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Simultaneous and sequential price competition in heterogeneous duopoly markets: experimental evidence

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Abstract

We investigate simultaneous and sequential price competition in duoply markets with differentiated products and random matching of symmetric firms. We find that second movers gain from the sequential structure in comparison to simultaneous-move markets whereas first movers do not. As predicted by the theory, there is a significant first-mover disadvantage in the sequential game. Finally, we report the results of control treatments varying the matching scheme and the mode of eliciting choices (strategy method vs. standard sequential play).

JEL classification: C92; D43

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1. Introduction

While in a simultaneous-move duopoly firms decide upon their strategic variables (e.g. quantity or price) at the same time, in a sequential-move duopoly one firm can commit to an action first. The other firm, or second mover, is

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assumed to decide after observing the action of the first mover. The timing of decisions has a pronounced effect on the market outcome. Consider for example two symmetric firms facing linear demand. In a homogeneous market with quantity competition the following holds: First, total quantity (as well as consumers' and total welfare) is higher in the market with sequential moves. Second, in the market with sequential moves, there is a first-mover advantage as the first mover earns higher profits than the second mover. Third, both the individual quantity and profit of the first mover (second mover) is higher (lower) as compared to individual quantities and profits in the simultaneous-move duopoly.[1]

Now consider a market with heterogeneous products and price competition where firms set prices either simultaneously or sequentially. In the sequential-move market both firms set higher prices than in the simultaneous-move market implying higher profits and lower consumer rent in the sequential market.[2] Moreover, in the market with sequential moves, there is a first-mover disadvantage as the first mover earns a lower profit in the subgame-perfect outcome. The latter observation is due to the fact that reaction curves in a heterogeneous market are upward-sloping when products are substitutes (see Gal-Or, 1985, Dowrick, 1986, and Boyer and Moreaux, 1987).

Our study addresses the experimental comparison of simultaneous and sequential duopoly markets with price competition where products are imperfect substitutes. To the best of our knowledge this study is the first reporting experimental results of such a sequential duopoly market and comparing them with behavior in simultaneous duopoly markets. There are, however, a number of studies on simultaneous play in markets with differentiated products, for example, Dolbear et al. (1968), Harstad et al. (1998) and Huck et al. (2000).[3] Dolbear et al. (1968) vary the amount of information subjects receive about the basic structure of the market, i.e. about how competitors' prices influence one's own profit. Harstad et al. (1998) analyze the effect of non-binding price announcements in Bertrand markets with differentiated products. Closest to our study is the work of Huck et

[1] Huck et al. (2001) report on an experiment designed to compare simultaneous and sequential play in a homogeneous duopoly market with quantity competition. They find that in sequential duopolies, aggregate output is in fact higher than in simultaneous duopolies. Hence, not only theory, but also experiments seem to suggest that in this case a sequential market structure is beneficial for welfare. Moreover, although first movers do not exploit their first-mover advantage as strongly as predicted, first movers earn higher profits than second movers.

[2] It can be argued that this property makes Stackelberg equilibria more plausible with heterogeneous than with homogeneous goods as both firms profit from the sequential-move structure.

[3] In addition, there is an experimental literature studying games with a unique survivor of iterated elimination of strictly dominated strategies, just as the simultaneous-move market we investigate. Overall, it emerges that the subjects' ability or propensity to play iteratively undominated strategies is limited (See in particular Rapoport and Amaldoss, 2000; Capra et al., 1999, 2000), and, most relevant for our work, Dufwenberg and Gneezy (2000) who study an experimental Bertrand market with homogeneous goods).

al. (2000). They find that prices in differentiated Bertrand markets with four firms are very close to the Nash equilibrium prediction, independent of whether players get feedback about aggregate or individual prices of rivals.

A famous example of sequential price setting is the US cigarette industry during the late 1920s and early 1930s. The largest seller of cigarettes, Reynolds, acted as the price leader. Between 1923 and 1941 eight price changes occurred, and Reynolds led six of them. Its price changes were followed immediately by other cigarette companies.[4] Another example for price leadership is the European market for dye producers in 1967. In a landmark decision of European cartel law it was established that after an announced price increase of 8% by the leading firm for dyes, Geigy, all major firms on the market for a range of related products increased their prices by the same percentage.[5] Other examples of price leadership in markets for differentiated products are the automobile industry in the US after 1950 and the US market for ready-to-eat-cereals.[6] Evaluating the case studies Scherer and Ross (1990) argue that ''price leadership tends to (. . .) increase prices on average (. . .)'' (p. 261), as predicted by the model that we have tested experimentally.[7]

In theory, duopolistic price leadership has been investigated both for the case of homogeneous (Deneckere and Kovenock, 1992) and the case of heterogeneous products (Furth and Kovenock, 1993). Deneckere and Kovenock, covering the case of capacity-constrained duopolists producing a homogenous good, review the properties of the simultaneous-move game (including the well-known Bertrand-paradox result) and—extending previous work by Shubik and Levitan (1980)—examine the equilibria obtained in the case where the large firm is a price leader as well as in the case in which the small firm is a price leader. However, their main concern is to determine conditions under which one of the firms endogenously becomes a price leader. More relevant for our study is the work by Furth and Kovenock (1993) who consider duopolistic price-leadership with capacity constraints and differentiated products. Similar to the paper by Deneckere and Kovenock, the authors first characterize the equilibria with an exogenously specified leader before specifying capacity combinations that would lead to the

[4] See Scherer and Ross (1990, p. 250f).

[5] Absolute prices differed among firms, but the proportional increase allowed firms to coordinate on a market with a great variety of goods of different prices and qualities. See Markert (1974).

[6] See Scherer and Ross (1990, p. 254–258).

[7] Note that it is not clear in these examples why certain firms move first (thereby foregoing some profits, in the light of our model). However, it also follows from the model that both firms profit from moving sequentially compared to a market with simultaneous moves. It is thus conceivable that in reality, asymmetries between the firms (which are absent from our simple model with exogenous timing of decisions) facilitate coordination. For the case of cost asymmetries see, e.g. Ono (1978) or van Damme and Hurkens (1998) and for the case of differences in capacities Deneckere and Kovenock (1992).

endogenous emergence of price leadership once the duopolists are given more flexibility with regard to the timing of decisions.

