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Conspiracy against the public - an experiment on collusion

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"People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices."
(Smith, 2005 [1776], pp. 111)

Abstract

Cooperation is usually presented as prosocial and for the common good. But collusion is also a form of cooperation, where the gains from cooperation are at the public's expense. How is collusion affected by this public aspect? Social preferences can mean caring for the public. But it can also mean caring for the bilateral relationship with one's partner. This paper investigates cooperation when it is at the expense of the public, and compares it to cooperation when it is not at the public's expense. I do so by running two versions of an infinitely repeated prisoner's dilemma game: One version with and one without a public aspect. I find that there is more collusion when collusion is at the expense of the public - conspiracy against the public.

1 Introduction

Cooperation is usually presented as prosocial and for the common good in the behavioral and experimental literature (Camerer and Fehr, 2006; Fehr and Fischbacher, 2002; Frey and Meier, 2004). However, collusion is also a form of cooperation - one which implies secret or illegal cooperation and conspiracy - at the expense of a third party. Firms can cooperate on price increases,

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on quantity and quality decisions in order to achieve higher profits, all at the public's expense. Do these negative externalities imposed on the public matter for the colluding parties? I investigate this topic experimentally by running two versions of an infinitely repeated prisoner's dilemma game.

If the colluding parties are only concerned with profit and the strategic interaction with their partner(s) in crime, then the negative externalities imposed on the public should be irrelevant to them. However, Armstrong and Huck (2014) argue that collusive agreements are different from ordinary agreements. As illegal cartels cannot rely on the legal system to resolve disagreements, building trust and relations is especially important in collusive settings.

The following example illustrates that collusion, in addition to being motivated by profit, also involves a relation between the colluding parties, the competitors. During the mid-1990s the world's five largest producers of lysine, an animal feed additive, succeeded in doubling the world price of lysine for several years. This cartel overcharged consumers and customers by an estimated US$ 140 million. The cartel was prosecuted and charged after a member was caught on tape saying that "Our competitors are our friends. Our customers are the enemy." (Hammond, 2005, pp. 3). The notion that relations potentially play an important role in settings where legal systems are absent is central to this paper. If relations and ties matter for collusion, it also begs the question whether other relations matter - the relation to the public. I do find that relations matter - the main finding of the paper is that collusion is higher when collusion is at the public's expense.

I investigate collusion at the expense of the public by running two versions of an infinitely repeated prisoner's dilemma game. The baseline is taken from Dal Bó and Fréchette, 2011: Two subjects simultaneously choose between colluding and not colluding in an infinitely repeated game. The second treatment, denoted the *public good treatment*, includes a public aspect. In the public good treatment the subjects contribute to a public good when they do not collude. If they collude, they do not contribute to the public good. In other words: In the public good treatment, the gains from collusion are at the expense of the public. In the baseline the gains from collusion are not at the public's expense. The public good is represented by a student organization which provides services with public good properties to the students at the university. By comparing the levels of collusion in these two treatments, I can study how collusion is affected by the public aspect.

Collusion is often studied in the laboratory, as its secretive nature makes it hard to observe in natural settings. There is growing literature studying how corruption and gift-giving are affected by the public aspect (Abbink, 2004; Abbink, Irlenbusch, and Renner, 2002; Barr and Serra, 2009; Currie, Lin, and Meng, 2013; Malmendier and Schmidt, 2017; Pan and Xiao, 2016). But the main focus of this literature is on forms of reciprocity - to my knowledge, there are no experimental studies on how collusion is affected when the gains from collusion are at the public's expense.

The strategic situation facing two colluding firms is captured well by the infinitely repeated prisoner's dilemma game. One firm can raise its price (collude) in anticipation that the other firm will follow. If both firms are sufficiently patient/ care sufficiently about the future, they can tacitly

agree to maintain higher prices.[1] If one firm deviates and charges a price below the collusive price, the other firm can punish the price-reducing firm by charging a lower price itself. Profits are then reduced, which hurts both. In this simple setting, collusion can be sustained in the long run by standard rational actors, but only if punishment is sufficiently likely and costly. If the loss from all future excess profit from collusion outweighs the one-time higher profit from charging a lower price, then both firms should stick to collusion.

What sort of behavior can we expect to see?

1) If subjects are rational agents with standard selfish preferences, they do not care about the public good. Hence, the presence of a public good should not affect their decision to collude or not. So with selfish, rational subjects there should be no difference between the treatments, as the subjects in the public good treatment should not be affected by the public good.

2) If subjects have social preferences of some form, we should see different behavior in the two treatments. A subject who, everything else equal, cares sufficiently about the public good should refrain from colluding. Hence, if there are some subjects who care sufficiently about the public good in the public good treatment, there should be less collusion when collusion is at the expense of the public.[2]

3) But social preferences can also mean caring about relations, as illustrated by the lysine cartel anecdote. The economic literature on social preferences in general pays little attention to relations and social bonds. If subjects have preferences for bilateral collusion, the presence of the public good can have the opposite effect of 2): When collusion is at someone else's expense, it can lead to more and stronger collusion. I denote this the "conspiracy against the public" effect.

Malmendier and Schmidt (2017) and Bault et al. (2016) propose two similar models which show how affective ties/ reciprocal bonds between subjects can develop.[3] Social ties/ bonds/ relations are defined as affective weights attached to other players' well-being. The central feature is that the social tie is influenced by interactions with others, and that it can develop over time. Their models are simple extensions of outcome-based models that make the strength of the bond endogenous, and they provide a potential mechanism for the "conspiracy against the public" effect. *Expectations* about whether the partner will collude or defect matter for the relation building. If the subjects in the public good treatment think that some of the other participants have social preferences, they should expect lower rates of collusion compared to what the subjects in the baseline should expect, as is in explained in 2). Then, if a subject in the public good treatment experience unexpected collusion, s/he will attach more weigh to the welfare of the colluding partner than a

[1] Tacit collusion occurs when two firms agree to play a certain strategy without being explicit about it. This could mean avoiding price-cuts, decreasing quality, investing less in advertising, or lowering production. Explicit collusion means that the colluding parties communicate directly, and this is usually banned by antitrust law.

[2] In addition, if there are any subjects who only cares about efficiency, these should also prefer not to collude, as this choice is more efficient in absolute terms.

[3] Malmendier and Schmidt (2017) show that pure outcome-based models of social preferences have difficulties predicting behavior in gift-exchange games where subjects can send gifts to influence behavior. Bault et al. (2016) show that the extended model does a better job at prediction behavior in public good games.

subject in the baseline treatment. Applying the logic of this model to the design in this paper, the social bonds between two colluding subjects can become stronger in the public good treatment compared to the baseline if expectations initially were lower in the public good treatment.

