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FAIRNESS, RECIPROCITY AND INEQUALITY: EXPERIMENTAL EVIDENCE FROM SOUTH AFRICA

Martine Visser

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Abstract

This thesis consists of six papers, related to artifactual field experiments, conducted in South Africa. The main focus of the thesis is the effect of different forms of heterogeneity on cooperation and punishment within groups. We conduct public goods experiments where the first study draws on a sample of nine fishing communities in South Africa; the second is conducted in Cape Town amongst four high schools with distinctly different socio-economic profiles.

The first paper "***Bridging the Great Divide in South Africa: Inequality and Punishment in the Provision of Public Goods***" explores the effect of income inequality and peer punishment on cooperation. Aggregate cooperation is higher in both the voluntary contribution mechanism and punishment treatments for unequal groups. Low endowment players also contribute a significantly greater fraction of their endowment to the public good than high endowment players in the presence of punishment. Demands for punishment by low and high endowment players are similar, irrespective of differences in relative costs, and in unequal groups free-riding is punished more, specifically by low endowment players. We observe inequality aversion both in endowments and with respect to the interaction of endowments and contributions.

We explicitly examine the impact of heterogeneity in actual per capita household incomes and expenditures of participants on contributions to the public good in the second paper: ***"Games and Economic Behavior in South African Fishing Communities."*** We find that contributions to the public good are increasing in income levels, and income heterogeneity is associated with greater contributions towards the public good, especially by those at the lower end of the income distribution. Racial and gender diversity in groups tends to lower contributions to the public pool.

In the third paper "***Contributing My Fair Share: Inequality and the Provision of Public Goods in Poor Fishing Communities in South Africa"*** we consider only the treatments without punishment. We find that aggregate contributions are marginally higher in unequally endowed groups, and that low endowment individuals contribute a

significantly larger fraction of their endowments towards the public good than high endowment players. Contributions made by the majority of individuals approximate a proportional fair share threshold.

In “***Fairness and Accountability: Testing Models of Social Norms in Unequal Communities,”*** the last paper that forms a part of this project, we advance different behavioral models for fairness. We find that behavior observed in unequal groups does not accord with models of inequality aversion or egocentric altruism. Our empirical results support a proportional reciprocity model rather than a model of absolute reciprocity. Empirical testing of the proportional model enables us to estimate the intrinsic contribution norm for each community.

The second part of this thesis involves two essays conducted amongst schools from different social environments in Cape Town.

The first ***“Does Stake Size matter for Cooperation and Punishment?”*** finds that an increase in stake size does not significantly affect either cooperation or the level of punishment in a one-shot public goods experiment.

The second study ***“Social Capital, Cooperative Behavior and Norm-enforcement”*** examines the influence of an individual’s social environment on his or her cooperative and norm-enforcement behavior. Our main empirical results clearly confirm that social environment is consistently related with cooperative and norm-enforcement behavior. Moreover, its impact is able to overpower typical group variables.

Preface

The central themes in my research deal with issues that form an intrinsic part of life in South Africa. I hope that this work and also my future research may in some way make a contribution towards understanding behavioral issues concerning poverty, inequality and the provision of common goods. To all of those who have played some part in influencing my thoughts and development and helped to bring me to this place in my life – I want to give my sincerest acknowledgment.

I would like to express profound gratitude to both my supervisors Olof Johansson-Stenman and Peter Martinsson whose continued encouragement and belief in my research abilities have been invaluable. Olof has been one of my greatest teachers and the best intellectual sounding board a student can dream to have. His integrity, free thinking and sharp intellect has had a deep influence on me. I am also very grateful to Peter who started me on this journey of behavioral economics and social dilemmas. He has been an invaluable support, always providing encouragement and guidance, following up and doing quality control on my papers. I am indebted to Fredrik Carlsson who was always ready to give advice. I would like to acknowledge Gunnar Köhlin for his continued endeavor in building capacity in Africa. Special thanks also to Thomas Sterner for his loyal friendship and efforts to create collegiality in the EEU. My sincerest gratitude also to my teachers in the coursework component my studies.

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The people I have met in Sweden during my stay here have enriched my life tremendously. I am grateful to each and every one of you who have shared with me some of the life here. I would like to give much acknowledgment to my classmates, Rahimaisa Abdula, Wisdom Akpalu, Mintewab Bezabih and Jorge Garcia who have become more like brothers and sisters and shared in all that this experience brought us. My sincere thanks to Elizabeth Földi for her great spirit and enthusiasm and endless assistance. I would like to thank a number of people whose friendship and kindness I was privileged to enjoy during this time: Anatu Akpalu, Fredrik Andersson, Christian Azar, Constantin Belu, Sten Dieden, Henrik, Helena and Agnes Hammar, Anna Hedenus, Marcela Ibanez, Nizamul Islam, Miyase Köksal, Elina Lampi, Florin, Julia and Rarez Maican, Andreea Midrut, Eugene and Anton Nivoroshkin, Katarina Nordblom, Ola Ohlsson, Matilda Ord, Alexis Palma, Martin Persson and Frances Sprei, Bjorn Sund, Sven Tengstam, Ulrika Trolle, Elias Tsakas and Alex Wedin. Thanks also to my friends and colleagues in the EEU: Hala and Mustafa Abou-Ali, Fransico and Gabbi Alpizar, Yonas Alem, Mohammed Belaj, Gardner and Victoria Brown, Nasima Chowdhury, Olof Drakenberg, Håkan Egert, Anders Ekbom, Haoran He, Magnus Hennlok, Ada Janssen, Karin Jonson, Innocent Kabenga,, Martin Linde-Rahr, Razack Lokina, Minaj and Farsana Mahmud, Karl Göran Mäler and Sara, Edwin Muchpondwa, Pham Khanh Nam, Wilfred Nyenga, Daniel Slunge, Jesper Stage, Bjorn Ohlson, Qin Ping, Miguel Quiroga, Katarina, Per, Isabella and Felicia Renström, Mito Rossi, Daniela Roughsedge, Clara Villegas, Kofi Vondolia, Jiegen Wei, Conny Wolbrandt, Mahmud Yesuf and Precious Zikhali. Thank you very much to all the administrative staff for their kindness and assistance: Eva-Lena Neth, Eva Jonasson, Anna Karin Agren and Gerd Georgsson.

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I am indebted to my colleagues at the University of Cape Town for supporting me and for their help in making my studies abroad possible. Special thanks to Tony Leiman who has been a great mentor and friend. Thanks to my friends in South Africa and elsewhere who have remained close and made effort in spite of all my moving around.

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My heartfelt thanks to my mother and father whose love and unwavering support I have been blessed with during all this time away. Margareet and Melissa for all the times you listened and shared your wisdom when it was much needed. Comina and Martha for your warmth and encouragement.

I would like to express tremendous gratitude to Fred Nicolls, who has been my refuge, who indulged my living in two worlds while living in one, who went with me every step and then much further. You are still one of the most inspiring human beings and academics I know. Thank you for all this. Your love has taught me humility.

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Bridging the Great Divide in South Africa: Inequality and Punishment in the Provision of Public Goods

Martine Visser*†

Martine.Visser@economics.gu.se

Justine Burns‡

jburns@commerce.uct.ac.za

Abstract

We explore the effect of income inequality and peer punishment on voluntary provision of public goods in an experimental context. Our sample draws from nine fishing communities in South Africa where high levels of inequality prevail. We find that aggregate cooperation is higher in both the voluntary contribution mechanism (VCM) and punishment treatments for unequal groups. Low endowment players contribute a significantly greater fraction of their endowment to the public good than high endowment players in the VCM, and in the presence of peer sanctioning this difference in relative contributions is further enhanced. Demands for punishment by low and high endowment players are similar, irrespective of differences in relative costs, and in unequal groups free-riding is punished more, specifically by low endowment players. We observe inequality aversion both in endowments and with respect to the interaction of endowments and contributions: high endowment players receive more punishment, but also receive more punishment for negative deviation from the group mean share.

Keywords: Inequality, cooperation, punishment, public goods experiments JEL classification: C9, D63, H41, Q2

*Corresponding author. Göteborg University, Department of Economics, Telephone: +46 (0)31 773 5251. Fax: +46 (0) 31 773 1043. Address: Vasagatan 1, Box 640, 405 30 Göteborg, Sweden.

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‡University of Cape Town, School of Economics, Telephone: +27 (0)21 650 3757. Address: University of Cape Town,Private Bag, Rondebosch, 7700, South Africa.

1 Introduction

In the absence of formal institutions associated with effective centralized regulation, the role of social institutions at a local level is essential in securing provision of public goods and in resolving social dilemmas related to natural resource extraction. In this context a well-functioning society becomes a public good in itself, insofar as it lowers the transaction costs of doing business, enables the provision of communal infrastructure and support systems and allows for collective initiatives in managing local resources, which is often at the core of sustaining the livelihoods of those involved (Alesina and La Ferrara, 2000; Romer, 1986; Lucas, 1996). Poverty, lack of employment opportunities and competition for scarce resources put additional pressure on individuals to act in the interest of their own households to secure basic needs that are often in conflict with mutual needs of others in the community. Moreover, the majority of developing countries are characterized by large inequalities in income, education, and opportunities to accumulate private wealth. While it has been argued that the poor benefit more from the provision of public goods (La Ferrara, 2000; Alesina and Angeletos, 2005), it is not immediately clear how such inequalities within communities impact their ability to provide such communal goods.

