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Abstract: In the frame of decentralization reforms in Namibia, local water point associations evolved that have to collect water fees from community members to cover maintenance costs. Enforcement, however, is weak and water point associations have to rely on moral pleas. Partly as a consequence, several users refuse to pay. I test the impact of informal sanction mechanisms on cooperation among water point users in groups with equal and unequal incomes. Interestingly, and in contrast to the vast majority of related studies, cooperation does not increase under the threat of punishment, though the punishment option was frequently used. At individual level I show that while punishments do not affect cooperative behaviour, they provoke counter-punishment. This suggests that peer-sanctioning mechanisms as a means to enforce norm-compliance are not accepted among water point association members. Contribution levels were higher in heterogeneous groups compared with homogenous ones, and both pro-social and anti-social punishments occurred more frequently in homogenous groups. A comparison between different income types further reveals that the poor contribute larger shares of their income than those endowed with higher incomes and that they use punishment as frequently and as vehemently as the better-off, despite higher opportunity costs.

Keywords: Income heterogeneity, public goods experiment, peer punishment, anti-social punishment, Namibia

1. Introduction

Over the last two decades, rural communities in developing and transition countries have been moving increasingly into the focus of local resource management, and all over the world, decentralization and devolution reforms have been pushed forward by national governments (Mansuri and Rao, 2004). It has been argued that the devolution of responsibilities over natural or man-made resources from national to local level can reduce transaction costs, in particular monitoring and enforcement costs (Agrawal and Gibson, 1999; Bardhan, 2005; Meinzen-Dick et al., 1996; Ostrom et al., 1994) and that the potentials for such self-governance are especially high in countries where formal institutions are weak and the central government has little influence on local level (Fehr et al., 2008; Ostrom et al., 1994). However, there is evidence that this holds only if communities have developed effective informal monitoring and enforcement mechanisms which are widely accepted, obeyed, and, if necessary, enacted by community members to discipline free-riders in situations where individual and collective interests are at odds (Baland and Platteau, 1996; Gibson et al., 2005; Ostrom et al., 1992). In this context, informal enforcement mechanisms have to be understood as sanctions imposed by private actors and not by formal, legal bodies, comprising fines that impose tangible costs on the offender as well as sanctions that do not impose material costs but might nevertheless reduce the offender's utility, such as social disapproval, gossip, public embarrassment of offenders, or ostracism at the extreme (Elster, 1989).

In southern Namibia, where this study was carried out, the national government has been promoting community-based approaches since the country's independence in 1990; and has gradually begun to devolve authority over and responsibilities for wildlife, forest and water resources to local users (Barnes et al., 2002; Prediger and Kirk, 2010). The foundation of local water point associations (WPAs) is part of the national decentralization approach. In the frame of the rural water supply reform, WPAs obtained partial responsibility for the maintenance of the water infrastructure, thereby relying on the collection of fees from community members (Bock and Kirk, 2006). However, empirical studies suggested that the user-pay principle has compounded inequality and poverty within communities (Falk et al., 2009); and although fees are rather low, committee members of WPAs as well as extension officers from the Rural Water Supply (a WPA supporting government agency) frequently report local resource users who refuse to pay their water fees (own research). A major challenge to the enforcement of the user-pay principle is that "*WPAs have no legal means to force* [those] *who are unwilling to pay the water fees to contribute*, *but have to rely on moral pleas*"(Kirk et al., 2010). One goal of this paper is to examine the scope of informal sanction mechanisms for the provision of public goods (PG), such as the water infrastructure in rural southern Namibia, by applying an experimental approach.

Over the last two decades, several authors drew on experimental methods to research the effect of decentralized sanctions on the provision of public goods or exploitation of common-pool resources. These studies showed that a substantial fraction of subjects is willing to penalize others at their own cost in order to discipline free-riders (e.g. Fehr and Gächter, 2000; Gächter et al., 2008; Ostrom et al., 1992), even though costly peer punishment constitutes a second-order PG (Panchanathan and Boyd, 2004; Yamagishi, 1986). The existence of such altruistic punishment (or strong reciprocity) has served as an explanation as to why groups of genetically unrelated individuals are able to sustain high levels of cooperation (de Quervain et al., 2004; Gürerk et al., 2006). Generally, peer punishment has proven to substantially enhance cooperation among group members, often leading to outcomes close to the socially optimal contribution levels. Interestingly, this holds true even if punishment is purely symbolic and does not have material pay-off consequences for the punished individual (Carpenter et al., 2004a; Masclet et al., 2003; Noussair and Tucker, 2005), suggesting that punishment evokes feelings of shame or guilt in response of being punished (Elster, 1989; Gächter and Herrmann, 2009).

So far evidence for the cooperation-enhancing effects of peer punishment comes almost exclusively from experimental studies involving actors who are endowed with homogeneous incomes. By contrast, real-life societies are heterogeneous regarding demographics, religious and political beliefs or ethnicity, and of course with respect to income or wealth. Especially this holds true for Namibia, where wealth inequality is the highest in the world (CIA, 2011). To my knowledge, there is only one single working paper focusing on punishment behaviour in PG-settings involving groups with heterogeneous incomes (Visser and Burns, 2006). Visser and Burns found a higher incidence and severity of punishment in heterogeneous than in homogenous groups, inducing higher levels of cooperation in unequal groups and thereby causing a redistribution of wealth from the better-off to the less wealthy subjects within these groups. A further goal of my study is to test whether their results are robust across different subject pools, i.e. whether similar behavioural patterns are observed for rural dwellers in southern Namibia.

Moreover, my study extends the work of Visser and Burns (2006), by putting special emphasis on differences between homogenous and heterogeneous groups regarding the nature of punishment. That is, I shall investigate whether (1) punishment is mainly targeted towards non-cooperators, as usually observed in studies drawing on students from Western societies, or whether punishment is also exerted by free-riders towards cooperators; and (2) whether the patterns of punishment differ between equal and unequal groups as well among different player types. Punishment assigned by low contributors towards high contributors has been termed *anti-social* (Falk et al., 2005) or *perverse* punishment (Cinyabuguma et al., 2006) and it has been argued that it may have detrimental effects on cooperation and development (Fehr et al., 2008). My study contributes to the growing research field on anti-social behaviour by examining the impact of income heterogeneity on anti-social punishment.

The paper is structured as follows: In the next section I shall present the design of the experiments and derive hypotheses based on theoretical and empirical studies. Section 3 presents and discusses the main results, followed by a summary and conclusion.

2. Experimental design

The public goods experiments (PGG) were conducted in the end of 2009 in the communal areas around Karasburg and Keetmanshoop in the Karas region, southern Namibia, using pen and paper. I recruited 120 participants from 11 villages. A group of four subjects participated in each session, and 30 sessions were carried out in total. A session consisted of a series of two experiments, each lasting six rounds (excluding practice rounds). The group composition remained constant across all 12 rounds. That is, partner matching was in effect.

The first experiment was a standard linear PGG[1] without punishment option, which is also referred to as the voluntary contribution mechanism (VCM) game. The second experiment was a VCM game with a subsequent punishment stage. I implemented two treatments (homogenous or heterogeneous) that were assigned randomly to the groups. Each treatment was implemented in 15 sessions. In the homogenous treatment, all group members received an endowment of 30 tokens at the start of each round. In the heterogeneous treatment, I induced income inequality by providing different endowments: Two 'low-income' players received 20 tokens and two 'high-income' players were endowed with 40 tokens each round.[2] These endowments remained constant over the entire course of both experiments and were common knowledge.

[1] That is, the marginal per-capita return to the PG (MPCR) is a linear function of the sum of individual contributions toward the PG.

[2] The income-types were assigned randomly. Different approaches have been applied to introduce income heterogeneity into PGGs, including the alteration of participants' marginal per-capita returns or 'productivity' of their contributions (Noussair and Tan, 2009; Tan, 2008), the random variation of show-up fees or (Anderson et al., 2008), as adopted in this study, the provision of different endowments (e.g. Chan et al., 1996; Chan et al., 1999).

2.1 The VCM experiment

In each round of the VCM experiment without punishment, subjects simultaneously decide how to allocate their endowment *e* between a "private account" and a "community project". Subjects can contribute any integer amount c_i of their endowment *e* towards the project. It was explained to them that every token contributed to the project will be doubled, and then equally divided among all group members, so that a token invested in the PG returns half a token to each group member. On the other hand, each token *not* contributed ($e - c_i$) is automatically put into the player's private account and returns one unit. Accordingly, the pay-off for each subject *i* is given by $\pi_i^{stage\_1} = e - c_i + 0.5 \times \sum_{j=1}^{4} c_j$, in each round of the VCM experiment (rounds 1-6). After all subjects had made their contribution decisions and had learned the total group contribution as well as their earnings for that round, the round was over and subjects moved on to the next round.[3]

If all subjects behave in a purely self-interested manner (and expect the others to behave selfishly as well), the unique symmetric Nash equilibrium is a zero contribution to the PG, because the best-response function for each subject is $\partial \pi_i^{stage1} / \partial c_i = -1 + 0.5 < 0$. In contrast, the social optimum is reached if each subject contributes his or her entire endowment, since the marginal per-capita return to the PG (=1/2) is greater than 1/4.

2.2 The experiments with punishment option

The second experiment also lasted for 6 rounds and had the same design and parameters as described above, but included a punishment stage. In the first stage (contribution stage), subjects had to make their contribution decisions as described above. After everyone had made their decisions, again the total group contribution and the earnings from the project were announced. In addition (and in contrast to stage 1), subjects received information on each other group member's contribution decision and initial endowment. Then, in the subsequent stage (punishment stage), subjects were given the

[3] A detailed description of the procedure, as well as the instructions and further materials are provided in the Appendix.

opportunity to simultaneously punish each other group member by assigning punishment points (fines). Punishment was costly to both the punisher and the target of punishment: One unit of punishment awarded to another player reduced the punisher's income by 1 unit while it resulted in a deduction of 3 units in terms of income for the player who received the punishment.[4] Each player could assign a maximum of 10 punishment points (fees) to *each* other group member per round. The fines were cumulated if a subject was punished by more than one group member. Note if the amount of received fines exceeded the earnings from stage 1, the total pay-off in that round was set equal to zero. Thus, we obtain the following pay-off for individual i at the end of stage2: $\pi_i^{stage\_2} = \max\left\{ e - c_i + 0.5 \times \sum_{j=1}^{4} c_j - 3 \times \sum_{j \neq i} p_{ij}, 0 \right\} - \sum_{j \neq i} p_{ji}$. Apparently, a subject could realize a negative pay-off in a given period, namely if the sum of punishment points assigned exceeded the difference of stage-1-earnings and cumulated fines.[5] Subjects were explicitly warned of this possibility. However, a negative pay-off was nevertheless realized in 29 out of a possible 720 cases (120 subjects * 6 rounds in the PUN condition).

2.3 Procedures

The experiment took about 2 to 2 ½ hours, including the instructions, examples, payment and a follow-up survey. Instructions and examples were translated into Afrikaans and presented orally by a local field assistant. To control experimenter effects, the local field assistant was the same person in each session and was unknown to participants. The instructions contained several examples and subjects were encouraged to ask questions. However, to make sure that everybody understood the experiment, we ran also 2-3 practice rounds. After the actual experiment had started, communication was strictly prohibited and questions could only be asked and answered in private. After each round, subjects received information about the total group contribution and their personal earnings. In the experiment with punishment option (PUN condition), subjects were also

[4] This is the most commonly used fine-to-fee ratio and relies on the assumption that sanctions impose costs on both the punisher and the sanctioned.

