiziert, zu welchem Preis der Verkäufer bereit ist, die Einheit zu verkaufen.

Der Verkäufer wählt, welche Käufer über seine asks informiert werden sollen. Werden Sie vom Verkäufer ausgewählt, ein ask zu erhalten, werden Sie dieses Verkaufsangebot im Feld "Asks" auf Ihrem Bildschirm sehen.
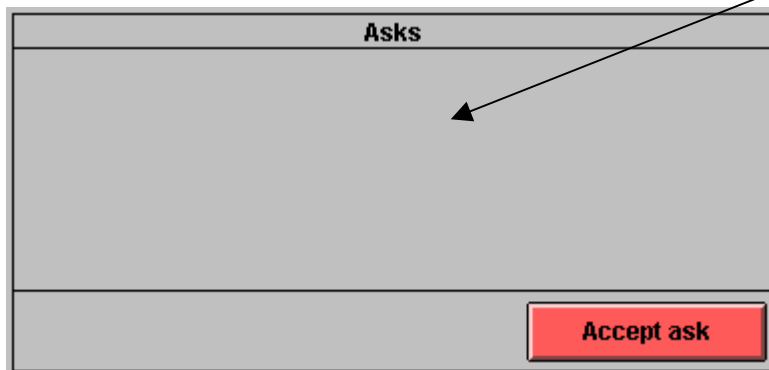
Eine Transaktion entsteht, wenn Sie ein ask annehmen.

Um ein ask anzunehmen, bewegen Sie den Cursor mit Ihrem Maus zu dem ask das Sie annehmen wollen.
Markieren Sie dann das ask mit der linken Maustaste.
Bewegen Sie schließlich den Cursor über den Knopf "Accept ask" und drücken Sie die linke Maustaste, um das Angebot zu akzeptieren.

Wenn Sie ein ask annehmen und damit eine Einheit kaufen, werden neben dem ask auch alle von Ihnen an den Verkäufer und an andere Käufer geschickten Angebote (bids) automatisch gelöscht und sind nicht mehr auf den Bildschirmen zu sehen.

A.6. Überblick über vorangehende Handelsperioden

Am unteren Bildschirmrand befindet sich ein Feld, das Informationen über die vorangehenden Handelsperioden enthält.

Trading period	Profit	Trading volume	Market trading volume	Average price
1	0	0	0	0

Die erste Spalte zeigt für welche Periode die Informationen gelten.

Die zweite Spalte (Profit) zeigt Ihre Gewinne in dieser Periode.

Die dritte Spalte (Trading volume) zeigt wie viele Einheiten Sie in dieser Periode gekauft haben.

"Market trading volume" zeigt wie viele Einheiten alle Käufer (Sie eingeschlossen) gekauft haben.

Die fünfte Spalte zeigt den durchschnittlichen Preis Ihrer Käufe.

Beispiel: In Handelsperiode 4 sehen Sie Information über diese Variablen von Periode 1, 2 und 3.

A.7. Gewinn und Auszahlung

Die Werte Ihrer Nachfragefunktion, alle Preise und Gewinne der 8 Handelsperioden sind in Pfennigen ausgedrückt. Ihr Gesamtgewinn in Deutschen Mark wird automatisch vom Computer berechnet und nach jeder Handelsperiode aktualisiert.

Am Ende des Experimentes werden Sie einen computerisierten Fragebogen beantworten. Darin bitten wir Sie, Ihren Namen und Ihre Adresse anzugeben. Dann wird Ihr Gesamtgewinn (einschließlich der 10 DM, die Sie auf alle Fälle erhalten) auf Ihrem Bildschirm angezeigt. Gleich im Anschluss bekommen Sie dieses Geld in bar vom Experimentator ausbezahlt.

Falls Sie nun Fragen haben, heben Sie bitte die Hand. Ansonsten warten Sie bitte ruhig, bis das Experiment beginnt.

Instructions (seller)

A.1. General

You are about to participate in an experiment in which you will have an opportunity to earn money. The experiment is estimated to last approximately 90 minutes. The money that you earn is tax-free and will be paid to you in cash immediately after the end of the experiment. The size of the payment depends upon the decisions you make during the experiment.

Ingegerd and Arne Skaug's Research Fund, Norway has provided funding for this experiment.

