Testing Forbearance Experimentally —Duopolistic Competition of Conglomerate Firms—*

Werner Güth† Kirsten Häger‡ Oliver Kirchkamp§
Joachim Schwalbach¶

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Abstract

Like Feinberg and Sherman (1985) and Phillips and Mason (1992) we test experimentally whether conglomerate firms, i.e., firms competing on multiple structurally unrelated markets, can effectively limit competition. Our more general analysis assumes differentiated rather than homogeneous products and distinguishes strategic substitutes as well as complements to test this forbearance hypothesis. Rather than only a partners design we also explore a random strangers design to disentangle effects of forbearance and repeated interaction. Surprisingly, conglomerate firms do not limit competition, they rather foster it. More in line with our expectations we find more cooperation in complement markets than in substitute markets and also more cooperation in a partners than in a strangers matching.

Keywords: Experiment, Forbearance, Competition
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†Max Planck Institute of Economics, Strategic Interaction Group, Kahlaische Str. 10, 07745 Jena, Germany, email: gueth@econ.mpg.de, phone: +49 3641 686 629, fax: +49 3641 686 623

‡Universität Jena, kirsten.haeger@uni-jena.de

§Universität Jena, email: oliver@kirchkamp.de, phone +49-3641-943240, fax +49-3641-943242

¶Humboldt-Universität zu Berlin, Institute of Management, schwal@wiwi.hu-berlin.de

1 Introduction

Typically, large firms do not only offer many products, they also sell them in several distinct national and international markets. This is a fairly recent development. In contrast to modern large firms, firms around the centuries were conglomerates operating in unrelated markets and being confronted with conglomerate rivals in these unrelated markets. This observation of multimarket contact by conglomerate firms led economists to believe that multimarket contacts foster collusive behaviour in markets where rivals meet. Corwin D. Edwards was among the first who pointed to the potential of anti-competitive market outcomes:

> "There is an awareness that if competition against the large rival goes so far as to be seriously troublesome, the logic of the situation may call for conversion of the warfare into total war. Hence there is an incentive to live and let live, to cultivate a cooperative spirit, and to recognize priorities of interest in the hope of reciprocal recognition. Those attitudes support such policies as refraining from sale in a large company's home market below whatever price that company may have established there; refraining from entering into the production of a commodity which a large company has developed; not contesting the patent claims of a large company even when they are believed to be invalid; abstaining from an effort to win away the important customers of a large rival; and sometimes refusing to accept such customers even when they take the initiative." (Edwards, 1955, p. 335).

Although conglomerates are much less frequent in the age of globalisation, the concern that multimarket firms mutually forbear from competing even in related markets remains. Despite the potential for mutual forbearance among multiproduct firms, relatively little research has analysed the effects on competitive behaviour and market outcomes. Available evidence on the mutual forbearance hypothesis comes from experimental, theoretical, and empirical studies.

Our attempt to test the mutual forbearance hypothesis has been inspired by theoretical and experimental studies. Theoretical work by Bernheim and Whinston (1990) shows that asymmetries among multimarket firms and between market structures facilitate mutual forbearance. In Bernheim and Whinston's analysis cooperation relies on the threat of punishment. Markets with a less efficient punishment technology benefit from markets where punishment is more efficient in a conglomerate. Firms will cooperate in markets with less efficient punishment since they have to fear retaliation in the other market.

A first experimental study has been conducted by Feinberg and Sherman (1985). They assume that two firms compete in two homogeneous markets, with zero cross-elasticity of linear demand across markets, and linear production costs in both firms which are unrelated across markets. Their results provide some support for the mutual forbearance hypothesis. In view of Bernheim and Whinston's analysis the result of Feinberg and Sherman is surprising. In Feinberg and Sherman's experiment markets were identical. Nevertheless they found a forbearance effect. As a next step Phillips and Mason (1992) study conglomerates where the two markets differ. They find strong support for the idea of Bernheim and Whinston. One of the two markets becomes more cooperative at the expense of the other market. Does this mean that the interaction between the two markets is purely strategic? To answer this question Phillips and Mason (2001) study the situation of firms who are all active in two markets, but face different opponents in each of them. There is no strategic reason to punish one opponent for an experience made with the other opponent. Phillips and Mason find out that these two markets are still linked through learning.

This sequence of experimens was motivated by the empirical study of Heggestad and Rhoades (1978) who found that multimarket linkages between 187 major U.S. banking markets deterred competition. Successive empirical studies looked at the conditions under which multimarket contacts are weakened or strengthened, but consistently show that multimarket contacts go along with mutual forbearance. In particular, Evans and Kessides (1994) and Gimeno and Woo (1996, 1999) detected that collusive pricing is associated with multimarket contacts in the U.S. airline industry. Parker and Röller (1997) and Busse (2000) found collusive behaviour in the U.S. cellular telephone industry due to interdependency. Fernández and Marín (1998) showed effects of multimarket contracts on prices in the Spanish hotel industry and Jans and Rosenbaum (1997) in the U.S. cement industry. Furthermore, firms with multimarket contacts have higher profits (Scott, 1982, 1991), higher survival rates (Baum and Korn, 1996, 1999), lower R&D expenditures, fewer product introductions (Vonortas, 2000; Young et al., 2000), lower sales growth (Greve, 2008), and lower service quality (Prince and Simon, 2009).

With data from the field it is, of course, not easy to determine a clear causality. Do multimarket contacts lead to cooperation or does successful cooperation facilitate multimarket contacts? Our experimental study tries to complement the theoretical and empirical studies about mutual forbearance effects. In one framework, we study a large number of possible links between firms, different combinations of markets for substitutes and for complements and we vary the length of the interaction.

Section 2 describes our more general market environment and section 3 the experimental design. Section 5 analyses the experimental data for the various treatments. Section 6 concludes and compares our findings with those of Feinberg and Sherman (1985) and others.

2 The market model

Like Feinberg and Sherman (1985) and Phillips and Mason (1992), we capture "conglomerates" by seller firms which are active on two markets and "competing conglomerates" by duopolistic competition. Given this framework we compare 13 different treatments. In these treatments we vary the interaction between products, the "shadow of the future", and the matching of the conglomerate firms.

Different product types: From other experiments (see, for instance, Bester and Güth, 1998) we know that one often obtains qualitatively different results for strategic complements than for strategic substitutes. Hence, we allow for differentiated products which may be both, strategic substitutes and complements. We compare three cases:

- Both products on both markets are substitutes (this is the case considered by Feinberg and Sherman (1985), Phillips and Mason (1992) and Phillips and Mason (2001)).
- Both products on both markets are complements.
- The two products on the one market are substitutes, those on the other market are complements.

Different interaction times: Cooperation among firms does not need to be the result of a conglomerate structure, it could simply be the result of future dealings. To disentangle the two effects we vary the "shadow of the future" by comparing a design where players are rematched every four periods with one where they are rematched every twelve periods.[1]

[1]Relying on a partners design only like Feinberg and Sherman (1985) or Phillips and Mason (1992) appears realistic but invites all sorts of confounding effects as repeated interaction allows for reputation formation, punishment etc.

Different links between markets: We compare four different types of links between markets:

- In our baseline treatment there are only single firms, no conglomerates (this is also the baseline treatment in Phillips and Mason 1992 and Phillips and Mason (2001)).
- In "homogeneous conglomerates" firms face the same opponent in both markets (this is one of the treatments in Feinberg 1985 and Phillips and Mason 1992).
- In "heterogeneous conglomerates" firms face different opponents in both markets (this is the baseline treatment in Feinberg and Sherman 1985 and one of the treatments in Phillips and Mason 2001).

  Here we capture the case that conglomerates can be active on different markets. We employ a circle design with each firm selling on a left- and a right-hand market where it competes with its left-, respectively right-hand neighbour firm.
- In "asymmetric conglomerates" one unique conglomerate firm faces two different non-conglomerate firms.

  Here we want to disentangle the effect of "going conglomerate", i.e., of whether one gains from becoming active on more than one market and how this depends on the "conglomeration" of one's competitors.

Different types of markets There are two markets, X and Y. In each market there are two firms, i and j with $(i, j) \in \{(1, 2), (2, 1)\}$. Quantities in the X market are x_i and x_j. We abstract from production costs. Prices or unit profits in the X market are p_i and p_j. For the X-market the inverse demand functions are

$$p_i = a - bx_i + cx_j \text{ with } a, b > 0 \text{ and } |c| < 2b\,. \tag{1}$$

Quantities in the Y market are y_i and y_j. Prices in the Y market are q_i and q_j. For the Y-market the inverse demand functions are

$$q_i = \alpha - \beta y_i + \gamma y_j \text{ with } \alpha, \beta > 0 \text{ and } |\gamma| < 2\beta\,. \tag{2}$$

For $c > 0$, respectively $\gamma > 0$, the X-, respectively Y-products of both firms are strategic complements. For $c < 0$, respectively $\gamma < 0$ the products are substitutes. Profit for firm i's is given by

$$\Pi_i = p_i x_i + q_i y_i\,. \tag{3}$$

As the two markets are independent, except for possible forbearance effects, the equilibrium solutions are just the combinations of the two equilibria with

$$x_i^* = \frac{a}{2b-c} \text{ and } y_i^* = \frac{\alpha}{2\beta-\gamma} \text{ for } i = 1,2 \tag{4}$$

with the individual profits

$$\Pi_i^* = \frac{a^2 b}{(2b-c)^2} + \frac{\alpha^2 \beta}{(2\beta-\gamma)^2} \text{ for } i = 1,2\,. \tag{5}$$

As a reference point for a cooperative outcome we also derive the quantities that maximise the sum of profits of both firms on each market:

$$x_i^+ = \frac{a}{2(b-c)} \text{ and } \gamma_i^+ = \frac{\alpha}{2(\beta-\gamma)} \text{ for } i = 1,2 \tag{6}$$

with the individual profits

$$\Pi_i^+ = \frac{a^2}{4(b-c)} + \frac{\alpha^2}{4(\beta-\gamma)} \text{ for } i = 1,2\,. \tag{7}$$

3 Experimental design

Implementation: The experiment was programmed and conducted with z-Tree (Fischbacher, 2007). To recruit participants we used ORSEE (Greiner, 2004). It took place at the experimental laboratory of the School of Economics at the University of Jena between July 2008 and July 2009. All in all we collected 139 independent observations involving 574 participants.