Findings: Overall, the cooperation level is higher in the public good treatment. This neither consistent with standard selfish preferences, nor with simple outcome-based social preferences, such as altruism. First, the level of collusion in the experiment is initially lower when the gains from collusion are at the expense of the public. This corresponds well to the assumption in the social ties model - that subjects seem to have lower expectations in the public good treatment than in the baseline. Second, collusion increases as subjects gain experience. Furthermore, when collusion is at the public's expense, bilateral relations are more stable. The social tie model provides an explanation for how collusion can be higher for a matched pair in the public good treatment, and it describes the mechanism for how it can occur. However, while the model can help explain differences *between* treatments, but it does provide a general explanation for why people cooperate in prisoner dilemma games with an infinite horizon with these payoffs (as can be seen in Dal Bó and Fréchette, 2011, see also Breitmoser, 2015 for more on this).

Section 2 reviews the literature, Section 4 introduces the experimental design, Section 3 presents the theoretical framework, followed by the results section in 5, and some concluding remarks in Section 6.

2 Related literature

There is a large and growing literature studying collusion by using laboratory experiments (for a recent survey covering oligopoly experiments, see Potters and Suetens (2013) and Armstrong and Huck (2014)). The public aspect studied in this paper is usually present only implicitly in this literature. In these designs, the subjects in the room participate in a market, and prices increase when they collude. But I am not aware of any papers in this literature where there are actual subjects present in the lab representing consumers, who will experience an actual welfare loss from the increased collusive cooperation.

Malmendier and Schmidt, 2017 study the negative externalities of gift giving. They investigate how gift giving affects decision making in an experiment where prosocial behavior towards one person may come at the expense of another person. They find that subjects reciprocate to gifts, and more importantly that gift giving has a stronger effect when the gift imposes a negative externality on others.[4] The gift triggers an obligation to repay the gift, and they show that the gift is given with the intention to affect the decision of the recipient at the expense of a third party.

[4]Their design is a repeated one-shot gift-exchange game with two producers, one decision maker and a client. In the baseline a decision maker buys a product from one of the producers on behalf of the client. In the gift-treatment the producers are given the possibility to send the decision maker a gift before the decision makers decide. They can also send the decision maker a gift in the no-externality treatment, but here the decision makers act on their own behalf and not the client's.

In a related experiment, Pan and Xiao, 2016 also study whether gift giving triggers the obligation of the receiver to favor the gift giver.[5] They use the strategy method and study how the receiver allocates money when the two dividers have indicated the same level of generosity. They find that a gift triggers strong reciprocity, and that also regardless of the gain to the divider being smaller than the cost to the third party.

Abbink, Irlenbusch, and Renner (2002) and Abbink (2004) study how the public aspect influences corruption. The gains from corruption and collusion are both at the expense of the public, but corruption involves the abuse of public office for private gains, and reciprocity is the central feature. Both papers study corruption using the bribery game, which is similar to a finitely repeated trust game.[6] The reciprocal relationship between the briber and the bribee is undesirable with regard to social welfare and is subject to punishment when discovered. In Abbink, Irlenbusch, and Renner (2002), they find that bribery relationships do develop between the briber and the public official, but they do not find that the public aspect leads to more corruption. Barr and Serra (2009), on the other hand, find that bribers are less likely to offer bribes when the negative externalities imposed on the public are high and the experiment is framed as corruption. However, this did not hold for the bribees.[7]

Currie, Lin, and Meng (2013) study how gift-giving affects third parties in Chinese hospitals. A pair of trained actors visit physicians and play the role of patients. If the first patient gives a small gift to the physician, s/he received better service and is less likely to be described unwanted, unnecessary and costly medication. If the first "patient" introduce the second "patient" as a friend, this patient also receives better service.

The experimental designs in this literature share a common approach in that the players interact sequentially, meaning that the player can respond directly to their co-player's action. Hence, the scope for reciprocity and relation building is potentially much larger than in the infinitely repeated prisoner's dilemma game, where choices are made simultaneously and the number of strategies available to the players are quite large. The design in this paper in that regard provides a restrictive test of whether the public aspect matters. The designs of the mentioned papers also differ along many other dimensions than with respect to the sequence of acts (time horizon, representation of the public etc.) to the design in this paper, and it is interesting to see that very different designs produce similar results which support the "conspiracy against the public" effect.

[5] Participants play either the role of a divider or a receiver. The divider chooses whether to allocate a fixed small amount to the receiver. The receiver receives money from one divider, and in turn, the receiver has to allocate an amount between two dividers, including the one s/he played with initially. Importantly, the receiver's payoff from this task is independent of the allocation decision.

[6] The bribery game involves a briber (the trustor) and a public official (the trustee), and the subjects in the room represent the public. The briber first decides whether to make a bribe to a public official. If the public official rejects the bribe, no money is transferred, but the briber still has to pay a small fee. If the public official accepts the bribe, he receives the tripled amount of what the briber transferred. Then the public official decides whether to give a permission to the briber. The permission damages the public: each of the other participants in the session suffers a small deduction in their payoffs for each permission.

[7] For a detailed discussion on the design in these papers and possible explanations for the differences, see Serra and Wantchekon, 2012.

3 Behavioral Predictions

Malmendier and Schmidt (2016) and Bault et al (2016) propose two very similar formalizations of how affective ties between subjects can develop. In this section I sketch how the mechanism in this model can lead to different predictions for the two treatments in this paper. Note, however, that the model describes a setting where agents act sequentially and within a finite time horizon. Hence, I will apply the idea, but the model and the experiment differs with respect to timing and horizon.

Social preferences are modelled by including the utility of other people's welfare in the individual's utility function. The bond/ tie/ relation is defined by the weight the individual attaches to the utility of the other. As the individuals interact, the social tie is dynamically updated, and the relation/ social tie between the interacting players can become stronger or weaker.

Expectations are an important feature in this framework, and more specifically if they expected their partner to collude or not. When the subject experience unexpected collusion, s/he will increase the weight he attaches to the welfare of the other player. When s/he experiences unexpected defection, s/he will attach less weight to the welfare of the other player.

This mechanism leads to different predictions for the baseline and the public good treatment: If the subjects in the public good treatment expect there to be some players who care about the public good in the room, they should expect these players to collude less. Hence, the expected level of collusion should be lower in the public good treatment than in the baseline. Players in the public good treatment have lower expectations about how much their partners will collude with them compared to the baseline. Whenever they actually experience that their opponent collude with them, they increase the weight they attach to their opponent's welfare, and they increase it more than their counterparts in the baseline.