The plan for the experiment is as follows:

4. Read these instructions carefully. Try to finish reading within 40 minutes from now. If you have any questions, please be so kind as to raise your hand and the experimenter will assist you. *You are not allowed to speak to any of the other participants during this experiment.*

5. When everyone has finished reading the instructions you will practice your role in the experiment. You do not earn any money during this training session.

6. After the training session you will <u>participate in 8 experimental trading periods</u>. Your final payment equals the sum of your profits in these 8 trading periods plus a show-up fee equal to 10 DM.

A.2. Your trading role

In this experiment you are going to be a <u>seller</u> of a fictitious good on a computerized market.

Apart from you there are 4 buyers on this market.

In the experiment the buyers are called Buyer 1, Buyer 2, Buyer 3 and Buyer 4.

A.3. The computer screen

This is what the computer screen looks like:

At the very top of the screen you see which trading period you are currently in, as well as how much time is left (in seconds) of the trading period.

Each trading period lasts 300 seconds.

The following pages contain information about each part of the screen and explain your role in the experiment, bit by bit.

A.4. Supply function and trade information

Your **supply function** for the good is shown <u>numerically</u> on your computer screen. This function describes how many units you can sell and the cost associated with the selling of each unit.

You may sell one unit at a time, starting with unit 1 in your supply function. At most you can sell 16 units. <u>Your profit from a sale equals the price minus the cost of the unit you sell.</u>

<u>Example</u>: If you sell the first unit for a price equal to 75, your profit from this sale becomes (75 minus 10 =) 65. If the second unit is sold for a price equal to 50, your profit in that case is (50 minus 15 =) 35. Therefore the combined profit from selling these two units becomes 65 + 35 = 100.

Note that the supply function shown in the picture below and used in this example is different from the one you will see during the real experiment.

Supply function																
Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cost	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85

Trading volume:	0	Profit:	0

Price	Traded with

- **Trading volume** shows how many units you have sold in the current trading period.

- **Profit** measures how much you have earned in the current trading period.

- **Price** and **Traded with** lists the price of each sale in the current period (chronologically) as well as the name of the buyer (Buyer 1 or Buyer 2 or Buyer 3 or Buyer 4) that bought the listed unit.

A.5. Trading rules
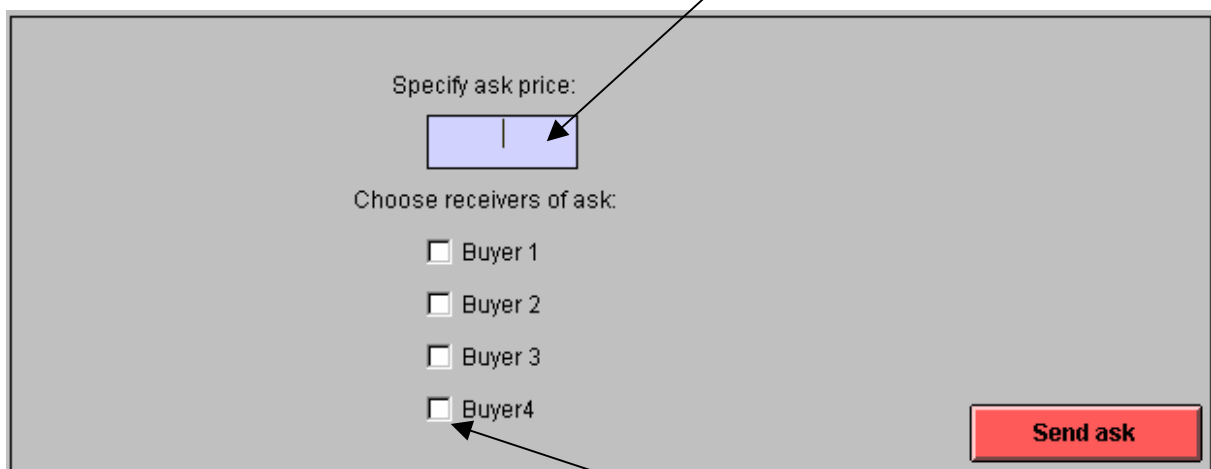
You can sell units of the good in two ways:
I.   You make an offer to sell that one of the buyers accepts, and/or
II.   A buyer makes an offer to buy that you accept.