Each session of the experiment started with a language test to ensure that everyone was able to understand the instructions. After the instructions were read and questions were answered in private participants completed a comprehension test to ensure that they understand the experiment. Then they participated in 24 periods of the actual experiment. Finally participants completed a post-experimental questionnaire eliciting, among others, the sales strategy used.

Parameters of the demand function: As in many other experiments with oligopoly markets we use payoff tables to represent payoffs in the game (see the instructions in appendix B). We have chosen parameters with identical equilibrium profits across markets, i.e.,

$$p_i^* x_i^* = \left(\frac{a}{2b-c}\right)^2 b = \left(\frac{\alpha}{2\beta-\gamma}\right)^2 \beta = q_i^* y_i^* \text{ for } i = 1,2\,. \tag{8}$$

Table 1 Parameters of the demand function used in the experiment

	a, α	b, β	c, γ	x^*	x^+	Π^*	Π^+
substitutes	64	2	-4	8	5	128	170
complements	24	2	1	8	12	128	144

As participants choose only integer quantities in the experiment, $x^+ = 5$ for markets with substitutes, and not 5 1/3. Profits Π^* and Π^+ are only profits within one market.

Requiring that also cartel profits Π^+ are the same under the x and the y market would imply

$$\alpha = a \cdot \sqrt{\frac{\gamma}{c}} \qquad \beta = b \cdot \frac{\gamma}{c}, \tag{9}$$

i.e. c must have the same sign as γ. But then both markets must feature either substitutes or complements. As we want to include the situation where one market is for substitutes and one for complements we have to accept that cartel profits can not always be the same.

Asymmetric attractiveness of the two markets—will forbearance mainly pacify the market which leads to higher equilibrium profits?—could be an interesting topic of future research. Here it has been neglected to limit the anyhow unusually large number of treatments. Due to the asymmetric parameters across markets, participants may not be aware that markets are equally attractive from a rational choice perspective and may actually experience them as yielding different profits.

The parameters of the demand functions used in the experiment are shown in table 1. With these parameters the values for sales, prices, and profits are positive in equilibrium and in the cooperative outcome.

Representation of choices and payoffs: Payoffs in the experiment are represented with the help of tables. A typical decision and feedback screen used in the experiment is shown in figure 1. Participants see—depending on the treatment which determines whether they are active on one or two markets—one or two tables, respectively. In each table they can choose a quantity x (between 1 and 12 and between 4 and 15 in substitute and complement markets, respectively). Participants are also asked to predict the quantity the other player (i.e. their rival on the respective market) is going to choose. Both players decide simultaneously. After each round players receive feedback about both choices and their payoff in this round. Earnings are cumulated over all 24 rounds and paid in cash after the experiment using an exchange rate of 250 Experimental Currency Units (ECU)/Euro if active in one market and an exchange rate of 500 ECU/Euro if active in two markets.

Figure 1 Decision and feedback screen in the experiment

Period 2

remaining time [sec]: 57

Market X

quantity of the other seller (columns); quantity you are selling (rows)

	1	2	3	4	5	6	7	8	9	10	11	12
1	58	54	50	46	42	38	34	30	26	22	18	14
2	112	104	96	88	80	72	64	56	48	40	32	24
3	162	150	138	126	114	102	90	78	66	54	42	30
4	208	192	176	160	144	128	112	96	80	64	48	32
5	250	230	210	190	170	150	130	110	90	70	50	30
6	288	264	240	216	192	168	144	120	96	72	48	24
7	322	294	266	238	210	182	154	126	98	70	42	14
8	352	320	288	256	224	192	160	128	96	64	32	0
9	378	342	306	270	234	198	162	126	90	54	18	-18
10	400	360	320	280	240	200	160	120	80	40	0	-40
11	418	374	330	286	242	198	154	110	66	22	-22	-66
12	432	384	336	288	240	192	144	96	48	0	-48	-96

Market Y

quantity of the other seller (columns); quantity you are selling (rows)

	4	5	6	7	8	9	10	11	12	13	14	15
4	80	84	88	92	96	100	104	108	112	116	120	124
5	90	95	100	105	110	115	120	125	130	135	140	145
6	96	102	108	114	120	126	132	138	144	150	156	162
7	98	105	112	119	126	133	140	147	154	161	168	175
8	96	104	112	120	128	136	144	152	160	168	176	184
9	90	99	108	117	126	135	144	153	162	171	180	189
10	80	90	100	110	120	130	140	150	160	170	180	190
11	66	77	88	99	110	121	132	143	154	165	176	187
12	48	60	72	84	96	108	120	132	144	156	168	180
13	26	39	52	65	78	91	104	117	130	143	156	169
14	0	14	28	42	56	70	84	98	112	126	140	154
15	-30	-15	0	15	30	45	60	75	90	105	120	135

OK

In the experiment participants click for each market on a row for their own sales quantity and on a column to indicate what they think their partner's choice will be. Chosen rows and columns are highlighted in red. The intersection of a highlighted row and column is marked with a circle. Feedback (regarding the other player's actual quantity and the own profit) is only given after both participants have entered their choices. Knowing the two quantities players can also look up the other player's profit in the table.

The earning per person was between 7.8 Euros and 18.6 Euros with an average of 12.49 Euros. Sessions usually lasted about 90 minutes.

Repetition and matching: Forbearance, if it can be detected, e.g. by higher than equilibrium profits or by higher profits than in the control treatment with one-market firms, may be strong initially and lose importance later or vice versa. It therefore seems important to repeat the experiment often enough to render such dynamics observable. In the partners design the two firms, represented by two participants, stay together over twelve rounds. After that they are matched with a new partner with whom they play the next twelve rounds. The repetition is not previously announced. But when starting the repetition, participants are told that after the repetition the experiment ends. Also in the strangers design participants are told that they will be matched three times for four rounds with a random interaction partner. After these twelve rounds they are told that they will again be matched three times for four rounds. The matching structure for the different treatments is described in detail in appendix A. An overview of the different treatments is provided in table 2.

Our design differs from that of Feinberg and Sherman (1985) and Phillips and Mason (1992) who performed pen-and-paper classroom sessions. Although one can easily infer other's profits from the own feedback information after a round, unlike Feinberg and Sherman 1985 we did not provide this information to avoid demand effects like inspiring payoff comparisons or imitation learning and other regarding concerns. Furthermore, whereas Feinberg and Sher-

Table 2 Treatments

treatment	type of conglomerate	matching structure	rematching every...rounds	market x	market y	independent observations	participants
1	no conglomerate	(a)	12	substitutes		8	32
2	no conglomerate	(a)	12	complements		8	32
3	no conglomerate	(a)	4	substitutes		11	44
4	no conglomerate	(a)	4	complements		8	32
5	homogeneous	(b)	12	substitutes	substitutes	12	48
6	homogeneous	(b)	12	substitutes	complements	12	48
7	homogeneous	(b)	12	complements	complements	11	44
8	homogeneous	(b)	4	substitutes	substitutes	12	48
9	homogeneous	(b)	4	substitutes	complements	12	48
10	homogeneous	(b)	4	complements	complements	12	48
11	heterogeneous	(c)	12	substitutes	complements	12	48
12	heterogeneous	(c)	4	substitutes	complements	12	48
13	asymmetric	(d)	12	substitutes	complements	9	54

The matching structure is described in detail in appendix A.

man (1985) explore their treatments within subjects we employed a between subjects design throughout.

4 Hypotheses:

As profits with cooperation are substantially higher, we expect that participants will try to maintain cooperation with their partner. Although the experimental game that we study here has a finite horizon and can easily be solved by backward induction we know that cooperation emerges in these kind of games.

Hypothesis 1 (Cooperation) *The majority of the subjects will sell more than the equilibrium quantity with complements and less than the equilibrium quantity with substitutes.*

From other experiments with finitely repeated games we know that participants don't do backward induction from the last up to the first period. At the beginning of a finitely repeated game behavior is similar to behavior in an infite game. Let us assume for a moment that participants treat this game as one with an infinite horizon and discount factor δ. Cooperative quantities are given by x^+ and quantities in the Nash equilibrium are given by x^*. If players follow a simple "grim" strategy, then cooperation can emerge if

$$\Pi(x^-, x^+) + \frac{\delta}{1-\delta}\Pi(x^*, x^*) \leq \frac{1}{1-\delta}\Pi(x^+, x^+)\,, \tag{10}$$

where x^- is the best reply against a cooperative opponent. Bernheim and Whinston (1990) argue that cooperation is easier to obtain if inequality (10) holds even for smaller values of δ. The critical value for δ is, with our parameters, $12/19 \approx 0.632$ for substitutes and $9/17 \approx 0.529$ for complements. Following this line of reasoning we should expect more cooperation in markets for complements. Bester and Güth (1998) use an evolutionary argument and point out that, generally, in markets for complements incentives are more aligned than in markets for substitutes and, hence, in an evolutionary setting cooperation can be achieved more easily. Both arguments suggest hypothesis 2.