4 Experimental Design

The experiment use a between-subjects design and consists of two treatments. The baseline is an ordinary infinitely repeated prisoner's dilemma game where the gains from collusion are not at the expense of the public. The second treatment is based on the same infinitely repeated prisoner's dilemma as the baseline, but now the gains from collusion are at the expense of the public. The public is represented by a student organization, StOr. The baseline is a replication of a treatment in Dal Bó and Fréchette' (2011), who study cooperation in infinitely repeated games. The subjects are divided into pairs, denoted "matches". Each match consists of an ex-ante unknown number of rounds. Infinity is simulated using what is known as a random continuation rule. The random continuation rule assigns a fixed probability of continuation, and in this experiment it is equal to 3/4. In each match, all the subjects in a room are divided into random pairs. They play the first

round and then a lottery decides if there will be another round. There is a 75% chance that this round will be followed by another round. This means that in expectation each match lasts for 4 rounds. When the match ends, the subjects are all randomly re-matched, and the same procedure is repeated until the experiment is over, which is after an hour. The shortest session consists of 31 matches, the longest session consists of 42 matches. Before the subjects leave the room, they also make one more decision (more below) and fill in a questionnaire. The payoffs are presented in Table 1:

Table 1: The baseline

		Player 2	
		Collude	Defect
Player 1	Collude	40, 40	12, 50
	Defect	50, 12	25, 25

All decisions are paid, as is standard in this literature (see e.g. Sherstyuk, Tarui, and Saijo, 2013). The payoff when both subjects collude is equal to 40 experimental units (ECU) for both subjects. Temptation payoff is 50, sucker's payoff is 12, and if they both defect, they both get 25 each. The exchange rate is 10 ECU for 1 NOK, or 58 ECU per 1 USD. The public good treatment has the exact same payoffs as the baseline. The only difference is that now the subject contributes 25 to a public good if he or she chooses defect. The treatments are identical in all other regards. When both subjects choose defect, they both contribute 25 to the public good, 50 in total. When one of the subjects chooses defect, and one subject chooses collusion, the defecting subject contributes 25 to the public good. Finally, when both subjects choose to collude, the contribution to the public good is zero. The payoffs are shown in Table 2:

Table 2: The public good treatment

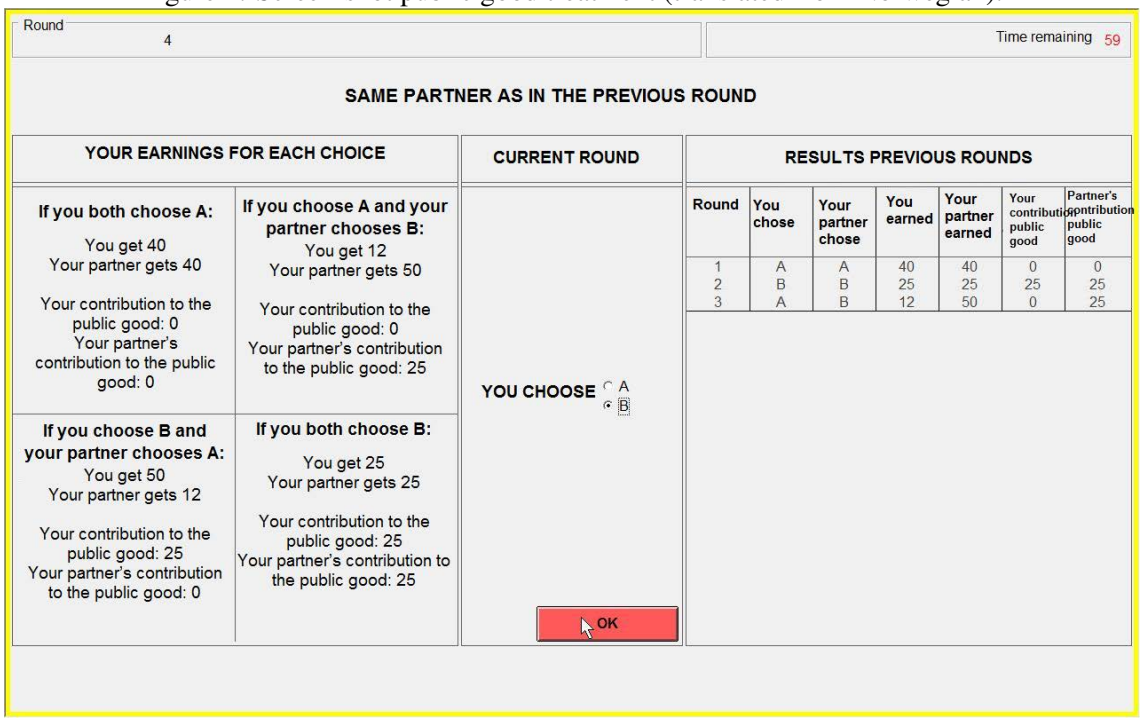
	Collude-Collude	Collude-Defect	Defect-Collude	Defect- Defect
Player 1	40	12	50	25
Player 2	40	50	12	25
Public good	0	25	25	50

The public good in this experiment is provided by the student organization StOr at the home university of the subjects, the University of Stavanger. StOr is a non-party affiliated interest organization, where all students at the UiS are members. The organization is responsible for life on campus, student welfare, student elections, student organizations, international students, exchange programs, legal issues regarding exams, syllabus and so on. In sum, it provides services which have public good properties. The services provided by this organization allow multiple agents to consume most of it at the same time (non-rival), and it is not possible to exclude subjects who did not contribute to the good from consuming it (non-excludable). The contribution to the public good is a fixed amount, and since the organization already exists, there is no provision point that needs to be reached. When the subjects contribute to the public good, it will translate into a very small increase in the provision of the public good. This is meant to capture the fact that when firms refrain from colluding, this increases efficiency in the economy, from which both consumers

and firms benefit (although to a smaller extent than the consumers).

The instructions and the design were presented in a neutral language (*A* is collusion, *B* is defection/ not colluding), and the subjects were provided with an overview of all the information within each match, but not between matches. Figure 1 is a translated screen-shot from the public good treatment, see the appendix for instructions for both treatments.

Figure 1: Screen-shot public good treatment (translated from Norwegian).



120 subjects participate in the experiment, 60 in each treatment. The subject sample in each treatment is similar to of recent papers investigating cooperation using infinitely repeated prisoner's dilemma games (see e.g. Duffy and Ochs, 2009; Fréchette and Yuksel, 2013; Fudenberg, Rand, and Dreber, 2012; Kagel and Schley, 2013; Sherstyuk, Tarui, and Saijo, 2013).