In this paper we present the results of public goods experiments conducted with individuals from nine fishing communities in South Africa. We introduce treatments with inequality in endowments and also the opportunity for peer punishment in order to study the impact of inequality on the ability of groups to sustain and enforce cooperation through social sanctioning.

Recent arguments (e.g. Harrison and List, 2004) favoring experiments with subjects who have exposure to the issues being studied are strengthened by findings such as those of Barr (2001, 2003) and also of Cardenas and Carpenter (2003) that rural participants in developing countries have a clear understanding of the problems related to free-riding, and use social sanctions and criticism to curb it. Moreover, students who are normally recruited for participation in experiments are not that familiar with the provision of public goods and are usually quite homogenous in terms of income. We have therefore selected individuals with extensive experience in social dilemmas and sanctioning since their livelihoods depend directly or indirectly on fishing. South Africa, with a Gini of 57.8, is one of the most unequal countries in the world (UNDP, 2005) and within ethnic groups inequality has increased since the end of Apartheid (Whiteford et al., 2000). Moreover, irregular allocation of fishing quota by the government has resulted in externally imposed income inequality, leaving subsistence and small-scale commercial fishing communities divided (O'Riordan, 1999). Allocation of quota is generally perceived as unfair and arbitrary by the community members: complicated application procedures and exorbitant application fees restrict entry, and there is an overall lack of transparency (Isaacs et al., 2005). Those who receive quota allocations (which vary) are basically endowed with a windfall gain which serves as a supplement to household income from other sources. This renders poaching a common and lucrative activity pursued by both quota holders and those who do not receive a fishing quota. We therefore include both these groups and also members from the community with indirect exposure to fishing activities in the experiments[1]. Our main questions in this study are as follows: Are unequal groups able to use peer punishment to maintain cooperation, and if so, who ends up providing the public good, faced with the threat of punishment? Moreover, are there differences in the demand for punishment or in the motivation for punishment behavior between low and high endowment players in unequal groups?

There exist a number of interesting studies that have focused on the effect of inequality on behavior. Since the ground-breaking work of Fehr and Gächter (2000), a series of insightful studies on the effect of peer sanctioning on cooperation has been done as well. However, empirical research on the role of social institutions in unequal societies has been limited. Our study extends previous literature by specifically focussing on the impact of inequality on the ability of groups to sustain cooperation when peer sanctioning is introduced. To our knowledge, no experiments have specifically dealt with the interaction of inequality and peer punishment.

It has been reported that extremely unequal societies may be limited in their capacity to interact as communities due to a breakdown in cooperation (Alesina and La Ferrara, 2000; Bowles and Gintis, 2000). A number of empirical studies (Gaspart et al. 1998; Baland and Platteau, 1999; La Ferrara 2000) have indicated that the overall effect of inequality on the provision of public goods can be ambiguous, but that incentives to participate are greater for those who are able to appropriate

[1]While common pool resource (CPR) experiments may be more appropriate to model the effect of free-riding on a fisheries stock, we are only interested in the ability of groups faced with wealth inequalities to cooperate in the joint provision of a public good. Moreover, CPR experiments are generally framed with non-linear pay-off functions, which place high demands on the numeracy skills of participants. We therefore choose to use a linear public goods design, given that the underlying characteristics of collective management of natural resources such as fisheries are very similar to those of public goods.

greater net benefits from the public good.

While some experimental studies on inequality and the provision of public goods conducted with students in labs confirm this (Cherry et al., 2005; Anderson et al. 2004), others have found that inequality has a positive effect on aggregate contributions (Buckley and Croson, 2006; Chan et al., 1993, 1997, 1999). Studies of behavior within unequal groups, although scant, report that low endowment players contribute a higher share towards provision of the public good than high endowment players in repeated (Chan et al., 1997, 1999; Buckley and Croson, 2006) and one-shot (Cherry et al., 2005) public goods games.

Internal sanctions aimed at mitigating free-riding behavior are important in developing countries, given demanding administration and costs associated with external monitoring and enforcement. Studies by Tyran and Feld (2004) and Noussair and Tucker (2005) suggest that internal sanctions may be more efficient than externally enforced sanctions. Evidence from the field (see Van Soest and Vyrastekova, 2004)[2], as well as experimental studies on the provision of public goods (Fehr and Gächter, 2000; Bochet et al., 2005; Falk et al., forthcoming; Sefton et al. 2001; Carpenter, 2004a&b), has indicated that individuals use peer sanctioning to express disapproval and successfully coerce free-riders into contributing, even if such actions are costly to undertake. Social institutions (peer sanctioning) may therefore help to maintain cooperation in repeated interactions (Axelrod, 1997). The welfare implications of costly punishment are however not clear and a number of studies have shown that the overall outcome on welfare may actually be negative once the reduction in pay-offs due to punishment costs has been taken into account(Nikiforakis, 2005; Cinyabuguma et al., 2004; Denant-Boemont et al., 2005). It is therefore of particular interest to understand how the interaction of inequality and punishment may affect welfare outcomes in unequal groups.

This study involves a repeated public goods experiment, combining treatments with inequality and peer sanctioning. In Part I of the experiment we compare contributions in a linear public goods experiment for equal and unequal treatments - inequality is randomly introduced via differing endowments. In Part II we introduce a peer punishment treatment for both equal and unequal groups. Each treatment has six periods and involves partner matching where individuals remain in the same groups throughout the rounds.

[2]The authors cite examples of fishermen in the Bahia region in Brazil who destroyed the nets of fellow fishermen who did not adhere to quotas.

We find that unequal groups contribute more in aggregate than equal groups and that within unequal groups, low endowment players contribute a higher share of their endowment to the public good. Once sanctioning is introduced this gap in contribution share is enlarged on both counts. Reasons for this can be gleaned from studying the punishment behavior in these groups. In unequal groups, free-riding elicits more punishment than in equal groups, in particular by low endowment players. Moreover, demand for punishment does not differ significantly between low and high endowment players, even though low endowment players face higher relative costs in allocating and receiving punishment. We show that low endowment players receive greater net gains from cooperation when the return from the public good is fixed. Fear of costly punishment may be an additional factor driving this difference in behavior between low and high endowment players. Lastly, we find significant evidence of inequality aversion, not only based on differences in endowments per se, but also directed at the interaction of contribution share and endowments.

Section 2 describes the experimental design, while the results are discussed in Section 3. Section 4 concludes the paper.

2 Experimental Design

In this section we outline the design, parameters and procedures of the public goods experiments employed here. We also describe the field setting and recruitment process involved.

2.1 Public Goods Experiment - Basic Design

Our experiment uses a repeated linear public goods (PG) design similar to that used by Fehr and Gächter (2000) and Masclet et al. (2003). Subjects within a group each receive an endowment, which can be allocated to either a private account or a public account. Each subject is provided with a very simple pay-off formula where the Nash-equilibrium is to contribute nothing and the Social Optimum is attained when everyone in the group contributes their entire endowment.

In Part 1 of the experiment, two treatments (1A and 1B) are conducted to compare the effect of allocating equal versus unequal endowments to individuals in the voluntary contribution mechanism (VCM). The first treatment (1A) consists of a standard VCM where all four players in a group receive equal endowments. In the second treatment (1B), all groups are divided into two players with high endowments and two players with low endowments. The players remain in the same groups (fixed matching) for six rounds. In Part 2 of the experiment we conduct further treatments (2A and 2B) with the same groups that participated in the equal and unequal treatments before. At this point we introduce the opportunity for players to punish each other after contributions are made.

The treatment conditions are shown in Table 1. Each treatment involves six rounds

Table 1: Treatment Conditions.

Treatments	**Equal Endowments***	**Unequal Endowments****
Part I: VCM without punishment	**IA**	**IB**
Part II: VCM with Punishment	**IIA**	**IIB**

* Four players in a group each receive 40 ECUs

** Two players in a group receive 50 ECUs (high endowments) and two players receive 30 ECUs (low endowments)

where real money is at stake. A detailed discussion of the pay-off structure for each of the treatments follows.

2.2 Part I: Pay-off structure for the VCM treatment

In every round, each of the $n = 4$ subjects receives a fixed endowment of y Experimental Currency units (ECUs) from which they may invest g_i tokens in a public account. The investment decision is made simultaneously by all players. The pay-off function used in the VCM treatment and also the first stage (I) of the punishment treatment is

$$\Pi_{Ii} = (y_i - g_i) + 0.5 \sum_j g_j$$

for each round and $0 \leq g_i \leq y$ and 0.5 is the marginal per capita return (MPCR)[3] from public good contributions, where $0 < 0.5 < 1 < n \times 0.5$, implying that the

[3]Note that the marginal per capita return from the public good is fixed and hence there is an implicit redistribution of benefits from the public good similar to the tax mechanism described in Alesina and Angeletos (2005). Fisher et al. (1995) present results from experiments with varying MPCRs within groups.

dominant strategy for rational and self-interested individuals is to not contribute anything whereas the social optimum for the group is achieved if each individual contributes his or her full endowment to the public account.

