Cooperation in Viscous Populations — Experimental Evidence*

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February 28, 2007

Abstract

We experimentally investigate the effect of imperfect separation of groups (population viscosity) on group selection and cooperation in a standard prisoner's dilemma environment. Subjects can repeatedly choose between two groups, that differ in the defector gain in the associated prisoner's dilemma. Choosing into the group with the smaller defector-gain can signal one's willingness to cooperate. The degree of separation of the two groups is varied between treatments. We find that both, the share of agents that choose into the "cooperative" group and the share of agents that cooperate, rise monotonously with the degree of group separation. Furthermore we estimate the subjects' intrinsic willingness to cooperate as a function of the expected probability of their match cooperating. We find positive feedback effects between population viscosity and cooperation in the sense that the intrinsic willingness to cooperate rises with the degree of population viscosity.

Keywords: Experiments, Cooperation, Group Selection, Social Norms, Population Viscosity.
JEL classification: C70, C73, C90.

*We thank Axel Ockenfels as well as seminar participants at Cologne, Bonn, Cornell, Amsterdam, and Magdeburg for helpful comments and suggestions, and Felix Lamoroux and Rene Cyranek for most valuable research assistance. Financial support by the *Deutsche Forschungsgemeinschaft,* the *Instituto Valenciano de Investigaciones Económicas (IVIE)* and the *Spanish Ministery of Education and Science* (grant SEJ 2004-02172) is gratefully acknowledged.

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1 Introduction

One of the biggest challenges in social sciences, as well as in biology is to explain pro-social behavior in social dilemma situations. The paradigmatic model of such a situation is the prisoner's dilemma game. In this game agents can choose between a cooperative action and a deficient action. Defection is a dominant strategy for both players (thus individually rational), but both would be better off if they jointly cooperated. People are often observed to cooperate in such situations although they could achieve a higher payoff choosing defection, independently of what their opponent does. This phenomenon has been termed the puzzle of pro-sociality.

Cultural Group Selection is an often advanced explanation for the survival of pro-sociality in social dilemma situations. The basic idea is that if there are two separated cultural groups, one in which agents cooperate (because they share a social norm to do so or because they are genetically programmed) and one, in which agents defect, the agents in the cooperative group will earn higher payoffs and thus have higher evolutionary fitness. This will lead to a proliferation of the cooperative trait or norm.[1] Typically though cultural groups are not perfectly separated. However, as long as agents of the cooperative group are matched with a sufficiently high probability among themselves cooperation can still survive. The intuition simply is that if cooperators interact relatively often with other cooperators they will receive the high payoff of joint cooperation a lot of times, whereas defectors will get the low payoff of joint defection a lot of times. Populations in which there is an increased probability of interacting with agents of one's own type (cultural group) are called *viscous populations*.[2]

In this experiment we investigate the effect of population viscosity on cooperation and the strenght of cooperative norms of agents in a standard prisoner's dilemma environment. Subjects can repeatedly choose between two groups. In one of the groups (group A) the defector payoff is lower such that cooperation is less costly as compared to defection. Agents can choose into that group in order to signal their willingness to cooperate. The degree of separation of the two groups is varied between treatments. We find that participants choose into the group A if and only if the degree of separation between groups is high enough. Also while agents in the "cooperative" group cooperate only if the degree of separation is high enough, agents in the other group almost never cooperate. Finally both, the share of agents that choose into the "cooperative" group and the share of agents that cooperate, rise monotonously with the degree of population viscosity (the degree of separation between groups). Population viscosity - sometimes also referred to as assortative matching - seems a powerful mechanism to sustain cooperation.

We also tackle the difficult question of measuring the subjects' intrinsic disposition to cooperate as a function of the expected probability of cooperation of others. By doing so we gain additional insight into the relation between population viscosity,

[1]See Mitteldorf and Wilson (2000), Boyd and Richerson (2005), Richerson, Boyd and Henrich (2003) or Wilson and Sober (1994) among others.

[2]See Myerson, Pollock and Swinkels (1991) or Mitteldorf and Wilson (2000) among others.

norm strenght and cooperation. We find clear feedback effects between population viscosity and social norms.[3] Whereas on average subjects are conditional cooperators under high viscosity (i.e. they cooperate the more the higher they estimate the share of cooperators in the population), the average pattern of cooperation is hump shaped under low viscosity (i.e. subjects try to exploit others in case a high share among them acts cooperatively). Moreover, measurement of the individual cooperator types reveals that the distribution of cooperator types shifts towards a less cooperative pattern as viscosity decreases. In particular, we find significantly less norm guided agents and significantly more flat defectors. Note that this is taking into account only the intrinsic - not the extrinsic (material) - incentives to cooperate.[4]

Let us finally relate our study to the experimental literature. Only very recently experimental economics has started to focus on the relation between interaction structures and cooperation. Coricelli, Fehr and Fellner (2004), Engelmann and Grimm (2006), or Page, Putterman and Unel (2005) are examples of studies in which agents can endogenously choose interaction partners.[5] In Bohnet and Kübler (2005) and Ehrhardt and Keser (1999) subjects can choose between groups that are perfectly separated. In those studies, however, cooperation cannot establish at a high level. Only two studies investigate group selection in the presence of punishment institutions. Guererk, Irlenbusch and Rockenbach (2006) and Grimm and Mengel (2006) show that subjects learn to choose into a group where a punishment mechanism is at place.[6] In Grimm and Mengel (2006) we moreover elicit cooperator types in a post experimental questionaire and find evidence for feedback effects between the norm guidedness of agents and population viscosity in the questionnaire data.