After the prisoner's dilemma game and before the questionnaire, the subjects were given a final task. Subjects in both treatments were asked if they preferred either *ECU 40 for themselves*, or *ECU 25 for themselves and ECU 25 to StOr* (incentivized).[8] This decision involves the same payoffs as the prisoner's dilemma, but the difference is that it does not involve any interaction with other subjects. Hence, this task can shed some light on the subjects' social preferences when coordination issues are absent I will come back to this in the results section.

[8] On the screen subjects in both treatments were given the same introduction to the public good StOr as presented in the written instructions for the subjects in the public good treatment.

5 Main Experimental Results

The six experimental sessions were conducted on the 23rd and 24th of May 2013. A total of 120 students at the University of Stavanger (Norway) participated in the experiment, with 20 students in each session. The subjects earned an average of $75, with a minimum of $48 and a maximum of $114.[9] The subjects were rematched on average 34 times. As the shortest session lasted 31 matches, the analysis is based on the first 31 matches for every session. The average number of rounds per match was 4.1, and the maximum number of rounds was 24. All instructions were given both written and verbally. The experiment was conducted and programmed with the software z-Tree (Fischbacher 2007).

5.1 General Description of Behavior

Table 3 displays collusion rates for the baseline and the public good treatment. The top left panel describes the collusion rates in the first round of the first match, and the bottom left panel describes collusion rates for all first rounds for all matches. The top right panel describes collusion for all rounds in the first match, and the bottom right panel describes collusion rates for all observations. Statistical significance in Table 3 is assessed by estimating probit regressions (robust standard errors clustered at the individual level) with an indicator variable for the public good treatment (see Table 8).

Table 3: Collusion/ cooperation rates

First match First round			First match All rounds		
Baseline		Public good	Baseline		Public good
0.55	$>$ **	0.35	0.44	$>$***	0.23
$\bigvee$		$\bigwedge$ ***	$\bigvee$		$\bigwedge$ ***
All matches First round			All matches All rounds		
Baseline		Public good	Baseline		Public good
0.49	$<$	0.57	0.37	$<$*	0.48

Notes: Probit regressions with robust clustered standard errors (see Table 8) in the Appendix. * p<0.10, ** p<0.05, *** p<0.01.

Different matches have different number of rounds, and the level of collusion may vary across rounds. Hence, I start by investigating the first rounds. In the baseline, the initial collusion rates are significantly higher compared to the public good treatment: In the first round, 55 percent of the individuals in the baseline choose to collude, compared to 35 percent in the public good treatment. In the first match, 44 percent in the baseline choose to collude, compared to 23 percent in the public good treatment.

[9] Exchange rate May 25th 2013: 5,82 NOK per USD. Table 7 presents session statistics.

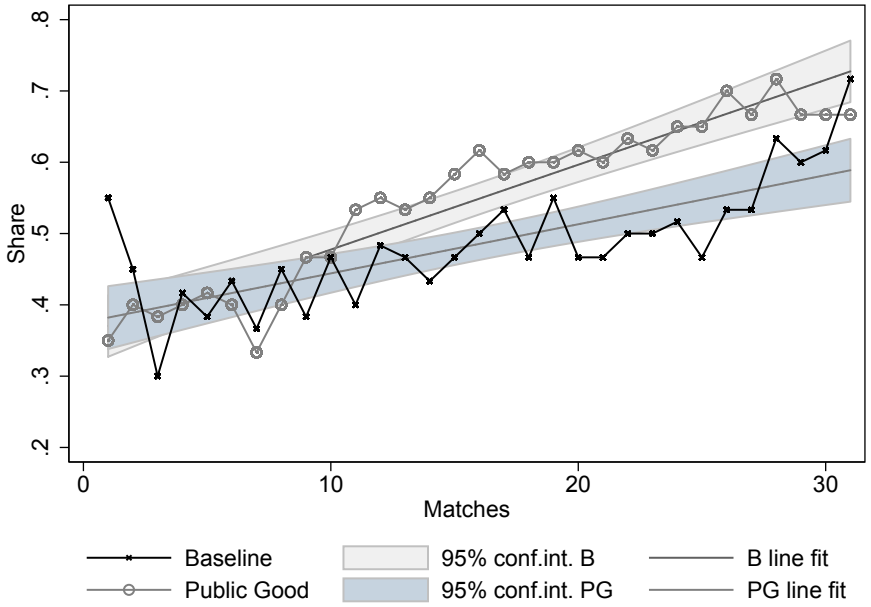
However, this pattern changes to the opposite as the subjects gain experience. Looking at all the first rounds and pooling all observations, it is clear that the collusion rates are significantly higher in the public good treatment: In the first round of all matches, 49 percent in the baseline choose to collude, versus 57 percent in the public good treatment. When we look at all the rounds in all the matches, 37 percent in the baseline choose to collude, versus 48 percent in the public good treatment (significant at the ten percent level).

Collusion rates in the baseline do not change significantly as the subjects gain more experience (from 0.55 to 0.49, and from 0.44 to 0.37). Meanwhile, collusion rates are increasing with experience in the public good treatment, from 0.35 to 0.57, and from 0.23 to 0.48 (both significant at the 1 percent level). These differences between the first match and all matches suggest, as in Dal Bó and Fréchette (2011), that experience affects how subjects play in repeated matches. In the following section, I look into how collusion evolves as the subjects gain more experience.

Figure 2 graphically illustrates how collusion rates evolve match by match. The graph displays the rate of subjects who choose to collude in the first round of each match in each treatment. The rate of collusion in the first few matches falls from about 0.55 down to 0.30 in the baseline, and then it slowly increases to levels reaching 0.6. In the public good treatment, the level of collusion starts out around 0.35, and remains low until match 8, from which collusion increases steadily and reaches levels above 0.6 for the remaining ten matches. Collusion is higher in the public good treatment compared to the baseline in the matches following the first ten matches. The public good slope displays a clear positive trend well above the baseline. I investigate this more formally in the next section.

Finding 1: *When subjects gain experience, collusion is higher in the public good treatment.*

Figure 2: Evolution of collusion (first rounds)



5.2 Regression analysis

Table 6 in the appendix provides a summary of the subjects randomly placed into each treatment and test for balance in predetermined variables (gender, age, field of study) across treatments. Attitudes towards the organization representing the public good and previous membership are also included, as well as political preferences. Considering an F-test for the joint significance, the data are balanced across these characteristics, with the exception of gender. The share of females is slightly higher in the public good treatment (significant on the ten percent level). Pre-determined control variables are therefore included in the regression analysis in Section 5.2 (gender, age, field of study, and previous/ current membership in the organization).[10] On a scale from 1 to 10, the subjects on average rate the importance of the student organization's work to 6.8 (std.err. 0.19), which supports that they value the services of the organization.