[5] Thus, the lowest pay-off possible was -30 which could only happen if a player received cumulated fines that exceeded the pay-off so that the pay-off was set equal to zero and if he or she assigned 10 punishment points to each of the other 3 group members. However, this never happened in our study.

informed about the contribution decisions of every other group member before they had to decide whether to punish.[6] [7] At the end of the round, before turning to the next one, participants were further informed about the *total* number of punishment points they had received from the other group members. By providing them only with information about the total punishment received, they neither learned the identity of the punisher nor the actual number of group members who punished them. Subjects were given 'record sheets' to record this information and to calculate their total earnings themselves.[8]

The experiments were held in public buildings such as community halls, kindergartens and schools. At the end of the session, participants were paid according to the sum of tokens earned in all 12 rounds. One token was worth 10 Namibian Cents. In addition, they received a show-up fee of N$ 10. Averaged over both treatments, participants earned N$ 58.5 (including the show-up fee), ranging from N$ 28 to N$ 84.6 (standard deviation: N$ 12.7).[9]

2.4 Subject pool

The participants are rural dwellers from southern Namibia. Exactly half the sample was men. On average, participants were 33.5 years old and had received schooling up to grade 9. When asked for their main source of (personal) income, 8% stated having a permanent job, while about 21% worked occasionally. 41% received their main income from livestock farming and 18% did not earn any income themselves but had to rely on

[6] For the punishment decision, subjects received a 'sanction sheet' containing information on all players' endowments and contributions in the given period where they could indicate the number of punishment points they wanted to assign to any other group member. The order in which player numbers appeared on the sheet was randomized each round, to minimize reputation formation effects.

[7] Recently, Nikos Nikiforakis (2010) demonstrated that the feedback format can have a substantial impact on cooperation. His data show that cooperation was significantly lower in a treatment where participants received feedback about the *earnings* of their peers compared to a treatment where they were informed about the *contributions* of their peers. He argued that "*contribution feedback can be seen as emphasizing the social benefit of contributing to the public account, while earnings feedback highlights the private benefit from contributing to the private account*" (ibid, p: 700).

[8] During the practice rounds, we checked whether the subjects reported their earnings correctly. To ease calculation, each subject was provided with a pocket calculator. If subjects had problems operating the calculator or if they did not understand the composition of their earnings, a field assistant helped them in practice rounds 2 and 3 until they had understood.

[9] Separated by treatments, participants earned on average N$ 55.6 in the homogenous treatment and N$ 55.1 (low-income players) and N$ 67.7 (high-income players) in the heterogeneous treatment. The daily salary of an unskilled laborer is about N$40 in my study site.

transfers from household members or relatives. The remainder either got a pension or ran a small-scale business. Almost two-thirds were in possession of livestock. A livestock owner had on average a herd size equivalent to 58 small stock units (SSU).[10] (These and other socio-demographic characteristics are summarized in Table A.1 in the Appendix. Non-parametric tests reveal no significant difference regarding any socio-demographic variable between the homogenous and heterogeneous sub-sample).

2.5 Hypotheses based on related studies

Assuming fully rational and selfish actors, the economic standard model predicts zero contributions in a linear PGG. The prediction is the same for each player type, irrespective whether endowed with a high or a low income. Thus, based on the *homo oeconomicus* model, one would expect differences neither between the homogenous and heterogeneous groups nor between low- and high-income players. Similarly, punishment would not occur if all players behaved fully rational and self-interested (and assumed the others to be so as well), because punishment is costly to the punisher. However, there is overwhelming empirical evidence that the homo oeconomicus model fails to predict actual behaviour in PGGs (see Gächter and Herrmann (2009) for a current review). I thus prefer deriving hypotheses from recent empirical results rather than from the standard theoretical model.

While cooperative and punishment behaviour in PG settings has been studied extensively with homogenous groups, only a few studies investigate the effect of income-heterogeneity on the provision of PG, with mixed results. In a comprehensive literature review of public goods experiments, Ledyard (1995) cited five studies that examine the impact of income inequality on cooperation and concluded that heterogeneity tends to decrease contributions compared to homogeneity. Similarly, in a one-shot linear PGG, Cherry et al. (2005) found those subjects staying in groups with heterogeneous endowments to give significantly less than their counterparts who act in homogenous groups, irrespective of whether subjects ‘earned’ their tokens or received a windfall endowment. On the contrary, Visser and Burns (2006) and Chan et al. (1996) obtained

[10] Sheep and goats are usually referred to as small stock units (SSU), while cattle are referred to as large stock units (LSU). LSU were converted to SSU at a rate of 1:6.

the opposite results in repeatedly played linear and non-linear PGGs, respectively, where mean contribution levels were significantly higher in heterogeneous groups than in homogenous groups. Finally, Hofmeyr et al. (2008) did not find any significant difference between heterogeneous and homogenous groups regarding average contribution levels.

Hypothesis I: Given the mixed empirical evidence, I expect contribution levels not to differ between homogenous and heterogeneous groups.

As mentioned above, the standard model predicts zero contributions in a linear PGG for each player type, irrespective of whether they are endowed with a high or a low income. Models of inequity aversion come to different predictions. The model of Fehr and Schmidt (1999), for instance, bases on the assumption that individuals neither like advantageous nor disadvantageous inequality (though the first is preferred to the latter), and that the utility of an inequity-averse individual increases in the equality of pay-offs of other group members. This in turn would imply that high-income individuals, if motivated by the desire to reduce inequality, will contribute a relative larger share of their endowment to the public account than their counterparts endowed with a smaller income (see Buckley and Croson (2006) for an algebraic proof); and thus will automatically give more in absolute terms. By contrast, empirical evidence from *non-linear* PGGs suggests that low-income people rather over-contribute towards the PG relative to the induced Nash equilibrium, while their better-off counterparts tend to under-contribute (Chan et al., 1996). Similarly, and also in contrast to predictions based on models of inequity-aversion, in *linear* PGGs it has been found that low-income players contribute more than better-off subjects both in relative terms (Cherry et al., 2005), and even in absolute terms (Buckley and Croson, 2006). Because the MPCR is the same for low and high-income players in my experimental set-up, low-income players can realize higher net benefits from mutual cooperation. (The net benefit from full cooperation, for instance, is 60 tokens compared to 40 tokens for the high-income players and 60 tokens compared to 20 tokens for low-income players). Hence, low-income players could have stronger incentives to cooperate, at least initially, in the hope that high-income players will reciprocate.

Hypothesis II: Based on experimental evidence from recent studies, I expect low-income players to give more in relative terms than high-income players.

What has to be expected from the introduction of peer punishment? It is a stylized fact that a substantial fraction of subjects is poised to punish others at an own cost; and that the opportunity of peer punishment increases cooperation significantly (see the references quoted in the introduction). The latter has been explained by the existence of individuals with other-regarding preferences (e.g. Falk and Fischbacher, 2006; Fehr and Schmidt, 2006) or incomplete information about the other players' types (Kreps et al., 1982). Fehr and Schmidt (1999), for example, showed that inequity-averse subjects who are sufficiently upset by the disadvantageous inequality they face in the presence of free-riders may be willing to sanction free-loaders even at an own cost, provided that punishment can reduce inequity. The latter holds if the fine-to-fee ratio is higher than 1, which is the case in my experimental set-up. If free-riders perceive the threat of punishment to be credible, this can induce them to abstain from free-riding and instead to contribute to the PG, implying that cooperation could be maintained at high levels. Given the overwhelming empirical evidence for the cooperation-enhancing effects of peer-punishment institutions, I expect contribution levels to increase in the PUN condition compared to VCM condition in either treatment.

Hypothesis III: The introduction of peer punishment will increase contribution levels in both treatments.

One major goal of this study is to examine whether punishment behaviour in general and anti-social punishment in particular is affected by income heterogeneity. However, research on anti-social punishment is still in its infancy and, to my knowledge, there is no theoretical or empirical paper examining the impact of income heterogeneity on anti-social punishment, thereby providing a basis for hypotheses. In general, there is still little knowledge about motives behind anti-social punishment. Nor am I aware of a theoretical study that predicts different punishment patterns in general between homogenous and heterogeneous groups. One working paper investigated the effect of peer punishment in unequal groups empirically (Visser and Burns, 2006). The authors reported that punishment was less frequently exerted in heterogeneous groups than in homogenous ones, which might be attributed to the fact that contributions were higher in heterogeneous groups which in turn made punishment less necessary. Figure 2 in their paper (ibid: 12) further suggests that in both treatments a good deal of punishments were anti-social, i.e. were targeted towards subjects who contributed more than the group average, but the authors did not pay further attention to this observations. However, the qualitative difference in their study was not high, I thus do not have any a priori hypothesis regarding punishment differences between homogeneous and heterogeneous groups.

What differences regarding punishment behaviour could one expect between high- and low-income players? On the one hand, low-income players face higher opportunity costs of punishment than their group members endowed with 40 tokens, which may hinder them punishing with the same frequency and intensity as their high-income group members. On the other hand, the exogenously induced inequality may be perceived as unfair by low-income players, thereby fuelling envy among them, which in turn may lead them to sanction high-income players more vehemently even in situations where high-income players have given more than the punisher. This in turn could trigger a spiral of punishment and counter-punishment. Moreover, the net gains from mutual cooperation compared to non-cooperation are higher for low-income players, as argued before. Hence, low-income players may have stronger incentives to use pro-social punishment in order to discipline free-riders (Visser and Burns, 2006), but also to use anti-social punishment to induce recipients to contribute even more (Eldakar et al., 2007). Visser and Burns (2006) reported low-income players punishing as vehemently as high-income players. But again, they did not analyse whether the intensity of anti-social punishment differed between player types. Other studies found that anti-social punishment is partly driven by motives of revenge (Herrmann et al., 2008; Nikiforakis, 2008) and/or strong preferences for advantageous inequality or pay-off dominance (Falk et al., 2005). However, these studies did not provide a reference point regarding potential differences between members of homogenous or heterogeneous groups or between low- and high-income players within heterogeneous groups. Henceforth, I do not have a priori hypothesis regarding differences among player types.

3. Results

The results section is subdivided into two parts. In section 3.1 I will examine determinants of cooperation, thereby analysing differences between the VCM and PUN conditions as well as between treatments at group level, followed by an investigation of differences among different income types at individual level. Then, in section 3.2, I shall analyse punishment decisions, again first at group and then at individual level.

3.1 Cooperation in the VCM and PUN condition

In accordance with related studies, average contribution decisions deviate substantially from the zero-contribution prediction based on standard economic theory. Averaged over all periods and both treatments, subjects spent 50.6% (std. dev.=33%) of their endowment. In my sample, the distribution of contributions has two modes, 50% and 100%, both chosen in roughly 12.5% of all decisions. Altogether, zero-contribution occurred in only 8.33% of all cases and is observed less frequently in the first six rounds (6.67%) than under the PUN condition (10%). However, none of the subjects strongly free-rode by contributing nothing across all twelve rounds.

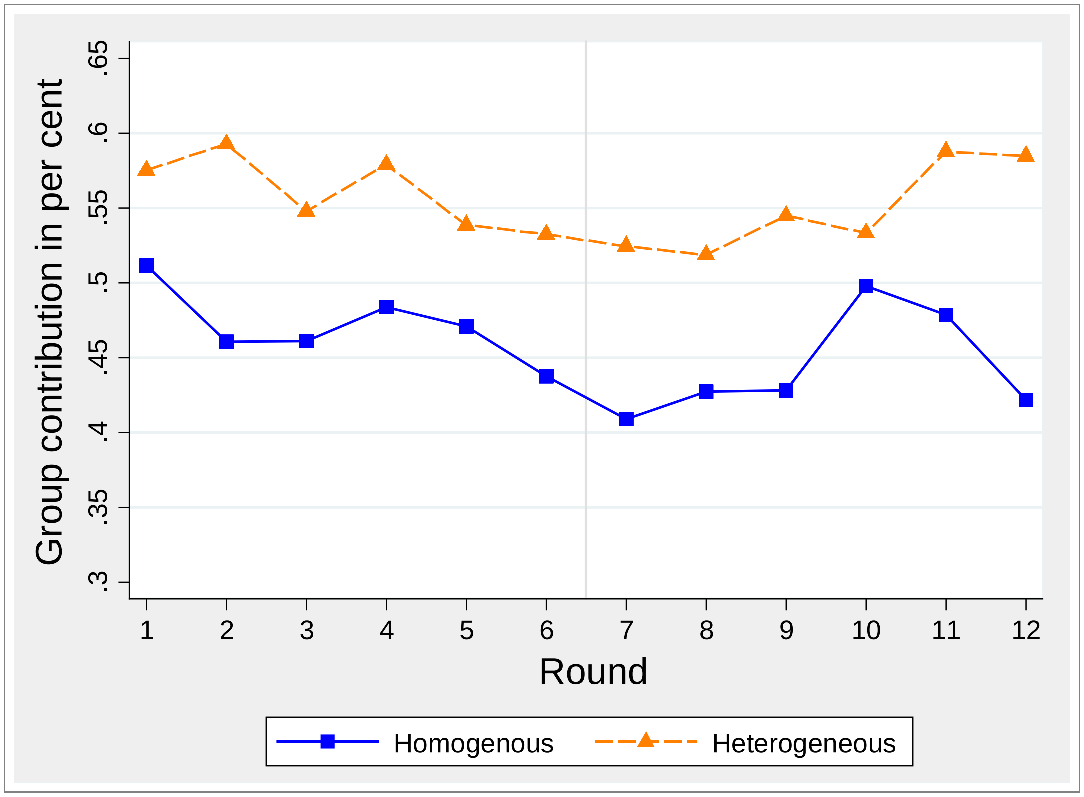

Figure 1: Average group contributions as percentage of total endowment in homogenous and heterogeneous groups.