All the above studies except our own deal only with the case of perfect separation of groups. To the best of our knowledge our studies are the first to analyze the case of imperfect separation. Another novelty in our experiment is that we measure the subjects' attitudes towards normative criteria and relate this measure to the experimental conditions they were in.

The paper is organized as follows. Section 2 describes the experimental design. The results from the experiment are presented and discussed in Section 3. In Section 4 we derive a random utility model in order to estimate the norms that guide the subjects' behavior and report the results. Section 5 concludes.

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[3]If such feedback effects do indeed exist many interesting theoretical predictions arise (See Benabou and Tirole (2005), Mengel (2006), Lindbeck, Nyberg and Weibull (1999) or Traxler (2005)).

[4]The pattern of cooperator types we find is roughly consistent with results by Fischbacher, Fehr and Gächter (2001), Fischbacher and Gächter (2006) or Brandts and Schram (2001).

[5]See also Ones and Putterman (2006) or the literature on network experiments reviewed in Falk and Kosfeld (2003).

[6]See also Goette, Huffman and Meier (2006) for a field study on these issues.

2 The Experiment

In our experiment 128 participants (with no, or very little, prior exposure to game theory) anonymously interacted in a social dilemma situation in 100 rounds. Each round consisted of three stages: A group choice stage, a stage where subjects had to deliver an estimate of the cooperativeness of the other players, and at the last stage the participants played a prisoner's dilemma game.

We ran three treatments that differed in the matching technology. In all three treatments matching takes place randomly in a viscous population, the latter meaning that individuals have a tendency to interact more often with individuals that are of the same type. The degree of viscosity is measured by the parameter $x \in [0, 1]$. $x = 1$ corresponds to the case of random matching. $x = 0$ means that the population is fully viscous, implying that agents interact with probability 1 with agents of the same group and never with agents from another group.[7] In a viscous society with parameter x, if p_A is the share of agents of type A (members of group A) the probability for any one of them to interact with a B type is $(1 - p_A)x = p_B x$ and the probability to interact with a member of group A is $(1 - (1 - p_A)x) = 1 - p_B x$. The matching probabilities are summarized in table 1.

	A	B
A	$1 - p_B x$	$p_B x$
B	$p_A x$	$1 - p_A x$

Table 1: Matching Probabilities

In the experiment we chose the values $x \in \{0, \frac{1}{3}, \frac{2}{3}\}$. One population consisted of 8 subjects. The members of a population were initially randomly assigned to groups A and B in equal proportions. At the first stage of each round, two of the eight subjects could decide to either join the other group, or to stay in their own group. Each subject could make this decision every fourth round. At the second stage of each round subjects were asked for their expectation on the cooperation probability of their match.[8] At the third stage subjects played the prisoner's dilemma game with payoffs as given by the tables 5 with an interaction partner who was assigned randomly according to the matching technology. As it can be seen from tables 5, the two groups differ only in the defector's payoff. Independently of their group membership, subjects face a prisoner's dilemma game. However, in group A the defector's payoff is lower (i. e. cooperation is less costly as compared to defection).

Prior to playing the game subjects were informed about (a) the percentage of subjects in group A and B, and (b) their individual probability to meet a group A and group B member, respectively. At all times agents had incomplete information

[7] This is the case typically considered in models of group selection.

[8] We did not pay this answer because we wanted to avoid that subjects try to trade off earnings from correct guessing and from the game payoffs.

Group A		other	
		C	D
me	C	800	100
	D	850	150

Group B		other	
		C	D
me	C	800	100
	D	1100	400

Table 2: Payoffs in the Prisoner Dilemma Games.

about the group membership (i. e. the type) of their match. When choosing an action in the bilateral game they had to estimate the type of their match from the information we gave to them.

Since in our experiment the population was necessarily finite, one-to-one matching was not feasible. Instead, we first realized a random draw with the probabilities given in table 1 to decide whether a subject's interaction partner was from group A or B. Then the interaction partner played the actions "cooperate" or "defect" with probabilities that corresponded to the proportions with which those actions were played in the respective group (in that round). In the unlikely event that only one subject remained in a group (either A or B) and the first random draw determined that he had to play against an member of his own group, the subject's interaction partner was preprogrammed to play C or D with equal probabilities.[9] After each of the 100 rounds, subjects were informed of whether their interaction partner belonged to group A or B, his action, and their own monetary payoffs.