Now we explain these trading rules in detail:

I. You can make an offer to sell, one of the buyers accepts
Offers to sell are called **asks** and specify the price you want to sell a unit for.

To make an ask you move the cursor with your mouse to the field below "Specify ask price". Here you
enter the price at which you want to sell a unit.

Afterwards you have to decide which buyer(s) that are going to receive your ask. If, say, Buyer 4 is to
be informed about your ask, you must move the cursor to the checkbox in front of that buyer's name
and click the left button on the mouse. You have to inform at least one buyer. After you have finished
choosing receivers of the ask, move the cursor to the "Send ask" button. Press the left button on the
mouse in order to send your ask.

The chosen buyer(s) then get to see your offer on his (their) computer screen(s). A transaction takes
place if a buyer accepts your ask.

You can formulate more than just one ask for a unit. Each ask you send - and to whom - is shown on
your computer screen in the "Asks Receiver" box (see next page).

If a buyer accepts an ask from you, the ask disappears from your computer screen and the computer
screen(s) of the buyer(s) who were informed about your ask. Any other asks are also then cancelled
and are no longer visible on your and the informed buyer(s)' computer screens.

Any ask you specify has to be higher than the cost of the unit you want to sell.
Example: If you want to sell a unit with cost equal to 10, you have to offer to sell the unit at more than
10 in order to make a profit.

II. The buyers make offers to buy, you accept one such offer to buy

Offers to buy are called **bids** and specify the price a buyer wants to purchase a unit for.

A bid from any one buyer, and who sent the bid (Buyer 1 or Buyer 2 or Buyer 3 or Buyer 4), can be seen in the "Bids Sender" box on your computer screen. (If a buyer has also chosen to inform one or more other buyers about his bid, they see this bid on their computer screens as well.)
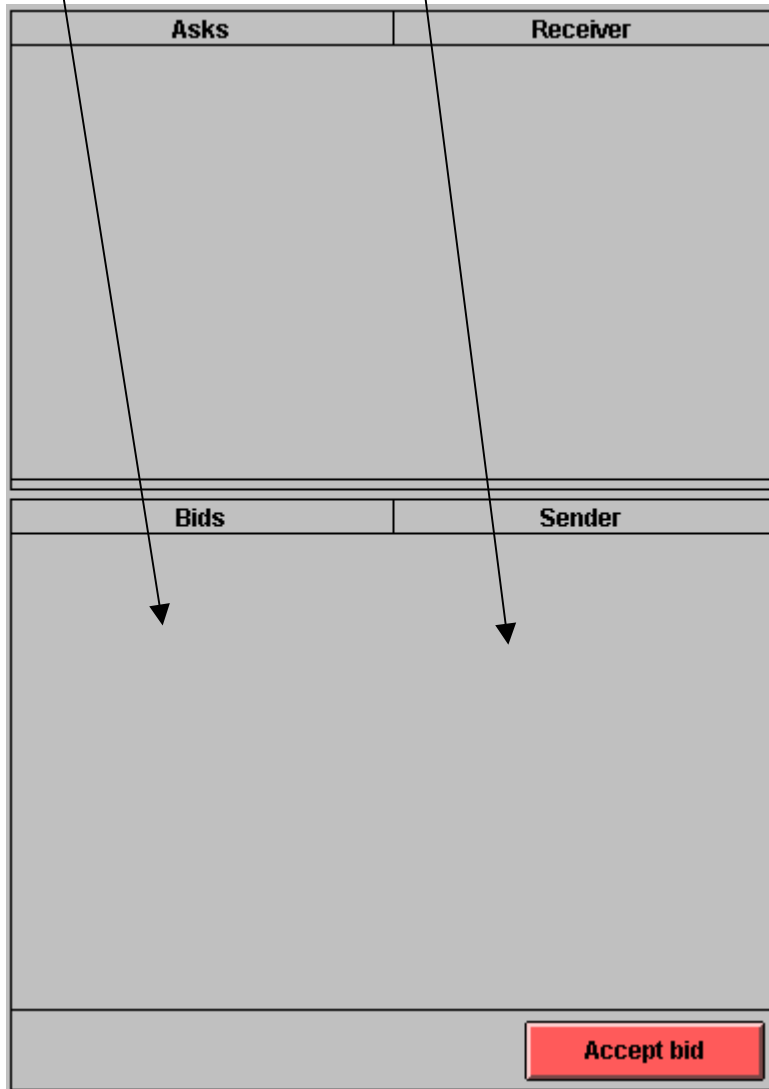
A transaction occurs if you choose to accept a bid.