Other papers investigating the question how sequential moves of firms can arise endogenously, include for example, Ono (1978, 1982), Anderson (1987), Hamilton and Slutsky (1990) or van Damme and Hurkens (1998). Ono (1978, 1982) determines the preference of a firm to be a leader or a follower in a model in which the leader firm is a price setter whereas the follower firm is a price taker deciding how much to produce at the given price. Anderson (1987) shows that the introduction of spatial competition provides a means of endogenizing the role of price leadership. Hamilton and Slutsky (1990) analyze games in which firms have to choose both an action (quantity or price—thus covering both the homogenous as well as the heterogenous goods case) and the date of the action.[8] Finally, van Damme and Hurkens (1998) study Hamilton and Slutsky's endogenous timing game with price-setting firms and use risk-dominance considerations to show that the low cost firm will most likely emerge as the endogenous price leader.[9]

In our experiment subjects were repeatedly and randomly rematched to play one of the two market games. In the treatment with simultaneous play, both players in a market set one price in each period. In the treatment with sequential play, we employ the so-called strategy method by asking all players to submit a strategy. Thus, the first mover decides upon a single price whereas the second mover is asked to specify a complete response function in each period.

Regarding the experimental results, we find that in both treatments median prices exactly converge to the game-theoretic predictions. However, this is not the case with regard to observed mean prices. In the market with simultaneous play the mean price is above the equilibrium prediction whereas in the treatment with sequential play the first and the second movers' average price is lower than predicted. Moreover, whereas first movers in the sequential market set on average higher prices than firms in the simultaneous markets, second movers do not. Nevertheless, as in theory, we find a significant first-mover disadvantage. It turns out that second movers gain from the sequential structure in comparison to simultaneous-move markets whereas first movers do not. Finally, second movers' average response function has the same intercept but a slightly greater slope than predicted.

To check whether these findings are robust, we conducted a number of additional treatments. First, we investigated whether truly sequential play leads to different results than our baseline treatment where second mover behavior is

[8] For experimental evidence on endogenous timing in homogenous markets with quantity competition, see Huck et al. (2002).

[9] Also, demand uncertainty can make the large firm change its price first, because it is the first to detect a shift in market demand, making it the price leader (see Eckard, 1982). Similarly, customer loyalty can be the source of endogenous sequential moves when firms set prices (see Deneckere et al., 1992).

elicited using the strategy method. Second, we varied the matching procedure to study the effect of repeated interaction of fixed pairs of subjects on the market outcome. In short, we find that with truly sequential play and fixed matching our main results are corroborated. However, if the strategy method is combined with fixed matching, none of the theoretical predictions regarding differences in individual prices and profits in the two markets hold.

The paper is organized as follows: Section 2 introduces the market games, experimental procedures, and hypotheses. Section 3 reports the experimental results and Section 4 summarizes and concludes.

2. Markets, procedures and hypotheses

In a series of experiments, we study two heterogeneous duopoly markets with price competition. The two markets differ with regard to the timing of decisions. In the first market firms decide simultaneously upon prices. In the second market firms choose their prices sequentially: the first mover, player 1, decides upon his price p_1, then—knowing p_1—the second mover, player 2, decides upon his price p_2.

Participants received a payoff table (see Appendix A) showing all possible combinations of prices and corresponding profits. The numbers given in the payoff table were measured in a fictitious currency unit called 'Taler'. Assuming zero production costs, the raw payoff table was generated according to the profit functions $\pi_i(p_i, p_j) = p_i \cdot q_i(p_i, p_j)$ where $q_i(p_i, p_j) = \max\{16 - 2p_i + p_j, 0\}$, $i, j = 1, 2, i \neq j$. However, we manipulated a number of entries in the payoff table in order to get unique equilibria and to separate equilibrium strategies for the simultaneous-moves and the sequential market, and the collusive action.[10] Each firm could choose a price from the set $\{1, 2, \ldots, 10\}$.[11] In the final payoff table, there is a unique equilibrium with regard to simultaneous play, a unique subgame-perfect equilibrium with regard to sequential play and unique joint profit maximizing prices as given in Table 1. This table also shows the profits implied by these predictions.

The computerized[12] experiments were conducted at Humboldt University in

[10] Due to the discreteness of the strategy space, typically multiple equilibria arise (see Holt, 1985), which we avoided by changing some payoffs. Also note that the demand functions specified above have the property that the quantity demanded decreases when both prices increase by one unit, which limits the players' ability to earn high collusive profits. However, the larger the negative coefficient of the rival's price, the flatter the best reply functions and the closer the equilibrium strategies in both market games get. The above parameterization strikes a compromise between these two issues.

[11] The prices 1, 2, . . . ,10 given in the payoff table correspond to the prices 2, . . . ,11 in the underlying market. However, for the experiment we wanted to use a more prominent range of numbers. Therefore, we shifted the numbers one position to the left.

[12] We used the software tool kit *z-Tree*, developed by Fischbacher (1999).

Table 1
Theoretical predictions

	Simultaneous	Sequential	Collusion
Individual prices	$p_i = 4$	$p_1 = 6$; $p_2 = 5$	$p_i = 8$
Individual profits	$\pi_i = 53$	$\pi_1 = 58$; $\pi_2 = 68$	$\pi_i = 65$

June 2000 and in January and May 2001. Upon arrival in the lab, subjects (undergraduate as well as graduate students mostly of economics or business administration) were assigned a computer screen and received written instructions. After reading them, questions could be asked in private. Twelve subjects participated in each session, and all sessions consisted of 15 rounds.

The natural way of implementing a game with sequential moves is to let subjects choose sequentially. However, some information sets may be reached seldom. In order to get more information about the behavior of second movers in the market with sequential play (treatment SeqRand), we employed the so-called strategy method by simultaneously asking all players for decisions at *every* information set. Thus, in each of the 15 rounds the first mover had to specify a single price whereas the second mover was asked to name a price for each of the possible prices of the first mover.

We conducted three sessions for treatment SeqRand. At the beginning of each session, the subjects were randomly assigned to be first or second mover and these roles were kept fixed during the entire experiment. In each round players of different roles were randomly matched with each other. This was known to the subjects. Starting in the second round, the decision screen also showed the results of one's own pair in the previous round, that is, the price of the first mover, the relevant[13] price of the second mover and the implied payoffs for both players.[14] The decision screen of second movers also showed the strategy submitted in the previous round. (In this treatment the firms were labelled *A* (first mover) and *B* (second mover).)

For the markets with simultaneous play (treatment SimRand) no labels were assigned to firms. The instructions simply used the words 'you' and 'the other firm'. We conducted two sessions for treatment SimRand. For the sake of

[13] The relevant price of the second mover is the price he or she chose at the information set corresponding to the price of the first mover.

[14] We chose to give players detailed feedback to facilitate learning. However, it remains an open question how this affects the market outcome. For example, it is conceivable that withholding information about the other player's profit could facilitate collusion. Huck et al. (2000) find that in experimental Bertrand markets with differentiated products and fixed groups of four firms, giving the players more information about rivals' prices and profits has no significant effect on the competitiveness of the market. They compare a treatment where players are informed about aggregate prices and profits of the previous round to a treatment with information about individual prices and profits. Note that in our duopoly framework, these two treatments are identical.

comparison with treatment SeqRand, we used the following matching procedure in treatment SimRand: At the start of each session the 12 subjects were divided into two groups of six subjects each. Duopoly markets were then created in each round by randomly matching two subjects from different groups. This was known to the subjects. After each round subjects got individual feedback about what happened in their own market, i.e. next to a subject's own price the feedback screen displayed the price of the other subject and the implied individual payoffs. Our main interest is in the comparison of these treatments SimRand and SeqRand.