The experiment was conducted in four sessions in October, 2006. The three experimental sessions were computerized.[10] Written instructions were distributed at the beginning of the experiment.[11] Each session took approximately 120 minutes (including reading the instructions, answering a post-experimental questionnaire and receiving payments). Subjects participating in the experiment received 2.50 Euros just to show up. On average subjects earned Euro 15.16 (all included).

3 Results

Figure 1 impressively illustrates the effect population viscosity has on group selection. While in the perfectly separated population (treatment $x = 0$) a high share of subjects join group A, the share of subjects that are in group A decreases as viscosity decreases. We find that in the treatments with a high degree of viscosity group A contains a considerable share of subjects (averages are 59.2% in treatment $x = 0$ and 36.8% in treatment $x = \frac{1}{3}$). Interestingly, we do not even observe that the share of subjects decreases in the last periods. In treatment $x = \frac{2}{3}$, on the contrary, group A shrinks

[9]The subjects were informed that the interaction partner would use a preprogrammed strategy in this case.

[10]The experiment was programmed and conducted with the software z-Tree (Fischbacher 1999).

[11]The instructions for $x = 0$, translated into English, can be found in the Appendix. Instructions for the remaining treatments are available upon request.

and finally disappears (average share of subjects in group A is 9.8%).

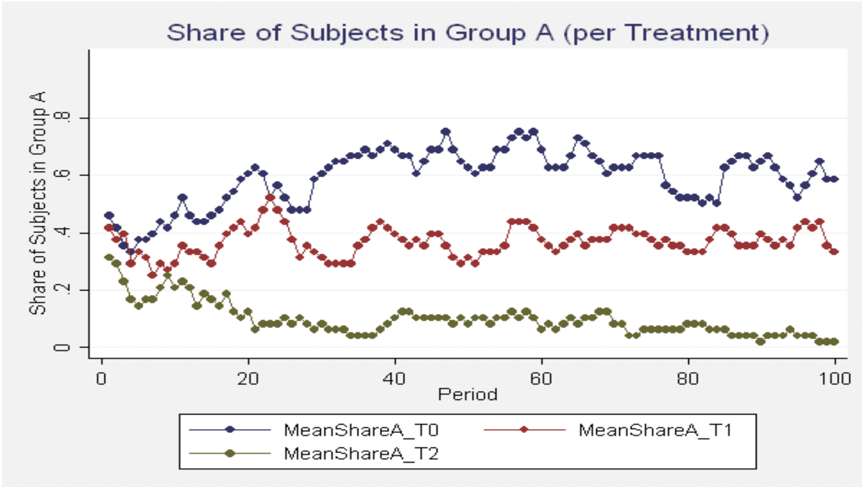

Figure 1: The Share of Subjects in Group A (per Treatment).

Result 1 (Group Selection) *The share of subjects in group A is higher, the more viscous the population is. In* $x = 0$ *and* $x = \frac{1}{3}$ *a constant share of around 60% and 35%, respectively, is in group A. In treatment* $x = \frac{2}{3}$ *the share of subjects in group A decreases until it is finally zero.*

Analyzing cooperation rates separately for the two different groups (A and B) reveals that in all treatments the majority of subjects in group A cooperates, while almost no group B–member does.

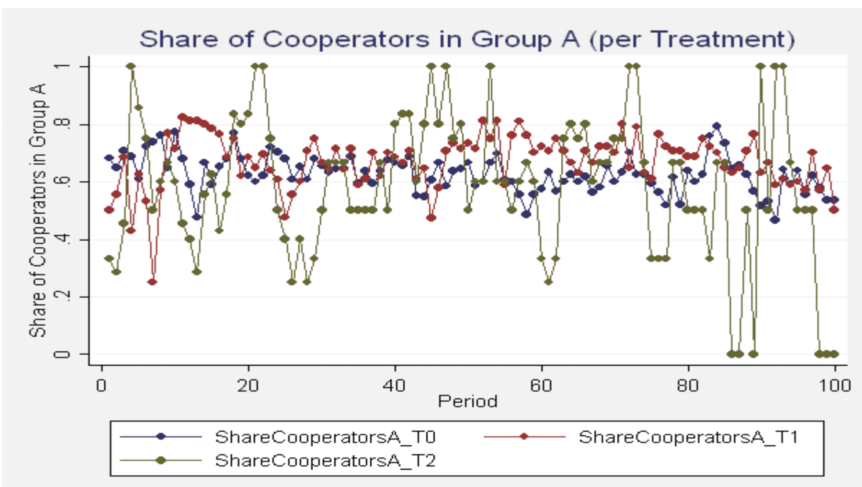

Figure 2: Shares of Cooperators in Group A (per Treatment).