Figure 1 graphically examines the development of average group contributions over the course of the game, separated for homogenous (blue line with squares) and heterogeneous groups (orange line with triangles).[11] Considering the contribution decisions made in the VCM experiment only (rounds 1-6), it becomes apparent that they tend to slightly decline over the course of six rounds, a tendency which is more pronounced in homogenous groups. Mann-Whitney U tests performed to investigate whether contributions in round 1 differ from those in round 6 reveal that they are significantly lower in the 6th round in homogenous groups, while they are not in heterogeneous groups. Notwithstanding a downward tendency, in neither treatment do contribution rates sharply decline and converge towards the zero-contribution equilibrium with rounds played, but still remain relatively high (above 40%). This is in sharp contrast to results from VCM experiments carried out with students from Western societies, but is

[11] I use group behaviour as the independent units of observations for overall treatment comparisons because partner matching was in effect, i.e. subjects remained in stable groups throughout the entire 12 rounds of the experiments.

in line with those conducted with non-students in Thailand and Vietnam (Carpenter et al., 2004a; 2004b). A possible explanation is that my subjects (and those in the quoted studies) are drawn from relatively small and stable communities, sharing a common history of working and interacting together, which may increase the level of trust and mutual cooperation. Moreover, while in many laboratory experiments subjects play anonymously, in our study members of a session usually knew each other personally, which most probably also affected cooperation positively.

3.1.1 Cooperation patterns in homogenous and heterogeneous groups

Turning attention to a comparison between treatments, I find group contributions to be significantly higher in heterogeneous groups than in homogenous groups in each round. This is illustrated in Figure 1 and holds true for the VCM condition, where members of heterogeneous groups contribute on average about 56% (std. dev.=21.4) of their endowment compared to roughly 47% (std. dev.=20.6) in homogenous groups (Mann-Whitney U test: Z=3.074, $p<0.01$, n=180), as well as for the PUN condition, where average group contributions amount to 55% (std. dev.=22.7) in heterogeneous groups and 44% (std. dev.=26.4) in homogenous groups (Mann-Whitney U test: Z=3.018, $p<0.01$, n=180). The difference between the treatments remains highly significant in OLS estimations where I regress the group contribution on treatment dummies and the round number (estimation 1 in Table 1). In the regression, it turns out that group contributions increase by about 9 to 10 percentage points if the group was assigned to the heterogeneous treatment. The strong treatment effect remains significant if I perform OLS regressions either only for the VCM condition (estimation 2) or only for the PUN condition (estimation 3).[12] My results are qualitatively the same as those reported by Chan et al. (1996) and Visser and Burns (2006), where subjects assigned to unequal groups made also significantly higher contributions than their counterparts in equal groups. I thus have to reject hypothesis I.

[12] Significance of the treatment effect disappears, once I control for the average group contribution cumulated over the first 6 rounds in estimation 5. This happens because this variable is strongly correlated with *heterogeneous* (ρ=0.27***) and thus partly overlaps the treatment effect.

Result 1: Group contributions are significantly higher in heterogeneous groups than in homogenous groups. This holds true for both the VCM condition and PUN condition.

Table 1: OLS estimation for group contributions in the VCM and PUN condition

Y: Group contribution	(1) VCM+PUN	(2) VCM	(3) PUN
Heterogeneous	0.098***	0.090***	0.105***
	(0.024)	(0.031)	(0.037)
PUN condition	-0.025		
	(0.049)		
Round	0.001	-0.001	0.011
	(0.007)	(0.009)	(0.011)
Constant	0.464***	0.504***	0.337***
	(0.032)	(0.039)	(0.105)
Observations	360	180	180
F	5.682***	4.668**	4.652**
R-squared	0.046	0.050	0.050
Adjusted R-squared	0.038	0.039	0.039

Notes:

1) OLS regressions, the dependent variable is the group contribution, either in rounds 1-12 (estimation 1), rounds 1-6 (estimation 2), or rounds 7-12 (estimation 3).
2) Standard errors in parentheses. ***, ** and * refers to significance at the 1%, 5% and 10% level, respectively.

More surprising is that the introduction of peer punishment in round 7 seems to be without effect in my study, as it increases group contributions and henceforth cooperation among group members, neither in the heterogeneous sample (Z=0.167; p=0.87) nor in homogenous groups (Z=1.373; p=0.17). In contrast to hypothesis III and the results of related studies, where peer punishment has proven to enhance cooperation, in my study average contributions rather tend to decline under the threat of punishment, as shown by the negative coefficient of the categorical variable *PUN condition* in specification 1 of Table 1. But the effect is not significant.

Result 2: Peer punishment is without effect; it does not increase cooperation among participants.

Altogether, only 14 out of 30 groups (seven in each treatment) could realize higher levels of cooperation once peer punishment was in effect. Herrmann et al. (2008) found peer-punishment institutions being without effect in societies where the incidence and severity of anti-social punishment was outstandingly high. At macro level, they attributed the high occurrence of anti-social punishment to weak *norms of civic cooperation* as well as a *weak rule of law* in these countries.[13] The rule of law is also rather weak in the communal lands of southern Namibia, and anti-social punishment was frequent in my study site (as will be presented in more detail below). Hence, to examine the influence of anti-social punishment on cooperation, and the relation between contributions and punishment in general, I perform GLS random-effects models explaining group contributions in rounds 8-12 in the PUN condition, given the total amount of pro-social punishment (PSP) and anti-social punishment (ASP) points assigned by all group members in round t-1 (Table 2).[14] Applying random-effects models allows me to control for unobserved heterogeneity at group level. In addition to the amount of ASP and PSP assigned in the previous round, I consider the round number and the average group contributions cumulated over the VCM condition as explanatory variables.

The regression results reported in Table 2 shows that punishment intensity, measured as the amount of punishment points assigned by all group members in the previous round, does *not* affect average group contributions in the following round. Thus, and in contrast to Herrmann et al. (2008), there is no evidence that the ineffectiveness of the peer-punishment option is caused by a high incidence of anti-social punishments.

Finally, I obtain a very strong effect of previous group performance in the VCM condition on cooperation levels in the Pun condition, indicated by the substantial increase of the Chi2 statistic (from 5.09 in estimation 1 to 155.4 in estimation 2) once I control for the average group contributions cumulated over the first six rounds. The interpretation is straightforward: Groups that experienced comparably high levels of cooperation in the

[13] Herrmann et al. (2008) found anti-social punishment to be exceptionally high in societies with weak *norms of civic cooperation* and a *weak rule of law* (in their sample Saudi Arabia, Greece and Oman). Both indicators are taken from the World Value Survey. According to Herrmann et al. (2008:1365), rule of law indicates "*the extent to which agents have confidence in and abide by the rules of society*", while norms of civic cooperation "*are expressed in people's attitudes to tax evasion, abuse of the welfare state, or dodging fares on public transport*". The authors argued that "*if the rule of law is strong, people trust the law enforcing institutions* (…) and *revenge is shunned*" (ibid:1365), which makes anti-social punishment less likely. Similarly, they argued that in societies with strong norms of civic cooperation, "*free-riding might be viewed as unacceptable and the more it might be punished in consequence*" and that "*strong norms of civic cooperation might act as a constraint on anti-social punishment*" (ibid:1365).

[14] The inclusion of lag variables restricts the analysis to choices made in rounds 8 to 12.

first six rounds are able to realize significantly higher contribution levels under the threat of punishment as well. This relationship is observed for the entire sample (estimation 2) as well as for each sub-sample (estimations 3 and 4).

Table 2: Random-effects models explaining group contributions in the PUN condition

Y: Group contribution in PUN condition	(1)	(2)	(3)	(4)
	Total	Total	HET	HOM
Heterogeneous	0.103	0.007		
	(0.084)	(0.039)		
Round	0.011	0.011	0.012	0.002
	(0.007)	(0.008)	(0.013)	(0.011)
ASP assigned in t-1	-0.003	-0.003	-0.003	-0.005
	(0.003)	(0.003)	(0.003)	(0.005)
PSP assigned in t-1	0.002	0.003	-0.001	0.005
	(0.002)	(0.002)	(0.004)	(0.003)
Cumulated av. Group contribution in VCM		1.086***	0.861***	1.323***
		(0.101)	(0.168)	(0.140)
Constant	0.344***	-0.167*	-0.099	-0.198*
	(0.092)	(0.091)	(0.155)	(0.109)
Observations	150	150	75	75
Number of session	30	30	15	15
chi2	4.090	155.4	80.68	108.2
p	0.394	0	0	0

Notes:

1) GLS Random-effects model. Dependent variable is the group contribution in rounds 8-12. Estimations 1 and 2 refer to the total sample. Estimations 3 and 4 consider the heterogeneous and homogenous sub-samples only.
2) Heteroscedasticity-robust standard errors are reported in parentheses.
3) ***and * indicate significance at the 1% and 10% level, respectively.

Due to the high incidence of punishment and the fact that cooperation (and hence group revenues) did not increase in the PUN condition, the average pay-offs were lower in rounds 7-12 compared to the first 6 rounds where punishment was not in effect. In other words, the introduction of peer punishment has negative consequences for the overall welfare. Averaged over both treatments, individuals earned a total of 214 across the 6 rounds of the PUN condition compared to 271 tokens in the experiments without punishment. The difference is highly significant according to a two-sided t-test ($t=6.339$, $p<0.001$, $df=238$).

3.1.2 Differences in cooperation among income types

Having analysed differences between the heterogeneous and homogenous treatment at group level, I now turn attention to a comparison among the different player types in terms of income at individual level. Recall, participants differed with respect to the endowment they received at the beginning of each round. In the heterogeneous treatment, the high-income players were endowed with 40 tokens, while the low-income players received 20 tokens. In the homogenous treatment, all participants received 30 tokens.

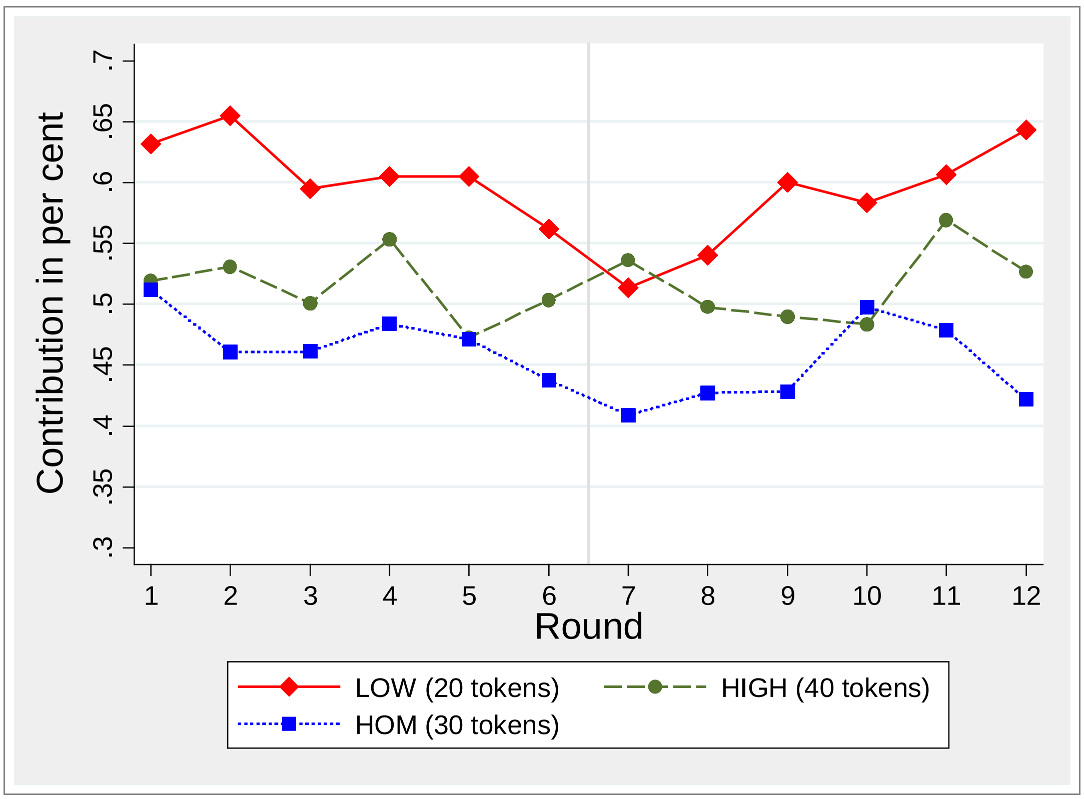

Figure 2: Average individual contribution decisions of low- and high-income players in heterogeneous groups.