Table 4 presents the results from linear probability models with collusion as the dependent variable.[11] Only indicator variables are used rather than multivalued variables, in order to preserve many of the finite sample properties that simple comparisons of means have, see (Athey and Imbens, 2016). The dependent variable is equal to 1 if a subject collude, 0 otherwise. All regressions include dummy variables for rounds, matches, age (deciles), gender, field of study, and membership in the organization, unless otherwise stated.

The overall collusion rate is significantly higher in the public good treatment, and the size of the

[10] As answers to survey questions were provided after the experiment was conducted, only information which cannot be influenced by treatment is considered as predetermined.

[11] I employ linear probability models from here and onwards in order to adjust for covariates.

Table 4: Rate of collusion/ cooperation

	(1) Collude	(2) Collude	(3) Collude	(4) Collude	(5) Collude	(6) Collude	(7) Collude	(8) Collude
PG	0.14***	0.10	0.02	0.00	0.16***	0.14*	0.21***	0.16**
	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)	(0.08)	(0.06)	(0.08)
Observations	15,160	3,720	4,540	1,200	5,700	1,200	4,920	1,320
R-squared	0.09	0.08	0.04	0.03	0.08	0.08	0.13	0.10
Round	all	1	all	1	all	1	all	1
Match	all	all	1-10	1-10	11-20	11-20	21-31	21-31
Match FE	yes	yes	yes	yes	yes	yes	yes	yes
Round FE	yes	no	yes	no	yes	no	yes	no
Individual controls	yes	yes	yes	yes	yes	yes	yes	yes
Cluster	ind	ind	ind	ind	ind	ind	ind	ind
Mean ind.var.	0.52	0.50	0.59	0.50	0.53	0.50	0.44	0.50
SD ind.var.	0.50	0.50	0.49	0.50	0.50	0.50	0.50	0.50
Mean dep.var	0.42	0.52	0.31	0.41	0.42	0.53	0.50	0.61
SD dep.var.	0.49	0.50	0.46	0.49	0.49	0.50	0.50	0.49

Note: Robust clustered standard errors on the individual level in parentheses, * p<0.10, ** p<0.05, *** p<0.01. The dependent variable is equal to 1 if a subject colluded/ cooperated in a round, 0 otherwise. Individual controls include field of study, membership in PG organization, gender, and age. Sample consists of matches 1-31.

effect is equal to about the third of the average collusion rate in the experiment (0.14/0.42). In (2), only first rounds are included in the sample, and we see that the collusion rates are not significantly different when we only compare the start of each match. In (3) - (8) the sample is divided into three equal parts, the ten first matches, the ten matches in the middle, and the last 11 matches. In (3), we see that we find no significant differences in collusion rates in the baseline and the public good treatment when we look at the early matches (all rounds). The same is true when we only look at first rounds (4). In matches 11-20 in column (4) and (5), we see that collusion rates are significantly larger in the public good treatment. This result holds when we only include first rounds, but the result is now only marginally statistically significant at the ten percent level. In match 21-31 in column (7) and (8), collusion rates are significantly higher in the public good treatment, and the result is also statistically significant at the five percent level when only including first rounds.

Hence, the results in Table 4 implies that when we take individual characteristics, trends, repeated interactions, and the length of matches into consideration, the results confirm the second finding that collusion is higher in the public good treatment when subjects gain experience.

5.2.1 Social ties

Are the collusive relations/ social relations also stronger in the public good treatment? In the following I present a measure meant to capture the strength of the collusive relation: For each match, I calculate the share of rounds where two subjects collude/ cooperate continuously. If a pair colludes in every round of the match, they are assigned the maximal value of 1. If a pair does not collude in any round of the match, they are assigned the minimum value 0. A pair which colludes continuously in 3 out of 4 rounds is assigned the value 3/4=0.75.[12] Figure 3 displays the results, and we see that the collusive relations are not stronger initially, but they do grow stronger as subjects gain experience. The collusive relations in the public good treatment are on average at least 10 percent longer for the last 20 matches.

[12] If the game only lasts for one round, and they colluded, this is defined as a collusive relation and given the value 1. If a match lasts for 7 rounds, and a pair colludes in rounds 1-3 and in rounds 5-6, the strength of the collusive relation is equal to ((3+2)/7)=0.86 in this match.

Figure 3: Continuous collusion.

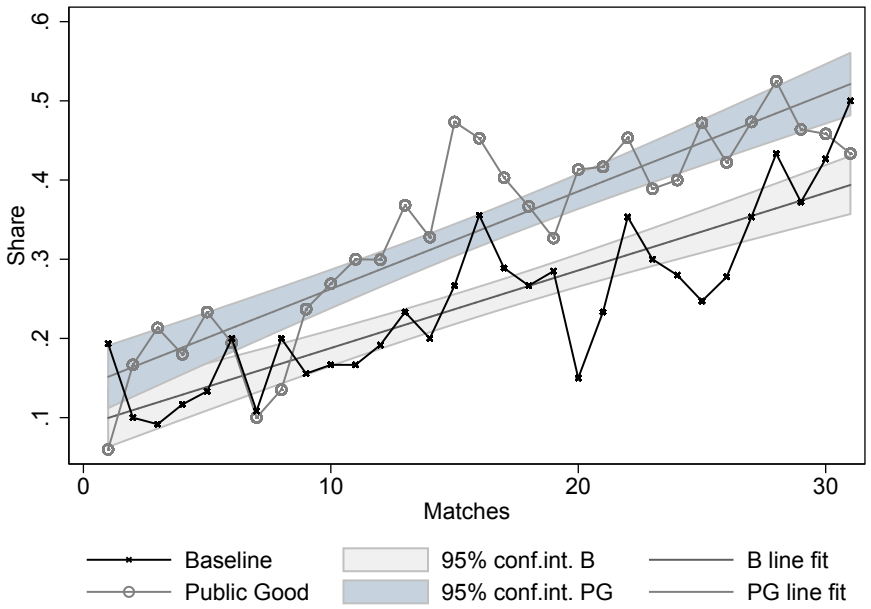


Table 5 presents the results from linear probability models with the share of continuous collusion within each match as the dependent variable. I use the same specifications as in Table 4. Regression (1) confirms the overall picture from Figure 3: Collusive relations are significantly stronger in the public good treatment. After taking individual characteristics, trends, repeated interactions, and the length of matches into consideration, we see that the size of the effect is equal to a third of the mean (0.11/0.29). In (2) we only look at the ten first matches, and we see that the coefficient is small and insignificant, but positive. From match 10 to 20 the effect is large and significant at the one percent level, with the same results for the last ten matches. Collusive relations are becoming stronger in both treatments, but when collusion/ cooperation is at the expense of a third party, the effect is significantly stronger.