As figure 2 illustrates, the shares of cooperating subjects in group A is constantly around 60% in treatments $x = 0$ and $x = \frac{1}{3}$. Moreover, the cooperator share does not drop down at the end of the experiment. In treatment $x = \frac{2}{3}$ the cooperation rate in group A fluctuates a lot, which is mainly due to the low number of subjects in group A. Note that Figures 1 and 2 also show that - unlike in most other experimental studies of cooperation - cooperation does not break down at the end of the experiment, i.e. there is no so-called "endgame effect". This illustrates a) that viscosity is a powerful mechanism to sustain cooperation and b) our results are not driven by the use of repeated game strategies of players with limited foresight.

Figure 3 shows that in group B initial cooperation quickly breaks down and that from round 20 on almost noone cooperates in that group. Table 3 gives an overview over average cooperation rates, separately for both groups and the whole population.

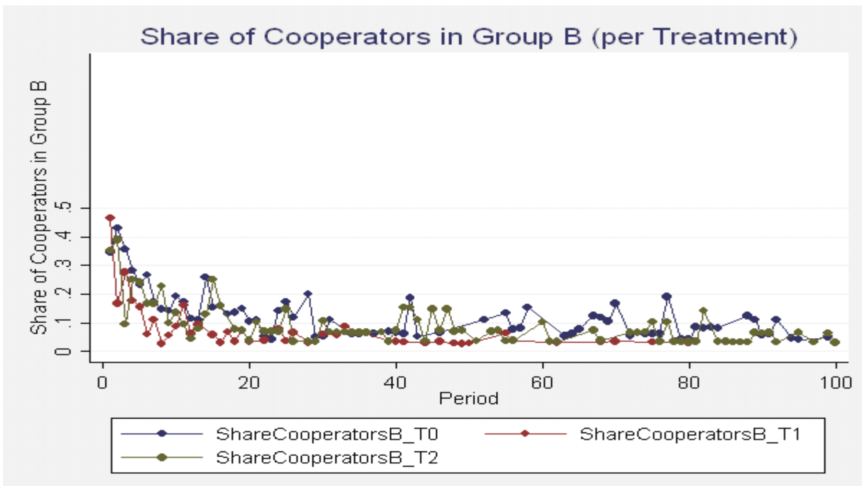

Figure 3: Shares of Cooperators in Group B (per Treatment).

Result 2 (Cooperation)

Subjects in group A cooperate significantly more than subjects in group B. Consequently the rate of cooperation is highest in treatment $x = 0$ and lowest in treatment $x = 2/3$.

Treatment	Group A	Group B	Overall
$x = 0$	62.4	9.9	41.0
$x = \frac{1}{3}$	67.1	3.2	26.7
$x = \frac{2}{3}$	59.5	6.7	11.9

Table 3: Average Cooperation Rates

The observed behavior (concerning group selection and cooperation) had clear consequences on profits. Note that from the results it follows that overall rates of cooperation in the population were the higher, the higher population viscosity was (compare also table 3). Consequently, payoffs were highest in treatment $x = 0$, lowest (and close to the payoffs from mutual defection) for $x = \frac{2}{3}$, and in between for the remaining treatment. Members of group A have a higher payoff than members of group B in treatments $x = 0$ and $x = \frac{1}{3}$ and vice versa in treatment $x = \frac{2}{3}$. We summarize our results in table 4.

Treatment	Group A	Group B	Overall
$x = 0$	560	457	518
$x = \frac{1}{3}$	494	460	472
$x = \frac{2}{3}$	350	452	436

Table 4: Profits.

Result 3 (Profits)

(i) Average profits in the population are highest in treatment $x = 0$, followed by $x = \frac{1}{3}$ and treatment $x = \frac{2}{3}$.

(ii) The profit of a group A–member is higher than the profit of a group B–member in treatments $x = 0$ and $x = \frac{1}{3}$ and vice versa in treatment $x = \frac{2}{3}$.

4 Feedback Effects between Interaction Structure and Norm

Our results clearly indicate that subjects display intrinsic incentives to cooperate.[12] To estimate those intrinsic incentives we use a model which assumes that the subjects attach a value w to "being cooperative" as compared to defecting. Let us call a subject's incentive w his or her *norm* in the following. In this section we tackle the difficult question of experimentally investigating the shape of norms and how it can vary with the matching structure.[13] We estimate the norm w both, at the aggregate and at the individual level and find that indeed it changes with the degree of population viscosity.

[12] Since we observe no endgame effects, the observed behavior cannot be explained by strategic behavior of rational agents that only consider the monetary incentives.

[13] Social norms are particularly interesting in this context because of the feedback effects between equilibrium and norm. These effects have been studied theoretically by Benabou and Tirole (2005), Lindbeck, Nyberg and Weibull (1999), Mengel (2006) and Traxler (2005).