Hypothesis 2 (Complements vs. Substitutes) *We will find more cooperation in complement markets than in substitute markets.*

In our partner design with twelve repeated rounds the players have more time to find out how their partners act than in our random stranger design with only four rounds with the same partner. That way they are more likely to come to a cooperative solution. In addition, taking a choice which yields low profits for the partner can be punished for a longer time by the opponent in the partner matching. Knowing this, we suspect subjects to be more prudent of their choice and, thus, to cooperate more in the treatments with a partner matching.

Hypothesis 3 (Partners) *We will find more cooperation in treatments with partner design (rematching every 12 periods) than in treatments where rematching occurs every 4 periods.*

According to the forbearance hypothesis, two firms that compete against each other on two unrelated markets will behave less aggressively than two firms that are only active in one market. The former will fear that an aggressive strategy in one market will be met with retaliation in not only one but actually both markets.

Hypothesis 4 (Forbearance) *We will find more cooperation in markets with conglomerate firms than in markets with single firms.*

While hypothesis 4 might look plausible, forbearance should have no effects at all in heterogeneous conglomerates.If the fear of retaliation in more than one market supports cooperation in conglomerate firms then this effect should be visible only in treatments where players face the same opponent in two markets simultaneously (homogenous conglomerates). It should not be visible in treatments where players act in two markets, but with different opponents (heterogenous conglomerates).

Hypothesis 5 (Homogeneous forbearance) *We will find more cooperation in homogeneous conglomerates than in heterogeneous conglomerates.*

In the asymmetric conglomerate situation both markets are entirely independent. Still, the conglomerate firm faces a smaller amount of risk since it is operating in two markets simultaneously. This might tempt the conglomerate to act more aggressively.

Hypothesis 6 (Relative conglomerate power) *In asymmetric conglomerates profits are larger for the conglomerate than for the single firms.*

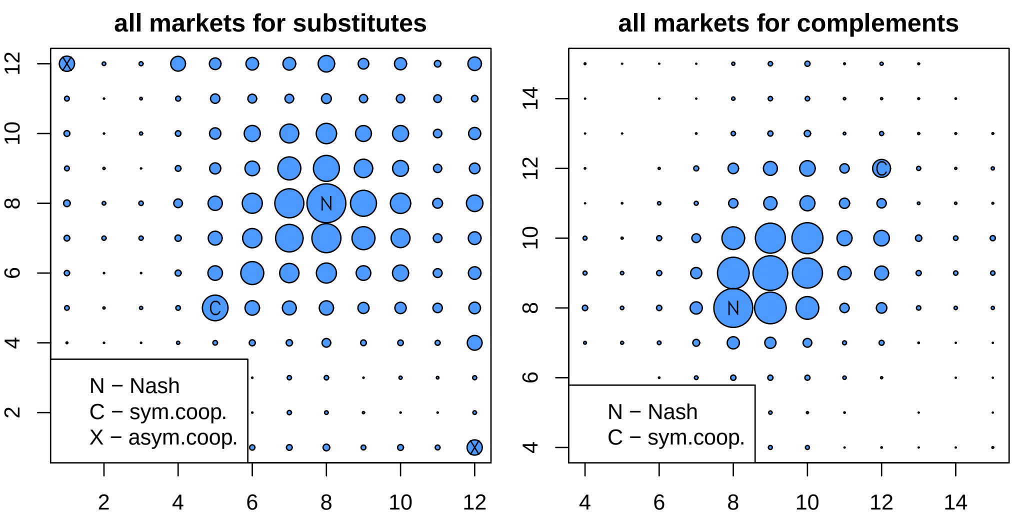
5 Results

5.1 Overview

Figure 2 shows frequencies of pairs of choices for all markets and for all markets with complements. The size (area) of the circles is proportional to the frequency. The equilibrium is denoted by N, the symmetric cooperative outcome is denoted by C, the asymmetric cooperative outcome in markets for substitutes is called X. Figures 3 and 4 provide more details for the individual treatments. Each graph shows the difference between the relative frequency of choices in a treatment (for a given market type, either substitutes or complements) and the average of this market type (substitititutes or complements). In addition to the figures, we will present the results of estimating mixed effects models to measure these effects in a more systematic way in sections 5.2 and 5.3.

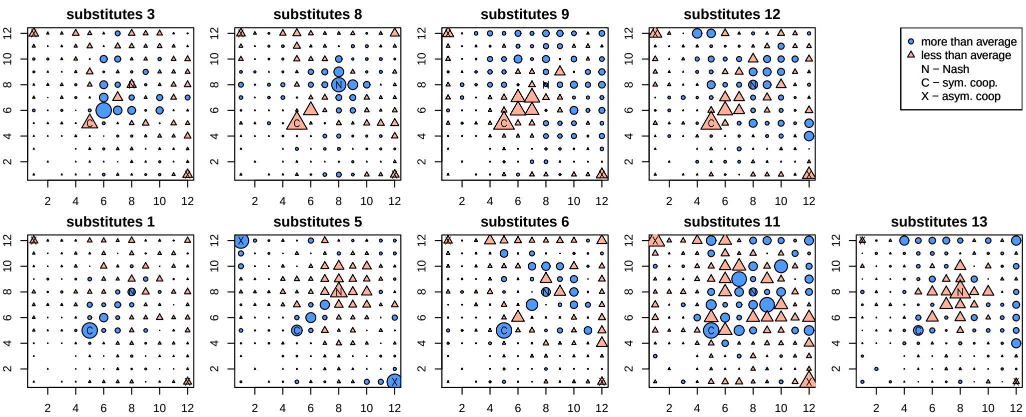
The average profit for each market per round was between -96 and 432 with an average of 129.6 ECU, slightly above the profit of the equilibrium level of 128. Figure 5 shows the development of average profits over time during the experiment. We see a clear end-game effect, i.e. a decrease in profits in the last round of every matching sequence. Figure 6 shows boxplots of profits for the different treatments and markets indicating that the variance

Figure 2 Frequencies of pairs of choices



The size (area) of the symbols is proportional to the frequencies of choices.

Figure 3 Frequencies of pairs of choices compared to average — substitutes

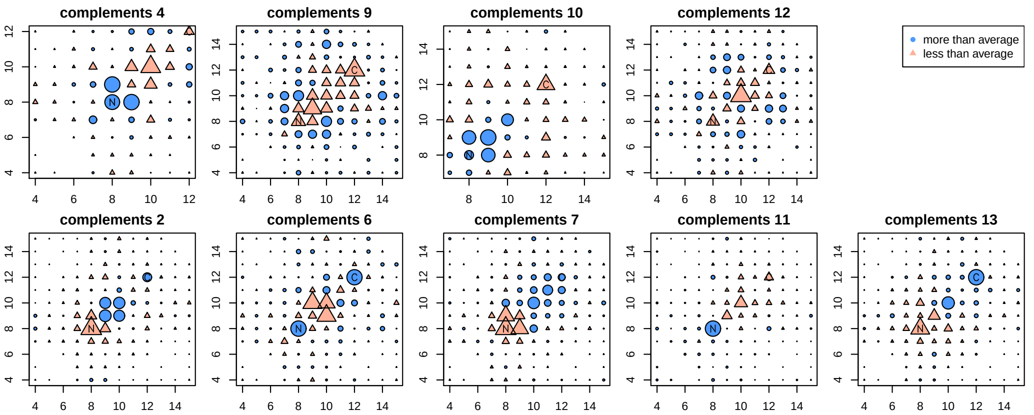


The size (area) of the symbols is proportional to the relative frequencies of choices in the treatment minus the relative frequency of choices in all treatments with markets for substitutes. Numbers of treatments correspond to table 2.

of profits is much smaller in markets for complements. We also see that profits in conglomerates (treatments 5–13) are more heterogeneous than in our baseline treatments (treaments 1-4).

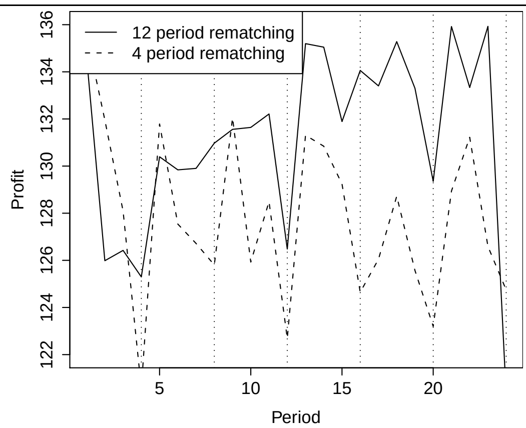
The left part of figure 7 illustrates the distribution of quantities separately for substitutes and for complements. In line with hypothesis 1 most quantities (67.71%) are strictly larger than the equilibrium quantity of 8 for

Figure 4 Frequencies of pairs of choices compared to average — complement



The size (area) of the symbols is proportional to the relative frequencies of choices in the treatment minus the relative frequency of choices in all treatments with markets for complements. Numbers of treatments correspond to table 2.