In addition, we conducted four control treatments. First, we checked whether the strategy method used in the afore-mentioned treatment SeqRand induces different behavior than truly sequential play. On the one hand, the strategy method can reveal more information about the motivations of a single subject than standard sequential play. On the other hand, as Roth (1995, pp. 322–323) puts it: ''The obvious disadvantage is that it [the strategy method] removes from experimental observation the possible effects of the timing of decisions in the course of the game.'' To test for the presence of such effects we conducted two sessions of the sequential-move market with followers submitting their prices after observing the leader's decision (treatment TrSeqRand). Here the same matching scheme was used as in SimRand and SeqRand. Second, the effect of fixed matching on the nature of prices and profits was tested. From a game-theoretic point of view, random matching seems to be appropriate as it resembles most closely the one-shot nature of a game, at the same time allowing subjects to gain experience. But from the point of view of industrial organization, it seems more natural to let fixed pairs of subjects play the game repeatedly. Therefore, one session with fixed pairs was conducted for each order of moves (treatment SimFix and treatment SeqFix (which again employed the strategy method)). To complete the design matrix, we also ran one treatment of the sequential market game with fixed pairs in the truly sequential mode (TrSeqFix). Thus, in this treatment we check for the effect of the simultaneous change of both the matching scheme and the mode of eliciting choices on behavior in the sequential market.

Subjects were informed that, at the end of the experiment, three of the 15 rounds would be randomly selected in order to determine the actual monetary profit in German marks. The latter was computed by using an exchange rate of 10:1. Before the first round started, subjects were asked to answer a control question (which was checked) in order to make sure that everybody fully understood the payoff table. Altogether $10 \times 12 = 120$ subjects participated in the experiments. Sessions lasted about 50 min and the subjects earned on average DM 17.00.

Summarizing the theoretical predictions one should expect

Hypothesis 1. The average price in treatment Sim is lower than the average price of both the first and the second mover in treatment Seq, that is, (a) $p^{\text{Sim}} < p_1^{\text{Seq}}$, and (b) $p^{\text{Sim}} < p_2^{\text{Seq}}$. Also, the average price of the second mover is smaller than the average price of the first mover in treatment Seq, that is, (c) $p_2^{\text{Seq}} < p_1^{\text{Seq}}$.

Hypothesis 2. Average firm profits in treatment SIM are lower than both the first and the second mover's average profit in treatment SEQ, that is, (a) $\pi^{\text{SIM}} < \pi_1^{\text{SEQ}}$, and (b) $\pi^{\text{SIM}} < \pi_2^{\text{SEQ}}$. Furthermore, in treatment SEQ there is a first-mover disadvantage, that is, (c) $\pi_1^{\text{SEQ}} < \pi_2^{\text{SEQ}}$.

Hypothesis 3. Industry profits in treatment SIM are lower than industry profits in treatment SEQ, that is, $(\pi_1 + \pi_2)^{\text{SIM}} < (\pi_1 + \pi_2)^{\text{SEQ}}$.

Hypothesis 4. Second movers in treatment SEQ learn to choose the best response (function).

Note that we maintain the hypotheses independent of the matching procedure (RAND or FIX) and the design of the sequential game (SEQ or TRSEQ). Note, furthermore, that Hypothesis 3 is derived directly from Hypothesis 2.

3. Experimental results

The results are reported in two subsections. Section 3.1 reports the results of the sessions with random matching whereas Section 3.2 reports the results of the sessions with fixed matching. Within each section we first test the above hypotheses by comparing results from the simultaneous-move markets with results from the sequential-move markets employing the strategy method. Then we examine which effect the mode of soliciting choices of second movers (strategy method vs. truly sequential play) has on prices in the sequential markets.

Table 2 shows summary statistics for all six treatments both for all rounds and for the last five rounds. In the sequential treatments, the first number denotes the first mover's price, followed by the second mover's price. Note that the variability in observed prices decreases over time in most treatments as standard deviations (shown in parentheses in Table 2) are usually lower in the last five rounds than in all rounds. More detailed information for all treatments is given in Tables B.1 and B.2 in Appendix B, where medians and mean prices along with standard deviations are shown for each period.

In the following, we will work with data from the last five rounds. To test for significance of the difference in means, we ran linear regressions across mean prices or profits, using the treatment (SIM vs. SEQ) or the player's position (first vs. second mover within SEQ treatments) as a dummy. For example, to test part (a) of Hypothesis 1 we use the estimation equation $p = \beta_0 + \beta_1 Dummy + \varepsilon_i$ where the variable *Dummy* is equal to zero in treatment SIM and equal to one in treatment SEQ. The estimate for β_1 can be directly interpreted as the difference in means. ε_i is a normally distributed error term with mean zero and variance σ_i^2. We use White

Table 2
Aggregate data

Treatment	Rounds	Individual prices		Individual profits	
		Median	Mean	Median	Mean
SimRand	All	5.00	5.02 (1.36)	58.00	56.55 (10.50)
	Last 5	**4.00**	**4.66** (1.16)	**53.00**	**55.72** (8.76)
SeqRand	All	6.00/5.00	5.29/4.54 (1.25/1.20)	58.00/61.00	54.22/60.27 (8.45/10.04)
	Last 5	**6.00/5.00**	**5.28/4.51** (1.07/1.20)	**58/00.68.00**	**55.01/60.22** (7.92/10.22)
TrSeqRand	All	6.00/5.00	5.44/4.63 (1.03/0.78)	58.00/68.00	55.98/63.55 (4.10/7.40)
	Last 5	**6.00/5.00**	**5.55/4.65** (0.87/0.71)	**58.00/68.00**	**56.28/64.35** (3.50/6.70)
SimFix	All	6.00	6.19 (1.88)	64.50	58.92 (12.85)
	Last 5	**5.00**	**5.58** (2.01)	**60.00**	**57.62** (10.14)
SeqFix	All	5.00/5.00	5.07/4.98 (1.22/1.09)	58.00/60.00	57.28/58.88 (5.81/8.14)
	Last 5	**5.00/5.00**	**5.13/4.97** (1.25/0.96)	**58.00/60.50**	**57.20/59.57** (4.50/7.11)
TrSeqFix	All	6.00/5.00	6.28/5.50 (0.79/1.14)	58.00/68.00	59.12/66.92 (3.13/2.50)
	Last 5	**6.00/5.00**	**6.33/5.50** (0.76/1.14)	**58.00/68.00**	**59.16/67.50** (2.65/1.14)

Notes: Only relevant prices for second movers. Standard deviations in parentheses.