4.1 The Model

To estimate the norm w we use a random utility model. Consider the following payoff matrix (payoffs for row player, denoted player i). w_i measures player $i's$ intrinsic

		other	
		C	D
me (player i)	C	$800 + \varepsilon_{iC}$	$100 + \varepsilon_{iC}$
	D	$850 + 250\delta_B - w_i + \varepsilon_{iD}$	$150 + 250\delta_B - w_i + \varepsilon_{iD}$

Table 5: Random Utilities.

incentive to cooperate (i. e. his norm), $\delta_B = 1$ if i is in group B and zero otherwise, and ε_{iC}, ε_{iD} are error terms. We define $\varepsilon_i = \varepsilon_{iD} - \varepsilon_{iC}$. We denote by $\widehat{c}$ the probability with which an agent believes that his match cooperates (we elicit this probability in our experiment). Say $c_{it} = 1$ if agent i cooperates at time t and $c_{it} = 0$ otherwise. Then the utility of an agent can be written,

$$U(c_{it}) = \underbrace{800\widehat{c} + 100(1-\widehat{c}) + \varepsilon_{iCt}}_{\text{exp. profit from coop.}} + (1 - c_{it}) \underbrace{(50 + 250\delta_B - w_i + \varepsilon_{it})}_{\text{add. perceived profit from defection}}, \quad (1)$$

where ε_{it} are iid extreme value distributed with cumulative distribution function

$$F(\varepsilon_{it}) = e^{-e^{-\mu\varepsilon_{it} - \gamma}}$$

The choice rule then predicts that whenever the additional perceived profit of cooperation as compared to defection, i. e.

$$c^*_{it} = w_i - (50 + 250\delta_B) + \varepsilon_{it}$$

is negative, a subject cooperates whereas if it is positive, the subject defects, i. e.

$$c_{it} = \begin{cases} 1 & \text{if } c^*_{it} \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

We consider the following quadratic specification for the norm w,

$$w_i = n_i + m_i\widehat{c} + l_i\,(\widehat{c})^2\,.$$

The case where w is a constant and does not depend on $\widehat{c}$ and the case where w is linear in $\widehat{c}$ will be treated as particular cases of the quadratic model where the coefficients of higher order terms are zero. We can estimate a logit choice model where the independent variable is the expected monetary payoff of defection as compared to cooperation, $\Delta = 50 + 250\delta_B$. Given the payoff matrices used in the experiment $\Delta = 50$ in group A and $\Delta = 300$ in group B. The logit model for the quadratic case can be written

$$\Pr(c_{it} = 1) = \frac{e^{\mu(n_i + m_i\widehat{c} + l_i(\widehat{c})^2 - 50 - 250\delta_B)}}{1 + e^{\mu(n_i + m_i\widehat{c} + l_i(\widehat{c})^2 - 50 - 250\delta_B)}}. \quad (2)$$

Regressing $\Pr(c_{it} = 1)$ on $\widehat{c}$, $(\widehat{c})^2$and δ_B, we have that (given our utility model) the coefficient for the constant term (of the regression) is an estimate of $\mu(m - 50)$, the coefficient on δ_B is an estimate of -250μ, the coefficient on $\widehat{c}$ is an estimate of μn and the coefficient on $(\widehat{c})^2$ is an estimate of μl.

4.2 Results

We find that on average the norm depends as follows on $\widehat{c}$ in our three treatments:

$$\begin{aligned} w_0 &= -103.77 + 838.01\widehat{c} - 545.21\,(\widehat{c})^2 && \text{for } x = 0 \\ w_1 &= -111.3 + 812.25\widehat{c} - 543.71\,(\widehat{c})^2 && \text{for } x = 1/3 \\ w_2 &= -119.72 + 1104.0\widehat{c} - 995.91\,(\widehat{c})^2 && \text{for } x = 2/3 \end{aligned}$$

If $\widehat{c} = 0$ the norm w is actually negative, i.e. subjects seem to have additional incentives to defect. This seems to indicate the presence of sth like "spite". But then the norm-function is rapidly increasing in all treatments indicating that conditional cooperation is a strong behavioral motive.