Figure 5 Average profits per period



complements. This property is less pronounced for substitutes.

According to hypothesis 1 we should find a smaller than equilibrium quantity for substitutes if players, indeed, cooperate also in the market for substitutes. However, we see that there is less cooperation in markets for substitutes: Only 43.3% of all players choose quantities strictly smaller than the Nash equilibrium when products are substitutes.

Result 1 *Most participants clearly choose more than equilibrium (cooperative) quantities with complements. A much smaller fraction chooses less than equilibrium (cooperative) quantities with substitutes.*

We will come back to this observation in section 5.2 below.

Figure 6 Profits per interaction in different treatments

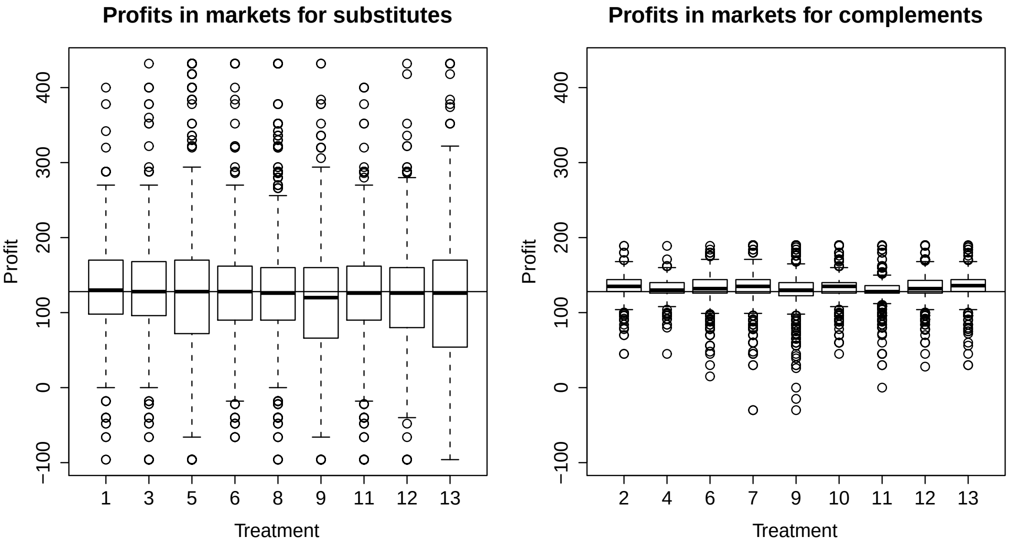
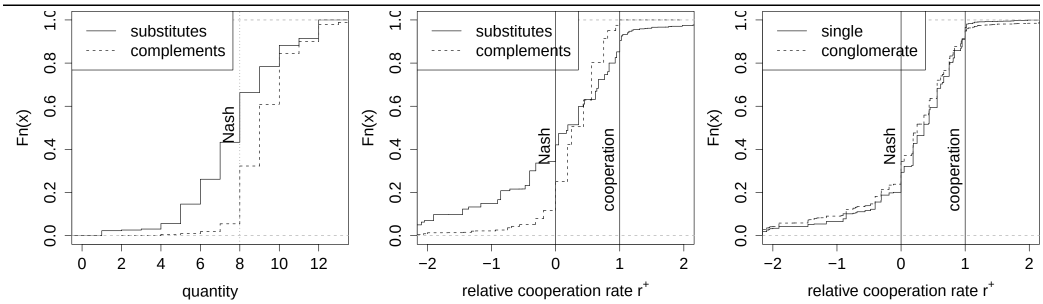


Figure 7 Quantities and cooperation rates



Cooperation rate The definition of a cooperation rate is a bit messy since for substitutes profit is actually maximised in an asymmetric allocation: One player chooses the smallest possible quantity and the other chooses the largest possible quantity. For simplicity we use a symmetric outcome in both market types and define the cooperation rate as follows: We will say that subjects cooperate fully if they choose the *symmetric* cooperative solution. To measure different degrees of cooperation we define a cooperation rate (henceforth denoted as r^+).

$$r^+ = \left(\frac{\Pi(x_i, x_j) + \Pi(x_j, x_i) - 2 \cdot \Pi^*}{2 \cdot (\Pi^+ - \Pi^*)} \right) \tag{11}$$

$\Pi(x_i, x_j) + \Pi(x_j, x_i)$ is the joint profit of both players, Π^* the equilibrium profit of a single player, and Π^+ is the profit of a single player in the symmetric cooperative outcome.

By definition, $r^+ = 1$ in the symmetric cooperative outcome and $r^+ = 0$ in the Nash-equilibrium. In complement markets $r^+ > 0$ requires that a player chooses a quantity higher than the equilibrium quantity of 8. In substitute markets r^+ requires a quantity lower than 8. Figure 7 shows in the middle and on the right the distribution of the relative cooperation rate r^+.

Result 2 *In the majority (i.e. 76.7%) of cases the relative cooperation rate is positive ($r^+ \geq 0$).*

5.2 Cooperation

In this section we want to have a more formal look at hypotheses 2 to 6. We will first present an overview over treatments, then we will have a more detailed look at the different market situations, and then we will look at specific hypotheses.

Treatments: We estimate two models with mixed effects for relative cooperation r^+ and for profits Π:

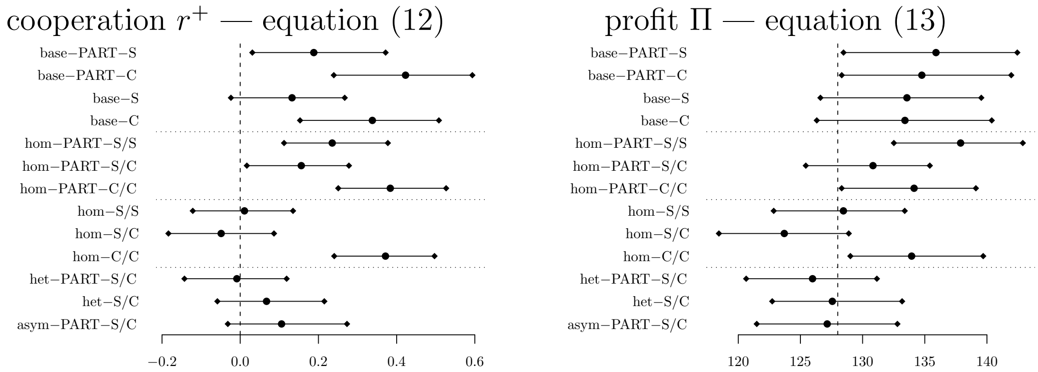
$$r^+_{it} = \sum_{T \in \mathcal{T}} \beta_T d_T + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{12}$$

$$\Pi_{it} = \sum_{T \in \mathcal{T}} \beta_T d_T + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{13}$$

Here $\mathcal{T}$ is the set of our 13 treatments. Dummies d_T are one in treatment T and zero otherwise. For each treatment $T \in \mathcal{T}$ we estimate as β_T the average cooperation rate r^+ in equation (12) and the average profit Π in equation (13). The mixed effects model takes into account the correlation of observations in our experiment as follows: g is an index of the matching group in the experiment (independent observation), i is an index for the individual participant, and t indicates the period. In addition to the residuals ϵ_{it} each equation includes a random effect for the matching group in the experiment ϵ_g and a random effect for the individual participant ϵ_i.[2] To exclude end game behaviour (see figure 5) we drop the last period of each interaction. Estimation results are presented in figure 8.

[2]Mixed effects models are estimated with lme4 version 0.999375-33 (2010-03-31). HPD confidence intervals and significance levels are based on bootstraps with 1000 replications.

Figure 8 Treatments



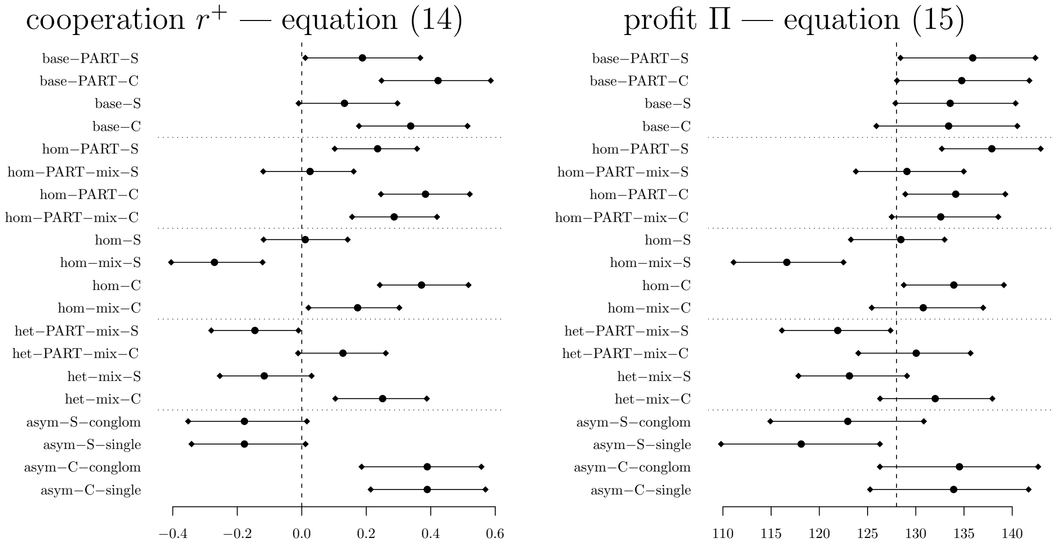
Each line shows the range of the HPD confidence interval, based on 1000 bootstrap replications. The larger dot is the parameter estimate of the coefficient for this treatment. Different links between markets are denoted “base”,“hom”,“het”, and “asym” for the baseline, homogeneous, heterogeneous, and asymmetric conglomerate. The partner treatment is denoted as “PART”. Markets for subtitutes are called ”S”, those for complements are called ”C”.