To accept a bid you first have to use your mouse to move the cursor to the bid you want to accept.

Then click the left button on your mouse to highlight that bid.
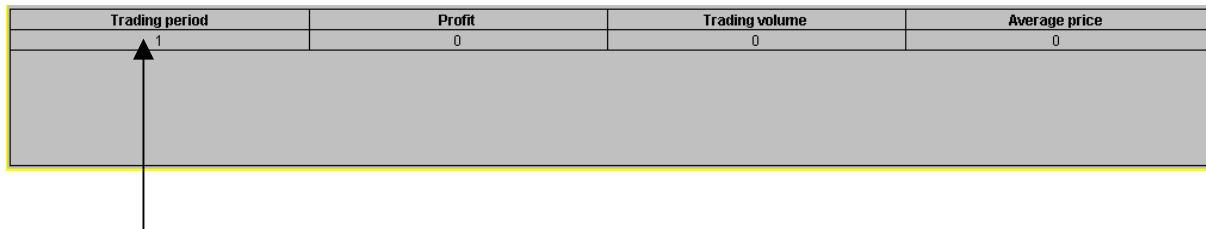
Finally move the cursor to the "Accept bid" button and press it.

If you accept a bid, any ask you have sent to one or more buyers is automatically cancelled and disappears from your and the buyers' computer screens.

A.6. Trading history

At the bottom of your computer screen there is a box that contains information from previous trading periods.

Trading period	Profit	Trading volume	Average price
1	0	0	0

The first column shows which trading period the provided information relates to.

The second column shows the profit you made.

The third column (Trading volume) shows how many units you sold.

The fourth column lists the average price of your sales.

Example: In trading period 4 you will see how much you have earned, sold and the average price of your sales in each of the trading periods 1, 2 and 3.

A.7. Profit and payment

All costs, prices and profits in the 8 experimental trading periods are nominated in German Pfennig. Your aggregate profit in Deutsche Mark is automatically calculated by your computer and updated after each trading period.

Before the experiment ends you have to complete a questionnaire in which you are asked to write your name and address. Then your aggregated profit (including a show-up fee equal to 10 DM) is displayed on your computer screen only. Afterwards you will be paid this amount in cash by the experimenter.

Please raise your hand if you have any questions. Otherwise please wait until the experiment continues.

Erklärungen (Verkaufer)

A.1. Einleitung

Sie nehmen nun an ein Experiment teil. In diesem Experiment können Sie Geld verdienen. Das Experiment wird etwa 90 Minuten dauern. Das Geld, das Sie verdienen, ist steuerfrei und wird an Sie unmittelbar am Ende des Experimentes in bar an Sie ausbezahlt. Wie viel Sie verdienen, hängt von Ihren Entscheidungen während des Experimentes ab.

Das Experiment wird vom "Ingegerd und Arne Skaug" Forschungsfond, Norwegen, finanziert.

Der Ablauf des Experimentes ist, wie folgt:

4. Studieren Sie diese Erklärungen sorgfältig. Versuchen Sie bitte, die Erklärungen innerhalb von 40 Minuten zu lesen. Wenn Sie Fragen haben, heben Sie bitte die Hand. Der Experimentator wird dann zu Ihnen kommen. *Während dieses Experimentes ist es nicht gestattet, mit anderen Experimentteilnehmern zu reden.*

5. Nachdem alle die Erklärungen gelesen haben, werden Sie Ihre Rolle in einem Probeexperiment üben. Während des Probeexperimentes können Sie noch kein Geld verdienen.

6. Nach dem Probeexperiment werden Sie in 8 experimentellen Handelsperioden in einem Markt teilnehmen. Ihre abschließende Auszahlung entspricht der Summe Ihrer Gewinne in diesen 8 Handelsperioden zuzüglich den 10 DM für Ihr pünktliches Erscheinen.

A.2. Ihre Rolle im Markt

In diesem Experiment sind Sie ein Verkäufer von einem fiktiven Gut auf einem computerisierten Markt.

Außer Ihnen gibt es 4 Käufer auf diesem Markt.