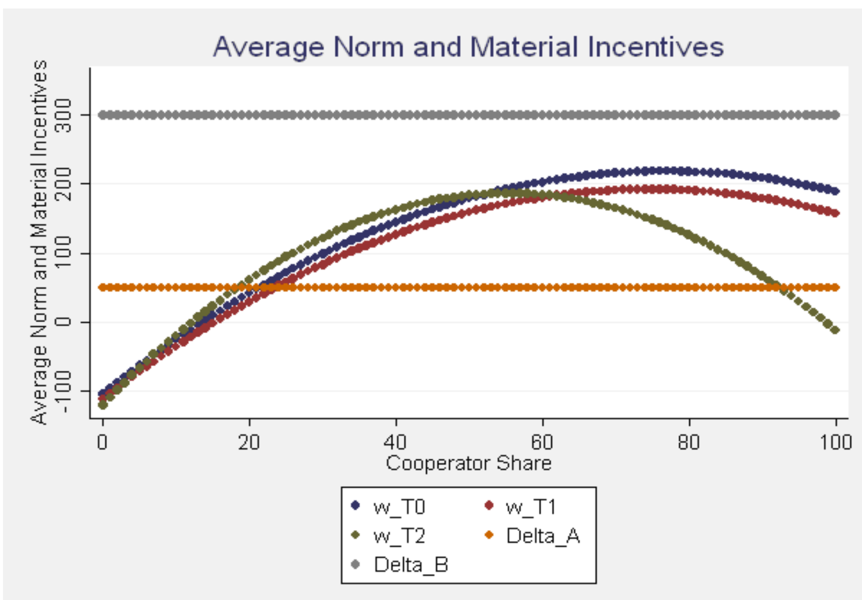

Figure 4: Average Norm and Material Incentives.

The result is illustrated in figure 4. In the figure, the lower of the two similar lines is $x = \frac{1}{3}$, whereas the most "U-shaped" one is $x = \frac{2}{3}$. In all treatments subjects on average are reluctant to cooperate if they expect cooperative behavior only of a *low* fraction of other subjects. Whereas in treatments $x = 0$ and $x = \frac{1}{3}$ subjects on average are conditional cooperators (the functions $w(\widehat{c})$ are more or less increasing), in treatment $x = \frac{2}{3}$ the function $w(\widehat{c})$ is inversely U-shaped. This implies low willingness to cooperate also if subjects expect a *high* share of cooperators among the other players (whereas subjects are rather cooperative if they expect intermediate cooperation rates). We conclude that if population viscosity is low the possibility to exploit other subjects gets more into the focus such that cooperation cannot establish at a high level.

Naturally the average norm does not reflect all the differences at the individual level. In order to investigate how individual behavior differed across treatments we ran individual regressions for each subject in each treatment. This allowed us to classify the subjects into six types that displayed different kinds of norm guided behavior. The results are given in table 6. A subject is attributed the model that fits best. To be attributed any model all, the coefficients of the regression have to be significant at 10% at least.[14] Subjects who cooperate/defect at least 91 out of 100 times are classified into always C / always D, respectively. Subjects that follow a strategy C in A and D in B at least 91 out of 100 times are classified into that category. Those who cannot be classified in any of the categories are classified into "none of the previous".

Treatment	$x = 0$	$x = \frac{1}{3}$	$x = \frac{2}{3}$
Constant Model	13 %	6 %	3 %
Linear Model	38 %	36 %	16 %
Quadratic Model	19 %	10 %	13 %
C in A, D in B	6 %	13 %	3 %
Always C	4 %	2 %	0 %
Always D	10 %	27 %	53 %
None	10 %	6 %	12 %

Table 6: Subject Classification in the Three Treatments.

It is remarkable that norm guided agents (constant model, linear model, and always C) decrease and flat defectors (always D) increase as population viscosity decreases. This of course is partly due to the fact that in treatment $x = 2/3$ subjects predominantly choose into group B. But of course this choice is endogenous and motivated as we have seen above by their intrinsic disposition to cooperate.

5 Conclusion

In this paper we have experimentally investigated the impact of population viscosity on cooperation in social dilemma situations. Participants in our experiment could repeatedly choose between two groups, where in one of them cooperation was less costly as compared to defection. The degree of population viscosity was varied between treatments. We found that under high population viscosity subjects chose into the group with the lower defector payoff in order to signal their willingness to cooperate.

[14]Mostly the significance level is 1%.

In all treatments a significant share of subjects actually cooperated in that group, while almost no subject cooperated in the other group. The share of participants that choose into the "cooperative" group rises with the degree of population viscosity. Average profits for participants in the "cooperative" group are the higher the more separated groups are. Consequently, under high population viscosity subjects realize a significant part of the possible efficiency gains of mutual cooperation.

Our experiment provides clear evidence on the importance of cultural group selection for sustaining cooperation. We also find evidence for a positive relation between norms and population viscosity. Participants of treatments characterized by high viscosity tend to have higher intrinsic incentives to cooperate. Also the distribution of cooperator types changes with population viscosity. In short, population viscosity seems a powerful and important mechanism not only for sustaining cooperation *given* a distribution of cooperator types but it also positively *affects* this distribution towards a more cooperative society. To further understand the way population viscosity acts on economic incentives and social norms gives rich potential for further research, both theoretically and experimentally.

References

[1] Benabou, R. and J.Tirole (2005), "Incentives and Prosocial Behavior", *NBER working paper 11535*.

[2] Bohnet, I and D. Kübler (2005), "Compensating the cooperators: Is sorting in the prisoner's dilemma possible ?", *Journal of Economic Behavior and Organization*, 56, 61-76.

[3] Brandts, J. and A.Schram (2001), "Cooperation and noise in public goods experiments: applying the contribution function approach", *Journal of Public Economics 79*, 399-427.