As expected, partners (PART) cooperate more, in particular in homogeneous conglomerates. Also as expected, we see that in all treatments there is more cooperation in the market for complements than in the matching market for substitutes.

The figure reveals one complication that we have to take into account in the next step: Cooperation rates and profits of treatments where one market is for substitutes and the other for complements are clearly below cooperation rates in the treatments where both markets are of the same type, i.e. either both are for substitutes or both are for complements. In other words, it seems to affect the profitability of a market for, e.g. substitutes, whether the other market is one for substitutes, too, or one for complements.

Market situations: Several of our treatments include only one situation. Either both markets are the same or (in the baseline treatments) there is only market. There are, however, treatments that are “mixed” in the sense that the two markets are different (one is for substitutes and the other for complements) or that the two players have different roles (in the asymmetric treatment one firm is a conglomerate firm, the other two are single firms). As an extension of equations (12) and (14) we distinguish here between these situations.

Figure 9 Market situations



See also the notes for Figure 8. If the other market is of a different type (e.g. for complements if this market is for substitutes) we denote this situation as "mix". In the asymmetric treatment we denote the conglomerate with "conglom" and the single firm with "single".

We estimate the follwing two models:

$$r^+_{it} = \sum_{S\in\mathcal{S}} \beta_S d_S + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{14}$$

$$\Pi_{it} = \sum_{S\in\mathcal{S}} \beta_S d_S + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{15}$$

Here $\mathcal{S}$ is the set of our 20 different situations. For each situation $S \in \mathcal{S}$ we estimate as β_S the average cooperation rate r^+ in equation (14) and the average profit Π in equation (15). The mixed effects are defined as in equation (12) and (13). Again we drop the last period of each interaction to exclude end game behaviour. Figure 9 shows estimated coefficients and confidence intervals.

Let us first look in figure 9 at mixed markets in homogeneous conglomerates. As we already saw in the discussion of equations (14) and (15), these mixed markets are special. Regardless whether we look at the partners or strangers matching, regardless whether we look at complement or substitute markets, firms who operate in a mix of complement and substitute markets cooperate less in our experiment. To establish this formally we estimate the

Table 3 Mixed markets

	cooperation — eq. (16)		profit — eq. (17)	
(Intercept)	0.343^{***}	$[0.260; 0.440]$	133.828^{***}	$[129.480; 137.519]$
mixed	-0.199^{**}	$[-0.321; -0.081]$	-6.426^{**}	$[-11.349; -1.560]$
partner	0.150^{*}	$[0.027; 0.262]$	5.737^{*}	$[0.922; 10.227]$
subs	-0.332^{***}	$[-0.379; -0.278]$	-5.972^{***}	$[-9.085; -3.047]$
AIC	29776.806		125294.651	
N	11344		11344	

Stars denote the following significance levels: ***=.001, **=.01, *=.05, $^{+}$=.1. 95% HPD confidence intervals are given in brackets. The estimation includes only data from homogeneous conglomerates.

following model only for homogeneous conglomerates:

$$r_{it}^{+} = \beta_{\text{mixed}} \cdot d_{\text{mixed}} + \beta_{\text{partner}} \cdot d_{\text{partner}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \quad (16)$$

$$\Pi_{it} = \beta_{\text{mixed}} \cdot d_{\text{mixed}} + \beta_{\text{partner}} \cdot d_{\text{partner}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \quad (17)$$

Estimation results are shown in table 3. We see that the coefficient of "mixed" is highly significant.

Result 3 (Mixed markets) *Rates of cooperation and profits are smaller if the type of the other market differs from the type of the own market.*

This is important when we compare conglomerates with our baseline treatments. Since the baseline treatment can not contain any mixed situations we should better leave them out in the comparison. To compare baseline treatments and homogeneous conglomerates we estimate the following (only for baseline and homogeneous conglomerates, and leaving the mixed situations and the endgames aside):

$$r_{it}^{+} = \beta_{\text{homcon}} \cdot d_{\text{homcon}} + \beta_{\text{partner}} \cdot d_{\text{partner}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \quad (18)$$

$$\Pi_{it} = \beta_{\text{homcon}} \cdot d_{\text{homcon}} + \beta_{\text{partner}} \cdot d_{\text{partner}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \quad (19)$$

Results are shown in table 4. According to hypothesis 4 we should find more cooperation and higher profits in markets with conglomerate firms than in markets with single firms. We can not confirm this hypothesis. In contrast to our expectations we find a negative (though not significant) effect. In any case, if we compare the magnitude of the "conglomerate" effect (-0.022) with the intercept (0.343), i.e. the cooperation rate of firms on a market for complements, we see that the conglomerate effect is very small.

Result 4 *Conglomerate firms cooperate less than firms that are only active in one market.*

Table 4 Conglomerates versus non-conglomerates

	cooperation — eq. (18)		profit — eq. (19)	
(Intercept)	0.343^{***}	$[0.232; 0.456]$	132.719^{***}	$[127.870; 137.375]$
homcon	-0.022	$[-0.131; 0.091]$	-0.822	$[-5.312; 3.314]$
partner	0.099^{+}	$[-0.013; 0.197]$	3.740^{+}	$[-0.613; 7.886]$
subs	-0.240^{***}	$[-0.348; -0.133]$	-0.235	$[-4.391; 4.110]$
AIC	26531.043		113473.611	
N	10280		10280	

Stars denote the following significance levels: ***=.001, **=.01, *=.05, $^{+}$=.1. 95% HPD confidence intervals are given in brackets. The estimation includes only data from homogeneous conglomerates and the baseline treatments. Mixed markets are exluded.

How to explain such surprising results will be discussed in the concluding section.

One could argue that the comparison of conglomerates with single firms in equations (18) and (19) is not adequate. Perhaps the task for participants in the experiment was easier in the baseline treatment since there participants could concentrate on a single market and, thus, easier reap the fruits of cooperation. A more adequate comparison would be to compare homogeneous with heterogeneous conglomerates. For participants in the experiment the two situations are very similar. However, there is no forbearance effect possible in heterogeneous conglomerates: Partners in the X market know that they have both different partners in the Y market.

In our next step we will, hence, compare homogeneous with heterogeneous conglomerates. Since in the heterogeneous conglomerates we have only "mixed" markets we will restrict our analysis to this market type. We estimate the following equation:

$$r_{it}^{+} = \beta_{\text{hetcon}} \cdot d_{\text{hetcon}} + \beta_{\text{partner}} \cdot d_{\text{partner}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \quad (20)$$

$$\Pi_{it} = \beta_{\text{hetcon}} \cdot d_{\text{hetcon}} + \beta_{\text{partner}} \cdot d_{\text{partner}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \quad (21)$$

Results are shown in table 5. According to hypothesis 5 we should find more cooperation in homogeneous conglomerates than in heterogeneous conglomerates. If there is a forbearance effect then we should find it here. Indeed, the coefficient of "hetcon" has the right sign, but the value is not significant and very small (-0.026) — much smaller than anything else that plays a role here.

Result 5 *We do not find significantly more cooperation in homogeneous than in heterogeneous conglomerates if we restrict ourselves to "pure" markets.*

Table 5 Heterogeneous versus homogeneous conglomerates

	cooperation — eq. (20)		profit — eq. (21)	
(Intercept)	0.187***	[0.060; 0.301]	130.129***	[125.743; 134.163]
hetcon	−0.026	[−0.155; 0.116]	−0.605	[−4.936; 4.627]
partner	0.064	[−0.061; 0.208]	2.771	[−2.064; 7.171]
subs	−0.329***	[−0.368; −0.292]	−8.385***	[−10.505; −6.180]
AIC	20294.225		82334.466	
N	7680		7680	

Stars denote the following significance levels: ***=.001, **=.01, *=.05, $^{+}$=.1. 95% HPD confidence intervals are given in brackets. The estimation includes only data from mixed markets of homogeneous and heterogeneous conglomerates.

Table 6 Single firms versus conglomerate firms

(Intercept)	135.048***	[124.306; 145.872]
asymSingle	−2.715	[−14.220; 7.953]
subs	−12.619***	[−20.538; −5.690]
AIC	17655.791	
N	1584	

Stars denote the following significance levels: ***=.001, **=.01, *=.05, $^{+}$=.1. 95% HPD confidence intervals are given in brackets. The estimation includes only data from asymmetric conglomerates.

So far we have established in results 4 and 5 that, compared with the effects of repeated interaction or the influence of the market type, the forbearance effect is very small and not significant. What can we say about the interaction among a conglomerate firm with other market participants? According to hypothesis 6 we should expect relatively larger profits of the conglomerate and smaller profits of the single firms. Since the rate of cooperation is the same for both firms, the single firm and the conglomerate, we can only estimate the equation for profits:

$$\Pi_{it} = \beta_{\text{asymSingle}} \cdot d_{\text{asymSingle}} + \beta_{\text{subs}} \cdot d_{\text{subs}} + \epsilon_g + \epsilon_i + \epsilon_{it} \qquad (22)$$

Results are shown in table 6. We see that the effect of being a single firm has the expected sign, it is negative and -2.715, but the effect is not significant.