(1980) robust standard errors adjusted for possible non-independence of observations within markets to estimate the covariance matrix.[15]

[15] Within clusters (markets), the error terms should not be assumed to be independent. Relaxing the independence assumption, the formula for the robust covariance matrix is:

$$\left(\frac{N-1}{N-k}\right)\left(\frac{M}{M-1}\right)(X'X)^{-1}\left(\sum_{m=1}^{M} u'_m u_m\right)(X'X)^{-1}$$

where X is the matrix of regressors, N the number of observations, M the number of clusters G_m (markets), k the number of regressors, $u_m = \Sigma_{j\in G_m} \varepsilon_j x_j$, $\beta\varepsilon_j = y_j - x_j$, y_j is the dependent variable for observation j, x_j the vector of independent variables for observation j, and β are the coefficient estimates. This procedure is implemented in the *cluster* option for linear regressions of the STATA package. See STATA Corp. (1999), vol. 3, pp. 156–158 and 178–179) and Rogers (1993).

Table 3
Synopsis of the hypotheses and the test results

Hypothesis		Random matching		Fixed matching	
		SeqRand	TrSeqRand	SeqFix	TrSeqFix
1(a)	$p^{\mathrm{Sim}} < p_1^{\mathrm{Seq}}$	***	**	–	–
1(b)	$p^{\mathrm{Sim}} < p_2^{\mathrm{Seq}}$	–	–	–	–
1(c)	$p_1^{\mathrm{Seq}} < p_2^{\mathrm{Seq}}$	***	**	–	***
2(a)	$\pi^{\mathrm{Sim}} < \pi_1^{\mathrm{Seq}}$	–	–	–	–
2(b)	$\pi^{\mathrm{Sim}} < \pi_2^{\mathrm{Seq}}$	**	**	–	***
2(c)	$\pi_1^{\mathrm{Seq}} < \pi_2^{\mathrm{Seq}}$	**	**	–	***
3	$(\pi_1 + \pi_2)^{\mathrm{Sim}} < (\pi_1 + \pi_2)^{\mathrm{Seq}}$	–	**	–	**
4	Resp. function	✓	✓	✓	(✓)

Note: *** resp. ** indicates (one-tailed) significance at the 1 resp. 5% level whereas, '–' indicates that the respective hypothesis was rejected. For the test, we used the opposite of the hypotheses stated in column 2 as the null. The symbol ✓ indicates that the empirical response function (almost) coincides with the best reply function.

Table 3 provides a synopsis of the test results indicating the respective levels of significance. These results will be elaborated on in the following.

3.1. Random matching

3.1.1. Strategy method

Regarding the above hypotheses and comparing the results of the baseline treatments SimRand and SeqRand, we make the following observations:

Hypothesis 1

The mean price in treatment SimRand (4.66) is significantly lower than the mean price of the first mover in treatment SeqRand (5.28). This provides support for Hypothesis 1, part (a). However, the mean price in treatment SimRand is slightly higher than the mean price of the second mover in treatment SeqRand (4.66 vs. 4.51) which immediately rejects part (b) of Hypothesis 1. Finally, the difference in average prices of first and second movers in treatment SeqRand has the predicted sign and is statistically significant which supports part (c) of Hypothesis 1.

Hypothesis 2

Refer to Table 2 again. Average profits in treatment SimRand are slightly higher than first mover profits in treatment SeqRand (55.72 vs. 55.01), which is the reverse of the theoretical prediction. However, average profits in treatment

SIMRAND are significantly lower than average profits of second movers in treatment SEQRAND (55.72 vs. 60.22), thus confirming part (b) of Hypothesis 2. Furthermore, the difference between first and second movers' profits in the last five rounds (55.01 vs. 60.22) is not as pronounced as theory predicts (58 vs. 68). However, it is statistically significant. Hence, there is a significant first-mover disadvantage in treatment SEQRAND—just as predicted.

Hypothesis 3

A comparison of the sum of firms' profits under the sequential move structure with the case of simultaneous moves yields $(\pi_1 + \pi_2)^{\text{SIMRAND}} < (\pi_1 + \pi_2)^{\text{SEQRAND}}$ (as $111.44 < 115.23$) meaning that two firms jointly benefit from the sequential move structure, just as predicted. However, this difference is not significant.

Hypothesis 4

Fig. 1 shows both the best response function and the empirical response function (based on averages of the last five rounds) for second movers in treatment SEQRAND (along with the response function of treatment SEQFIX which will be discussed below).

Second movers aiming at profit maximization, as it is assumed in the derivation of the subgame-perfect equilibrium, are supposed to react according to $p_2 =$

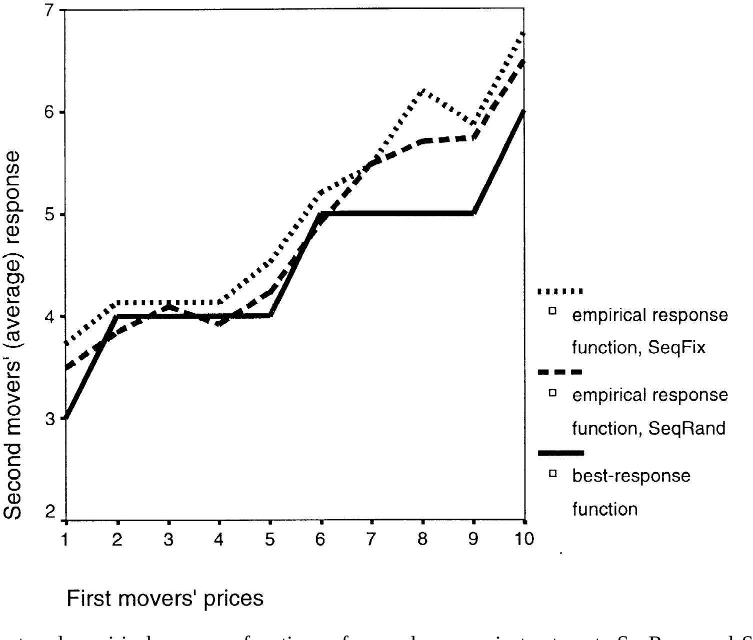

Fig. 1. Best and empirical response functions of second movers in treatments SEQRAND and SEQFIX.