[4] Boyd,R. and P.Richerson (2005), "The Origin and Evolution of Cultures (Evolution and Cognition)", University of Chicago Press..

[5] Coricelli, G., D. Fehr and G. Fellner (2004), " Partner Selection in Public Goods Experiments", *Journal of Conflict Resolution 48*, 356-378.

[6] Ehrhardt, Keser (1999)

[7] Engelmann, D. and V. Grimm (2006),...........

[8] Fischbacher, U. (1999), Z-tree Zurich Toolbox for Readymade Experiments, *IERE working paper No 21*, University of Zurich.

[9] Fischbacher, U., Gächter, S. and E.Fehr (2001), "Are people conditionally co-operative ? Evidence from a public goods experiment", *Economics Letters 71*, 397-404.

[10] Fischbacher, U. and S. Gächter (2006), "Heterogenous social preferences and the dynamics of free-riding in public goods", CeDEx Discussion paper.

[11] Goette, L., D. Huffman and S. Meier (2006), "The Impact of Group Membership on Cooperation and Norm Enforcement: Evidence Using Random Assignment to Real Social Groups", *working paper 06-07* Federal Reserve Bank of Boston.

[12] Grimm, V. and F. Mengel (2006), "Group Selection with Imperfect Separation: An Experiment", working paper University of Cologne.

[13] Guererk, Ö., B. Irlenbusch, and B. Rockenbach (2006) "The Competitive Advantage of Sanctioning Institutions," *Science 312 (5770)*, 108-111.

[14] Kosfeld, M. (2003), "Network Experiments", *IERE working paper No 152*, University of Zurich.

[15] Kosfeld, M. and A. Riedl (2004), "The Design of Decentralized Punishment Institutions for Sustaining Cooperation", mimeo University of Zurich.

[16] Lindbeck,A., S.Nyberg and J.Weibull (1999), "Social Norms and Economic Incentives in the Welfare State", *Quarterly Journal of Economics 114,* 1-35.

[17] Mengel, F. (2006) "A Model of Immigration, Integration and Cultural Transmission of Social Norms", *IVIE working paper AD 2006-08.*

[18] Mitteldorf,J. and D.S. Wilson (2000), "Population Viscosity and the Evolution of Altruism", *Journal of Theoretical Biology 204*, 481-496.

[19] Myerson R.B., G.B.Pollock and J.M.Swinkels (1991), "Viscous Population Equilibria", *Games and Economic Behaviour 3,* 101-109.

[20] Ones, U. and L. Puttermann (2006), " The ecology of collective action: A public goods and sanction experiment with controlled group formation", *forthcoming Journal of Economic Behavior and Organizatio*n.

[21] Page, T., L. Putterman and B.Unel (2005), "Voluntary Association in Public Goods Experiments: Reciprocity, Mimicry and Efficiency, *The Economic Journal 115*, 1032-1053.

[22] Richerson, P., R.Boyd and J.Henrich (2003), "Cultural Evolution of Human Cooperation" in: P.Hammerstein (ed.), *Genetic and Cultural Evolution of Cooperation,* MIT-Press.

[23] Traxler, C. (2005), "Social Norms, Voting and the Provision of Public Goods", mimeo, University of Munich.

[24] Wilson, D.S. and E.Sober (1994), "Re-Introducing Group Selection to the Human Behavioural Sciences", *Behavioral and Brain Science 17*, 585-654.

A Regression Results

Estimated Norm using all Observations:

$x = 0$ **(except "always C in A...")**

cooperate	Coef.	Std. Err	z	$P > \|z\|$	[95% Conf. Interval]
myprobcguess	.0826623	.0081416	10.15	0.000	.066705 .0986197
myprobcgue˜d	-.0005378	.0000715	-7.52	0.000	-.0006779 -.0003976
groupB	-2.466043	.1262566	-19.53	0.000	-2.713502 -2.218585
_cons	-1.516847	.2404864	-6.31	0.000	-1.988192 -1.045503

x=1/3

cooperate	Coef.	Std. Err	z	$P > \|z\|$	[95% Conf. Interval]
myprobcguess	.1056852	.0108448	9.75	0.000	.0844298 .1269405
myprobcgue˜d	-.0007066	.0001133	-6.24	0.000	-.0009286 -.0004845
groupB	-3.252846	.1574204	-20.66	0.000	-3.561384 -2.944308
_cons	-2.098794	.2365592	-8.87	0.000	-2.562442 -1.635146

x=2/3

cooperate	Coef.	Std. Err	z	$P > \|z\|$	[95% Conf. Interval]
myprobcguess	.0945457	.0087753	10.77	0.000	.0844298 .1269405
myprobcgue˜d	-.0008529	.0001005	-8.48	0.000	-.0009286 -.0004845
groupB	-2.141006	.171408	-12.49	0.000	-3.561384 -2.944308
_cons	-1.453488	.2358278	-6.16	0.000	-2.562442 -1.635146

B Instructions Treatment $x = \frac{1}{3}$

Welcome and thanks for participating at this experiment. Please read these instructions carefully. They are identical for all the participants with whom you will interact during this experiment.