Figure 2 illustrates the evolution of average individual contributions of the different player types over all twelve rounds. Contributions are measured as the fraction of endowment contributed towards the PG. Apparently, there is a substantial difference between player types: Low-income players contribute a larger fraction of their endowments than their group fellows endowed with 40 tokens as well as than those assigned to the homogenous treatment in all but one round across both the VCM and the PUN condition. Averaged over all rounds, low-income players contributed 59.5% of their endowments compared to 51.5% spent by 40-token players and 45.7% contributed by those assigned to the homogenous treatment. The differences between low- and high-income players within the heterogeneous treatment (Z=3.42, p<0.01, n=720) as well as between low-income players and 30-token players from homogenous groups (Z=6.29, p<0.01, n=1080) are significant at any conventional level according to Mann-Whitney U tests.[15] Results from random-effects tobit regressions further show that these differences remain significant if I control for unobserved heterogeneity among individuals as well as for round effects (Table 3).[16] The analysis of individual contribution decisions for the pooled sample (estimation 1 in Table 3) reveals that low-income players contribute significantly higher fractions of their endowments than subjects assigned to homogenous groups. Moreover, a separate analysis of contribution decisions for the heterogeneous treatment (estimation 2 in Table 3) confirms that low-income players give significantly more than their group fellows endowed with 40 tokens over the course of the entire 12 rounds. The results remain qualitatively the same if I add standard socio-demographic variables, such as age, gender, educational background and employment situation, in regressions 1 or 2.[17] The results contradict theories of inequity aversion which predict that high-income players will contribute a relative larger share of their endowment in order to reduce inequity; but are in line with hypothesis II and other studies examining the effects of income heterogeneity on PG provision (Chan et al., 1999; Cherry et al., 2005). As mentioned earlier, the fact that low-income players contribute a relative larger share than the better-off could be motivated by strategic considerations which most probably matter in repeated interactions (Milinski et al., 2002; Rockenbach and Milinski, 2006). By making high contributions, low-income players could try to signal their willingness to cooperate, thereby intending to induce the high-income group members to

[15] In absolute terms, however, low-income players contribute fewer tokens (11.9 tokens averaged over all rounds) than their counterparts endowed with high incomes (20.6 tokens) and the players in the homogenous treatment (13.72 tokens).

[16] I apply tobit models because the dependent variable is censored from below and above at 0 (=zero contribution) and 1 (=100% of endowment), respectively.

[17] None of the socio-demographics had a significant effect in more than one estimation. Therefore, I do not report the corresponding regression outputs here but refer the reader to Table A.2 in the Appendix.

reciprocate. The fact that the net gains from cooperation are higher for the less-endowed subjects than for the better-off, owed to the constant MPCR of 0.5, at least speaks for this argumentation. (Compared to the Nash equilibrium of zero contribution, low-income players would increase their income by 300% (from 20 to 60 tokens) in the social optimum, while high-income players realized an increase by 50% (from 40 to 60 tokens)).

Result 3: Low-income players contribute a significant larger share of their endowments than high-income players and subjects in homogenous groups.

Analogous to Table 2, in estimations 3-5 of Table 3 I restrict the analysis to individual contributions made in the PUN condition, thereby controlling for time effects, the amount of anti-social and pro-social punishment points received by the individual in the previous round t-1, as well as for the average contribution cumulated over the first six rounds. Due to the inclusion of lag variables, estimations 3-5 refer to contribution decisions made in rounds 8-12.

In line with observations at group level, it turns out that received punishment does *not* affect individual contribution decisions. This suggests that "*justified*" sanctions received from a subject who contributed more than the punished (i.e. received pro-social sanctions in t-1) do not have a disciplining effect as they do not induce the punished to raise contributions. This contrasts with observations from studies involving students from Western societies but confirms claims of some authors (e.g., Gintis, 2008; Herrmann et al., 2008) who emphasized cross-cultural differences regarding the impact of being punished, arguing that punishment may *"not trigger guilt and shame in the same way everywhere"* (Gächter and Herrmann, 2009: 795). On the other hand, received anti-social sanctions in t-1 do not have any effect on contribution decisions in round t either, suggesting that unfair treatment or *"unjustified"* sanctions does not crowd-out subjects' willingness to maintain comparably high contribution levels. However, one must recall that subjects were not disclosed the identity of their punisher; therefore, they could not determine but only surmise whether the sanction was intended to signal to them that their contribution was too high or too low. To sum up, received punishment does not impact cooperation at individual level. In fact, individual contribution decisions made in the

PUN condition rather seem to strongly depend on the average contributions made in the rounds prior to the introduction of punishment, suggesting that strong cooperators in the first six rounds continue behaving pro-socially and do not lower their contributions, given the amount of received sanctions.[18] The same effects were found at group level. The separate analyses for each treatment further suggest that this effect was more pronounced in the heterogeneous groups, where an increase in the average contribution in rounds 1-6 by 1 percentage point leads to an increase in contributions in the punishment stage by about 0.67 percentage points compared to 0.33 in the homogenous treatment.

Result 4: Received sanctions have no effect on individual contribution decisions.

Table 3: **Random-effects tobit estimations for individual contribution decisions in the VCM and PUN condition**

Y: Individual contribution	VCM+PUN			PUN	
	(1)	(2)	(3)	(4)	(5)
	Total	Het	Total	Het	Hom
Low income player	0.141**	0.085**	0.025	0.024	
	(0.057)	(0.039)	(0.046)	(0.04)	
High income player	0.056		0.022		
	(0.057)		(0.045)		
PUN condition	-0.025	-0.025			
	(0.026)	(0.035)			
Round	-0.001	0.002	0.009	0.017*	-0.001
	(0.004)	(0.005)	(0.007)	(0.009)	(0.011)
ASP received in t-1			-0.007	0.002	0.005
			(0.005)	(0.007)	(0.008)
PSP received in t-1			-0.003	-0.004	-0.006
			(0.005)	(0.009)	(0.007)
Av. contribution in round 1-6			0.862***	0.672***	0.327***
			(0.075)	(0.122)	(0.094)
Constant	0.458***	0.494***	-0.052	0.167	0.083
	(0.036)	(0.081)	(0.081)	(0.125)	(0.131)
Session dummies	No	Yes	No	Yes	Yes
sigma_u	0.245***	0.137***	0.169***	0.111***	0.0394
sigma_e	0.245***	0.227***	0.234***	0.209***	0.261***
Observations	1,440	720	600	300	300
Number of player_id	120	60	120	60	60

[18] Note, once I control for the average contribution cumulated over the first six rounds the treatment effect disappears (estimation 3 and 4). This is owing to the fact that this variable partly captures the treatment effect, because the variables are positively correlated (0.18***). If this variable is not considered, *Low-income player* is significant at the 5% level and 10% level in estimation 3 (z=2.28, p=0.028) and estimation 4 (z=1.88, p=0.06) respectively.

chi2	9.856**	116.8***	150.2***	168.5***	270.0***
ll	-296.3	-60.39	-119.8	-7.996	-62.40
N_lc	120	53	62	25	37
N_unc	1320	667	538	275	263
N_rc	0	0	0	0	0

Notes:

i) Random-effects tobit model. Dependent variable is the fraction of endowment contributed towards the PG in rounds 1-12 (specifications 1 and 2) and 8-12 (estimations 3-5), respectively.

ii) Specifications 2, 4 and 5 include session-dummies.

iii) Meaning and reference categories for dummies: *Low income player:* Takes the value of 1 if the subject had 20 tokens. The reference category in estimations 2, 3 and 4 is subjects who were endowed with 40 tokens. *PUN condition*: Takes 1 if contribution decisions were made in in rounds 7-12 where punishment was in effect. The reference category is decisions made in the VCM condition.

iv) Standard errors are in parentheses

v) The symbols ***, **, and * refer to significance at the 1%, 5% and 10% level, respectively.

3.2 Punishment behaviour

The previous analysis has revealed that the introduction of peer-punishment institutions was without effect as it did not lead to higher levels of cooperation. Interestingly, it further turned out that the amount of anti-social or pro-social punishments allocated in the previous round had no effect on subsequent group contributions. Similarly, received punishment did not affect subjects' willingness to cooperate.

However, punishment occurred frequently and it is worth analysing the rationale behind punishment decisions. In particular, I am interested in differences among income types as well as between unequal and equal groups in terms of the frequency and intensity of punishment in general and anti-social punishment in particular.

Recall that punishment was costly for both the punisher and the punished, reducing their income by 1 and 3 tokens, respectively. Each subject could assign at maximum 10 punishment points to each other group member. Though punishment was costly, a substantial fraction of individuals nevertheless assigned punishment points to another group member in 30.28% of all cases (654 out of 2160).[19] The incidence and intensity of

[19] Recall, in each round each subject could punish each other group member. Thus, each subject makes 18 punishment decisions over the course of six rounds under the PUN condition. Because 120 subjects participated in total, I have 120*18=2160 observations for punishment decisions.

punishment varied greatly among individuals and groups. On average, each participant assigned 0.77 punishment points (std.dev.=1.67) to any other group member per round, implying an average welfare loss at group level of about 37 tokens each round.[20] In only 4 out of 30 groups, punishment was never exerted.

3.2.1 Treatment differences in the punishment condition

Figure 3 shows the evolution of average punishment points assigned per group member over the course of the PUN condition, separated for heterogeneous and homogeneous groups, thereby illustrating two interesting facts: First, the amount of allocated punishment points was higher in the homogenous treatment than in heterogeneous groups: Each homogenous group member assigned on average 0.96 (std.dev.=1.87) punishment points each round to any other group member compared to 0.58 (std.dev.=1.42) in heterogeneous groups. The difference is statistically highly significant according to a Mann-Whitney U test (Z=5.36, p<0.01, n=2160). A Fisher's exact test further reveals that punishment was not only harsher in homogenous groups but also occurred more frequently than in the heterogeneous treatment (in roughly 35% of all possible cases compared to about 25.5% in unequal groups, p<0.01). Second, subjects allocated more punishment points towards group members who gave the same or a larger fraction of their endowment than towards those who contributed fewer tokens than they had spent themselves. In other words, expenditures for anti-social punishment were higher than for pro-social punishment. This holds true for both treatments. In the homogeneous (heterogeneous) treatment, subjects spent on average about 0.51 (0.32) tokens on sanctioning high contributors compared to about 0.45 (0.26) tokens that were assigned towards free-riders. Mann-Whitney U tests testing the hypothesis of equal means show that (i) the expenditures for both pro-social and anti-social sanctions are significantly higher in homogenous groups than in unequal ones, and (ii) that they do not differ statistically from each other within treatments. Anti-social sanctions were also more frequent than pro-social ones, accounting for 55% of all decisions where punishments were exerted.

[20] Because each punishment point incurred costs at the punisher (1 token) and the punished (3 tokens) we obtain $4*(0.77*3*4)\approx37$ tokens.