In the equal treatment, y is fixed at 40 ECUs for all players. In the unequal treatment, two players each receive $y_L = 30$ ECUs and two players each receive $y_H = 50$ ECUs. The pay-off function for a high endowment player, H_1, is

$$\Pi_{I_{H1}} = (y_H - g_{H1}) + 0.5(g_{H1} + g_{H2} + g_{L1} + g_{L2})$$

and similarly, the pay-off function for a low endowment player, L_1, is

$$\Pi_{I_{L1}} = (y_L - g_{L1}) + 0.5(g_{L1} + g_{L2} + g_{H1} + g_{H2}).$$

2.3 Part II: Pay-off structure for the treatment with punishment

The punishment treatment involves a second stage during which subjects can reduce the first stage payoff (Π_{Ii}) of other players. Subjects are provided with information about the endowments received by other players, along with their respective contributions. The payoff (Π_{Ii}) for player i from both stages of the punishment treatment is

$$\Pi_i = max\left[0, \Pi_{Ii} - \left(5\sum_{j\neq i} p_{ji} + \sum_{j\neq i} p_{ij},\right)\right]$$

where p_{ji} is the punishment points that player i receives from player j, and p_{ij} is the punishment points player i within a group assigns to player j. Each punishment point received by player i therefore reduces her pay-off by 5 ECUs, whereas each punishment point assigned by player i costs her 1 ECU. Aggregate pay-off from this treatment is then just the sum of Π_i over six rounds.

Theoretically, there is no incentive for any self-interested individual to allocate punishment to free-riders, given that punishment has second-order public good characteristics which makes it optimal for the individual to rely on others in the group to undertake costly punishment of free-riders within the group.

Given low numeracy levels within our sample, we prevent individuals from having negative earnings at the end of each punishment round. Nobody can therefore allocate more punishment points than his/her stage I earnings from that round. Similarly, the cost to the person receiving punishment can never exceed his/her stage I earnings. If the cost of receiving punishment reduces an individual's income to below zero, his/her income is automatically set to zero[4].

2.4 Parameters and Procedures

The experiments were manually performed with a sample of 569 participants in field laboratories in nine communities[5]. Some subjects knew one another, but within the experiments the identities of the other players in each group were never revealed[6]. The group size across all treatments was four. Of the 143 groups involved, 70 participated in the equal treatment and 73 in the unequal treatment. All groups participated in both the VCM treatment and the punishment treatment.

The marginal per capita return (MPCR) in each round was 0.5 for both the equal and unequal treatments[7]. In both scenarios the return from the group account under full cooperation was therefore equal to 80 tokens.

[4]While this design feature is common in punishment experiments (see Fehr and Gächter, 2000 and Gächter and Herrmann, 2006), a subject whose cost due to allocating punishment exceeds his/her stage I earnings after the cost of receiving punishment has been deducted, can obtain negative earnings which he or she has to fund from her show-up fee. The fact that we did not allow for negative earnings did not seem to have a significant effect on punishment behavior, as there are only five observations where an individual was prepared to incur a cost of allocating punishment equal to his or her stage I earnings for that round. On average, 10% of participants would have had negative earnings at the end of any one round (once the cost of punishment received and the cost of punishment allocated had been deducted), had we not applied the zero minimum. On average, participants awarded 3 punishment points in a round, which translates into 6% of their earnings from the first stage of the game. The average punishment points received (after multiplying by five) in a round was 18, which is 31% of first stage earnings. However, this behavior was different for the group of individuals who would have experienced negative earnings had there been no zero minimum. On average, these individuals awarded 12 punishment points per round, or approximately 22% of their first stage earnings. Moreover, they received 83 punishment points (after multiplying by 5) per round, or approximately 1.5 times their first stage earnings. Given that punishment allocation happened simultaneously it is unlikely that free-riders punished harder in anticipation of losing their entire earnings.

[5]Given expected heterogeneity over these nine communities, we chose to use a large sample. Few experimental studies of this size have been executed, and our findings may therefore provide further external validity to public goods experiments with much smaller sample sizes performed with students in labs.

[6]We control for the "number of persons who you know in your group" in the regression analysis section of the paper, but this is not significant.

[7]Although a number of studies have used a MPCR of 0.4 and group sizes of 4 following the work of Fehr and Gächter (2000), varying designs with group size ranging from 3–10 members and MPCRs ranging from 0.2–0.75 (Bowles et al., 2001; Cinyabuguma et al., 2005; Sefton et al., 2001; Carpenter, forthcoming, and Anderson and Putterman, 2005) have also been used.

In the equal treatments each subject received an endowment of 40 tokens. In the unequal treatments two players randomly received endowments of 50 tokens and two players randomly received endowments of 30 tokens. The rules of the game were explained in detail to each group before starting each treatment[8]. All the parameters in the pay-off functions used in both VCM and punishment treatments were known by the participants in advance. Individuals were informed at the start that there would be six rounds during which they would play for actual money. The last round was announced specifically. Subjects were also informed that they would participate in two exercises at the start of the session.

Each player received personal decision-making sheets on which to enter information before coming forward and entering the amounts allocated to private and public accounts on a large template behind the voting booth. The templates were designed so that players could only view their own entries, by using velcro to seal cardboard flaps over each person's corresponding line on the template. To further increase anonymity, players were seated with divisions between them. After the contribution decisions were made, the enumerators calculated the group's total contribution and announced the return from the group account. The players were able to record this information.

In the second stage of the punishment treatment, individuals could view the endowments received by all players as well as their corresponding contribution on a punishment template. Players then had the choice to allocate "fine" points to other players by making entries on the punishment template. Punishment decisions were again anonymous due to the design features described above.

Each punishment or "fine" point received reduced a player's stage I earnings by 5 tokens[9]. Allocating "fine" points was costly, with 1 token being deducted for each point awarded to another player. Individuals within the group did not have access to information about the punishment decisions of other players in the group: each

[8]Instructions are available from the authors on request.

[9]Fehr and Gächter (2000) and others following their design use a punishment scale where each point allocated reduces a player's pay-off by 10%. Carpenter (2004b) suggests a simpler punishment design which allows for a constant price of punishment. We use such a design (given low literacy and numeracy rates among our subjects), but receiving punishment is costly and probably at the upper limit of a number of studies that have varied the cost of punishment across treatments (Nikiforakis and Normann, 2005; Carpenter, 2004a&b; Anderson and Putterman, 2005). Denant-Boemont et al. (2005) use a punishment structure similar to Fehr and Gächter, resulting in reductions in earnings in the range 4.6–16.24% range. The reduction in income observed in our study ranges from 39% in equal groups to 24% and 22% for high and low endowment players in unequal groups (on average).

was just given the aggregate number of punishment points allocated to them in each round[10].

2.5 Field setting and recruitment

Our study focuses on nine rural fishing communities along the west coast of South Africa. Participants were recruited in a number of ways to minimize the potential for sample selection problems. Both males and females were targeted as quota have also been allocated to women in the last 5 years. They were contacted through key persons in the community, representatives of fishers' groups, posters, and local newspapers. In one larger community we informed parents at a school function[11]. Attrition rates between the survey and the experiments were relatively low.

A survey was executed during June 2004, one and a half months before the experiment. In total, 569 individuals participated in both the survey and experiments, of whom just over 60% were male. Participants were on average 41 years old and had lived in their communities for most of their lives. Most reported Afrikaans as their home language, so the survey and the experiments were executed in Afrikaans. Educational attainments were low, with 14% of the sample having completed their primary schooling, and 8% having completed high school. Unemployment among participants was high, with only 48% reporting that they were currently employed at the time of the survey[12].

The experimental sessions lasted for 2–3 hours. In some communities two or three sessions were scheduled per day[13]. Each experimental token earned the participant

[10]We did not test for order effects of the punishment treatment given previous findings by Fehr and Gächter (2000) indicating that the order of treatments does not affect the results in any significant way.

[11]We specified up front that only one person per household was allowed to participate, that participants had to be literate, and that they would receive a show-up fee. There was no way to completely isolate the study from self-selection (see List and Levitt, 2006). However, we tried to schedule the survey on more than one day and at different times of the day, and took into account that active fishers often work in the morning. While generally cooperative persons may have volunteered, the fact that we indicated that each participant should be paid would have been enough incentive to attract self-interested individuals as well (Holm and Danielsson, 2005). Further comparisons of our study with of census data from these communities show that our sample is representative in most respects, other than the fact that we intentionally over-sampled those involved in fishing.

[12]This level of employment is reflective of prevailing unemployment in these communities.

[13]We control for spill-over effects by randomly allocating sessions as equal or unequal for the public goods experiments. We also test for spill-over effects in the regression analysis that follows.