Im Experiment sind die Käufer "Buyer 1", "Buyer 2", "Buyer 3" und "Buyer 4" genannt.

A.3. Der Computerbildschirm

So sieht der Bildschirm während einer Handelsperiode aus:

Trading period																
1 of 8															Remaining time [sec]: 300	

Supply function

Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cost	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85

Trading volume: 0   Profit: 0

Price	Traded with

Asks	Receiver

Bids	Sender

Specify ask price:

Choose receivers of ask:

☐ Buyer 1
☐ Buyer 2
☐ Buyer 3
☐ Buyer4

Send ask   **Accept bid**

Trading period	Profit	Trading volume	Average price
1	0	0	0

Ganz oben am Schirm sehen Sie, in welcher Handelsperiode (Trading period) Sie jetzt sind, und wie viel Zeit (in Sekunden) in dieser Periode noch bleibt.

Jede Handelsperiode dauert 300 Sekunden.

Auf den nächsten Seiten erhalten Sie Information über jeden Bereich des Bildschirms, und wir erklären schrittweise Ihre Rolle im Experiment.
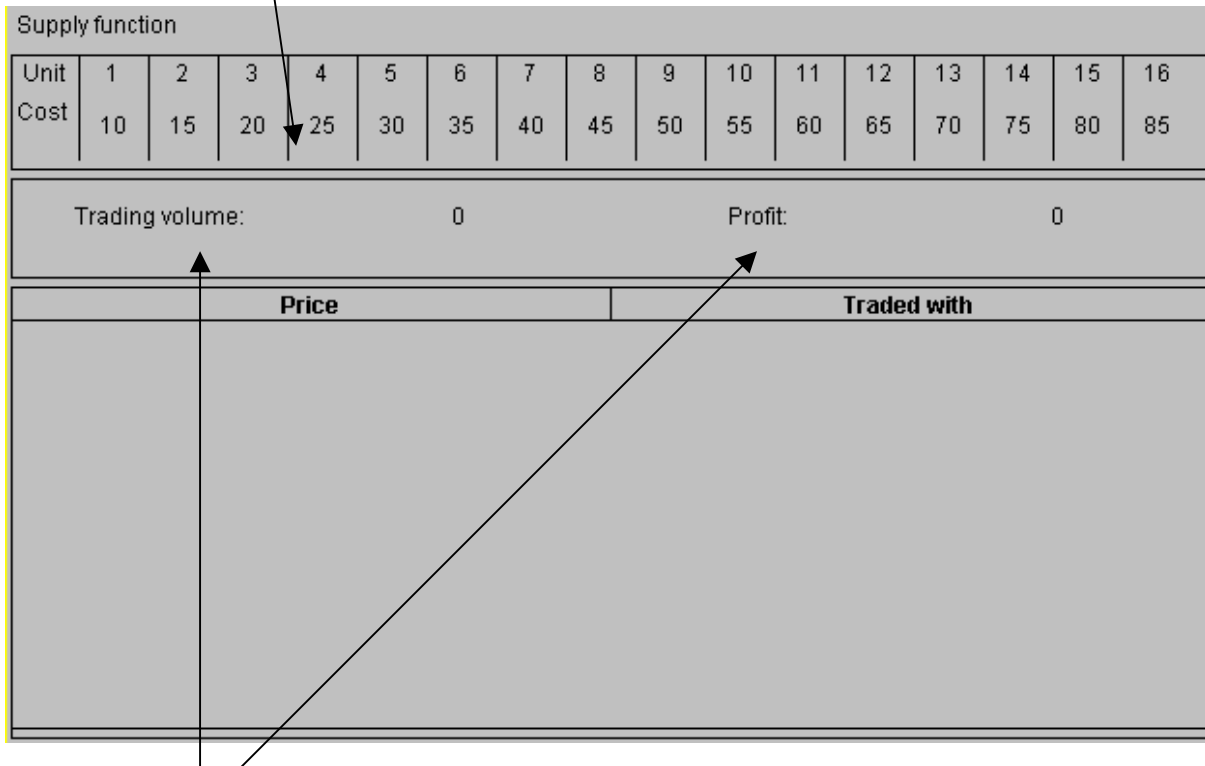
A.4. Angebotsfunktion (Supply function) und Information zum Handel

Ihre **Angebotsfunktion** für das Gut ist in Zahlen auf dem Bildschirm angegeben. Diese Funktion erklärt, wie viele Einheiten des Gutes Sie verkaufen können, und wie viel Ihnen jede Einheit (Unit) kostet (Cost).