Finding 3: *Collusive relations are stronger in the public good treatment - collusion is more stable and lasts longer in the public good treatment.*

Table 5: Continued collusion/ cooperation

	(1) ContC	(2) ContC	(3) ContC	(4) ContC
PG treatment	0.11***	0.04	0.16***	0.13**
	(0.04)	(0.03)	(0.05)	(0.05)
Observations	3,720	1,200	1,200	1,320
R-squared	0.09	0.03	0.07	0.08
Match	all	1-10	11-20	21-31
Match FE	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Mean ind.var.	0.50	0.50	0.50	0.50
SD ind.var.	0.50	0.50	0.50	0.50
Mean dep.var	0.29	0.16	0.31	0.39
SD dep.var.	0.44	0.35	0.45	0.48

Note: Robust clustered standard errors on the individual level in parentheses, * p<0.10, ** p<0.05, *** p<0.01. The dependent variable is the share of rounds where the subjects cooperated continuously within a match. Individual controls include field of study, membership in PG organization, gender, and age. Sample consists of matches 1-31.

6 Concluding remarks

Illegal cartels cannot rely on the legal system to resolve disagreements, be it about market shares, cheating, and so on. Hence, building trust and relations amongst conspirators becomes especially important (Armstrong and Huck, 2014). Under tacit collusion, direct communication is illegal and decisions often have to be made simultaneously - a situation captured by the infinitely repeated prisoner's dilemma. This paper studies collusion experimentally, with and without a public aspect. The baseline is a replication of a treatment in (Dal Bó and Fréchette, 2011). In the public good treatment the gains from collusion are at the expense of the public, while in the baseline the gains they are not. The public good is represented by a student organization which provides services with public good properties to the students at the university. By comparing the levels of collusion in these two treatments, I can study how collusion is affected by the public aspect.

The results indicate that cooperation is strengthened when cooperation is at a third party's expense. Initially, the level of collusion is lower when the gains from collusion are at the expense of the public. However, collusion increases as subjects gain experience, and overall there is more collusion when collusion is at the expense of the public compared to the baseline. Furthermore, bilateral relations are stronger and more stable when collusion is at the public's expense. The social ties model (Bault et al., 2016; Malmendier and Schmidt, 2017) provide a potential explanation for the differences between the treatments.

The finding of this paper are also consistent with the findings from a recent and growing literature using variations of the gift-exchange game to investigate how the presence of a third party affects cooperation/ bribery (Abbink, 2004; Abbink, Irlenbusch, and Renner, 2002; Barr and Serra, 2009; Malmendier and Schmidt, 2017; Pan and Xiao, 2016). While these studies show that gift-giving created strong relationships, this paper goes further and shows that these darker forms of cooperation do not even depend on direct reciprocity - social ties seems to be become stronger when there is third party involved.

One alternative explanation relates to in-group/ out-group thinking (Tajfel, 1982). In the public good treatment, the students organization can appear like an out-group, while the matched pairs can appear like an in-group. The identity of the group of players can then strengthen over time, and hence, people will collude more. However, this explanation implies that collusion should increase over time, regardless of the subjects' experiences. While in-group/ out-group thinking can explain how collusion evolve, it does not provide a clear mechanism for how it arises.

Another potential explanation for the higher levels of collusion in the public good treatment is related to the theory of self-concept maintenance. When people do not collude as much in the early matches, they build a positive image of themselves. They keep this positive image of themselves, while they continue to collude towards the end (Mazar, Amir, and Ariely, 2008). In order to investigate this, the subjects were asked after the prisoner's dilemma game whether they preferred a) 40 for themselves and 0 to the public, or b) 25 for themselves and 25 for the public. There was no difference between treatments (two-sided Mann-Whitney test: p-value 0.70), which does not provide evidence in support of this explanation. But in-group/ out-group thinking and self-image building are factors which can be of importance for understanding collusion and corruption, and which should be investigated further.

A related argument is that subjects contribute less towards the public good as the game evolve, because they feel that they have contributed enough to the public good already. If subjects felt that they had contributed enough to the public good in the public good treatment, and subjects cared equally much about the public good in both treatments, contributions to StOr should be lower in the public good treatment compared to the baseline. However, the numbers imply high and similar contributions to the public good in both treatments, and hence do not lend much support to this argument.[13]

Future research should investigate whether the representation of the public good matters. Another issue is whether the ratio between the gains from collusion and the harm imposed on the public matters. Does a threshold exist where the subjects are no longer willing to harm the public? Another question is whether social ties become stronger if the negative externality is made explicit. Recent literature provide results which are in line with the "conspiracy against the public effect" using different experimental designs, which is reassuring. As with any experimental study, replication is key, and future work should also continue to look for these effects in the field (see e.g. Currie, Lin, and Meng, 2013).

[13]This is provided that subjects do not treat this decision as independent from the main game.

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7 Appendix

Randomization

Table 6: Orthogonality

	(1) Base	(2) PG	(3) (1) vs. (2)	(4) p-value from joint orthogonality test of treatment arms
Age	23.97	24.07	-0.10	0.89
	(0.44)	(0.56)	(0.71)	
HF	0.05	0.10	-0.05	0.30
	(0.03)	(0.04)	(0.05)	
SV	0.28	0.28	-0.00	1.00
	(0.06)	(0.06)	(0.08)	
TN	0.63	0.62	0.02	0.85
	(0.06)	(0.06)	(0.09)	
Shares females	0.50	0.67	-0.17	0.06
	(0.07)	(0.06)	(0.09)	
Attitude PG	6.62	6.93	-0.32	0.40
	(0.27)	(0.26)	(0.38)	
Member PG	0.10	0.07	0.03	0.51
	(0.04)	(0.03)	(0.05)	
Left	0.23	0.27	-0.03	0.68
	(0.06)	(0.06)	(0.08)	
Center	0.10	0.12	-0.02	0.77
	(0.04)	(0.04)	(0.06)	
Right	0.45	0.38	0.07	0.46
	(0.06)	(0.06)	(0.09)	
N	60	60	120	

Standard errors in parentheses. Pair-wise t-tests in square brackets (control versus public good treatment). Field of study: arts and education (*HF*), the faculty of social sciences (*SV*), the faculty of science and technology (*TN*). Political preferences: Right, Center, Left. Attitude PG: *How important is the work done by StOr, in your opinion.* Member PG: "Have you been previously/ are you currently member of StOr?".