$3.067 + 0.261p_1$. (This is the result of a linear regression estimation of the best-reply function for our discretized game.) We estimate the empirical response function of second movers, $p_2 = \gamma_0 + \gamma_1 p_1$, by linear regressions, including dummy variables for subjects, periods and sessions. We coded the dummy variables such that both the estimated intercept γ_0 and the estimated slope γ_1 shown in Table 4 represent actual averages.[16]

According to Table 4, the empirical response of second movers in treatment SEQRAND has the same intercept as and a somewhat bigger slope than the best response function. As can be seen from Fig. 1, the empirical response function in treatment SEQRAND more or less coincides with the best response function for leaders' prices up to 6. But for prices higher than the subgame-perfect price of the first mover, second movers in the experiment set higher prices than theoretically predicted. Thereby, second movers would decrease their own profit slightly and increase the profit of first movers at a much higher rate, resulting in a reduced payoff gap (see the payoff table in Appendix A). As it turns out, first movers almost never chose a price higher than 6 in the last five rounds. This lack of 'hard' feedback for all sampling points of their reply function may explain the deviation of second movers from subgame-perfect behavior. Overall we find that Hypothesis 4 is confirmed whenever second movers get enough feedback. This positive result is indicated by the symbol ✓ in Table 3.

3.1.2. Standard sequential play

Now turn to the question whether the strategy method induces different behavior than standard sequential play where the second mover chooses his price after having observed the first mover's price. Cursory inspection of Table 2 suggests that the results from standard sequential play are in line with the results from the treatment using the strategy method. However, prices (and especially the leader's price) are slightly higher (and closer to the predicted values) when follower

Table 4
Regression results

	Estimating equation: $p_2 = \gamma_0 + \gamma_1 p_1$				
	γ_0	γ_1	df	Adj. R^2	N
SEQRAND	3.002*** (33.40)	0.325*** (22.43)	22	0.42	90
SEQFIX	3.202*** (33.57)	0.330*** (21.46)	10	0.66	30

Notes: *** indicates significance at the 1% level. Absolute value of asymptotic t-statistics in parentheses.

[16] We restrict the sum of the dummy coefficients to be equal to zero. See Suits (1984) for the use of restricted least squares models in general and Königstein (2000) for their particular importance in experimental economics.

behavior is elicited by truly sequential play. Overall, we find that the method of eliciting choices does not have a strong impact on behavior under the random matching protocol.[17] In fact, as Table 3 reveals we find that the test results regarding Hypotheses 1 and 2 are very similar. That is, hypotheses that were confirmed [rejected] when individual behavior in treatment SimRand was compared to behavior in treatment SeqRand are also confirmed [rejected] if one compares individual behavior in treatments SimRand with behavior in treatment TrSeqRand. However, Hypothesis 3 was rejected with regard to the main treatments (SimRand and SeqRand), but is confirmed when comparing the simultaneous markets with the truly sequential markets: Industry profits (i.e. the sum of firm 1 and firm 2's profits) are significantly lower when firms move simultaneously (115.24 on average) than when firms move in standard sequential order (120.63 on average). Thus, the industry benefits from truly sequential play compared to simultaneous price decisions.

As mentioned in the introduction, with truly sequential play some information sets may be reached only seldom. In fact, during the last five rounds in treatment TrSeqRand virtually all prices chosen by first movers were either 4 or 6. Therefore it is not meaningful to draw a picture of the second movers' empirical response function or to run a regression. Instead, Table 5 simply lists the prices chosen by first movers, the number of times they were chosen, and the average response by second movers (with standard deviations in parentheses) along with their optimal response. Neglecting the single observation at $p_1 = 3$, it turns out that the second movers' reactions to prices of $p_1 = 4$ or $p_1 = 6$ were close to optimal, supporting Hypothesis 4.

3.2. Fixed matching

The composition of real markets does not follow a random pattern. Instead, firms typically compete with each other over a certain period of time. Therefore,

Table 5
Followers' responses in the truly sequential markets

	p_1	N	Average observed p_2	Optimal p_2
TrSeqRand	3	1	3.00 (–)	4.00
	4	12	3.67 (0.89)	4.00
	6	47	4.94 (0.25)	5.00
TrSeqFix	6	25	5.00 (0.00)	5.00
	8	5	8.00 (0.00)	5.00

[17] This finding is consistent with results of Brandts and Charness (2000) who compare standard sequential play and choice elicitation using the strategy method in a Prisoner's dilemma and a Chicken game. Their results indicate that the strategy method does not affect subjects' responses in the two games investigated.

we conducted three additional control sessions to analyze firm behavior with repeated interaction. Note that according to theory, the equilibrium of the stage game should be played in each round, due to backward induction. Both baseline treatments were run with fixed pairs (SimFix and SeqFix) as well as the market with truly sequential moves (TrSeqFix). For a summary of the results refer to Table 2 again.

3.2.1. Strategy method

Comparing the fixed-matching treatments with the corresponding random-matching treatments in Table 2, we make the following three observations regarding qualitative differences: (1) Behavior in treatment SimFix is more collusive than in treatment SimRand as prices and profits are higher in the former treatment than in the latter, no matter whether medians or means are considered.[18] (2) Comparing means in treatments SeqFix and SeqRand, behavior is, by and large, not very different in the two treatments.[19] (3) Comparing means again, we find that behavior in treatment TrSeqFix is more collusive than in treatment TrSeqRand as prices and profits are higher in the former treatment than in the latter.

Now turn to Hypothesis 1–4 for the fixed matching sessions. Observations (1) and (2) have a dramatic effect with regard to Hypotheses 1, 2, and 3, as all of these predictions are rejected when comparing behavior in treatments SimFix and SeqFix (see Table 3). In fact, the average price in treatment SimFix (5.58) is higher than both the average leader price (5.13) and the average follower price (4.97) in treatment SeqFix, immediately rejecting parts (a) and (b) of Hypothesis 1. And although the difference between the leaders' and the followers' prices in treatment SeqFix has the predicted sign, it is not significant. These negative results regarding individual prices carry over to individual profits as all three predictions of Hypothesis 2 are rejected. Also, industry profits do not differ significantly when firms set prices simultaneously or sequentially (115.24 on average for SimFix and 116.97 for SeqFix) rejecting Hypothesis 3. Next consider Hypothesis 4. Fig. 1 shows the empirical response function (again based on averages of the last five rounds) for second movers in treatment SeqFix. Apparently, it is quite similar to the one observed in treatment SeqRand which might explain why behavior of first movers in these two treatments is not too different from each other. However, the empirical response function in the treatment with fixed matching lies slightly above the function in the treatment with random matching, as well as above the best-response function. In fact, as Table 4 reveals, the intercept of the response function in treatment SeqFix is slightly higher than in treatment SeqRand (3.202

[18] Note that there is a dramatic drop of median prices over time in treatment SimFix whereas the decline of mean prices is moderate (see Table B.2 in Appendix B).

[19] A notable exception is the fact that p_1 and p_2 differ significantly in SeqRand, but not in SeqFix. This is commented on below.

vs. 3.002) whereas the slope is about the same in both treatments (0.330 vs. 0.325). In all, it seems fair to conclude that the empirical response function of treatment SeqFix is quite close to the best response function, supporting Hypothesis 4.