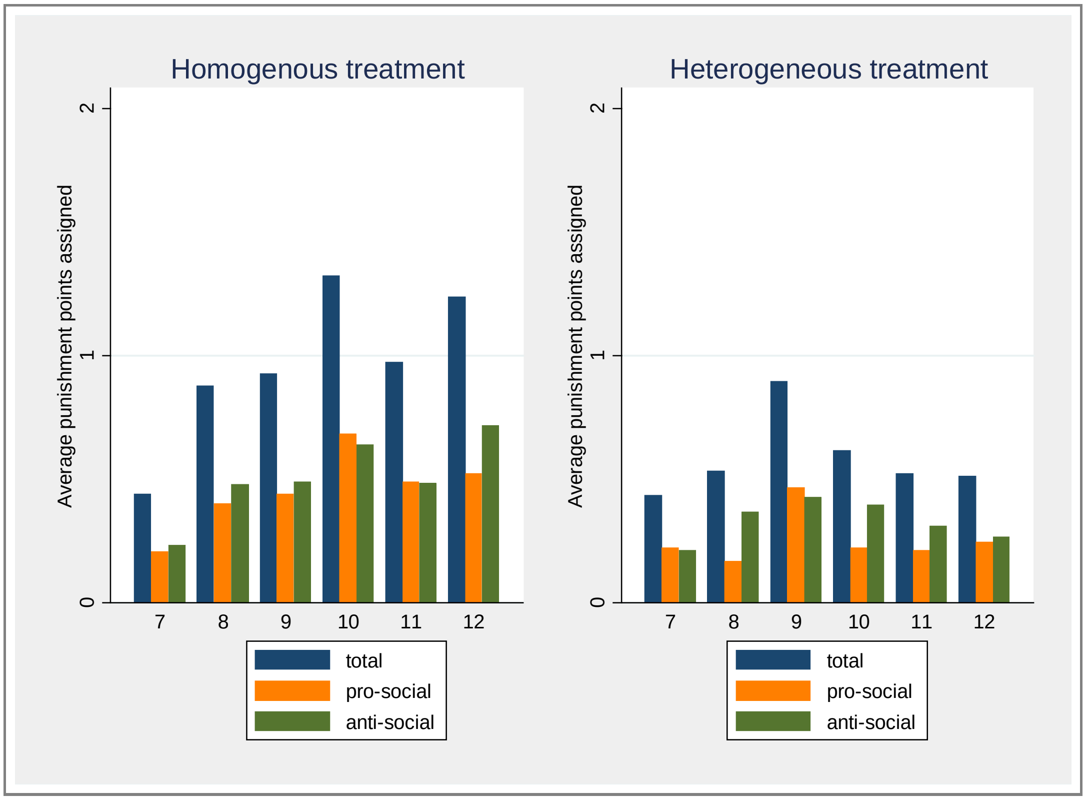

Figure 3: Assigned punishment points per group member and round in the homogeneous and heterogeneous treatment.

I perform multivariate regressions for robustness checks and to examine whether the treatment differences regarding punishment intensity remain once I control for group contributions (Table 4). The dependent variables are the total amount of punishment assigned at group level in round t (estimations 1, 2 and 3), as well as the total amount of allocated pro-social (model 4) and anti-social (model 5) punishment points in round t. Because the exogenous variables are censored from below at zero (= no punishment assigned) I apply a left-censored tobit regression. As explanatory variables I consider the round index to capture time effects, a treatment dummy (*heterogeneous*) as well as the group contribution in round t. In estimations 2 and 3 I further add the sum of punishment points assigned by all group members in round t-1. Overall, the regression results confirm that heterogeneous groups assign significantly fewer punishment points, even when controlling for group contributions in round t or the average group contribution cumulated over the first 6 rounds (model 3). This holds true for the total amount, as well as for the amount of anti-social and pro-social punishment.

Result 5: Pro-social and anti-social punishment occurs more frequently and vehemently in the homogenous treatment.

Second, group contributions in t affect subsequent punishment levels significantly: As expected, the more tokens a group contributed on average, the less severe subsequent punishment was (estimations 1, 2, 4 and 5). This is intuitive in so far that high levels of cooperation make the use of punishment, if intended to increase contributions, less necessary. Similarly, average group contributions cumulated over the first 6 rounds are negatively related to punishment as well (estimation 3), suggesting that groups with high levels of cooperation in the VCM condition spent fewer resources for punishment in the PUN condition. The strongly positive and highly significant correlation between group contributions averaged over the first six rounds and group contributions in the PUN condition ($\rho=0.83$, $p<0.001$, $n=180$) further indicates that those groups that cooperated successfully in the VCM condition reach also higher levels of cooperation in the PUN condition. Finally, a Mann-Whitney U test reveals that punishments were significantly less intense in groups that could improve their performance in the PUN condition compared to the first six rounds ($Z=3.34$, $p<0.001$, $n=180$).

Result 6: The amount of punishment at group level decreases with group contributions in round t as well as with average group contributions cumulated over the first six rounds, implying that punishment was harsher in groups with comparably low levels of cooperation.

Not surprising, however, punishment decisions in round t are not solely influenced by previous contributions, but also by the amount of assigned punishment in round t-1. The parameters in estimations 2 and 3 suggest that, ceteris paribus, each punishment point assigned in round t-1 increases expenditures for punishment in round t by almost 0.7 tokens, pointing towards adverse dynamics of punishment in some groups, where I find an upward spiral in punishment fuelled by low contributions and high previous punishment levels. The fact that the game was played repeatedly, however, makes it difficult to separate the specific influence of group contributions on the one hand, and exacted punishment in t-1 on the other hand, on the preceding amount of punishment in t.

Table 4: Tobit regressions explaining the amount of punishment points assigned at group level

Y: Punishment points assigned in t	(1) Total	(2) Total	(3) Total	(4) PSP	(5) ASP
Heterogeneous	-4.754**	-3.951**	-3.693*	-2.992**	-2.202*
	(2.072)	(1.998)	(2.013)	(1.421)	(1.258)
Group contribution in t	-17.39***	-8.445**		-9.760***	-10.53***
	(4.296)	(4.262)		(2.952)	(2.621)
Av. Group contribution in 1-6			-12.63**		
			(5.960)		
Amount of punishments assigned in t-1		0.698***	0.681***		
		(0.0958)	(0.0971)		
Round	1.309**	-0.400	-0.472	0.570	0.784**
	(0.598)	(0.702)	(0.697)	(0.413)	(0.364)
Constant	5.486	11.95*	14.96**	2.639	1.989
	(5.956)	(7.119)	(7.457)	(4.106)	(3.626)
Sigma					
Constant	13.00***	11.37***	11.34***	8.670***	7.756***
	(0.822)	(0.771)	(0.769)	(0.612)	(0.529)
Observations	180	150	150	180	180
chi2	29.10***	68.25***	68.83***	19.84***	26.15***
Ll	-573.3	-468.8	-468.5	-452.4	-464.6
Left-censored obs.	45	35	35	67	59
Uncensored obs.	135	115	115	113	121
Right-censored obs.	0	0	0	0	0

Notes:

1) Left-censored tobit estimations. Dependent variables are either the total amount of punishment assigned per round at group level (Total: estimations 1-3), or the amount of pro-social (PSP: estimation 4) and anti-social punishment points (ASP: estimation 5) at group level, respectively.
2) Standard errors in parentheses. ***, **, and * refers to significance at the 1%, 5% and 10% level.

3.2.2 Differences in sanctioning behaviour among player types

Having examined treatment differences at group level, in the next step I turn to the analysis of differences among player-types. Table 5 presents regression results from left-censored random-effects tobit estimations, where I regress the number of anti-social and pro-social punishment points awarded to *each* other group member on treatment and several game-related variables. That is, I consider 3 punishment decisions of each individual in each round. This mirrors recent empirical observations that the relevant *reference agent* for the punishment decision is each of the other group members rather than the entire group on average (Falk et al., 2005; Falk and Fischbacher, 2005). A left-censored tobit models allows me to account for the fact that in about 70% of all cases subjects did not punish when offered the opportunity. Random-effects models are applied to control for unobserved heterogeneity at individual level.

Columns 1-3 of Table 5 report the estimation results for all situations in which the individual who had to make a punishment decision contributed *a larger fraction* of her endowment than the other group member, i.e. all pro-social punishment (PSP) decisions. The examination of anti-social punishment (ASP) decisions is provided in columns 4-6, where I consider all situations where the punisher contributed the *same or a smaller fraction* of his/her endowment to the PG than the target of punishment. Both dependent variables range from 0 to 10, whereby 0 means that the decision maker did not exert any punishment towards the other group member. Note, as a reference category for punishments I use the *fractions* of endowments instead of the *amounts*. That is, I explicitly assume that subjects' punishment decisions are contingent on the relative contribution of the other group members. Of course, this distinction is irrelevant for the homogenous treatment, but one could expect differences within heterogeneous groups. In Table A.4 in the Appendix I present regression results if punishment decisions are defined according to differences in absolute numbers: Interestingly, I obtain (qualitatively) the same results as those reported in Table 5 for all explanatory variables.

The regressions for the entire sample (estimations 1 and 4) reveal that both high and low-income player assign fewer punishment points than subjects in homogenous groups.[21] [22] However, the difference between low-income players and 30-token players is statistically significant for pro-social punishments only. The separate analysis for the heterogeneous groups (estimation 2 and 5 in Table 5) show further that the average number of

[21] Due to the inclusion of lagged variables in the regressions reported in Table 4, decisions made in round 7 cannot be considered. I thus have 1800 (900) instead of 2160 (1080) observations for the entire (heterogeneous) sample.

[22] I obtain qualitatively the same results if I control for age, age squared, sex, education and the employment situation (regression results reported in Table A.3 in the appendix).

punishment points assigned by high and low-income players is very similar, although low-income players face higher opportunity costs of punishment. This replicates the results of Visser and Burns (2006) and is consistent with the observation that demand for punishment is relative income-inelastic (Carpenter, 2007). High-income players assign on average 0.55 (0.64) pro-social (anti-social) punishment points to each other group member per round, compared to 0.58 (0.55) punishment points allocated by their poorer counterparts. Non-parametric Mann-Whitney U tests cannot reject the null hypothesis of equal mean expenditures for punishments.

Result 7: The intensity of assigned punishment points does not differ between low- and high-income players within the heterogeneous treatment.

Table 5: Pro-social and anti-social punishment points assigned at individual level

Y: PSP and ASP assigned	Pro-social punishments			Anti-social punishments		
	(1) Pooled	(2) HET	(3) HOM	(4) Pooled	(5) HET	(6) HOM
Low income player	-1.736***	-0.322		-1.052	0.472	
	(0.661)	(0.856)		(0.750)	(1.039)	
High income player	-1.398**			-1.557**		
	(0.692)			(0.752)		
Received punishments in t-1	0.229***	0.370***	0.130	0.210***	0.091	0.272***
	(0.062)	(0.088)	(0.084)	(0.046)	(0.079)	(0.058)
Difference in contributions	0.779	0.520	0.911	1.537***	2.882***	0.573
	(0.758)	(1.017)	(1.084)	(0.565)	(0.896)	(0.734)
Other player high income		0.717			0.487	
		(0.645)			(0.567)	
IA punisher low*punished high		-0.150			-0.175	
		(0.883)			(0.811)	
Round	-0.015	-0.009	0.015	-0.109	-0.170	-0.057
	(0.115)	(0.147)	(0.171)	(0.095)	(0.138)	(0.129)
Constant	-1.755	-3.297**	-1.995	-1.183	-2.513	-1.592
	(1.198)	(1.608)	(1.712)	(1.014)	(1.578)	(1.307)
Sigma u	2.170***	1.771***	2.400***	2.754***	3.044***	2.484***
	(0.283)	(0.371)	(0.405)	(0.292)	(0.503)	(0.347)
Sigma e	3.342***	2.906***	3.599***	2.886***	2.849***	2.882***
	(0.173)	(0.234)	(0.244)	(0.134)	(0.201)	(0.178)
Observations	797	407	390	1,003	493	510
Number of player_id	113	58	55	118	58	60
chi2	27.29***	20.55***	3.810	36.97***	14.02**	25.20***
Ll	-955.7	-393.0	-556.6	-1095	-476.3	-614.6
N_lc	529	298	231	684	357	327
N_unc	259	108	151	310	132	178
N_rc	9	1	8	9	4	5

Notes:

1) Left-censored random-effects tobit regressions. Dependent variable is the number of pro-social (columns 1-3) and anti-social punishment points (columns 4-6) assigned per round and group fellow.
2) The regressions consider only rounds 8-12, but not decisions made in round 7 due to the *lagged punishment variable.* Each individual has to make 3 punishment decisions in each round, because punishment could be allocated to each other group member.
3) Standard errors are in parentheses. *** indicates significance at the 1% level, ** and * indicate significance at the 5 and 10% level.