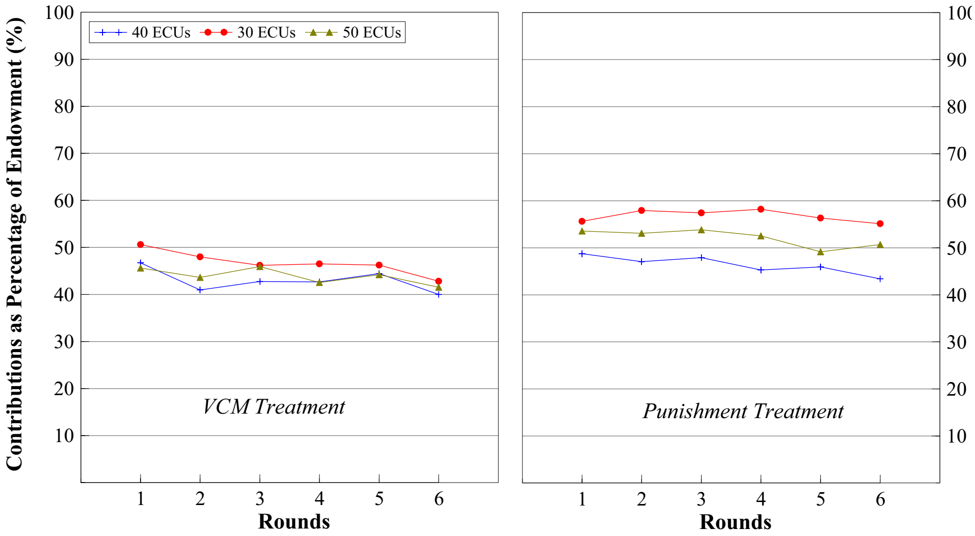

Figure 1: Average fraction of endowment contributed in the VCM and punishment treatments, for players in equal groups (40 ECUs) and for low endowment (30 ECUs) and high endowment (50 ECUs) players in unequal groups.

10 cents (US 2 cents) and on average participants earned about R110 (US22) for the entire experiment. In most cases this translated to about two days' wages.

3 Results of the Experiments

In this section we compare contributions as a fraction of endowment first for equal and unequal groups and then also for low and high endowment players in unequal groups. Thereafter follows our analysis of punishment behavior for equal and unequal treatments.

3.1 Impact of Punishment on Contributions to the Public Good in Equal and Unequal Treatments

Figure 1 illustrates average contributions as a fraction of endowments (or tokens received) in the VCM and punishment treatments, both for players in equal groups (40 ECUs) and for high (50 ECUs) and low (30 ECUs) endowment players in unequal groups.

RESULT 1*: Punishment is successful in maintaining cooperation in equal and unequal groups, but less successful compared to previous laboratory experiments with students.*

Wilcoxon's matched-pairs signed rank test indicates that the increase in average contributions between the VCM and punishment treatments is significant for the equal ($z = -4.231; p < 0.0001$) and unequal ($z = -11.746; p < 0.0001$) treatments (see Figure 1). The average increase in contributions between the VCM and punishment treatment is 2.7% for equal groups and 8% for unequal groups.

Average contributions in our punishment treatment are in the range 46–57% range. For other public goods experiments with peer sanctioning contribution levels vary between 40 and 90%, depending on the cost of punishment (Fehr and Gächter, 2000; Masclet et al., 2003; Anderson and Putterman, 2005). While average contributions in our study are lower than those reported for other artifactual field experiments, the increase in contributions between the VCM and punishment treatment is in line with that described by Carpenter et al. (2004a) for experiments in urban slums in Thailand and Vietnam. They show that social sanctioning increases average contributions in Vietnam by 5% and in Thailand by 11%. One possible reason why a lower increase in contributions in the presence of punishment is observed in artifactual field experiments compared to experiments with students, may be that (unsuccessful) past experience with social sanctions affects the actions of individuals familiar with social dilemmas. Survey results obtained one month prior to these experiments indicated that 46.4% of the individuals in our sample did not believe that arresting violators of fishing regulations caused them to change their behavior.

RESULT 2*: Aggregate contributions in unequal groups is higher on average than in equal groups. This contribution pattern becomes exaggerated once punishment is introduced.*

Average contributions for players in the equal VCM treatment vary between 46.7 and 40% of their token endowment between rounds 1 and 6. For the unequal treatment, contributions are somewhat higher, ranging between 47.45 and41.98% over the six rounds[14]. In the punishment treatment the gap in contributions between equal and

[14]This is in line with studies that have been performed with students (see Fehr and Schmidt, 1999, and Cardenas and Carpenter, 2003), but we do not see the characteristic rapid decline towards full free-riding that is observed in experiments with students (Davis and Holt, 1993). There have been similar findings in other studies with non-students (Cardenas and Carpenter, 2003)

unequal groups is even greater: for equal groups the average contribution starts at 48.76% and declines to 43.4% in the last round, while for unequal groups average contributions range between 55.63% and 55.13%. For both treatments the two-sample Wilcoxon ranksum test confirms that the average fraction of contributions is significantly higher for unequal than for equal groups (VCM: $z = -2.98; p < 0.0029$; Punishment: $z = -8.84; p < 0.0001$).

The estimation results shown in Table 2 for equal and unequal groups (regressions 1 and 3) verify these findings for the punishment treatment[15].

We model the fraction of an individual's endowment contributed to the public account using ordinary least squares (OLS) and multilevel hierarchical modelling (MLHM) techniques[16].

> ***RESULT 3***: *In the punishment treatment, low endowment players in unequal groups contribute a higher share of their endowments than high endowment players on average.*

In both the VCM and punishment treatments, low endowment players contribute a higher share of their endowment towards provision of the public good. In the punishment treatment this difference between contributions of low and high endowment players is enhanced (see Figure 1). These results are significant according to the two sample Wilcoxon ranksum test for both treatments (VCM: $z = 1.86$; $p < 0.07$, Punishment: $z = 3.052$; $p < 0.0023$). While average contributions for high endowment players are 52.2% of their endowment in the punishment treatment, the average contribution for low endowment players is 56.8%. From the regression results reported in Table 2 it is evident that the average fraction contributed by the high endowment players in the punishment treatment is 6–7% less than that of the low endowment players, once we control for other factors. This estimate is significant for both OLS and MLHM model specifications (regressions 2 and 4).

[15]Estimation results for the VCM treatment (not reported here) similarly show a significant difference in the average contributions of low and high endowment players.

[16]Multilevel modelling is more appropriate in this context given that it takes into account individual and group level random effects, and also controls for individual nesting within groups (Rabe-Hesketh and Skrondal, 2005). The likelihood ratio tests comparing the linear and MLHM models indicate that the latter is a superior fit in all cases presented here, and we therefore put more confidence in the results obtained using this estimation procedure. All models are specified to include experimental variables and also variables containing socio-economic and self-reported attitudinal information to account for individual level observed heterogeneity.

Table 2: Fraction of endowment contributed.

	Punishment treatment (OLS)		Punishment treatment (MLHM)	
	(1)	(2)	(3)	(4)
Dep. var.: Fraction of endowment contributed	Equal & Unequal	Unequal only	Equal & Unequal	Unequal only
Round	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***
	(.002)	(.002)	(.001)	(.002)
Unequal treatment (dummy)	0.19 **		0.09 ***	
	(.084)		(.025)	
Player is HIGH		-0.07 ***		-0.06 *
		(.011)		(.032)
Constant	0.50 ***	0.80 ***	0.58 ***	1.00 ***
	(.093)	(.057)	(.082)	(.159)
n	4986	2484	4986	2484
R-squared	0.40	0.45		
Adjusted R-squared	0.38	0.43		
Wald chi2			78	47
Log likelihood			2782 ***	777 ***
LR test vs. linear regression:			7175 ***	1671 ***
Controlling for:				
Community Fixed effects	**Yes**	**Yes**	**Yes**	**Yes**
Group Fixed effexts	**Yes**	**Yes**	**Yes**	**Yes**
Group and Individual Random effects (Nested)	**No**	**No**	**Yes**	**Yes**

Additional controls for age, gender, race, years of education, employment status, self-reported trust in others and participation in voluntary organizations are included in all regressions but not reported here
Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

La Ferrara (2000) argues that the economic gains from participation in the provision of public goods are asymmetric in unequal communities, with higher-income households having less to gain from joining social groups than poorer low-income households. Gaspart et al. (1998) and Baland and Platteau (1999) similarly find that those who appropriate greater net benefits from a public good are more inclined to participate in its provision. A possible explanation for why low endowment players in our study are observed to make higher relative contributions may also be that the potential net gains from cooperation are higher for them. The fixed marginal per capita return (MPCR) from the public good clearly favors 30 token players over 50 token players[17]. Conceding that there may be incentives for strategic behavior in repeated interaction (Axelrod, 1997; Fehr and Gächter, 2000), lower endowment players may have a greater willingness to signal their intent to commit to cooperative behavior. For instance, our results for the punishment treatment (Visser, 2006) indicate that net gains realized by low endowment players relative to their initial endowment are significantly higher (10 times) on average than for high endowment players.

[17]For instance, if no one allocates punishment, full contribution by both low and high endowment players results in returns of 50 (=80-30) ECUs and 30 (=80-50) ECUs respectively. Similarly, if low and high endowment players contribute equal shares of their endowments, low endowment players also receive disproportionate net benefits from the public good.

Moreover, in the punishment treatment the relative expense (as a fraction of endowment) suffered by a low endowment player from being punished is roughly 1.5 times of what a high endowment player incurs on average (Relative cost: Low endowment, 13.3/30=0.433; High endowment, 14.6/50=0.292). Fear of punishment may therefore be another factor in explaining the higher relative contributions of low endowment players in the punishment treatment. Both Egas and Riedl (2005) and Nikiforakis and Normann (2005), in testing the effect of altering cost of punishment, indicate that the higher the cost of receiving punishment, the more efficient groups are at maintaining cooperation.

3.2 Punishment Behavior in Equal and Unequal Groups

In this section we investigate the demand for punishment and determinants for punishment in equal and unequal groups. The average number of punishment points allocated by one player to another in equal groups is 1.51, whereas in unequal groups it is 0.91. Assuming that punishment is allocated in response to free-riding, this is consistent with earlier findings that average contributions in the equal treatment (46%) are lower than in the unequal treatment (55%). The two sample Wilcoxon ranksum test indicates that this difference in punishment allocation is significant ($z = 8.328; p < 0.0001$).