3.2.2. Standard sequential play

Consider which results of the baseline random matching treatments continue to hold when matching is fixed, but play is truly sequential (SimFix vs. TrSeqFix). It will emerge that the qualitative results are similar to the results from the comparison of treatments SimRand and TrSeqRand.

Regarding Hypothesis 1, the firms' average price in the market with simultaneous price choices (5.58 in SimFix) is lower than the price leaders' average choice (6.33 in TrSeqFix), but this difference is not significant. Furthermore, as in all other comparisons so far, the average price in markets with simultaneous price decisions is higher than the average price of second movers in the market with sequential decisions (5.58 vs. 5.50)—rejecting part (b) of Hypothesis 1. However, the leaders' average price is significantly higher than followers' prices (6.33 vs. 5.50), supporting part (c) of Hypothesis 1. Concerning Hypothesis 2, we find a significant first mover disadvantage in TrSeqFix (59.16 vs. 67.50), but again no significant difference between profits in SimFix and leader profits in TrSeqFix. However, profits in SimFix are significantly lower than follower profits in the sequential market, just as predicted. Furthermore, industry profits are significantly higher in TrSeqFix (126.6 on average) than in SimFix (115.24), supporting Hypothesis 3. Finally, only two prices are chosen by first movers in the last five rounds in treatment TrSeqFix, namely the prices $p_1 = 6$ or $p_1 = 8$. Interestingly, second movers react to the price $p_1 = 6$ optimally by choosing a price of $p_2 = 5$ without any exception (see Table 5). In one of the six experimental markets conducted, the first player always chose the collusive price of $p_1 = 8$ in each of the last five rounds, which was always matched with 8 by the second mover.

4. Summary and discussion

The experiments reported in this study were designed to compare simultaneous and sequential play in heterogeneous duopoly markets when firms are symmetric with respect to cost. We conducted two baseline treatments, one with simultaneous and one with sequential price decisions. Subjects in both markets were matched randomly across periods. In the sequential treatment, the so-called strategy method was used, asking second movers to name a price for each of the possible prices of the first mover.

We find that many of the qualitative predictions are confirmed. More precisely, in the baseline treatments SimRand and SeqRand observed median prices and profits exactly match the (subgame-perfect) equilibrium predictions. However, this is not true with regard to observed mean prices and profits. In treatment SimRand the mean price is higher than predicted, whereas in treatment SeqRand the mean prices of the first and the second movers are lower than predicted. Nevertheless, the average leader price in the sequential market is higher than the average price in the simultaneous market, as predicted (Hypothesis 1(a)). This does not hold with regard to the average follower price, which is below the average price of the simultaneous market, contrary to the prediction (Hypothesis 1(b)). Furthermore, as in theory we find that leaders set on average higher prices than followers (Hypothesis 1(c)). As predicted there is a significant first-mover disadvantage in the sequential market (Hypothesis 2(c)). Moreover, whereas second movers gain from the sequential structure in comparison to simultaneous-move markets, first movers do not, the latter finding not being in line with theory (Hypothesis 2(a) and (b)). Again as predicted, we find that industry profits in the sequential markets are higher than in simultaneous markets although these differences fail to be statistically significant (Hypothesis 3). Finally, we observe that whenever second movers get enough feedback, they react as theory predicts (Hypothesis 4).

To test whether the strategy method induces behavior different from standard sequential play, we conducted control sessions in which second movers chose their price after having observed the first mover's price. We find that the method of eliciting choices does not have a strong impact on qualitative behavior under the random-matching protocol. The results regarding our hypotheses remain the same with the exception that firms do not only jointly gain from the sequential-move structure, but that these gains are significant. And prices are slightly higher (and closer to the predicted values) when follower behavior is elicited by truly sequential play.

We also controlled for the effect of the matching scheme on the results by implementing a fixed-matching counterpart for each of the treatments mentioned above. We find that prices and, therefore, profits are higher in the simultaneous and sequential markets with truly sequential play under the fixed-matching protocol as compared to random matching. However, this is not true for the sequential market when the strategy method is employed. In this case, behavior under the fixed-matching protocol is similar to behavior with random-matching. This has a marked effect on the hypothesis tests when comparing the simultaneous-move markets with the sequential-move markets based on the strategy method: None of the hypotheses regarding prices and profits find support in the data. In contrast to the prediction, the average price in the simultaneous markets is higher than both prices in the markets with sequential moves. Moreover, we find that the second movers' average response function (almost) does not vary across matching schemes if subjects are asked to specify a complete reaction. Finally, the results from the hypothesis tests are almost the same whether one compares simultaneous and truly sequential play under fixed matching or their respective random-matching counterparts.

To sum up, the theoretical predictions do better in the treatments with random matching than in the treatments with fixed matching when simultaneous markets are compared to sequential markets employing the strategy method. In particular, prices in the market with simultaneous moves are too high when firms interact repeatedly. However, with fixed matching and standard sequential play, a number of results from the random matching design continue to hold.

The slightly above-equilibrium prices in the simultaneous-move markets are in line with a result of Dufwenberg and Gneezy (2000) who report that prices in a homogeneous goods Bertrand duopoly with random matching do not converge to the Nash equilibrium, but stay above the equilibrium prediction. The result is, however, in contrast with previous experimental studies on duopoly markets with quantity competition which report convergence to the Cournot–Nash equilibrium when subjects are repeatedly and randomly matched.[20] A possible explanation for our results could be that with heterogeneous products best reply functions are comparatively flat, which makes deviations from the equilibrium price not very costly. It is then not too surprising that deviations go into the direction where both payoffs potentially increase, that is, towards more collusive behavior.[21]

How can it be explained that in both sequential markets with random matching the average price of first movers is lower than predicted? Inspecting first-mover data in these two treatments more closely shows that in both treatments the choice of the equilibrium price of 6 and the choice of a price of 4 account for the bulk of observations. In fact, in treatment SeqRand a price of 6 was chosen by first movers in 62.2% and a price of 4 in 30% of all cases in the last five rounds. In treatment TrSeqRand these frequencies are 78 and 20%. And some subjects tend to choose 6 consistently while others choose 4 in most of the rounds.[22] Thus, the observation that average prices of first movers are below the equilibrium prediction in the sequential random-matching treatments is caused by the fact that some first-movers choose a price of 4 rather than 6.[23]

Our finding that behavior in the markets with fixed matching is overall (excluding treatment SeqFix) more collusive than in the respective markets with

[20] See e.g. Fouraker and Siegel (1963), Holt (1985) and Huck et al. (2001).