According to hypothesis 2 we should find more cooperation in complement markets than in substitute markets. Indeed, β_{subs} is highly significant and negative in equations (18)–(22).

Result 6 *We find more cooperation and higher profits in markets for complements than in markets for substitutes.*

According to hypothesis 3 we should find more cooperation in treatments with partner design. Indeed, the coefficient β_{partner} has the correct sign in equations (18)–(22), although it not signficant.

Result 7 *There is slightly more cooperation in treatments with partner design (matching for twelve periods) than in treatments with more frequent rematching (every four periods).*

5.3 Market Interaction: Reciprocity and Learning

Above, in section 5.2, we have studied aggregate levels of cooperation. In this section we want to analyse how firms interact in markets.

Bernheim and Whinston (1990) provide a theoretical model of equilibria in homogeneous conglomerates. They argue that the efficiency of punishment and reward can differ between different markets. Within one homogeneous conglomerate the market with the more efficient technology for punishment and reward can be used to support cooperation in the other market.

Phillips and Mason (2001) provide an experimental study of heterogeneous conglomerates. Of course, there is no strategic reason to punish or reward one firm for what another firm did in another market. However, players could still learn from one market for their behaviour in the other.

We distinguish two main motives for behaviour

- A firm optimises myopically and adjusts the own quantity towards a best reply to the opponent's behaviour in the previous period

$$\Delta x_t^{\text{BR}} = \frac{a + c x_{j,t-1}}{2b} - x_{i,t-1} \tag{23}$$

  or towards a best reply to the expected opponent's behaviour in the current period (note that we observe expectations in our experiment).

$$\Delta x_t^{\text{BR|E}} = \frac{a + c x_{j,t}^{E}}{2b} - x_{i,t-1} \tag{24}$$

- A firm could try to educate the opponent, punishing misbehaviour or rewarding kindness. This might be costly in the short run but might lead to higher profits in the future. To make our different market situations more comparable we define misbehaviour or kindness of player j as a change in the (potential) profits player i could obtain if player i played a best reply. The best profit player i could obtain, given the behaviour of player j is

$$\Pi_{i,t}^{\text{BR}} = \frac{(a + c x_{j,t})^2}{4b} \,. \tag{25}$$

Reward or punishment works differently in markets for substitutes than in markets for complements. The marginal gain of player j to a change in the quantity of player i is given by $c \cdot x_j$. We define the strategic incentive to change the own quantity as

$$\dot{\pi}_{t-1} = \frac{1}{c} \left(\Pi^{\mathrm{BR}}_{i,t-1} - \Pi^{\mathrm{BR}}_{i,t-2} \right) \, . \tag{26}$$

For reactions to changes in the other market we define $\dot{\pi}^{\mathrm{O}}_{t-1}$ accordingly. Lagged versions of this variable will be $\dot{\pi}_{t-2}$, $\dot{\pi}_{t-3}$, etc.[3]

We define

$$X^{\mathrm{BR}} \equiv \Delta x_t^{\mathrm{BR|E}} \cdot (\beta_1 d_{\mathrm{sub}} + \beta_2 d_{\mathrm{com}}) + \Delta x_t^{\mathrm{BR}} \cdot (\beta_3 d_{\mathrm{sub}} + \beta_4 d_{\mathrm{com}}) \tag{27}$$

$$X^{\mathrm{SAME}} \equiv \sum_{l=1}^{3} (\gamma_l^{\mathrm{S}} d_{\mathrm{sub}} + \gamma_l^{\mathrm{C}} d_{\mathrm{com}}) \dot{\pi}_{t-l} \tag{28}$$

$$X^{\mathrm{SC/CS}} \equiv \sum_{l=1}^{3} (\gamma_l^{\mathrm{SC}} d_{\mathrm{sub}} d^{\mathrm{O}}_{\mathrm{com}} + \gamma_l^{\mathrm{CS}} d_{\mathrm{com}} d^{\mathrm{O}}_{\mathrm{sub}}) \dot{\pi}^{\mathrm{O}}_{t-l} \tag{29}$$

$$X^{\mathrm{SS/CC}} \equiv \sum_{l=1}^{3} (\gamma_l^{\mathrm{SS}} d_{\mathrm{sub}} d^{\mathrm{O}}_{\mathrm{sub}} + \gamma_l^{\mathrm{CC}} d_{\mathrm{com}} d^{\mathrm{O}}_{\mathrm{com}}) \dot{\pi}^{\mathrm{O}}_{t-l} \, . \tag{30}$$

Here X^{BR} capture the tendency to play a best reply, X^{SAME} captures reciprocity on the same market, $X^{\mathrm{SC/CS}}$ captures reciprocity towards an other market of a different type, and $X^{\mathrm{SS/CC}}$ captures reciprocity towards an other market of the same type. The dummies d_{sub} and d_{com} are one in markets for substitutes and complements, respectively. The dummies $d^{\mathrm{O}}_{\mathrm{sub}}$ and $d^{\mathrm{O}}_{\mathrm{com}}$ are one if the other market is one for substitutes and complements, respectively. β and γ are the coefficients that we will estimate in the following three equations with random effects for participants ϵ_i and matching groups ϵ_g for the baseline (31), the homogeneous (32) and the heterogeneous (as well as the asymmetric) conglomerate (33):

$$\Delta x_t = \beta_0 + X^{\mathrm{BR}} + X^{\mathrm{SAME}} + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{31}$$

$$\Delta x_t = \beta_0 + X^{\mathrm{BR}} + X^{\mathrm{SAME}} + X^{\mathrm{SC/CS}} + X^{\mathrm{SS/CC}} + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{32}$$

$$\Delta x_t = \beta_0 + X^{\mathrm{BR}} + X^{\mathrm{SAME}} + X^{\mathrm{SC/CS}} + \epsilon_g + \epsilon_i + \epsilon_{it} \tag{33}$$

Estimation results are shown in tables 7 and 8. We make the following observations:

[3] We also ran regressions with fewer lags and obtained similar results.

Table 7 Estimation of equations (31), (32) and (33)

	baseline		homogeneous		heterogeneous	
(Intercept)	−0.111	[−0.407; 0.184]	−0.036	[−0.173; 0.096]	0.070	[−0.066; 0.198]
$\Delta x_t^{\text{BR}\|\text{E}} d_{\text{sub}}$	0.263***	[0.203; 0.313]	0.266***	[0.241; 0.288]	0.058**	[0.024; 0.100]
$\Delta x_t^{\text{BR}\|\text{E}} d_{\text{com}}$	1.756***	[1.478; 2.096]	1.256***	[1.125; 1.372]	1.394***	[1.203; 1.589]
$\Delta x_t^{\text{BR}} d_{\text{sub}}$	0.382***	[0.302; 0.438]	0.286***	[0.261; 0.311]	0.413***	[0.365; 0.464]
$\Delta x_t^{\text{BR}} d_{\text{com}}$	−0.801***	[−1.133; −0.478]	−0.533***	[−0.650; −0.405]	−0.672***	[−0.874; −0.498]
$\dot{\pi}_{t-1} d_{\text{sub}}$	0.051***	[0.043; 0.058]	0.025***	[0.022; 0.029]	0.028***	[0.022; 0.034]
$\dot{\pi}_{t-1} d_{\text{com}}$	0.022***	[0.012; 0.033]	0.013***	[0.009; 0.018]	0.014***	[0.007; 0.020]
$\dot{\pi}_{t-2} d_{\text{sub}}$	0.035***	[0.027; 0.041]	0.016***	[0.013; 0.019]	0.017***	[0.010; 0.022]
$\dot{\pi}_{t-2} d_{\text{com}}$	0.016*	[0.007; 0.027]	0.006*	[0.001; 0.011]	0.007*	[0.001; 0.014]
$\dot{\pi}_{t-3} d_{\text{sub}}$	0.023***	[0.018; 0.028]	0.009***	[0.006; 0.012]	0.013***	[0.008; 0.018]
$\dot{\pi}_{t-3} d_{\text{com}}$	0.013**	[0.004; 0.022]	0.007***	[0.002; 0.010]	0.003	[−0.004; 0.009]
$\dot{\pi}_{t-1}^{\text{O}} d_{\text{sub}}^{\text{O}} d_{\text{sub}}$			0.007***	[0.004; 0.010]		
$\dot{\pi}_{t-1}^{\text{O}} d_{\text{com}}^{\text{O}} d_{\text{sub}}$			0.036**	[0.013; 0.061]	0.022+	[−0.002; 0.048]
$\dot{\pi}_{t-1}^{\text{O}} d_{\text{sub}}^{\text{O}} d_{\text{com}}$			0.001	[−0.000; 0.002]	0.000	[−0.001; 0.001]
$\dot{\pi}_{t-1}^{\text{O}} d_{\text{com}}^{\text{O}} d_{\text{com}}$			0.006+	[0.000; 0.011]		
$\dot{\pi}_{t-2}^{\text{O}} d_{\text{sub}}^{\text{O}} d_{\text{sub}}$			0.006***	[0.003; 0.009]		
$\dot{\pi}_{t-2}^{\text{O}} d_{\text{com}}^{\text{O}} d_{\text{sub}}$			0.013	[−0.015; 0.039]	0.018	[−0.006; 0.048]
$\dot{\pi}_{t-2}^{\text{O}} d_{\text{sub}}^{\text{O}} d_{\text{com}}$			0.000	[−0.001; 0.001]	0.000	[−0.001; 0.001]
$\dot{\pi}_{t-2}^{\text{O}} d_{\text{com}}^{\text{O}} d_{\text{com}}$			0.001	[−0.006; 0.007]		
$\dot{\pi}_{t-3}^{\text{O}} d_{\text{sub}}^{\text{O}} d_{\text{sub}}$			0.006***	[0.002; 0.009]		
$\dot{\pi}_{t-3}^{\text{O}} d_{\text{com}}^{\text{O}} d_{\text{sub}}$			0.016	[−0.010; 0.035]	−0.005	[−0.029; 0.020]
$\dot{\pi}_{t-3}^{\text{O}} d_{\text{sub}}^{\text{O}} d_{\text{com}}$			0.001	[−0.000; 0.002]	−0.001	[−0.002; 0.001]
$\dot{\pi}_{t-3}^{\text{O}} d_{\text{com}}^{\text{O}} d_{\text{com}}$			−0.001	[−0.006; 0.005]		
AIC	9061.494		36824.986		12696.792	
N	2292		9360		3168	