In Table 3 we show the regression results from OLS and MLHM estimation for our pooled sample (where we compare behavior of equal and unequal treatments) and for unequal groups (where we compare the behavior of low and high endowment players). Here we estimate punishment awarded to another player, controlling for treatments, characteristics of the punisher and of the player being punished, as well as the mean contribution fraction by the rest of the group. We also include a number of socio-economic variables that are not reported here. Our results for the pooled OLS model (regression 1) confirm that players in unequal groups assign significantly fewer punishment points to other players, but once we account for individual nesting within groups (regression 3) the result is not significant.

> ***RESULT 4***: *Demand for punishment by low endowment and high endowment players is not significantly different, even though the low endowment players face higher relative costs in allocating punishment.*

Notwithstanding the relative cost (which includes the direct cost of assigning pun-

Table 3: Punishment awarded — all groups.

	OLS Equal&Unequal	OLS Unequal	MLHM Equal&Unequal	MLHM Unequal Only
Dependant Variable : Punishment awarded to other player	(1)	(2)	(3)	(4)
Round	-0,05 **	-0,06 **	-0,06 ***	-0,06 ***
	(,217)	(,027)	(,019)	(,024)
Unequal Treatment	-(2,89) **		-(,035)	
	(1,279)		(,46)	
OTHER PLAYER'S CHARACTERISTICS:				
Other player is HIGH (dummy)		0,22		0,25 *
		(,161)		(,147)
Pos. deviation of other player from group mean share (excl. other player)	-0,63 *	0,90	-0,51 *	1,48
	(,345)	(,627)	(,309)	(,578)
Pos. deviation of other player from group mean share (excl. other player) * Unequal Treatment	0,50		0,411	
	(,533)		(,477)	
Pos. deviation of other player from group mean share (excl. other player) * Punisher is HIGH		-1,70 ***		-1,97 ***
		(,73)		(,665)
Pos. deviation of other player from group mean share (excl. other player) * Other player is HIGH		-0,96		-1,60
		(,703)		(,655)
Abs. neg. deviation of other player from group mean share (excl. other player)	0,97 ***	2,56 ***	1,10 ***	2,88 ***
	(,367)	(,714)	(,329)	(,659)
Abs. neg. deviation of other player from group mean share (excl. other player)* Unequal Treatmen	1,33 **		1,26 **	
	(,56)		(,502)	
Abs. neg. deviation of other player from group mean share (excl. other player) * Punisher is HIGH		-0,87		-1,30 **
		(,76)		(,705)
Abs. neg. deviation of other player from group mean share (excl. other player)* Other player is HIGH		0,10		0,16 ***
		(,752)		(,691)
REST OF GROUP'S CHARACTERISTICS				
Rest-of-group share contributed (excl. punisher)	0,89	0,06	0,18	-0,67 *
	(,635)	(,649)	(,518)	(,655)
Rest-of-group share contributed (excl. punisher) * Unequal Treatment	-1,31		-0,93	
	(,915)		(,741)	
Rest-of-group share contributed (excl. punisher) * Punisher is HIGH		-0,97 *		0,12
		(,599)		(,876)
PUNISHER'S CHARACTERISTICS:				
Punisher is HIGH (dummy)		0,85 **		0,42
		(,387)		(,57)
Pos. deviation of punisher from group mean share (excl. punisher)	0,49	0,77	-0,25	0,29
	(,389)	(,504)	(,374)	(,521)
Pos. deviation of punisher from group mean share (excl. punisher) * Unequal Treatment	-0,36		0,49	
	(,607)		(,597)	
Pos. deviation of punisher from group mean share (excl. punisher) * Punisher is HIGH		-1,29		-0,31
		(,814)		(,814)
Abs. neg. deviation of punisher from group mean share (excl. punisher)	0,58	0,36	0,62	0,53
	(,422)	(,54)	(,427)	(,564)
Abs. neg. deviation of punisher from group mean share (excl. punisher)* Unequal Treatment	-0,14		-0,04	
	(,622)		(,622)	
Abs. neg. deviation of punisher from group mean share (excl. punisher)* Punisher is HIGH		1,25 *		0,33
		(,736)		(,772)
Constant	-5,44 ***	-3,61 ***	0,86	1,82
	(1,04)	(1,05)	(1,09)	(1,38)
Observations	4655	2214	4655	2214
R-squared	0,33	0,42		
Adjusted R-squared	0,31	0,40		
Wald chi2			155	185
Log likelihood			-10659 ***	-4722 ***
LR test vs. linear regression:			1572 ***	654 ***
Community Fixed effects	**Yes**	**Yes**	**Yes**	**Yes**
Group Fixed effexts	**Yes**	**Yes**	**Yes**	**Yes**
Group and Individual Random effects (Nested)	**No**	**No**	**Yes**	**Yes**

Additional controls for age, gender, race, years of education, employment status, self-reported trust in others and participation in voluntary organizations are included in all regressions but not reported here.
Standard errors in parenthesis. *** = 1% significance; ** = 5% significance; * = 10% significance.

ishment points and the possible additional cost of retaliation), the amount of punishment assigned by the high and low endowment players is very similar. The average number of punishment points allocated per individual to another player for the high endowment players is 0.9 points and for the low endowment players 0.93 points. This difference in demand for punishment is not significant according to the two sample Wilcoxon ranksum test ($z = 0.99; p < 0.322$). Although the estimation results in Table 3 reported for the OLS regressions indicate that high endowment players assign significantly more punishment, this effect is not significant for the MLHM model where we control for individual and group level nesting. As before, the likelihood ratio-test confirms that the results obtained from the MLHM model are more reliable.

Our results contrast with those of Anderson and Putterman (2005) and Nikiforakis and Normann (2005), who find that demand for punishment diminishes with the cost. Carpenter (2006 forthcoming) in turn specifically tests income elasticity of demand for punishment within subjects with respect to stage I pay-offs in each round. He finds that demand for punishment is rather income inelastic. Our findings similarly negate strong evidence of an income effect. As mentioned previously, the VCM with fixed MPCR favors low endowment players in terms of relative net gains from cooperation by the group. Low endowment players may therefore have additional incentives to use punishment to discipline free-riders, which exceeds the relative cost of assigning punishment.

> ***RESULT 5***: *Free-riding elicits more punishment from unequal groups, with low endowment players punishing both positive and negative deviation from the group mean share more vehemently than high endowment players.*

Figure 2 shows average punishment allocated to another player based on that player's positive or negative deviation in contribution from the average group share (excluding that player)[18]. The bar labels indicate the percentage of total deviations represented by the specific category, and error bars give 95% confidence intervals for the reported figures. In both equal and unequal groups, higher levels of punishment are clearly associated with larger negative deviation from the rest of the group share.

[18] In this histogram we exclude punishment allocated by individuals who punish more than 20 points in total per round (which accounts for only 3% of observations and slightly biases the observed effects), given that there is no control for individual fixed effects.

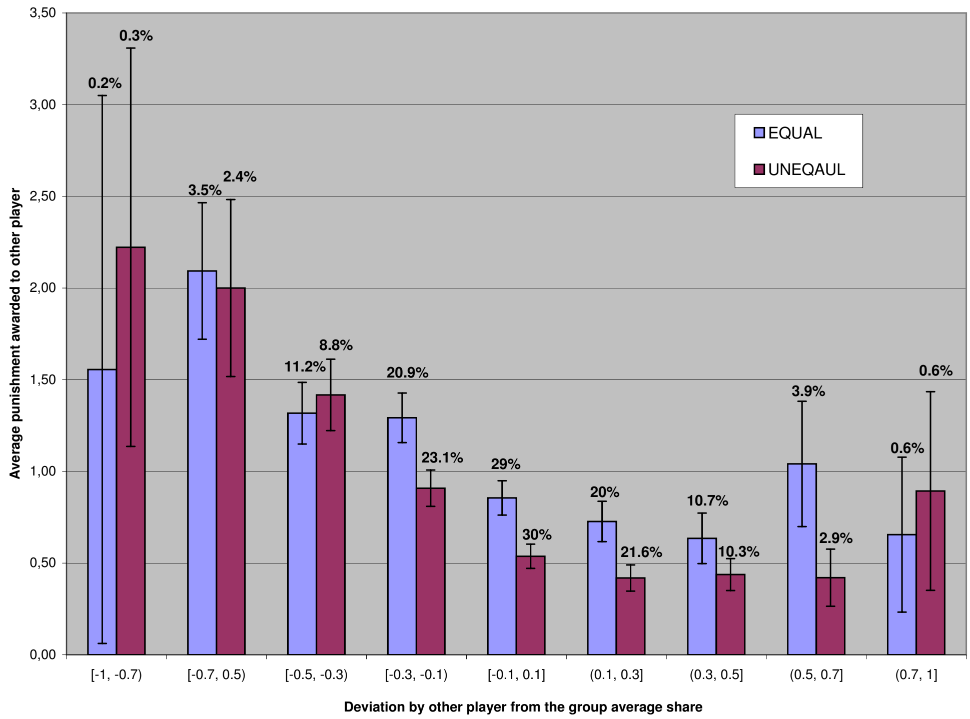

Figure 2: Histogram of punishment allocated: equal versus unequal groups.