Sie können Ihre Einheiten nur eine nach der anderen verkaufen und fangen dabei mit der Einheit Nummer 1 Ihrer Angebotsfunktion an. Sie können insgesamt nicht mehr als 16 Einheiten verkaufen. Der Gewinn, den Sie mit einer Transaktion machen, entspricht der Differenz zwischen dem Preis, den Sie für die aktuelle Einheit bekommen, und den Kosten der aktuellen Einheit.

Beispiel: Wenn Sie die erste Einheit für einen Preis von 75 verkaufen, würde Ihr Profit von dieser Transaktion (75 abzüglich 10 =) 65 sein. Verkaufen Sie die zweite Einheit für einen Preis von 50, würde der Profit (50 abzüglich 15 =) 35 sein. Folglich würde der gesamte Profit vom Verkauf diesen 2 Einheiten dann 65 + 35 = 100 betragen.
Beachten Sie bitte, dass sich die hier im Beispiel gezeigte Angebotsfunktion von Ihrer Angebotsfunktion im wirklichen Experiment unterscheidet.

Supply function

Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cost	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85

Trading volume:	0	Profit:	0

Price	Traded with

- **Trading volume** (Transaktionsvolumen des Marktes) zeigt, wie viele Einheiten Sie während der aktuellen Periode verkauft haben.

- **Profit** (Gewinn) misst, wie viel Sie in der aktuellen Periode verdient haben.

- **Price** (Preis) und **Traded with** (gehandelt mit) zeigen den Preis für jeden Verkauf, den Sie in der aktuellen Periode geschlossen haben (chronologisch), und die Käufernummer der Käufer (Buyer 1, Buyer 2, Buyer 3, Buyer 4) die Ihre Einheiten gekauft haben.

A.5. Handelsregeln

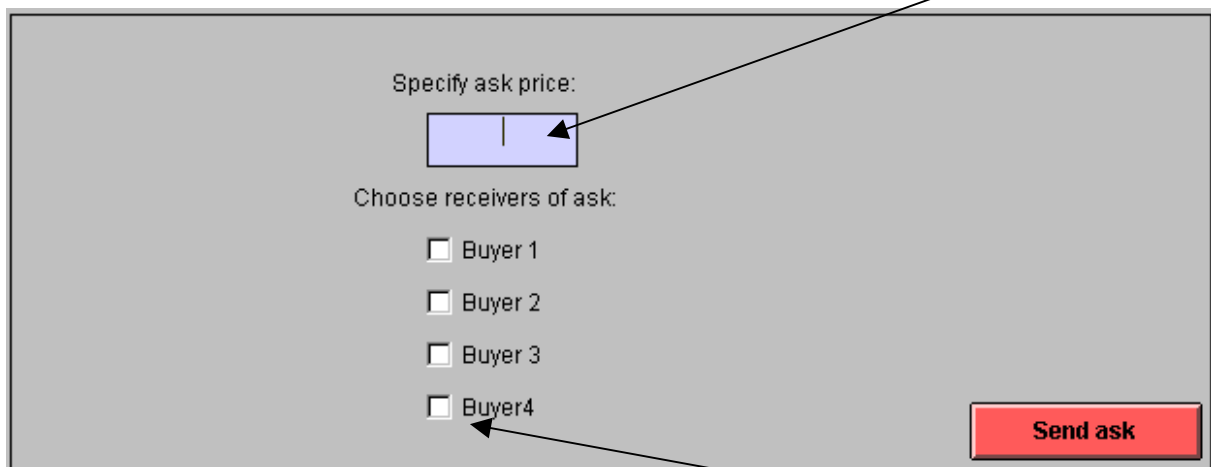Sie können auf 2 unterschiedliche Arten Einheiten verkaufen:

I.   Sie machen ein Verkaufsangebot, das einen Käufer annimmt, und/oder

II.   Ein Käufer macht ein Kaufangebot, das Sie annehmen.

Nun erklären wir diese Handelsregeln näher:

I. Sie machen ein Verkaufsangebot, einer der Käufer nimmt diesen Angebot an

Verkaufangebote werden **"asks"** genannt, und spezifizieren zu welchem Preis Sie bereit ist, eine Einheit zu verkaufen.