1. The main motive for choices in all situations is to play a best reply. The coefficients for the best replies to expectations $\Delta x_t^{\text{BR}|\text{E}}$ as well as for the best replies to the past choice of the opponent Δx_t^{BR} are highly significant for markets with substitutes as well as for markets with complements.

2. Reciprocity (the coefficients of $\dot{\pi}$) is strong and significant for complements and for substitutes. Players seem to have long memories. Even the third lag is still significant and has the expected sign.

3. We find significant reciprocity across markets in homogeneous conglomerates in particular towards markets for substitutes.

Table 8 Estimation of equations (33) for asymmetric conglomerates

	asym. conglom.		asym. single	
(Intercept)	-0.247	$[-0.592; 0.077]$	0.083	$[-0.326; 0.454]$
$\Delta x_t^{\mathrm{BR}\|\mathrm{E}} d_{\mathrm{sub}}$	0.152^{***}	$[0.078; 0.237]$	0.277^{***}	$[0.183; 0.358]$
$\Delta x_t^{\mathrm{BR}\|\mathrm{E}} d_{\mathrm{com}}$	0.855^{***}	$[0.464; 1.216]$	1.367^{***}	$[0.804; 1.964]$
$\Delta x_t^{\mathrm{BR}} d_{\mathrm{sub}}$	0.260^{***}	$[0.166; 0.358]$	0.456^{***}	$[0.351; 0.586]$
$\Delta x_t^{\mathrm{BR}} d_{\mathrm{com}}$	-0.473^{*}	$[-0.804; -0.056]$	-0.713^{*}	$[-1.344; -0.201]$
$\dot{\pi}_{t-1} d_{\mathrm{sub}}$	0.038^{***}	$[0.026; 0.051]$	0.054^{***}	$[0.039; 0.071]$
$\dot{\pi}_{t-1} d_{\mathrm{com}}$	0.019^{+}	$[-0.001; 0.036]$	0.017^{+}	$[-0.003; 0.037]$
$\dot{\pi}_{t-2} d_{\mathrm{sub}}$	0.026^{**}	$[0.013; 0.038]$	0.044^{***}	$[0.030; 0.059]$
$\dot{\pi}_{t-2} d_{\mathrm{com}}$	0.012	$[-0.007; 0.031]$	0.009	$[-0.011; 0.030]$
$\dot{\pi}_{t-3} d_{\mathrm{sub}}$	0.007	$[-0.001; 0.017]$	0.024^{***}	$[0.010; 0.034]$
$\dot{\pi}_{t-3} d_{\mathrm{com}}$	-0.000	$[-0.017; 0.017]$	0.016	$[-0.003; 0.036]$
$\dot{\pi}^{\mathrm{O}}_{t-1} d_{\mathrm{sub}}$	-0.039	$[-0.112; 0.033]$		
$\dot{\pi}^{\mathrm{O}}_{t-1} d_{\mathrm{com}}$	-0.001	$[-0.003; 0.002]$		
$\dot{\pi}^{\mathrm{O}}_{t-2} d_{\mathrm{sub}}$	0.007	$[-0.068; 0.083]$		
$\dot{\pi}^{\mathrm{O}}_{t-2} d_{\mathrm{com}}$	-0.000	$[-0.004; 0.002]$		
$\dot{\pi}^{\mathrm{O}}_{t-3} d_{\mathrm{sub}}$	0.011	$[-0.059; 0.080]$		
$\dot{\pi}^{\mathrm{O}}_{t-3} d_{\mathrm{com}}$	-0.001	$[-0.003; 0.002]$		
AIC	2865.706		2842.755	
N	648		648	

4. We do not find much reciprocity across markets with heterogeneous or asymmetric conglomerates.

Point 3 is in line with Bernheim and Whinston (1990) who would predict the punishment technology of markets for substitutes to be slightly weaker and hence, in need of help from other markets. It is interesting to note that this help is stronger if the other market is for substitutes. Looking at figure 3 again, we see that homogeneous conglomerates markets for substitutes are typically divided among players. This division of power requires coordination accross markets which is also in line with the positive and significant coefficients of $\dot{\pi}^{\mathrm{O}}$ in equation (32) when both markets are for substitutes.

Result 8 *We find reciprocity across markets in homogeneous conglomerates in particular in markets for substitutes.*

Also point 4 is in line with Bernheim and Whinston 1990. There is no strategic reason to find indirect reciprocity here. However, Phillips and Mason (2001) observe that players learn across markets. In their experiment both markets were for substitutes and learning was straightforward. In our treatment with heterogeneous conglomerates one market was for substitutes and the other for complements. In our experiment we observe lower cooperation rates in mixed markets (see result 3). In mixed markets it is certainly harder for participants to learn from one market for the other. This might explain that we observe no relation among the two markets in heterogeneous and asymmetric conglomerates.

Result 9 *We find no interaction across markets in heterogeneous conglomerates.*

6 Conclusions

To test the forbearance hypothesis we performed a very systematic experimental analysis. We allowed for differentiated products in the form of strategic substitutes as well as complements, we distinguished infrequent and frequent rematching, and we ran several control treatments with different types of links between markets.

Before summarising our own findings let us briefly view the major findings of the experimental investigations of forbearance effects by Feinberg and Sherman (1985) whose theoretical analysis is based on a conjectural variation approach. The markets that are considered by Feinberg and Sherman (1985) are homogeneous so that they can measure competitiveness by the sum of sales amounts. Within homogeneous markets they compare homogeneous with heterogeneous conglomerates and find only a small and insignificant treatment effect. They do find, however, a significantly larger variance with homogeneous conglomerates which one might take as an indication of active reciprocal behaviour across markets.

Phillips and Mason (1992) compare homogenous conglomerates with single firms (our baseline treatment). In their treatment the two markets are asymmetric. Hence, there is room for one market to 'help' the other in a conglomerate. Phillips and Mason find, indeed, that "conglomeration tends to reduce cooperation in markets where cooperation is relatively easy, and [...] tends to increase cooperation in markets where cooperation is relatively difficult." In Phillips and Mason (2001) the same authors study heterogeneous conglomerates, i.e. situations where there are no strategic motives to punish or reward an opponent in one market for what took place in the other. However, players can learn from the experience in one market for the other and, as Phillips and Mason find out, this happens in their experiment.

In our experiment we can confirm the standard hypotheses: Participants behave more cooperatively than the predicted equilibrium benchmark. We find more cooperation in complement than in substitute markets, and more cooperation in infrequent rematching than in the frequent matching.

We also find support for the theoretical driving forces of cooperation in conglomerates. In line with Bernheim and Whinston (1990) we find that markets in homogeneous conglomerates do interact with each other. We find no such interaction in heterogeneous conglomerates, i.e. in markets where there is no strategic reason for interaction. In contrast to Phillips and Mason (2001) learning does not seem to play a role in our conglomerates if markets are sufficiently different from each other.

A more surprising result is that conglomerate firms cooperate actually less than single firms, although not by a significant amount. Thus, at least in our experiment conglomerates do not have anti-competitive effects. Actually, conglomerates seem to enhance competition significantly in mixed markets. The mere presence of a second and sufficiently different market stimulates competition. A possible explanation could be a multi-market analogue of leapfrogging, i.e., of strong competitive attempts by those lagging behind, for instance, in market or innovative success (for an experimental study of the latter, see, for instance, Cantner et al., 2009). If one firm is less successful on one market, this firm might be induced to "win" the other market. If anticipated by the competitor, both firms could be inspired to behave more competitively.

Of course, such behaviour can more easily evolve over time. In our experiment, it could unfold when one conglomerate is dominating one market—in the sense that market results would be disastrous when the other firm sells the same amount as the dominating firm. If on the other market both conglomerates sell similar amounts, the disadvantaged firm might try to dominate the other market. Thus, any strong disparity on one market can easily initiate a process of alternating attempts to dominate at least one market and of lower than equilibrium profits.