Of further interest is whether high-income players are punished harsher than low-income players in the heterogeneous treatment. In order to address this question I also consider a categorical variable taking 1 if the other player was endowed with 40 tokens (*Other player has high income*) and 0 otherwise. Though the positive coefficients suggests that high-income players indeed tend to receive more anti-social and pro-social punishment points than their poorer counterparts, the difference is significant neither in the regressions nor according to Mann-Whitney U tests executed separately for pro-social punishments (Z=1.43, p=0.15) and anti-social sanctions (Z=0.76, p=0.45). The consideration of an interaction term between the punisher and the punished individual, which takes 1 if the punisher was endowed with 20 tokens while the victim of punishment was a high-income player, allows me to test whether the externally assigned inequality induced a kind of "peer group solidarity", i.e. whether it fostered the solidarity among low-income players and among high-income players respectively. If so, I would expect that, ceteris paribus, high- (low-) income players spare the other high- (low-) income player but target sanctions mainly towards low- (high-) income players. However, given contribution decisions, the interaction terms in estimations 2 and 5 have negative signs (insignificant), suggesting that 40-tokens players were sanctioned with higher intensity by their peers than by the 20-tokens players. Thus, there is no evidence for "peer group solidarity". The regression results are in accordance with descriptive analyses which reveal for pro-social (anti-social) punishments that high-income players penalize other high-income players with an average of 0.74 (0.8) tokens while low-income players allocate on average 0.58 (0.61) punishment points towards them. By contrast, low-income players are sanctioned equally intensively by their peers (PSP: 0.52, ASP: 0.48) and their high-income group fellows (PSP: 0.44, ASP: 0.56).

The positive sign of the variable measuring the difference in contribution levels between the punisher and the punished subject indicates that the higher the deviation of the sanctioned from his or her punisher in terms of contributions, the more punishment points were assigned.[23] This in turn means that pro-social (anti-social) punishments are the harsher the less (more) the target of punishment contributed relative to the punisher. However, the effect is only significant for anti-social punishments in heterogeneous groups.

Although the experiment was not designed to test for specific motives behind punishment decisions, the data nevertheless allow me to investigate whether punishment was at least partly motivated by (blind) revenge. Punishment is assumed to be vengeful if the sanction assigned in period t is positively affected by punishments received in the previous round t-1. Following Ostrom et al. (1992), I refer to exerted punishment in t in response to received punishment in t-1 as "blind revenge" because the recipient of punishment could not identify but only speculate as to who of the other group members punished him or her. This further implies that punished individuals could not determine whether they were punished by group members who gave relatively larger fractions or by those who invested fewer tokens than themselves. In other words, they could not unambiguously distinguish between received anti-social and pro-social punishments.

To account for motives of revenge, I consider the amount of punishment points received in the previous round as an explanatory variable, while at the same time controlling for contributions. The positive signs of the variable *Received punishments in t-1* shows that the more punishment points a subject received in the previous round the higher is the amount of punishment assigned towards other group members in the following round. However, an interesting pattern emerges: While having received sanctions in round t-1 tends to increase the amount of both pro-social and anti-social punishment in either sub-sample, statistical significance of these effects differs strongly between the treatments. Turning first to pro-social punishments, it becomes apparent that the expenditures devoted to sanctioning low contributors are significantly higher if the punisher was punished him- or herself in the previous round in heterogeneous groups only. By contrast,

[23] Note, the variable is defined as $\left|c_{i,t} - c_{j,t}\right|$, whereupon $c_{i,t}$ and $c_{j,t}$ denote the contribution of the punisher and the punished player in round t, respectively, ranging from 0 (the punisher contributed the same fraction of his/her endowment as the punished subject) to 1. For pro-social (anti-social) punishments 1 means that the punisher (punished) contributed 100% of his/her endowment while the punished (punisher) contributed nothing.

in the homogenous treatment pro-social punishment is unrelated to previously received sanctions. The opposite is observed for anti-social punishments which increase significantly in the amount of received punishment in homogenous groups, but not in the heterogeneous treatment. Therefore, and in accordance with previous studies (e.g., Herrmann et al., 2008), motives of revenge, in form or counter-punishment, seem to trigger anti-social sanctions among players assigned to homogenous groups; but not among members of heterogeneous groups. While motives of revenge matter in both treatments, it seems that the desire for retaliation is satisfied in different ways. In heterogeneous groups, vengeful punishment is rather directed towards low-contributors and thus revenge is satisfied in a way that is, in principle, conducive to cooperation. The opposite holds true for homogenous groups.

Result 8: To a large part, punishment decisions seem to be triggered by motives of revenge.

The positive and partly highly significant relations between the amounts of previously received sanctions and subsequent punishment decisions reported in Table 5 suggest that retaliatory counter-punishment is an important explanation for the high occurrence and vehemence of punishment in my study. However, the fact that both pro-social and anti-social punishment occurred already in the first round of the PUN condition also suggests that other motives than counter-punishment matter as well. Pro-social punishments might be triggered by a punisher's desire to retaliate unkind behaviour of low contributors who free-rode on his or her contributions. Because the exogenously determined fine-to-fee ratio was greater than one, punishments could also be motivated by equity concerns. Sanctions targeted towards low contributors reduce their income and may have followed the punisher's intent to eliminate inequity. On the other hand, anti-social punishments may mirror punisher's desire to maximize relative pay-offs (Falk et al., 2005) or strong preference for advantageous inequality (Fehr et al., 2008; Houser and Xiao, 2010). Anti-social punishments might also be a consequence of conspicuous or "*excessive generosity*" (Henrich et al., 2006:1768), particularly if targeted towards generous low-income players in heterogeneous groups. In principle, anti-social punishment could also be intended to enhance cooperation if assigned to induce targets to contribute even more (Gächter and

Herrmann, 2009). However, in general these motives are difficult to disentangle, and the design of my experiments does not enable me to do so.

4. Summary and conclusions

This paper has examined the scope of informal sanctions in rural communities in southern Namibia, thereby investigating the effects of income inequality on pro-social and anti-social punishments. In contrast to the vast majority of related studies, I do not find a cooperation-enhancing effect once the opportunity of peer punishment is given. The majority of groups (16 out 30) performed worse than in the without-punishment condition and realized lower average contribution levels.

I find a comparably high incidence of anti-social punishment. In both treatments, anti-social punishment occurred more frequently and vehemently than pro-social sanctions. Comparable levels of anti-social punishment were reported by Herrmann et al. (2008) and Gächter and Herrmann (2009) for samples from the Middle East (Saudi Arabia, Oman), and Southern Europe (Greece), where they did not find a cooperation-enhancing effect of peer-punishment institutions. Properties shared by all societies where levels of anti-social punishment were found to be high are weak norms of civic cooperation and a weak rule of law, suggesting that these societal indicators impel the occurrence of anti-social punishment (Herrmann et al., 2008). My results are in accordance with theirs insofar that the rule of law is also weak in southern Namibia.

As emphasized by Herrmann et al. (2008:1365), "[p]*unishment may be related to social norms of cooperation*" including "*shared views about acceptable behaviours*". My results suggest that peer punishment as a means to enforce norms is *not* accepted among a substantial fraction of water point users in southern Namibia. Two observations support this claim: First, received punishments triggered counter-punishments, pointing towards strong motives of revenge and suggesting that subjects dislike "reprehension" but feel anger rather than guilt when being punished. This has been observed at group level and at individual level. At group level, vengeful punishment leads to a downward spiral in cooperation; and punishments were highest in groups with low contribution levels. Second, received punishments did not alter subjects' willingness to cooperate. The positive is that victims of anti-social punishments were not discouraged by seemingly unfair or unjustified treatment and did not reduce their contributions. The flip side of the coin, however, is that low contributors sanctioned by group members who gave more than them did not adjust their contributions either, suggesting that received pro-social punishments did not evoke feelings of shame or guilt which in turn could have induced the punished to raise his or her contributions. However, this might be partly owing to the fact that subjects could not unambiguously determine whether the sanction was pro-socially or anti-socially intended, and the high occurrence and vehemence of both kind of punishments may have sent diffuse signals to the recipient of punishment.

My results confirm those of related studies as induced income heterogeneity leads to higher contributions in heterogeneous groups compared with homogenous groups. Moreover, and also in accordance with previous (experimental) research, low-income players contribute significantly higher fractions of their endowments towards the PG than their high-income group members and subjects assigned to homogenous groups. High efforts of low-income players -presumably motivated by higher net gains from mutual cooperation may have induced high-income players to increase their contributions as well, provided that the better-off oriented at the behaviour of the poorest. High-income players contribute about 6 percentage points more towards the PG than their counterparts in homogenous groups. This suggests that income inequality can serve as a promoter of collective action, rather than an obstacle. In the sociology literature it was argued "*that in heterogeneous environments there is a greater probability of finding a critical mass of individuals willing to contribute to the public good. This may have positive effects in that the motivated subjects* [i.e. the low-income players confronted with higher net gains from cooperation] *will devote resources to persuading* […] *less interested individuals* [the high-income players] *to contribute"* (Chan et al., 1996: 7). Such mechanisms might take effect especially in societies where inequality is high, like in the South African (Visser and Burns, 2006) and the Namibian society, and where experimental evidence for the positive effects of heterogeneity on cooperation come from. The fact that low-income players give more in relative terms also mirrors real-life observations from my study site. In most water point associations, water consumers have to pay a fixed amount of about N$10 per month and per household, irrespective of the actual household size and, more importantly, the number of livestock, implying that poor households with small herd sizes share a relatively higher burden of the water infrastructure provision than their better-off community fellows.[24]

Finally, I find substantial differences between heterogeneous and homogenous groups as well as among player types regarding punishment behaviour. First of all, both anti-social and pro-social punishment occurred more frequently and vehemently in homogenous groups. This holds if controlling for group contributions. Interestingly, in both groups anti-social punishment was harsher and more frequent than pro-social punishment. Second, low-income players punish with similar frequency and vehemence as high-income players, despite of higher opportunity costs. Third, responses to received punishment differ between homogenous and heterogeneous groups. While received sanctions generally increase the amount of preceding anti-social and pro-social sanctions across the treatments, which points towards vengeful counter-punishment, the relation between received sanctions and subsequent anti-social punishment was only significant in homogenous groups and the effect of previous punishments on pro-social sanctions was only significant for the heterogeneous treatment, indicating that members of unequal groups satisfy their desire to take revenge in a more "conducive" way.

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Appendix

A.1 Instructions, materials and sample description

Instructions for VCM condition

We are now to begin the game. It is very important that you listen carefully. If you have any questions, please raise your hand.
The game is similar to a situation where people has to make decisions on how much to contribute to a community project, like, for example, the water point association.

During the game we will play with Points that are exchanged into real money when the game is over.

In this game, 1 point represents 10 Cents, thus 10 points are 1 N$

We will play with groups of 4 people. These people shall represent in the game one community. The experiment consists of two parts, and each part you will play for 6 rounds, equivalent to months/years. At the beginning of **each round**, everybody receives 30 points. In each round, you will have to decide **how many of these points you want to contribute to a community project, and how many of those points you want keep for yourself.** The money you keep yourself will be put into a private account.

How are your earnings from your decisions calculated?

The earnings of each group member in each round will be calculated in the same way. The earnings consist of two parts:

(1) Points from your private account

(2) Points contributed to the community project

Each point you don't invest into the community project will be yours automatically and will be kept on your private account.

The following will happen with points you contributed to the project: Sebastian will double the sum of contributed points and this sum will be divided equally among all of you.