If you have any questions please raise your hand. One of the experimenters will come to you and answer your questions. From now on communication with other participants is forbidden. If you do not conform to these rules we are sorry to have to exclude you from the experiment. Please do also switch off your mobile phone at this moment.

For your participation you will receive 2,50 Euro. During the experiment you can earn more. How much depends on your behavior and the behavior of the other participants. During the experiment we will use ECU (Experimental Currency Units) and at the end we will pay you in Euros according to the exchange rate 1 Euro = 2500 ECU. All your decisions will be treated confidentially.

The Experiment At the beginning of the experiment we will split you and the other participants equally into two groups — **group A and group B**. In each round of the experiment you play a game against a "representative member" either from group A or group B that we will call in the following your **interaction partner**.

Each round has three phases:

- **phase 1**: Each round some participants can decide whether to change groups or not. You can make this decision for the first time between round 1 and 4 and from then on every 4 rounds.
- **phase 2**: You are asked to give an estimate about your opponent's likely behavior.
- **phase 3**: You play the game that we will describe in the next section.

The Experiment consists of 100 rounds.

The Game and the payments Independently from which group (A or B) you are in, you play during the first 4 rounds and in the second phase of every following round the following game with a randomly selected interaction partner:

In each round you and your interaction partner can choose between two alternative, C and D. How much you **earn** in each round depends on **what you and your interaction partner have chosen** and in **which group you are**.

Each member of group A receives the following payments:

Group A		your match chooses	
		C	D
you choose	C	800 ECU	100 ECU
	D	850 ECU	150 ECU

The table reads as follows:

- if both choose D, each gets 150 ECU (down right)
- if you choose D and your interaction partner C, you get 850 ECU (down left)

- if you choose C and your interaction partner D, you get 100 ECU (up right)
- if both choose C, each gets 800 ECU (up left)

Each member of group B receives the following payments:

Group B		your match chooses	
		C	D
you choose	C	800 ECU	100 ECU
	D	1000 ECU	490 ECU

The table reads as follows:

- if both choose D, each gets 400 ECU (down right)
- if you choose D and your interaction partner C, you get 1100 ECU (down left)
- if you choose C and your interaction partner D, you get 100 ECU (up right)
- if both choose C, each gets 800 ECU (up left)

Who do I play with and how does this depend on my group ? In each round your interaction partner is determined randomly. The probability to interact with someone of your own group differs from that of interacting with someone from the other group. The following is true:

- The more members a group has the more likely it is to meet a member of that group.
- Relatively it is more likely to meet someone from your own group.

The following tables give you an overview of the probabilities to interact with a member of group A or B respectively, depending on whether you yourself are in group A or B. If you are in group A the relevant table is table 1. If you are in group B the relevant table is table 2.

Table 1: you are in group A					
percentage of participants in group A:		25	50	75	100
percentage of participants in group B:		75	50	25	0
In which percent of all cases do I meet someone from group	A	71	81	90	100
	B	29	19	10	0

The tables are for your orientation. It can happen that the actual share of participants in group A is not listed in the table. Each time we will thus calculate the corresponding probabilities for you and inform you about them before the start of phase 2.

Table 2: you are in group B					
percentage of participants in group A:		0	25	50	75
percentage of participants in group B:		100	75	50	25
In which percent of all cases do	A	0	10	19	29
I meet someone from group	B	100	90	81	71

Your interaction partner Your interaction partner in each round is not another participant of the experiment, but a "representative member" of the group in which you are at the moment. He chooses the actions C and D with probabilities that correspond to the shares with which the other members of your group have chosen C and D.

If you are the only member of your group, the behavior of your interaction partner will be simulated by the computer (**but only in this case**). In all other cases the behavior of your interaction partner depends **exclusively** on the **behavior of the other members** of your group.

These rules obviously are the same for all other participants of the experiment.

Example: You are in group A and consequently your interaction partner will also be from group A.

- if among the other members in group A 70% chose action C and 30% chose action D, your interaction partner will choose with probability 70% action C and with probability 30% action D.

- if all other members of group A have chosen action C, your interaction partner will choose action C with probability 100%.

Information you receive Survey of the three phases and the information you get

- Phase 1: Some participants can change their group.

- Phase 2:

  (a) We inform you about,

    * your current group,
    * which share of participants is in group A and B respectively ,
    * with which probability you meet a participant of group A or B

  (b) You give an estimate about the behavior of your match. Specifically we will ask you the following question:

  How likely do you think it is (in percent) that your match in the next round will cooperate?

- Phase 3: you play the game described above with a randomly chosen match.

  After the third phase you are informed about which action you and your match have chosen and about your payment.