Um ein Verkaufsangebot (ask) zu machen, bewegen Sie der Cursor mit der Maus zum Feld unter "Specify ask price". Tragen Sie hier den Preis ein, zu dem Sie die Einheit verkaufen wollen.

Danach müssen Sie auswählen, welche(r) Käufer Ihr ask bekommen soll(en). Wenn beispielsweise Buyer 4 von Ihrem ask informiert werden soll, bewegen Sie den Cursor zum Kästchen vor der Käufernummer dieses Käufers, und markieren Sie es durch drücken der linken Maustaste. Sie müssen mindesten einen Käufer über Ihr ask informieren. Wenn Sie den oder die Empfänger Ihrer ask gewählt haben, bewegen Sie den Cursor zum "Send ask" Knopf. Drücken Sie mit der linken Maustaste auf diesen Knopf, um das ask abzuschicken.

Die von Ihnen gewählten Käufer werden dann Ihr ask auf ihren Bildschirmen sehen.

Eine Transaktion entsteht, wenn ein Käufer Ihr Angebot annimmt.

Sie können mehr als nur ein Angebot für eine Einheit machen. Jedes von Ihnen geschickte Angebot und zu wem es geschickt worden ist, wird an Ihrem Schirm im Feld "Asks | Receiver" angezeigt (siehe nächste Seite).

Wenn ein Käufer ein Angebot von Ihnen annimmt, wird das Angebot von Ihrem und von den Bildschirmen der Käufer, die Sie von Ihrem Angebot informiert haben, gelöscht. Auch alle anderen Angebote von Ihnen werden gelöscht und sind nicht mehr auf den Bildschirmen zu sehen.

Jedes Ihrer Angebote muss höher sein als die Kosten der Einheit, die Sie zu verkaufen wünschen.
<u>Beispiel</u>: Bei Kosten der Einheit von 10 müssen Sie Angebote höher als 10 machen, um einen Gewinn zu machen.

II. Die Käufer machen Kaufangebote, Sie nehmen ein solches Angebot an

Kaufangebote werden **"bids"** genannt. Ein bid spezifiziert, zu welchem Preis ein Käufer bereit ist, die Einheit zu kaufen.

Ein bid von einem Käufer, und von wem es stammt, wird auf dem Bildschirm in "Bids | Sender" box gezeigt. (Wenn ein Käufer entschieden hat, auch andere Käufer über sein bid zu informieren, sehen auch diese das bid auf ihren Bildschirmen.)
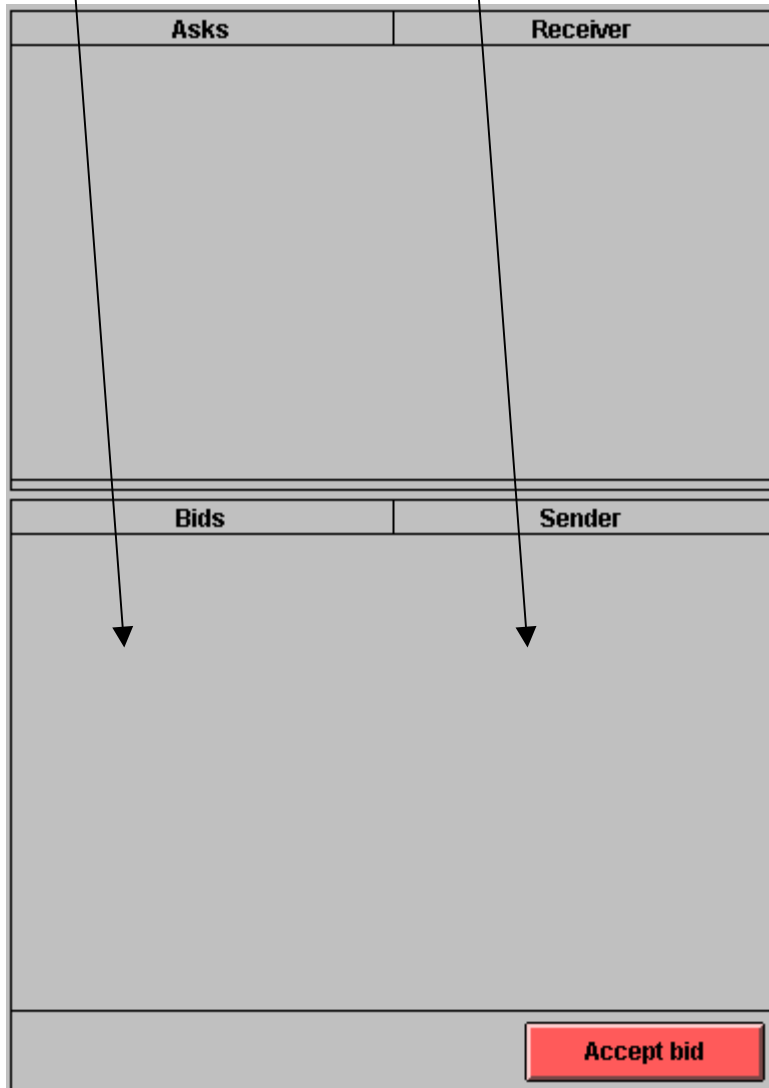
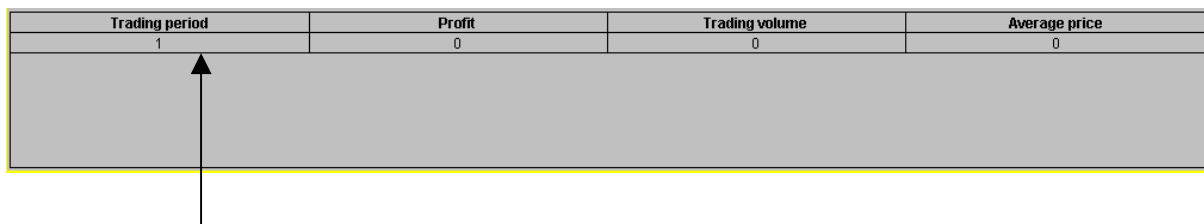Eine Transaktion entsteht, wenn Sie ein bid annehmen.