For example, if you contribute 1 point to the project, Sebastian will add 1 point; that is, he will double the points. The sum, namely 2 points, will be distributed equally among all four group members, so each member receives 0.5 points. Therefore, for every point you put into the project you and each other group member will earn 0.5 points, since everybody receives the same income from the community project. In turn, the contribution of 1 point to the project by another group member will raise your earnings by 0.5 points.

After all four group members have decided on their contributions to the project, the earnings of every participant for the respective round are determined as follows:

Your total earnings = earnings from the private account + earnings from the project =

(Your Points minus "the number of points you contribute to the water account") plus 0.5 times (number of points contributed by the whole group to the water account)

We will give you examples which will help you gain understanding about the calculation of your earnings in a few minutes. But beforehand, we will explain **how you will make your decisions:**

How do you make your decisions?

To be able to play the game you will receive a “record sheet” on which you can record your earnings of each round, a box where you can put all the sheets you receive during the game, and an “envelope”. The envelope is used for exchanging DECISION CARDS and RESULT CARDS between us and you. When you open the envelope, you will find a yellow sheet which is the DECISION CARD you will receive in each round.

[HAND OUT THE ENVELOPES, RECORD SHEETS AND THEN WAIT FOR A SHORT TIME UNTIL EVERYBODY HAS OPENED HIS ENVELOPE]

On this decision card, you have to fill in the box how many of your points you would like to contribute to the community project. You can contribute any integer amount from 0 to 30.

If you have made your decision, please put your decision card into the envelope and seal it. Richard or Sebastian will then collect the envelopes from all of you.

It is very important that you keep in mind that the decisions **are absolutely individual**. Only Sebastian will see your decision. When he has collected all of your envelopes filled with your DECISION CARDS he will write down the group contribution to the project on the poster and calculate your earning from the project for this round. Additionally, he will tell you the average contribution of the group.

You will then get an RESULT SHEET, in an envelope, which will inform you about your earnings in the particular round. You can record your total earnings in your RECORD SHEET.

> SHOW THEM THE RESULT SHEET>

We will now run a few examples which will help you gain understanding about how your earnings are calculated.

Remember, in each round you have to decide whether and, if so, how many points you want to contribute to the project and how many points you want to keep for yourself. Thus, your total earnings consist of two parts: 1) the points you kept yourself on the private account and 2) the points you earned from the project.

As explained above, each point contributed to the community project will be doubled by Sebastian and then equally distributed among all 4 participants. For example, if each of you contributes 10 points the total contribution of all 4 group members will be 4 times 10 = 40 points. Sebastian will double this amount and divide it equally through all of you. The double of 40 points is 80 points. 80 points divided by 4 (because there are 4 you participating) is 20 points. Thus, each one of you will earn 20 points **from the project**. But remember, this is only the first part of your earnings. To get your total earnings, you have to add the points you kept for yourself, which is 20 points. Thus the total earning is 20+20=40 points.

Let's run another example: "PLAYER 1" decides to contribute 25 points, "PLAYER 2" 8 points, "PLAYER 3" 27 points and "PLAYER 4" 0 points then the total contribution of the group is (25+8+27+0) 60 points. [TAKE DECISION CARD OF PLAYER 3 AND FILL IN 27]

We will double this amount and divide equally amongst all members. In this example we double 60 points to 120 points and thus everybody receives (120 divided by 4) 30 points from the community project.

At the end of the round you will earn the points you kept for yourself plus 30 points from the community project.
Let's see what every player gained:

PLAYER 1: receives 5 from his private account plus 30 from the project is 35 points
PLAYER 2: receives 22 plus 30 is 52 points
PLAYER 3: receives 3 plus 30 is 33 points
PLAYER 4: receives 30 plus 30 is 60 points
Altogether ____ points

[TAKE RESULT CARD OF PLAYER 4 AND FILL IN HIS EARNINGS AND PUT IN IN THE ENVELOPE]

EXAMLE 2
Let's take a look at another example:
PLAYER 1: has 30 points, keeps 20 for himself and contributes 10 points to the project
PLAYER 2: has 30 points, keeps 15 and contributes 5 points
PLAYER 3: has 30 points, keeps 25 and contributes 5 points
PLAYER 4: has 30 points, keeps 0 and contributes 30 points

[TAKE DECISION CARD OF PLAYER 2 AND FILL IN 5]

The total group contribution to the project is 50 points, doubled to 100. 100 divided by 4 players is 25 points.

PLAYER 1: receives 20 points he kept for himself plus 25 from the project is 45 Points, which is N$ 2.75
PLAYER 2: receives 15 plus 25 is 40 points
PLAYER 3: receives 25 plus 25 is 50 points
PLAYER 4: receives 0 plus 25 is 25 points
Altogether ____ points

EXAMPLE 3

Each player contributes all points to the community project. Thus, the total contribution is 4 times 30 = 120 points. 120 times 2 is equal to 240 points. 240 points divided by 4 players = 60 points. Since nobody kept any points for himself, this is also the total earning of everybody.
Altogether:

EXAMPLE 4
Each player decides to keep his points for himself. Thus nobody contributes to the project. In that case everybody will earn 30 points in this round

Do you have any questions?

In the following poster we summarize for you the steps to follow to play in each round. Please take your time reading through it again and raise your hand if you have any questions.

Finally, to get ready to play the game, please let us know if you have difficulties reading or writing numbers and one of the monitors will sit next to you and assist you with these. Also, please keep in mind that from now COMMUNICATION AMONG THE PARTICIPANTS IS STRICTLY PROHIBITED. We will now have first a few rounds of practice that will NOT count towards the real earnings, they are just for you to practise the game. After that you begin to play for money.

You now get your player numbers. Please do not show your number to anybody. It is your secret.

[HAND OUT PLAYER NUMBER and DECISION CARD]

Instructions for the Punishment condition

We come know to the second part of the experiment. After this part is finished you just have to answer a questionnaire and then you will receive your income from the experiments as well as your fee of 10 N$ for coming here today.

In this part of the experiment you must make two decisions: The **first decision** is identical to the decision you made in the experiment that you have just completed. In the first decision you must again make a decision about how many of your points you want to contribute to the project (and therefore also how many you will keep for yourself). The earnings after your first decision are calculated in the same way as they were calculated in the previous experiment.

What is different in the new experiment?

In this part you will learn the contributions each other group members invested in the project and you get the opportunity to **reduce the income** of each other group member, through the assignment of **deduction points**. You can also leave the income of the other members **untouched**. The other members of the group can also reduce **your** income if they wish.

How is your income from the second stage calculated?

Each deduction point will reduce the income of this group member by three points. That is, if you, for example, assign 2 deduction points to a group member, his/her income will reduced by 6 points. If you assign 8 deduction points his/her income will be reduced by 24 deduction points, etc…

You may assign a maximum of 10 deduction points to each other member.

However, it is costly to distribute deduction points to others. For each assigned deduction point, you will face a cost of 1 point. For example, if you assign 5 deduction points, you will face costs of 5 points. If you assign no deduction points, you will, of course, face no costs.

Let's make another example: You decide to reduce the income of one player by assigning 2 deduction points to him/her and to reduce the income of another player by assigning 1 deduction point. Then the first player's income will be reduced by 6 points and the other's income by 3 points. You will have to pay 3 points.

However, a person who received deduction points cannot lose more points than he/she has. If the amount of deduction points assigned to her is greater than her income from this round, the income will be zero. Independent of this, one must completely bear the costs of deduction points that one assigns to other members. Please note that you can, with certainty, exclude losses through your own decisions

How does the experiment proceed?
As in the first part of the experiment, you will get a yellow decision sheet where you have to fill in your contribution to the project. The envelopes with decision sheets and the contributions will be collected. Next, you will get a blue sheet for the second step. On the blue sheet you will be informed about how many points the other participants have contributed to the project

.

In the first row you can see how many points each player is given in the beginning of each round. Followed by the second row which displays your and the other group members' contributions to the project. In the second row "deduction points you want to assign" you have to fill the amount of deduction points you want to assign to the other players. If you, for example, want to reduce the income of player 2, you have to fill "2" in the column heading "Player 2". If you don't want to assign deduction points, please fill in "0".

[DEMONSTRATE]

If you have made your decisions please put the blue sheet back into the envelope. We will collect the envelope and then calculate your income. When the calculations are done you will receive the RESULT SHEET where you can see your earnings from the first stage, subtracted by the deduction points you may have received from other participants as well as by the deduction points you have assigned to other members. Of course, the RESULT SHEET will again display your total earning in the last row.

It is very important that you keep in mind that the decisions are absolutely individual, that is, only Sebastian will see your decision. On the RESULT SHEET you will only learn the total sum of deduction points you received from the other group members. But you will not know who attributed sanctions to you. Sebastian will tell nobody about your decisions during this experiment.

Further procedures and materials

At the beginning of each round, subjects got a yellow paper slip, called 'decision card' (see Figure A.1), to write down their contribution. No communication was allowed. To ensure privacy, subjects were placed so as not to be able to view others' decisions. In addition, the decision cards had to be put into an envelope. After all participants had made their contribution decisions, the envelopes were collected, and the total group contribution as well as the return from the project (i.e. the public good) were calculated and announced. Subjects were given 'record sheets' (Figure A.2) to record this information and to calculate their total earnings for that round themselves. During the practice rounds, we checked whether the subjects reported their earnings correctly. To ease calculation, each subject got a pocket calculator. If subjects had problems to operate the calculator or if they did not understand the composition of their earnings, a field assistant assisted them in practice round 2 and 3 until they had understood.
Each participant further received a sealed envelope containing an 'information sheet' (Figure A.3) which indicated her (i) private earning, (ii) her earning from the project and (iii) the total earning in that round. That way the subjects could test whether they reported their earnings correctly.

Punishment decisions were made simultaneously and written down on personal 'sanction sheets' that were distributed at the beginning of stage2. The 'sanction sheets' contained information on all players' endowments and contributions in the given period as well as a row where the subject could indicate the number of punishment points to be assigned to each of the other group members (see Figure A.4). In case they were not willing to punish any, they had to write zeros. I randomized the order in which player numbers appeared on the sheet in each round, to minimize reputation formation effects. When all players had made their punishment decisions, the 'sanction cards' were collected and the total earnings after stage2 calculated. Then 'information sheets' (Figure A.5) where I provided information on the final earnings in the given period, the cumulated punishment points *received from*, as well as the cumulated fees *assigned to* the other group members were handed out. Thus, subjects were just informed about the total number of fines allocated to them but not about the punishment decisions of single individuals.

RECORD SHEET			
YOUR PLAYER NUMBER			
Round	Earning from project	Earning from private account	**Total earning**
Practice 1			
Practice 2			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
SUM			

Figure A.1: Record sheet.

DECISION CARD	
YOUR PLAYER NUMBER:	
You have 30 tokens. Please indicate the number of tokens you want to contribute to the project. (You may contribute any integer amount between 0 and 30):	

Figure A.2: Decision card for homogenous group member. Players had to write down their player number and their contribution decision. In heterogeneous groups the information about player's endowment were adjusted accordingly.

INFORMATION SHEET YOUR PLAYER NUMBER:	
Your contribution to the project was	Tokens
Your earning from the project is	Tokens
Your private earning is	Tokens
Your total earning is	**Tokens**

Figure A.3: Information sheet. The information about earnings as well as the player number was filled in by the experimenter.

SANCTION SHEET				
YOUR PLAYER NUMBER: **1**				
	YOU	**Player 3**	**Player 2**	**Player 4**
Endowment	**20**	**40**	**20**	**40**
Contribution to the project				
Sanction points				

Figure A.4: Sanction sheet for heterogeneous group member. The Figure shows the sanction sheet issued in heterogeneous groups. In homogenous groups, the endowments of 30 tokens stayed constant. The order in which the player numbers appeared was changed randomly.

INFORMATION SHEET YOUR PLAYER NUMBER:	
Your earning in the first phase	
Minus sanctions you **received** from other players	**-**
Minus sanctions you **assigned** to other players	**-**
Total earnings for that round	

Figure A.5: Information sheet for the PUN condition.