Session statistics

The average number of rounds per match is 4.1, and the maximum number of rounds is 24 (Dal Bó and Fréchette (2011): average 4.4 and maximum 24):

Table 7: Session characteristics

	Session	Subjects	Games	Average no of rounds	Average Payoff
DBF	1	12	34	3.9	31.4
	2	14	47	3.2	29.2
	3	12	23	5.4	27.6
Baseline	2	20	32	4.6	82.8
	3	20	32	3.6	56.3
	4	20	31	4.1	64.2
Public good	1	20	43	4.3	101.6
	5	20	33	3.5	57.7
	6	20	32	4.6	86.0

Note: The payoffs for Dal Bó and Fréchette (2011) are in 2011 US dollars, the payoffs in this experiment are in 2013 US dollars, exchange rate May 24th: 5.92 NOK per US dollar. Subjects are on average 24 years old, 58.3 percent of the sample are females, 63 percent are from the faculty of science and technology, 28 percent are from the faculty of social sciences, and 8 percent from the faculty of arts and education.

Table 8: The share of collusion: Probit model with marginal effects

VARIABLES	(1) C	(2) C	(3) C	(4) C	(5) C	(6) C	(7) C	(8) C
PG treatment	-0.20**	-0.21***	0.06	0.10*				
	(0.09)	(0.07)	(0.07)	(0.05)				
First round&match vs. first match					0.07	-0.21***		
					(0.06)	(0.06)		
First match vs. all							0.07	-0.24***
							(0.06)	(0.04)
Observations	120	540	3,720	15,160	1,860	1,860	7,300	7,860
Match	first	first	all	all	all	all	all	all
Round	first	all	first	all	first	first	first	first
Subset					baseline	PG	baseline	PG

Notes: *** p< 0.01, ** p< 0.05, * p< 0.1. The dependent variable is a binary variable equal to 1 if a subject colludes/ cooperates, 0 otherwise. This Table presents the marginal effects results used in Table 3 from probit regressions with robust clustered standard errors on the individual level. The sample is limited to matches 1-31 as the shortest session ends after match 31.

Instructions Public Good Treatment

Welcome!

- In this experiment you will be asked to make some decisions.
- You will get the opportunity to earn money which will be paid to you in cash and anonymously when the experiment is over.
- In this experiment we use what we denote experimental currency units, ECU. By the end of the experiment your total earnings will be converted into Norwegian Kroners according to the following rate: 10 ECU = 1 NOK.
- Your earnings depend partly on your decisions, partly on others' decisions, and partly on chance.
- We will now go through the instructions in detail. You will be given sufficient time to read the instructions. The experiment will last for about one hour.
- If you have any questions regarding the instructions, please raise your hand and we will come to you.
- The experiment will be conducted using computers, and talking or communicating with others during the experiment is not allowed.
- Please turn your cellular phone off and put it away.

Instructions

1. All participants will be randomly matched into pairs several times during this experiment, and each time you and your partner will be asked to make some decisions. Each matched pair plays a sequence of rounds.
2. The number of rounds in each match will vary from match to match. The number of rounds in each match is determined by a lottery. After one round has been played, there is a 75 percent chance that there will be another round. Another way of saying this is that there will be another round in 3 out of 4 times. This means that when you have finished playing the first round, there is a 75 percent chance that there will be a second round. In other words - when round 2 is finished, the probability of a third round is still equal to 75 percent.
3. When the outcome of the lottery is that there will not be another round, all participants are randomly re-matched again. Your earnings from the previous match will be set aside on your personal account. The number of rounds which you and your new partner will meet will be decided by the same lottery as described in 2.
4. In the table below you can see what you earn, what your partner earns, and what is contributed to the public good for all the four possible choice sets:

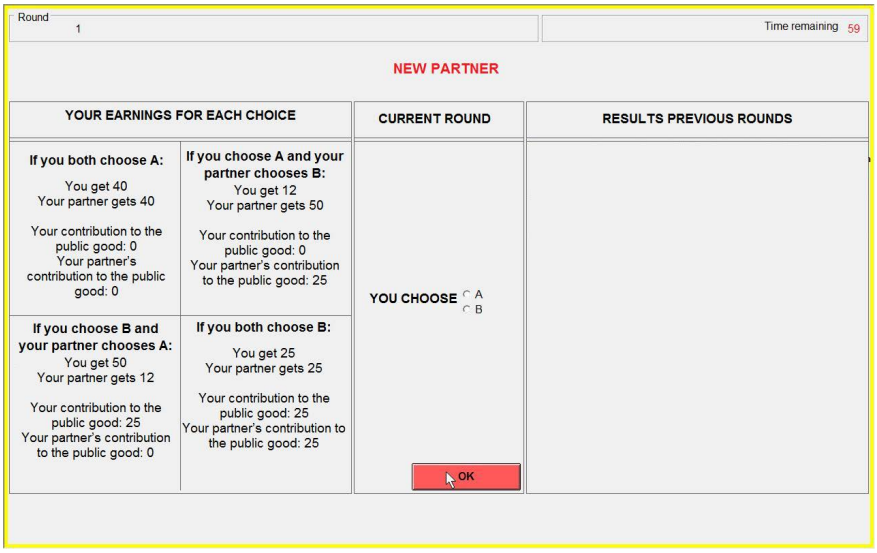
If you both choose A: You get 40 Your partner gets 40 Your contribution to the public good: 0 Your partner's contribution to the public good: 0	**If you choose A and your partner chooses B:** You get 12 Your partner gets 50 Your contribution to the public good: 0 Your partner's contribution to the public good: 25
If you choose B and your partner chooses A: You get 50 Your partner gets 12 Your contribution to the public good: 25 Your partner's contribution to the public good: 0	**If you both choose B:** You get 25 Your partner gets 25 Your contribution to the public good: 25 Your partner's contribution to the public good: 25

In each round you and your partner choose between choice **A** and choice **B**. You and your partner choose simultaneously, and you will get to know your partner's decision after you have made a decision. Your earnings depend on your decision, but they also depend on what your partner's decision is.

As you saw in the table above, you have the opportunity to contribute to a public good in this experiment. The public good is the student organization ***StOr*** here at the University of Stavanger, which works to promote the students' interests (see introduction below). When you choose **B**, you contribute to the public good. And by "public good" we always mean ***StOr***. When you choose **A**, you do not contribute to the public good. The same goes for your partner - when your partner chooses **B**, he/ she contributes to the public good. When your partner chooses **A**, he/ she does not contribute to the public good.