[21] However, the experimental literature indicates that the number of competitors is crucial for the Bertrand market outcome. Dufwenberg and Gneezy (2000) find that prices converge to the equilibrium in three- and four-firm Bertrand markets with homogeneous goods, and Huck et al. (2000) report convergence to equilibrium in experimental four-firm Bertrand markets with heterogeneous goods.

[22] In treatment SeqRand we find that 9 out of 18 or 50% of first movers chose the price of 6 in at least four of the last five rounds. Furthermore, 4 out of 18 or 22.3% of first movers chose the price of 4 in at least four of the last five rounds. In treatment TrSeqRand the picture is even more clear: 9 out of 12 or 75% of first movers choose the price of 6 in at least four of the last five rounds whereas 2 out of 12 or 16.8% of first movers chose the price of 4 in at least four of the last five rounds.

[23] One possible explanation for the first mover's choice of a price of 4 is that some subjects might aim at implementing equal payoffs, assuming rationality of the second mover (which is warranted, given observed second-mover behavior). That a price of 8 was never chosen could then be explained by fear from being exploited.

random matching, is perfectly in line with previous findings.[24] Dolbear et al. (1968) also conducted simultaneous duopoly markets with differentiated products and they, too, mainly report prices above the Nash equilibrium prediction with a fixed matching protocol. Second, as mentioned in Section 1, Huck et al. (2001) report on an experiment designed to compare simultaneous and sequential play in a homogeneous duopoly market with quantity competition both under a random and a fixed-matching scheme. They find that behavior is more collusive in both fixed-matching markets than in the two random-matching markets.[25] Taking this evidence together, it is interesting that we did not observe more collusive behavior in treatment SeqFix than in treatment SeqRand. We found that the average response function of second movers was very similar in both treatments. This suggests that using the strategy method makes second-mover behavior less sensitive to a change in the matching procedure.

Regarding the question whether a first mover disadvantage can be replicated in other experimental markets, we would like to investigate a setting where demand is stochastic and followers can learn from the decisions of leaders as in Gal-Or (1987). While information sharing in oligopoly has been studied experimentally by Cason and Mason (1999), they only consider simultaneous moves by firms. It seems worthwhile to investigate how experimental subjects deal with the problem of revealing information to their rival when they are in the position to move first.

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[24] Note that price leadership can be a means to achieve interfirm coordination (see e.g. Scherer and Ross (1990) or Phlips (1995) and the references therein) without explicitly resorting to direct communication between firms. In a repeated game, collusion can be sustained when price increases by the leading firm are followed by price increases of firms moving later by the credible threat of a price war if one firm deviates. However, our experimental results show that with random matching, sequential price decisions did not move the markets away from the subgame-perfect equilibrium prediction into the direction of greater cooperation. Also, with fixed pairs sequential price decisions did not facilitate collusion when the strategy method was employed. In contrast, behavior in treatment TrSeqFix is on average more collusive. However, only one out of six pairs in this treatment was able to sustain collusive prices from round 2 to 15 (no other subjects chose the collusive price of 8 in this treatment).

[25] For similar results, see also Fouraker and Siegel (1963) and Holt (1985).

Appendix A. Payoff table

	1	2	3	4	5	6	7	8	9	10
1	28 / 28	30 / 36	32 / 41	34 / 40	36 / 36	38 / 28	40 / 16	42 / 0	44 / 0	46 / 0
2	36 / 30	39 / 39	42 / 44	45 / 45	48 / 42	51 / 35	54 / 24	57 / 9	60 / 0	63 / 0
3	41 / 32	44 / 42	48 / 48	52 / 50	56 / 48	60 / 42	64 / 32	68 / 18	72 / 0	76 / 0
4	40 / 34	45 / 45	50 / 52	53 / 53	64 / 51	65 / 49	70 / 40	75 / 27	80 / 10	85 / 0
5	36 / 36	42 / 48	48 / 56	51 / 64	60 / 60	68 / 58	72 / 48	78 / 36	85 / 20	90 / 0
6	28 / 38	35 / 51	42 / 60	49 / 65	58 / 68	61 / 61	70 / 56	77 / 45	84 / 30	91 / 11
7	16 / 40	24 / 54	32 / 64	40 / 70	48 / 72	56 / 70	62 / 62	72 / 54	80 / 40	88 / 22
8	0 / 42	9 / 57	18 / 68	27 / 75	36 / 78	45 / 77	54 / 72	65 / 65	72 / 50	81 / 33
9	0 / 44	0 / 60	0 / 72	10 / 80	20 / 85	30 / 84	40 / 80	50 / 72	60 / 60	70 / 44
10	0 / 46	0 / 63	0 / 76	0 / 85	0 / 90	11 / 91	22 / 88	33 / 81	44 / 70	55 / 55

Note: The head of the row represents one firm's price and the head of the column represents the price of the other firm.
Inside the box at which row and column intersect, one firm's profit matching this combination of prices stands up to the left and the other firm's profit stands down to the right.

Appendix B. Summary of experimental results

Table B.1. Results in the treatments with random matching

Round	SimRand		SeqRand				TrSeqRand			
	p		p_1		p_2		p_1		p_2	
1	6.00	5.67	6.00	5.89	5.00	4.94	6.00	5.67	5.00	5.17
		(1.55)		(1.49)		(1.47)		(1.03)		(1.17)
2	6.00	5.75	5.50	5.56	5.00	4.56	6.00	6.33	5.00	5.83
		(1.42)		(1.26)		(0.62)		(0.82)		(1.33)
3	5.00	5.08	6.00	5.28	5.00	5.11	6.00	6.33	5.00	5.67
		(1.28)		(1.27)		(1.78)		(0.82)		(1.21)
4	5.00	5.25	6.00	5.22	5.00	4.61	6.00	6.17	5.00	5.33
		(1.75)		(1.52)		(0.98)		(0.98)		(1.37)
5	5.00	5.12	6.00	5.17	5.00	4.61	6.00	6.33	5.00	5.50
		(1.48)		(1.58)		(1.24)		(0.82)		(1.22)
6	5.00	4.83	6.00	5.33	4.00	4.28	6.00	6.33	5.00	5.50
		(1.20)		(1.50)		(1.49)		(0.82)		(1.22)
7	5.00	5.29	6.00	5.17	5.00	4.22	6.00	6.33	5.00	5.50
		(1.08)		(1.04)		(1.11)		(0.82)		(1.22)
8	5.00	5.25	6.00	5.28	4.50	4.44	6.00	6.33	5.00	5.50
		(1.26)		(1.27)		(0.78)		(0.82)		(1.22)
9	5.00	4.92	6.00	4.89	4.50	4.39	6.00	6.33	5.00	5.50
		(1.35)		(1.37)		(0.70)		(0.82)		(1.22)
10	5.00	4.79	6.00	5.22	5.00	4.39	6.00	6.33	5.00	5.50
		(1.56)		(0.94)		(1.24)		(0.82)		(1.22)
11	4.00	4.58	5.50	5.06	4.50	4.22	6.00	6.33	5.00	5.50
		(1.25)		(1.35)		(1.22)		(0.82)		(1.22)
12	4.50	4.54	6.00	5.11	5.00	4.78	6.00	6.33	5.00	5.50
		(1.28)		(1.02)		(1.77)		(0.82)		(1.22)
13	5.00	4.62	6.00	5.50	5.00	4.61	6.00	6.33	5.00	5.50
		(1.13)		(0.86)		(0.98)		(0.82)		(1.22)
14	4.00	4.71	6.00	5.22	5.00	4.50	6.00	6.33	5.00	5.50
		(1.08)		(1.22)		(1.04)		(0.82)		(1.22)
15	4.00	4.83	6.00	5.50	5.00	4.44	6.00	6.33	5.00	5.50
		(1.09)		(0.86)		(0.86)		(0.82)		(1.22)