Socio-demographic characteristics of the sample

Table A.1: Summary of sample characteristics

		Total sample		Homogenous treatment		Heterogeneous treatment		H0: equal means
	N	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Socio-demographics								
Age	120	33.54	11.599	33.62	11.756	33.47	11.538	*Z*=0.09
*Male**	120	0.50	0.502	0.48	0.504	0.52	0.504	*Z*=0.36
*Married**	120	0.25	0.435	0.23	0.427	0.27	0.446	*Z*=0.42
Education	120	8.96	2.658	9.05	2.258	8.87	3.022	*Z*=0.26
Household size	120	6.37	3.632	6.37	3.678	6.37	3.617	*Z*=0.21
*Household head**	120	0.38	0.486	0.33	0.475	0.42	0.497	*Z*=0.94
*WPC member**	118	0.22	0.416	0.25	0.439	0.19	0.393	*Z*=0.88
Economic background								
*Permanent job**	120	0.08	0.278	0.05	0.220	0.12	0.324	*Z*=1.31
*Occasional job**	120	0.21	0.408	0.25	0.437	0.17	0.376	*Z*=1.12
*Farmer**	120	0.41	0.493	0.40	0.494	0.41	0.497	*Z*=0.18
*Unemployed**	120	0.18	0.388	0.15	0.360	0.22	0.416	*Z*=0.94
*Livestock possession**	120	0.63	0.484	0.63	0.486	0.63	0.486	*Z*=0
SSU	120	57.93	56.191	55.21	55.308	60.66	57.671	*Z*=0.23
Session background								
Understand the game	120	4.07	1.083	4.13	0.982	4.00	1.179	*Z*=0.28
# friends in same session	118	2.20	1.090	2.08	1.134	2.32	1.041	*Z*=1.18
# relatives in same session	119	0.83	0.886	0.78	0.904	0.88	0.873	*Z*=0.75

Notes: The symbol * denotes categorical variables. For instance, 25% of the entire sample is married. The reference group for *Married* is single (71%) and widowed and divorced (3.3%). *Education* refers to the highest grade obtained at school, ranging from 0 (no schooling) to 12 (highest grade). *Household size* indicates the number of people who stay permanently in the participants' household. *Friends in same session* and *Relatives in same session* count the number of participant's friends and relatives who participated within the same session, respectively. *SSU* refers to Small Stock units and measures the livestock numbers of those participants who possess livestock (1 cattle is converted into 6 small stock units (e.g. goats and sheep).

A.2: Supporting statistical analyses

Regressions including socio-demographic variables

All regressions examining individual behavior that are reported in the main text are performed with socio-demographic controls. The variables comprise the (1) *age* of the subject, as well as the (2) *age squared* to control for non-linearities, (3) the educational background indicating the highest grade passed at school (ranging from 0 (no schooling) to 12 (highest grade)), (4) the sex of the participant (male =1) and (5) the employment status. As a control for the employment status I add a dummy variable taking 1 if the subject was unemployed, and 0 if the subject had any kind of income source. Table A.2 corresponds to Table 3 in the main text and examines individual contribution decisions, while controlling for socio-demographic variability. Similarly, Table A.3 is the pendant to Table 5 and analyses individual punishment decisions.

Table A.4 reports regression estimations for individual punishment decisions if the contribution is expressed as the total amount rather than the fraction of endowment. This distinction is irrelevant for the homogenous treatment, but could have mattered in the heterogeneous treatment. That is, situations in which the decision maker contributed a larger total amount (instead of a larger fraction) of her endowment than the other group member are defined as pro-social punishment decisions (estimations 1-3). Anti-social punishment decisions (estimations 4-6) are all situations where the punisher contributed the same or a smaller amount (instead of fraction) of her or his endowment than the victim of punishment. The results reported in table A.4 are qualitatively the same as in Table 5.

Table A.2: Impact of socio-demographic characteristics on individual contributions

Table A.2 Y: ind. contribution	(1) Total	(2) Het	(3) Total	(4) Het	(5) Hom
Low income player	0.153***	0.107***	0.0372	0.0414	
	(0.0582)	(0.0389)	(0.0466)	(0.0431)	
PUN condition	-0.0249	-0.0255			
	(0.0264)	(0.0345)			
Round	-5.09e-05	0.00166	0.00947	0.0170**	-0.000638
	(0.00382)	(0.00500)	(0.00694)	(0.00867)	(0.0112)
Male	-0.0586	-0.0400	-0.0246	0.00908	-0.0428
	(0.0477)	(0.0439)	(0.0373)	(0.0465)	(0.0353)
Age	-0.000790	0.0103	-0.00654	-0.00890	-0.00145
	(0.0112)	(0.0111)	(0.00874)	(0.0117)	(0.00853)
Age squared	1.00e-05	-0.000126	0.000107	0.000135	7.51e-06
	(0.000145)	(0.000143)	(0.000112)	(0.000151)	(0.000110)
Education	0.00174	0.0185**	0.0106	0.0115	-0.00401
	(0.0105)	(0.00938)	(0.00817)	(0.00999)	(0.0107)
Unemployed	-0.0348	-0.0640	-0.00214	-0.00743	-0.0973**
	(0.0529)	(0.0494)	(0.0414)	(0.0526)	(0.0415)
High income player	0.0587		0.0171		
	(0.0573)		(0.0449)		
ASP received in t-1			-0.00674	0.000820	0.00546
			(0.00512)	(0.00700)	(0.00785)
PSP received in t-1			-0.00338	-0.00424	-0.00628
			(0.00480)	(0.00890)	(0.00644)

Av. Contribution in round 1-6			0.859***	0.650***	0.309***
			(0.0750)	(0.134)	(0.0936)
Constant	0.496**	0.161	-0.0489	0.181	0.207
	(0.253)	(0.247)	(0.212)	(0.272)	(0.238)
Session dummies	No	Yes	No	Yes	Yes
Constant	0.243***	0.122***	0.165***	0.108***	0
	(0.0171)	(0.0145)	(0.0155)	(0.0189)	(0.121)
sigma_e					
Constant	0.245***	0.227***	0.234***	0.209***	0.262***
	(0.00507)	(0.00658)	(0.00816)	(0.0101)	(0.0117)
Observations	1,440	720	600	300	300
Number of player_id	120	60	120	60	60
chi2	12.01	151.8	157.3	175.3	306.0
p	0.213	0	0	0	0
ll	-295.3	-54.93	-118.2	-6.887	-59.09
N_lc	120	53	62	25	37
N_unc	1320	667	538	275	263
N_rc	0	0	0	0	0

Notes:

1) Table A.2 replicates Table 3 but includes also socio-demographic variables.
2) Left-censored random-effects models. Dependent variable is the individual contribution in terms of the fraction of endowment invested into the public good.
3) Standard errors in parentheses, ***, **, and * denote statistical significance at the 1%, 5% and 10% level respectively.

Table A.3: Anti-social and pro-social punishments including socio-demographic controls

	PSP			ASP		
	(1)	(2)	(3)	(4)	(5)	(6)
Y: Punishments assigned	Total	HET	HOM	Total	HET	HOM
Low income player	-1.749***	-0.497		-1.078	-0.283	
	(0.668)	(0.875)		(0.779)	(1.095)	
Received punishments in t-1	0.237***	0.392***	0.137	0.212***	0.0864	0.275***
	(0.0620)	(0.0897)	(0.0838)	(0.0461)	(0.0793)	(0.0579)
Difference in contributions	0.805	0.559	0.985	1.532***	2.861***	0.604
	(0.759)	(1.017)	(1.080)	(0.567)	(0.900)	(0.735)
Other player high		0.633			0.519	
		(0.650)			(0.569)	
IA low income*high income		-0.0703			-0.200	
		(0.888)			(0.813)	
round	-0.0126	-0.00118	0.0290	-0.106	-0.172	-0.0630
	(0.115)	(0.148)	(0.171)	(0.0949)	(0.139)	(0.129)
Male	0.407	0.598	-0.201	0.138	0.781	-0.497
	(0.557)	(0.691)	(0.807)	(0.615)	(1.015)	(0.771)
Age	0.116	0.340*	-0.0536	0.130	0.391	-0.0131
	(0.129)	(0.186)	(0.182)	(0.144)	(0.261)	(0.178)
Age squared	-0.00106	-0.00456*	0.00188	-0.00184	-0.00626*	0.000664

	(1)	(2)	(3)	(4)	(5)	(6)
	(0.00164)	(0.00251)	(0.00233)	(0.00186)	(0.00356)	(0.00231)
Education	-0.0138	-0.0837	0.301	-0.110	-0.193	0.170
	(0.118)	(0.120)	(0.229)	(0.136)	(0.188)	(0.208)
Unemployed	0.606	0.512	1.141	-0.229	0.755	-0.763
	(0.615)	(0.736)	(0.912)	(0.677)	(1.085)	(0.836)
High income player	-1.529**			-1.576**		
	(0.689)			(0.756)		
Constant	-4.642	-8.799**	-5.786	-2.222	-6.539	-2.966
	(3.147)	(4.322)	(4.674)	(3.372)	(5.817)	(4.220)
sigma_u						
Constant	2.093***	1.551***	2.206***	2.728***	2.881***	2.384***
	(0.283)	(0.377)	(0.394)	(0.290)	(0.479)	(0.337)
sigma_e						
Constant	3.353***	2.934***	3.598***	2.888***	2.845***	2.880***
	(0.174)	(0.240)	(0.244)	(0.134)	(0.201)	(0.178)
Observations	797	407	390	1,003	493	510
Number of player_id	113	58	55	118	58	60
chi2	30.62	26.07	9.193	38.65	19.77	28.89
p	0.000678	0.00634	0.326	2.92e-05	0.0485	0.000332
ll	-954.3	-390.2	-554.3	-1095	-472.7	-613.0
N_lc	529	298	231	684	357	327
N_unc	259	108	151	310	132	178
N_rc	9	1	8	9	4	5

Notes:

1) Table A.3 is the same as Table 5 in the main text but includes socio-demographic characteristics as further explanatory variables
2) Left-censored random-effects models. Dependent variables are the amount of tokens spent for pro-social and anti-social punishments.
3) Standard errors in parentheses, ***, **, and * denote statistical significance at the 1%, 5% and 10% level respectively.

Table A.4: Punishment behaviors using the total contribution as reference category

	PSP			ASP		
Y: Punishments assigned	(1) Total	(2) HET	(3) HOM	(4) Total	(5) HET	(6) HOM
Low income player	-1.705**	-0.315		-1.326*	-0.205	
	(0.767)	(0.899)		(0.759)	(1.070)	
received punishments in t-1	0.239***	0.396***	0.130	0.211***	0.106	0.272***
	(0.0628)	(0.0943)	(0.0843)	(0.0459)	(0.0737)	(0.0578)
Difference in contributions	0.000695	-0.0224	0.0304	0.0424**	0.0589**	0.0191
	(0.0246)	(0.0330)	(0.0361)	(0.0167)	(0.0240)	(0.0245)
Other player high income		0.792			-0.532	
		(0.605)			(0.657)	
IA punisher low*punished high		0.0342			0.0262	
		(0.938)			(0.822)	
Round	-0.00307	0.00459	0.0149	-0.110	-0.156	-0.0565
	(0.117)	(0.156)	(0.171)	(0.0946)	(0.136)	(0.129)
High income player	-1.799***			-1.378*		

	(0.690)			(0.753)		
Constant	-1.720	-3.390**	-1.995	-1.107	-1.380	-1.592
	(1.229)	(1.705)	(1.712)	(1.010)	(1.578)	(1.307)
sigma_u						
Constant	2.313***	2.011***	2.400***	2.759***	2.934***	2.484***
	(0.300)	(0.429)	(0.405)	(0.293)	(0.482)	(0.347)
sigma_e						
Constant	3.377***	2.990***	3.599***	2.882***	2.855***	2.882***
	(0.176)	(0.244)	(0.244)	(0.134)	(0.201)	(0.178)
Observations	801	411	390	1,003	489	510
Number of player_id	113	58	55	118	57	60
chi2	26.86	20.67	3.810	36.16	8.911	25.20
p	6.06e-05	0.00211	0.283	8.83e-07	0.179	1.40e-05
ll	-948.7	-385.3	-556.6	-1096	-489.2	-614.6
N_lc	536	305	231	684	350	327
N_unc	256	105	151	310	135	178
N_rc	9	1	8	9	4	5