In unequal groups, negative deviation in the contribution share of the other player from that of the rest of the group elicits significantly more punishment than in equal groups. Low endowment players in contrast punish both those who deviate positively and negatively from the group mean share significantly more than high endowment players do (see Table 3, regressions 2 & 4)[19]. These results are robust for all model specifications and are also visible in the top diagram of Figure 3, which illustrates punishment allocation for deviation from the group mean share by low and high endowment players. Our results suggest that unequal groups are less lenient when it comes to enforcement, perhaps due to differences in incentives and interests of group members. Specifically, low endowment players are more responsive to a contribution norm, and use punishment as a genuine attempt to coax other players into contributing their fair share (in this case proportional to their endowment).

> ***RESULT 6***: *Inequality aversion is evident from punishment behavior aimed purely at differences in endowments, but punishment is also elicited based on the interaction of endowments and contributions.*

Fehr and Schmidt (1999) predict that inequality averse players will use punishment

[19]In estimation results not reported here, we find that low endowment players punish their own type significantly more for contributing above the group mean share.

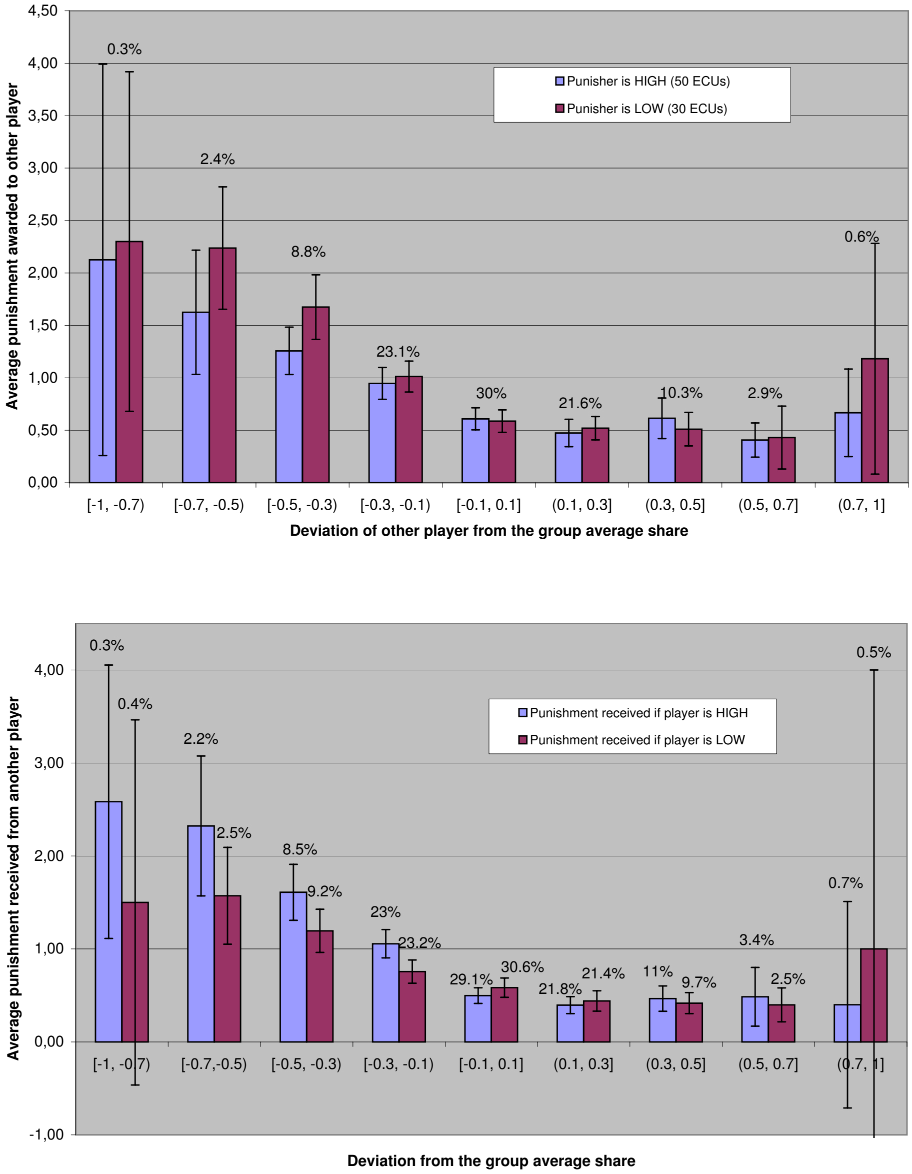

Figure 3: Histograms of punishment allocated and received in unequal groups.

to equalize differences in pay-offs in a public goods experiment[20]. Punishment is allocated in the second stage after contributions to the public good have been made. The first stage earnings in the punishment treatment are a combination of the endowment individuals received, the level of free-riding incurred by the individual, and the contributions made by the rest of the group. Inequality aversion in punishment behavior may hence be revealed as a response to ex-ante differences in endowment among players, a response to ex-post differences in relative contributions among players, or a response to ex-post differences in pay-offs among players. For the experimental design we use here, even if players follow a proportional contribution norm, high endowment players still receive a higher pay-off than low endowment players. Divergence from the proportional contribution norm by high endowment players may therefore attract more punishment than divergence by low endowment players.

Our findings indicate that, on average, a high endowment player in an unequal group receives more punishment in total than a low endowment player (0.96 versus 0.86 punishment points). The two-sample Wilcoxon ranksum test ($z = -2.527; p < 0.0115$) indicates that there is a significant difference in the punishment received by low and high endowment players. In Table 3 the coefficient obtained for the endowment dummy ("Other player is HIGH") is positive for both OLS and MHLM model specifications (regressions 2 and 4) and in the latter case the estimate is also significant.

We also observe evidence of inequality aversion with respect to player payoffs (or alternatively the interaction of endowments and contributions). While all players are punished for free-riding, high endowment players receive more punishment for being below the rest of the group's average contribution share (see lower diagram in Figure 3), and this difference is highly significant for our MLHM specification (see regression 4 in Table 3). In contrast, low endowment players are reprimanded for contributing more than the group's average share, but these estimates are not significant.

Overall we see that punishment is generally associated with a violation of a contri-

[20]Even in a treatment with equal endowments, punishment behavior in response to inequality aversion may not correspond with the exact difference in pay-offs among players. Depending on the number of group members, punishers may expect others in the group to punish free-riders as well. At the other extreme, Anderson and Putterman (2005) find that individual punishment behavior sometimes violates Fehr and Schmidt's prediction insofar as individuals will punish somebody even if the cost of doing so is greater than the loss incurred by the person receiving the punishment. A similar result was obtained by Falk et al. (2001).

bution norm, which in this case corresponds to each player contributing a proportional share of his or her endowment (Sugden, 1984; Visser and Burns, 2005). Both histograms in Figure 3 (indicating punishment allocated and punishment received within unequal groups) clearly show a pattern of punishment within unequal groups similar to that described in studies by Cinyabuguma et al. (2004) and Gächter and Herrmann (2006). There punishment is most frequently received for free-riding (being below the group average share), but perverse punishment of those above the group mean share occurs as well. However, the regression results in Table 3 however show that once we control for other variables, such as the contribution share of the punisher, those who contribute a greater share than the group average actually receive significantly less punishment in our pooled sample (regression 1 & 2). In unequal groups (regressions 2 & 4) this effect is positive but not significant.

3.2.1 Welfare implications of inequality and peer punishment

In this section we briefly summarize the welfare outcomes for unequal groups when peer punishment is involved. The welfare effects of punishment in unequal groups are important in understanding the motivation for punishment. Given higher average contributions in unequal groups for the VCM treatment as well as the punishment treatment, aggregate welfare in terms of final earnings within these groups is higher than for equal groups. Punishment raises contributions, and therefore first stage earnings from the treatment with punishment are higher relative to those in the VCM for all players. However, once the costs of punishment have been deducted, overall earnings are reduced dramatically (see Table 4).

Table 4: Average overall earnings after the VCM and punishment treatments.

	AVERAGE OVERALL EARNINGS (ECUs)			*AVERAGE OVERALL NET GAIN ON ENDOWMENT (ECUs)*		
	VCM	StageI Punishment (before Punishment)	Final Punishment (after Punishment)	VCM	StageI Punishment (before Punishment)	Final Punishment (after Punishment)
EQUAL	340	345	222	101	109	-14
UNEQUAL	348	370	281	109	130	42
T50	384	402	307	85	102	7
T30	313	337	256	133	157	76

While high endowment players do better in terms of absolute earnings in both the VCM and punishment treatments, the overall earnings difference in the VCM treatment between low and high endowment players is 27% lower after the punishment treatment than after the VCM treatment. This represents a redistribution of wealth from high to low endowment players. Moreover, in the VCM treatment, overall net gains for low endowment players are 1.57 times greater than for high endowment players. Once punishment is introduced, overall net gains for low endowment players are on average 10 times higher than for high endowment players. These findings are discussed in more detail in Visser (2006).