Notes: Median (left) and mean (right) of individual prices per round. Only relevant prices for second movers in Treatment SeqRand. Standard deviations in parentheses.

Table B.2. Results in the treatments with fixed matching

Round	SimFix		SeqFix				TrSeqFix			
	p		p_1		p_2		p_1		p_2	
1	8.00	6.67	5.00	4.83	4.50	4.17	6.00	5.67	5.00	5.17
		(1.87)		(1.17)		(1.17)		(1.03)		(1.17)
2	8.00	6.83	5.50	5.50	5.00	5.17	6.00	6.33	5.00	5.83
		(1.64)		(1.52)		(1.17)		(0.82)		(1.33)
3	8.00	7.00	5.00	4.83	5.00	5.33	6.00	6.33	5.00	5.67
		(1.14)		(1.17)		(1.51)		(0.82)		(1.21)
4	8.00	6.67	5.00	5.50	5.00	5.33	6.00	6.17	5.00	5.33
		(1.67)		(1.38)		(1.03)		(0.98)		(1.37)
5	8.00	6.92	5.00	5.17	5.00	5.50	6.00	6.33	5.00	5.50
		(1.15)		(1.17)		(1.22)		(0.82)		(1.22)
6	7.00	6.58	5.00	4.67	4.50	4.83	6.00	6.33	5.00	5.50
		(1.98)		(1.03)		(1.17)		(0.82)		(1.22)
7	6.00	6.00	4.50	4.33	4.50	4.83	6.00	6.33	5.00	5.50
		(1.95)		(1.37)		(1.17)		(0.82)		(1.22)
8	6.00	6.00	5.50	5.33	5.00	5.00	6.00	6.33	5.00	5.50
		(2.04)		(1.21)		(1.10)		(0.82)		(1.22)
9	5.50	6.08	5.00	5.17	4.50	4.83	6.00	6.33	5.00	5.50
		(1.83)		(1.17)		(1.17)		(0.82)		(1.22)
10	6.00	6.17	4.50	5.00	4.50	4.83	6.00	6.33	5.00	5.50
		(1.75)		(1.26)		(1.17)		(0.82)		(1.22)
11	7.00	6.33	4.50	4.83	4.50	4.83	6.00	6.33	5.00	5.50
		(1.83)		(1.47)		(1.17)		(0.82)		(1.22)
12	5.50	6.00	5.50	5.33	5.00	5.17	6.00	6.33	5.00	5.50
		(1.91)		(1.21)		(0.98)		(0.82)		(1.22)
13	4.50	5.50	5.50	5.17	5.00	5.17	6.00	6.33	5.00	5.50
		(1.98)		(1.47)		(0.98)		(0.82)		(1.22)
14	4.50	5.08	5.00	5.17	5.00	5.17	6.00	6.33	5.00	5.50
		(2.39)		(1.33)		(1.17)		(0.82)		(1.22)
15	4.00	5.00	5.00	5.17	4.50	4.50	6.00	6.33	5.00	5.50
		(1.91)		(1.17)		(0.55)		(0.82)		(1.22)

Notes: Median (left) and mean (right) of individual prices per round. Only relevant prices for second movers in treatment TrSeqFix. Standard deviations in parentheses.

Appendix C. Translated instructions

Welcome to our experiment! Please read these instructions carefully! Do not talk to your neighbors and be quiet during the entire experiment. If you have a question, give notice. We will answer your questions privately.

In our experiment you can earn different amounts of money, depending on your behavior and the behavior of other participants who are matched with you.

You play the role of a firm which produces a similar product as another firm in the market. Both firms have to make a single decision, namely which prices they want to set. In the attached table, you can find each firm's profit resulting from every possible price constellation.

The table can be read as follows: the head of each row represents one firm's [in treatment SEQ: firm A's] price and the head of each column represents the price of the other firm [in treatment SEQ: firm B]. Inside the little box where row and column intersect, you can see your firm's [firm A's] profit at this combination of prices in the upper left corner and the other firm's [firm B's] profit at these prices in the lower right corner. The profit is measured in a fictitious currency which we call Taler.

[This paragraph only in treatment SIM] Both firms make their pricing decisions simultaneously. This is repeated for 15 rounds. After every round you will be informed about your profit and the other firm's price. You don't know with which participant you serve the market. In every new round you will be matched randomly with another participant in the following way: All participants are divided into two groups of equal size and participants from one group are always matched with participants from the other group.

[The following two paragraphs only in treatment SEQ] Now, turn to the question of how to make a choice. When the experiment starts, you will be told on your computer screen whether you are an A-firm or a B-firm. During the entire experiment you will keep this role. The procedure is that the A-firm always starts. This means that the A-firm chooses its price (i.e. selects a row in the table) and that the B-firm is informed about the A-firm's choice. Knowing the price set by the A-firm, the B-firm decides on its price (selects a column in the table). But this procedure will be conducted in the following way: Instead of deciding one after the other, i.e. B-firm after A-firm, the B-firm determines the prices it wants to set for all possible prices that the A-firm can set. By the end of the round both firms will be informed about the relevant price of the other firm and about their own profits. This procedure corresponds to the one described above where the A-firm sets its price first followed by the B-firm who decides on its price after being informed about the A-firm's price decision.

This is repeated for 15 rounds. You don't know with which participant you serve the market. In every new round you will be matched randomly with another participant such that an A-firm always meets a B-firm. This means that if you are an A-firm you will always be matched with a B-firm and vice versa.

This experiment is conducted on a computer. Full anonymity among participants and between participants and the instructors will be kept since your decisions cannot be identified with your person.

Concerning the payment, note the following: At the end of the experiment 3 of the 15 rounds will be randomly chosen in to count for your final payment. The sum of your profits in Taler of (only) these 3 rounds determines your payment in DM. For each 10 Taler you earned during these 3 rounds you will be paid 1 DM.

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