Summary

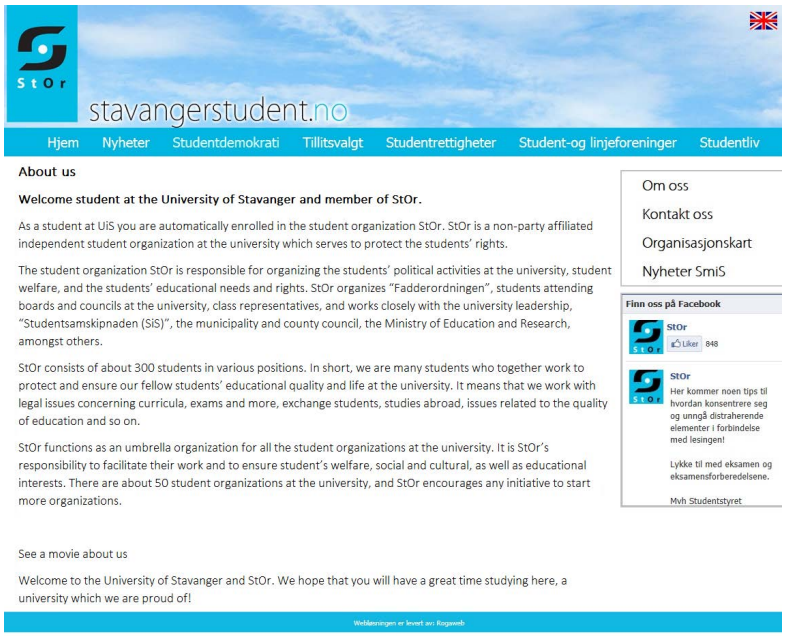
The number of rounds in each match is decided by a lottery. After each round there is a 75 percent chance that there will be another round. When there is no new round, all participants are re-matched. Below you can see what the screen will look like when you are making a decision. The left part of the screen shows what you earn for each choice set. In the middle you see where you make your decision. In the right part of the screen you will see the results from the previous rounds with the current partner. Take your time - feel free to take 30 seconds to make your decision and remember to press the OK-button when you have made your decision.



The lotteries are all drawn by the computer, and they are always randomly drawn.

Please follow the messages which appear on the screen. In the end you will be asked to fill out a short questionnaire, and you will be informed about your total earnings converted into NOK. On the pc cabinet you can see a white sticker with the logo of the university, and a number, for instance D10136. Please write down this number and your total income on the receipt when the experiment is over. When we tell you that the experiment is over, you can leave the room with the receipt. Please bring this to the EAL building, office H-161, to collect your earnings.

About StOr


StOr
stavangerstudent.no
Hjem
Nyheter
Studentdemokrati
Tillitsvalgt
Studentrettigheter
Student-og linjeforeninger
Studentliv
About us
Welcome student at the University of Stavanger and member of StOr.
As a student at UiS you are automatically enrolled in the student organization StOr. StOr is a non-party affiliated independent student organization at the university which serves to protect the students' rights.
The student organization StOr is responsible for organizing the students' political activities at the university, student welfare, and the students' educational needs and rights. StOr organizes "Fadderordningen", students attending boards and councils at the university, class representatives, and works closely with the university leadership, "Studentsamskipnaden (SiS)", the municipality and county council, the Ministry of Education and Research, amongst others.
StOr consists of about 300 students in various positions. In short, we are many students who together work to protect and ensure our fellow students' educational quality and life at the university. It means that we work with legal issues concerning curricula, exams and more, exchange students, studies abroad, issues related to the quality of education and so on.
StOr functions as an umbrella organization for all the student organizations at the university. It is StOr's responsibility to facilitate their work and to ensure student's welfare, social and cultural, as well as educational interests. There are about 50 student organizations at the university, and StOr encourages any initiative to start more organizations.
See a movie about us
Welcome to the University of Stavanger and StOr. We hope that you will have a great time studying here, a university which we are proud of!
Om oss
Kontakt oss
Organisasjonskart
Nyheter SmiS
Finn oss på Facebook
StOr
Liker 848
StOr
Her kommer noen tips til hvordan konsentrere seg og unngå distraherende elementer i forbindelse med lesingen!
Lykke til med eksamen og eksamensforberedelsene.
Mvh Studentstyret

Instructions Baseline

Welcome!

- In this experiment you will be asked to make some decisions.
- You will get the opportunity to earn money which will be paid to you in cash and anonymously when the experiment is over.
- In this experiment we use what we denote experimental currency units, ECU. By the end of the experiment your total earnings will be converted into Norwegian Kroners according to the following rate: 10 ECU = 1 NOK.
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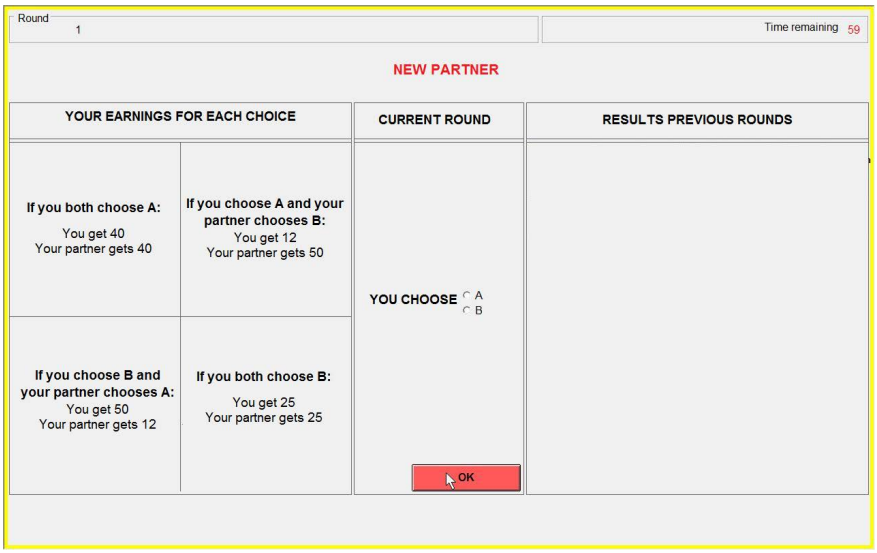
If you both choose A: You get 40 Your partner gets 40	**If you choose A and your partner chooses B:** You get 12 Your partner gets 50
If you choose B and your partner chooses A: You get 50 Your partner gets 12	**If you both choose B:** You get 25 Your partner gets 25

In each round you and your partner choose between choice **A** and choice **B**. You and your partner choose simultaneously, and you will get to know your partner's decision after you have made a decision. Your earnings depend on your decision, but they also depend on what your partner's decision is.

Summary

The number of rounds in each match is decided by a lottery. After each round there is a 75 percent chance that there will be another round. When there is no new round, all participants are re-matched. Below you can see what the screen will look like when you are making a decision. The left part of the screen shows what you earn for each choice set. In the middle you see where you make your decision. In the right part of the screen you will see the results from the previous rounds with the current partner. Take your time - feel free to take 30 seconds to make your decision and remember to press the OK-button when you have made your decision.



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