4 Conclusion

The effect of inequality on the ability of communities to jointly provide public goods or manage local resources may have important consequences for welfare outcomes of those involved, and also for the management of common resources. We use repeated public goods experiments with equal and unequal treatments, as well as punishment treatments, to study the interaction of inequality, cooperative behavior, and punishment in a controlled environment. In South Africa, one of the most unequal countries in the world, the allocation of fishing quota has introduced additional inequalities within communities, resulting in ongoing strife. Our sample draws from a large sample of 569 people from nine of the affected communities, with daily exposure to social dilemmas, inequality, and conflict over natural resource management.

We find that punishment leads to higher contributions that may be sustained over sequential play in both equal and unequal groups. This is in line with the findings of Fehr and Gächter (2000) and Masclet et al. (2003), although the increase in contributions in the presence of punishment is not as dramatic as that seen in laboratory experiments with students. This is the first study to our knowledge that combines inequality (in endowments) and punishment in the voluntary contribution mechanism. Of specific relevance to our research question is that peer punishment as a sanctioning mechanism is used more successfully in unequal than equal groups to increase cooperation.

Our results from the VCM treatment support the findings of a small number of previous experiments conducted in the laboratory which report higher aggregate contributions in unequal settings (Chan et al., 1997, 1999; Buckley and Croson, 2006) and over-contribution by lower endowment participants relative to those with higher endowments (Buckley and Croson, 2006; Cherry et al., 2005). With the introduction of punishment the difference in contributions between equal and unequal groups and also between low and high endowment players becomes significantly amplified. This may be attributed to differences in the relative cost of receiving punishment, but also differences in the net gains from group cooperativeness for high and low endowment players.

Interestingly, low endowment players use punishment as frequently as high endowment players. They are also more strategic in their punishment behavior, encouraging cooperation, but also ensuring that all group members contribute their fair share (in proportion to their endowment). While they punish free-riding more than high endowment players, they punish their own type more for over-contribution relative to the rest of the group.

Our results show evidence of inequality aversion in endowments and also in pay-offs (the interaction of endowments and contributions): high endowment players receive more punishment than low endowment players, but high endowment players are also punished significantly more for contributing less than the group average share.

These findings suggest that even though individuals may be inequality averse, the relative benefits derived from the public good by the poor are greater than for the rich in unequal groups (in line with La Ferrara, 2000). Incentives to attain social optimum contributions may therefore overshadow preferences for equality in such interactions. However, when sanctioning is available, individuals use punishment discriminately to favor the poor. Over repeated interaction, total inequality in pay-offs is reduced in the punishment treatment. Our results suggests that unequal groups are more efficient in coordinating their behavior, and that the ability to use peer sanctioning to secure the provision of a public good may be to the advantage of the poor in communities where wealth heterogeneities are prevalent.

While our results provide new insight into the provision of public goods in unequal settings in general, the extent to which these results are generalizable to the problems faced by the fishing communities we worked with is less certain (List and Levitt, 2005). There are many factors associated with inequality, such as lack of participation by disadvantaged minorities, trust, social status, and perceptions about group identity in the real world (Alesina and La Ferrara, 2002) that we can not control for in an experimental setting. They are therefore beyond the scope of this paper. Further empirical research and field experiments will be important in addressing these issues.

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Games and Economic Behaviour in South African Fishing Communities

Justine Burns and Martine Visser

Abstract

Heterogeneity, be it in terms of wealth, race or gender differences, affects the ability of communities and groups to resolve collective action problems. However, the theoretical, empirical and experimental literature in this field remains mixed and often, contradictory. In this paper, we report the results of linear public goods games conducted with a large sample of individuals from fishing communities in South Africa, that explicitly examine the impact of heterogeneity in actual per capita household incomes and expenditures of participants on contributions to the public good. We find that contributions to the public good are increasing in income levels, and that income heterogeneity is associated with greater contributions towards the public good, especially by those at the lower end of the income distribution. These results, based on the real world attributes of participants, match the results we find when we introduce heterogeneity explicitly as a treatment variable in an experimental setting. To our knowledge, this is the first case in which real world heterogeneity has been shown to affect contributions to the public good in the same direction as experimentally induced heterogeneity. In addition, we examine the impact of racial and gender diversity in groups on contributions to the public good, and find that such diversity tends to lower contributions to the public pool. This trend is exacerbated if one allows participants to punish free riders in their groups.

Keywords: public goods, experimental economics, heterogeneity, inequality, punishment JEL classification: C9, D63, H41, Q2

1 Introduction

Exploring the ways in which heterogeneity, be it in terms of wealth, race or gender differences, affects the ability of communities and groups to resolve social dilemmas is not a new topic, and a growing body of experimental work and audit studies suggests that individual attributes such as race (Glaeser et al. 2000; Fershtman and Gneezy, 2001; Ayres and Siegelman, 1995, Bertrand and Mullainathan, 2003), gender (Eckel and Grossman, 1998), linguistic differences (Fershtman et al., 2002), or even religious differences (Fershtman et al., 2002) affect interactions in strategic settings such as the trust and ultimatum game. However, there is no strong evidence in this body of work that individuals *always* favour insiders, that is, others who possess the same characteristics as themselves. Similarly, evidence on the impact of heterogeneity in wealth or income status on strategic interactions (typically within a public goods framework) is also mixed. In this paper, we add to this body of work by reporting the results from linear public goods games conducted with a large sample of individuals from fishing communities along the west coast of South Africa, that explicitly examine the impact of heterogeneity in *actual* per capita household incomes and expenditures of participants on contributions to the public good. We find that contributions to the public good are increasing in income levels, and that income heterogeneity is associated with greater contributions towards the public good, especially by those at the lower end of the income distribution. Our results, based on the real world attributes of participants, are consistent with the results we find when we introduce heterogeneity explicitly as a treatment variable in an experimental setting. To our knowledge, this is the first case in which real world heterogeneity has been shown to affect contributions to the public good in the same direction as experimentally induced heterogeneity.

2 Heterogeneity and the Provision of Public Goods

While it is uncontroversial to say that heterogeneity, be it measured in terms of wealth, race or gender differences, is likely to affect the provision of public goods, disagreement arises over the direction of such an effect. One school of thought argues that heterogeneity results in the under-provision of public goods, since heterogeneity undermines group cohesion, thereby raising the transaction costs of bargaining. Individuals may be more prone to cooperate when others in their group or community are similar to them, since this fosters a strong group identity (Kramer and Brewer, 1984; Kollock, 1994). Groups characterised by greater heterogeneity, be it extreme wealth inequalities or ethnic diversity, may be less successful in resolving collective action dilemmas, not only because polarised societies may be more prone to competitive rent-seeking by different groups within that society, but also because such diversity may promote polarisation in preferences, thereby making it difficult to reach a consensus of the type and quality of public goods and services to be provided (Baland and Platteau, 1997a&b; Dayton-Johnson and Bardhan, 1996; Persson and Tabellini, 1994; Alesina and Tabellini, 1989; and Alesina and Drazen, 1991). La Ferrara (2000) provides data from Tanzania that demonstrates an inverse relationship between the extent of income inequality in a community and civic participation in groups which provide economic benefits or informal insurance to their members. In part, this may be because public goods yield lower satisfaction to individuals in groups characterised by high income inequality or ethnic diversity because of different preferences regarding the scope and magnitude of provision, resulting in a suboptimal provision of the public good, thereby lowering growth (Alesina and Spolaore, 1997). There is also increasing evidence that the channel through which heterogeneity and wealth inequalities affect co-operation in the provision of public goods is through its impact on social capital, trust in particular. To the extent that similarities in wealth, ethnic or racial attributes are used as "information shortcuts" concerning the reliability, shared values and expectations of participants in an exchange, homogeneity may reduce transaction costs, thereby raising social capital or trust, and increasing the likelihood of cooperative behaviour in resolving social dilemmas (Knack and Keefer, 1997; Alesina and LaFerrara, 2000; Bardhan 1993; Dayton-Johnson, 1997; Varughese and Ostrom, 2001; Messick and Brewer, 1983; and Coleman, 1990).

An alternative school of thought, however, posits that heterogeneity will result in higher provision of the public good since heterogeneity is associated with a less well-endowed median voter, who "votes" in favour of public good provision. Moreover, if the benefits of public goods are purely localised, and enjoyed by specific groups alone, whether they are ethnic groups or groups defined in terms of income/wealth status, then a common pool model may well imply the over-provision of public goods in the context of ethnic or income diversity (Alesina and Drazen, 1991).

Against this theoretical and empirical backdrop, it is perhaps unsurprising that experimental results concerning the impact of heterogeneity on public goods provision is also a mixed bag. Income or wealth heterogeneity has been introduced in the public goods setting in a variety of ways, including differences in show-up fees (Anderson, Mellor and Milyo, 2004) and differences in endowment levels (Chan et al., 1999; Cherry, Kroll and Shogren, 2005; Rappoport and Suleiman, 1993; and Bergstrom et al., 1986). Some studies find evidence that income heterogeneity is associated with lower contributions to the public good, (Bergstrom et al., 1986; Ledyard, 1995; Isaac and Walker, 1988; Anderson, Mellor and Milyo, 2004; and Cardenas, 2002), while others find the opposite (Chan et al., 1997; Cherry et al., 2003; Chan et al., 1996; and Cardenas, 2002).

Moreover, consistent with theoretical models of altruism (Becker, 1974; Sugden, 1982; Andreoni, 1995) or inequality aversion (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999), some studies show that wealthier individuals tend to over-contribute (in relative terms) to the provision of public goods (Bergstrom et al., 1986). However, the weight of more recent studies is in favour of the opposite conclusion, namely that less well-endowed players tend to over-contribute to the public pool relative to the wealthier individuals in the group (Chan et al., 1996; Buckley and Croson, 2006).