Our study shows that identifying anti-competitive effects by multimarket firms requires complex explanatory variables because firms have become more complex. The complexity of multimarket firms is, for instance, reflected in the internal organisation between the headquarter and their subsidiaries as well as between factor and product markets. Thus, in firms with weak internal coordination the headquarter can not pose credible threats of retaliation to aggressive moves made by global multimarket firms against its subsidiaries. And, as Markman et al. (2009) have shown, forbearance in product markets may happen even at high costs to maintain forbearance in factor markets. Consequently, experiments, like ours, are able to test the mutual forbearance hypothesis from multimarket contact in a complex imperfectly observable context of a global market environment.

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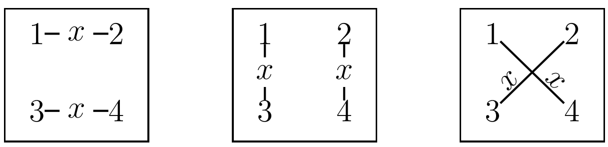
A Experimental Setup

We have relied on matching groups with four participants each in all treatments except for treatment 13 where conglomerate firms interact with single firms on the same markets. There we have matching groups of six.

Baseline treatment — no conglomerates: In our baseline treatment there are no conglomerates. The strategic interaction takes place only on a single market. If we write markets X and Y next to connections between the four members of a matching group, then matching in the baseline treatments follows one of these three structures:



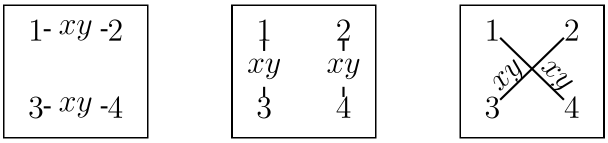
[a]

We study the case of no conglomerates both in a partners and in a strangers setting. In the partners setting we first play a game with one of these matchings for the first 12 rounds. Then another game is announced, again for 12 rounds, where we use another of the above matchings.

In the random matching setting we switch among the above matchings every four rounds. After 12 rounds another game is announced, again for 12 rounds, where again every four rounds the matching is changed.

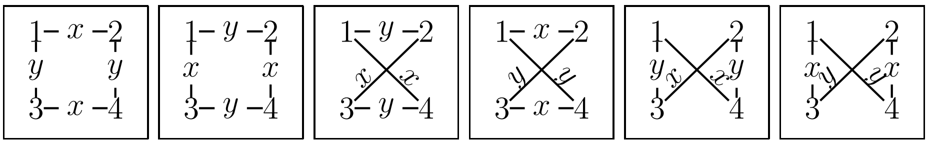
Participants are not aware of the small size of the matching group. All what they know is that pairs are randomly formed in every four or in every twelve rounds. We start a new game after 12 rounds both in the partners and in the random matching treatment to avoid as far as possible any biases between the partners and the strangers design. We run the baseline treatment both with substitutes and with complements (treatments 1-4).

Homogeneous conglomerates: In the homogeneous conglomerate treatment (treatments 5-10), two firms simultaneously interact on two markets, using one of the following matchings:



[b]

Heterogeneous conglomerates: When conglomerates are supposed to compete with two different conglomerates on both markets we use a circle matching as follows:

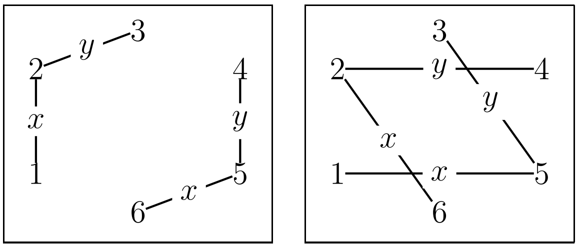


[c]

This setup is again studied in a partners design, where participants are first matched for 12 rounds, and then, following a different matching from [c], are rematched for another 12 rounds (treatment 11). In the random matching design we rematch every four rounds, with a restart after 12 rounds (treatment 12).

In the random strangers design the one missing of the other three participants was randomly changing between rounds. Furthermore, one could encounter the two partners on the X- or the Y-market in an irregular fashion.

Asymmetric markets with conglomerates and single firms: When conglomerates are supposed to compete with non-conglomerates, each matching group of six participants contained two conglomerates and four "one market-firms", one for the X-market and one for the Y-market for each conglomerate firm. Here we only ran a partners design with two sessions containing 3 matching groups each, i.e. with 36 participants (treatment 13).



[d]

A (random) strangers design would have required larger matching groups what might have questioned the comparability of the results across treatments.

Substitutes and complements: Interaction on the above markets might depend on whether products are substitutes or complements. For the baseline treatment [a] without conglomerates (treatments 1-4) and the homogeneous conglomerates (treatments 5-10) we study all possible combinations. The case of heterogeneous conglomerates (treatments 11 and 12, [c]) and the case of conglomerates and single firms (treatment 13, [d]) is only studied in one setting each: products on the X-market are substitutes, products on the Y-market are complements (again, see table 2).

B Experimental Instructions

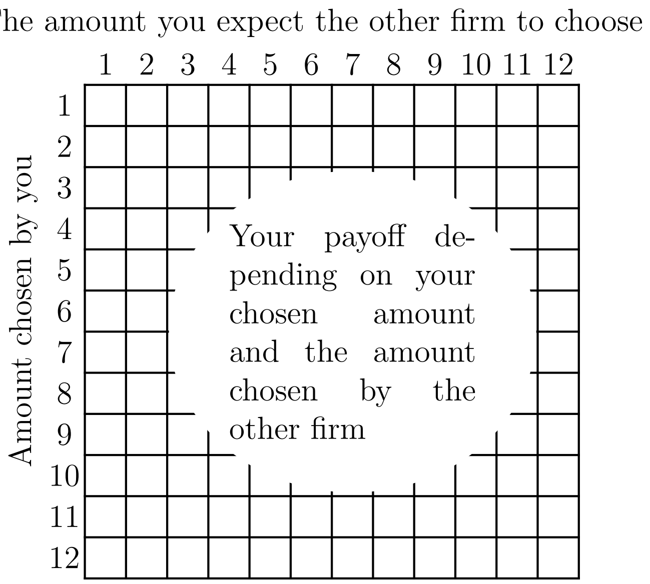
Here we present the translation of the originally German instructions for treatment 6 (partner design, homogeneous conglomerates, substitute and complement markets). The instructions for the other treatments differ only where necessary.

Welcome to this experiment and thank you for participating!

You can earn money in this experiment; the amount will depend on your own decisions and on the decisions of the other participants. *Therefore, it is very important that you read these instructions carefully.*

If you have any questions, please raise your hand. We will get to your seat and answer your questions. Please do not ask your questions out loudly. All participants of this experiment get the same instructions, whereas the information that appears on the computer screen during the game is for the respective participant only. That is why you are *not allowed to look at the screens of the other participants or to talk to them during the experiment.* Non-compliance with these rules will result in your exclusion from the experiment. Please switch off your mobile phones now.

In the following experiment you will play together with one partner. You and your partner each represent two firms. These firms are active in the same



markets, namely market X and market Y. Your task is to determine the sales volume of your firms in these markets. Your partner's task is to determine the sales volume of his/her firms in the same markets. Each of his/her firms will be confronted with one of your firms.

Your firm 1	market X ⟷	Partner's firm 1
Your firm 2	market Y ⟷	Partner's firm 2

You will play the following twelve rounds with the same partner.

During the experiment you will see charts on the screen. In these charts you can see how your decision and the decision of the other firm influence your profit and the profit of the other firm on the considered market.

The rows of the chart show your sales volume, it can be seen from the left margin. The sales volume of the other firm is shown in the columns. The amount you expect the other firm to choose can be seen in the top row. The number in each cell of the chart shows how much you would earn in this round if you choose the amount indicated by the row of this cell and the other firm chooses the amount indicated by this column.

The profit of your partner's firm in this market can be determined with the same chart. If you want to know how much the other firm will earn, all you have to do is invert the lines and rows of the chart, i. e. in this case your sales volume can be seen in the columns and the sales volume of your partner is shown in the rows. The intersection cell shows the earnings of your partner's firm. This might help you in finding out which amount the other firm might choose. However, you cannot influence the sales volume taken by the other firm. Nevertheless, it is important for your own decision to have a precise assumption about how the other firm will act.

To help you with your considerations you can click the sales volume you expect the other firm to choose in the top row and the sales volume you want to choose yourself on the left margin. The corresponding row and column will be indicated in red. The profit you will earn in this market in this round if your partner indeed acts as you guess will be circled. You can try several combinations if you want to. Please confirm your final decision by clicking the OK button. The payoff of one market in a round depends on the sales amount chosen by you and the sales amount chosen by the other firm.

To help you to keep track you can find a table at your seat into which you can fill in your sales volume, your partner's sales volume, and your profit after each round.

The profits in the charts are given in ECU (experimental currency units). You will be informed about the exchange rate of ECU into Euro on your computer screen at the beginning of the experiment. This exchange rate is the same for all participants. At the end of the experiment you will be paid the sum of your profits from all rounds in Euro. This amount will be paid to you privately. No other participant will learn from us how much you have earned.

Once you have read the instructions carefully, please start answering the questions on the computer screen. There will be one question at once on the screen. These questions check your understanding of the experiment. Unfortunately, you will only be allowed to take part in the experiment if you understood the rules. If you make too many mistakes in the questionnaire you cannot participate. If you are not sure how to answer a question, you may read the instructions again, of course.