Um ein bid anzunehmen, bewegen Sie den Cursor zum bid, das Sie annehmen wollen. Markieren Sie es mit der linken Maustaste. Bewegen Sie schließlich den Cursor über dem "Accept bid" Knopf und drücken Sie die linke Maustaste.

Wenn Sie ein bid annehmen und damit eine Einheit verkaufen, werden neben dem bid auch alle Ihre Angebote (asks) automatisch gelöscht, die Sie an die Käufer geschickt haben. Sie sind dann nicht mehr auf den Bildschirmen zu sehen.

A.6. Überblick über vorangehende Handelsperioden

Am unteren Bildschirmrand befindet sich ein Feld, das Informationen über die vorangehenden Handelsperioden enthält.

Trading period	Profit	Trading volume	Average price
1	0	0	0

Die erste Spalte zeigt für welche Periode die Informationen gelten.
Die zweite Spalte (Profit) zeigt Ihre Gewinne in dieser Periode.
Die dritte Spalte (Trading volume) zeigt wie viele Einheiten Sie in dieser Periode verkauft haben.
Die vierte Spalte zeigt den durchschnittlichen Preis Ihrer Verkäufe.

Beispiel: In Handelsperiode 4 werden Sie sehen wie viel Sie verdient und verkauft haben, und den durchschnittlichen Preis Ihrer Verkäufe, in jeder Handelsperiode 1, 2 und 3.

A.7. Gewinn und Auszahlung

Die Kosten Ihrer Angebotfunktion, alle Preisen und Gewinne der 8 Handelsperioden sind in Pfennigen ausgedrückt. Ihr Gesamtgewinn in Deutschen Mark wird vom Computer automatisch berechnet und nach jeder Handelsperiode aktualisiert.

Am Ende des Experimentes werden Sie einen computerisierten Fragebogen beantworten. Darin bitten wir Sie, Ihren Namen und Ihre Adresse anzugeben. Dann wird Ihr Gesamtgewinn (einschließlich der 10 DM, die Sie auf alle Fälle erhalten) auf Ihrem Bildschirm angezeigt. Gleich im Anschluss bekommen Sie dieses Geld in bar vom Experimentator ausbezahlt.

Falls Sie nun Fragen haben, heben Sie bitte die Hand. Ansonsten warten Sie bitte ruhig, bis das Experiment beginnt.

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