Curiously, very few experimental studies have focused on the ways in which real world heterogeneity affects co-operation in resolving the public goods problem, preferring to specifically introduce heterogeneity as the treatment variable in an experimental setting. We are only aware of one field experiment in which the impact of heterogeneity on co-operation in common pool dilemmas is studied by using the observed heterogeneity based on the actual attributes of participants. In this groundbreaking work, Cardenas (2002) demonstrates that both the actual wealth levels and the extent of wealth inequalities between participants in a common pool resource game affects the extent of co-operation in resolving the dilemma. In this setting, extraction of the common pool resources was higher (in relative terms) for groups with higher average wealth as well as a higher variance in the wealth distribution of group members. At an individual level, wealthier individuals were less likely to cooperate in preserving the common pool resource. Moreover, individuals were more prone to over-extraction of the common pool[1] resource as the absolute distance between their own wealth level and the average wealth level of others in their group increased, and this was especially the case for individuals falling into the lower percentiles of the wealth distribution.

In the spirit of the work by Cardenas (2002), we report the results from linear public

[1]Again, this comparison is in relative terms; that is, relative to their allocated endowment.

goods games played with a large sample of individuals from fishing communities along the west coast of South Africa. We examine the impact of observed income heterogeneity based on the real world, self-reported incomes and expenditures for our participants, on public good provision. We find that contributions to the public good are increasing in per capita household income levels, and that income heterogeneity is associated with greater contributions towards the public good, especially by those at the lower end of the income distribution. Furthermore, we exploit our study design and compare the results based on real world attributes, to the case where we introduce heterogeneity explicitly as a treatment variable in an experimental setting. We find that real world heterogeneity affects contributions to the public good in the same direction as experimentally induced heterogeneity.

3 Sample Description

Much of the experimental evidence concerning the impact of inequality on public goods provision comes from studies relying on University students as participants, leaving a dearth of information on the ways in which inequality might affect behaviour amongst other sample groups. Consequently, we choose to study the behaviour of a large sample of individuals from nine different fishing communities along the west coast of South Africa. We chose these communities in order to recruit individuals who would have some real experience in the kinds of social dilemmas presented in a public goods game. Since fishers typically have to resolve the very real co-operative dilemma of not engaging in over-extraction, they presented an interesting and appropriate sample for our purposes.

A total of 569 individuals[2] were recruited, making this a large sample in comparison with other experimental studies of this nature (see Table 1 for sample statistics). In our view, this is a real strength of this work and the results presented here. On average, participants were 40 years old, had lived in their communities for most of their lives and, with the exception of Community 2, almost exclusively spoke Afrikaans as their first language. Just under 60% of the participants were male, although this varied considerably by community. Two-thirds of the participants classified themselves as Coloured[3], while a majority of the remaining classified themselves as Black

[2]Of this, 128 were from community 1; 58 from community 2; 91 from community 3; 85 from community 4; 107 from community 5; 23 from community 6; 17 from community 7; 24 from community 8; and 36 from community 9.

[3]In South Africa, the term "Coloured" traditionally refers to an individual of mixed race her-

or "Other", although again, at the community level, there is some variation in these ratios.

Table 1: Sample Statistics by Community

Variable	ALL n=569	Com1 n=128	Com2 n=58	Com3 n=91	Com4 n=85	Com5 n=107	Com6 n=23	Com7 n=17	Com8 n=24	Com9 n=36
Male (%)	0.58	0.52	0.81	0.93	0.66	0.18	0.64	0.94	0.54	0.43
Coloured (%)	0.66	0.76	0.52	0.64	0.62	0.62	0.55	0.80	0.65	0.86
White (%)	0.02	0.00	0.19	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Black (%)	0.17	0.16	0.30	0.19	0.21	0.13	0.18	0.07	0.13	0.09
Indian (%)	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other (%)	0.14	0.08	0.00	0.17	0.17	0.24	0.27	0.13	0.22	0.06
Afrikaans (%)	0.88	0.77	0.41	1.00	0.92	0.99	1.00	1.00	1.00	1.00
English (%)	0.09	0.22	0.41	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Xhosa (%)	0.03	0.01	0.19	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Age	40.37	37.09	46.59	41.82	34.65	39.13	54.61	45.38	48.54	38.56
	(13.64)	(11.83)	(14.96)	(11.67)	(13.01)	(12.99)	(12.08)	(15.08)	(18.50)	(8.29)
Yrs. lived in Community	30.39	27.81	27.11	34.42	29.42	30.85	40.45	23.68	29.83	32.47
	(13.26)	(7.88)	(18.65)	(14.70)	(12.63)	(13.91)	(12.89)	(9.11)	(12.50)	(11.33)
Household size	5.10	5.38	4.33	5.56	5.19	4.94	4.70	5.43	4.96	4.63
	(2.33)	(2.29)	(2.52)	(2.63)	(2.36)	(2.14)	(1.82)	(2.87)	(2.36)	(1.65)
Yrs education	8.37	8.33	7.76	8.43	8.69	8.96	7.50	7.69	7.33	8.33
	(2.51)	(2.45)	(2.70)	(2.58)	(2.08)	(2.43)	(2.11)	(2.94)	(3.14)	(2.62)
Fishing is main Activity	0.56	0.56	0.63	0.65	0.48	0.58	0.43	0.63	0.33	0.60
	(0.50)	(0.50)	(0.49)	(0.48)	(0.50)	(0.50)	(0.51)	(0.50)	(0.48)	(0.50)
Have a job	0.48	0.44	0.58	0.55	0.46	0.57	0.30	0.38	0.29	0.33
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.47)	(0.50)	(0.46)	(0.48)
Monthly wage (after tax)	920.55	1145.97	929.37	999.61	720.43	846.67	517.50	980.00	520.00	958.21
	(1010.99)	(1201.88)	(709.32)	(1181.42)	(688.09)	(1150.91)	(321.86)	(506.95)	(285.93)	(817.90)
HH per capita Income	330.48	284.25	568.38	287.44	178.98	344.48	333.34	382.07	488.35	454.52
	(455.99)	(366.34)	(904.53)	(411.58)	(149.44)	(337.81)	(346.16)	(338.66)	(520.82)	(526.26)
HH per capita Expenditure	379.93	349.57	432.35	443.40	185.59	362.65	302.81	338.75	716.91	621.22
	(438.95)	(376.31)	(423.27)	(666.99)	(123.68)	(263.27)	(308.69)	(216.94)	(682.56)	(561.95)
No. known in group	2.24	1.72	1.68	2.71	2.62	2.43	1.83	2.63	1.73	2.81
	(1.05)	(1.21)	(1.22)	(0.70)	(0.73)	(0.91)	(0.89)	(0.89)	(1.12)	(0.58)
No. work with in group	0.62	0.37	0.76	0.91	0.72	0.55	0.10	1.06	0.24	0.88
	(1.00)	(0.75)	(1.12)	(1.19)	(1.08)	(0.91)	(0.30)	(1.18)	(0.70)	(1.12)
No. relatives in group	0.27	0.20	0.04	0.42	0.51	0.21	0.10	0.29	0.05	0.41
	(0.65)	(0.46)	(0.20)	(0.82)	(0.85)	(0.60)	(0.31)	(0.83)	(0.22)	(0.80)

On average, participants had obtained eight years of education. Fewer than 2% of our sample reported having no education at all. One third had obtained some primary education (of these, 13% had completed their primary schooling), while 60% reported having obtained some high school education. Of these, only 8% had

itage.

completed their school leaving exam. Finally, only 6% of our sample had any form of tertiary qualification. Unemployment amongst participants was high, with only 48% reporting that they were currently employed in a job at the time of the survey. Of those who were employed, more than half reported fishing activities to be their primary source of income. Mean wage income for employed individuals in our sample (after tax) was R920 per month (approx. US$184). Mean monthly household per capita income for the entire sample was R330.48 (approx. US$66) compared with mean monthly household per capita expenditures of R379.93 (approx. US$76). Not only is there considerable variation in these income measures across the different communities in our sample, but the standard deviations associated with these income measures are, in some communities, quite large.

Finally, note that participants knew at least one other person in their group, and on average, they knew two other individuals in their group. However, the incidence of relatives or work colleagues being allocated to the same group was low, and thus, it is unlikely that kinship ties or work relationships are the primary drivers of our results.

While we have reported the average sample statistics here, it is self-evident from Table 1 that there is considerable observed heterogeneity across the nine communities. We try to control for as much of the variation in observed individual characteristics as possible in our regression analysis, but also include community fixed effects to deal with heterogeneity at this level.

3.1 Representivity of sample

An important issue relating to field experiments is the extent to which the recruited sample reflects the demographic profile of the broader community, and this in turn has implications for the extent to which the results of the experimental study are more broadly generalisable. Sample selection is a problem for most experimental studies since researchers typically rely on individuals to volunteer to participate, raising the possibility of differences, both observed and unobserved, between those who choose to participate and those who do not. In Table 2, we present comparison descriptive statistics for the nine communities in which we ran the experiments based on the datafile of the 2001 census data. Column 1 of Table 2 reproduces the sample descriptives based on our own collected data, while Column 2 presents estimates based on the 2001 Census. Column 3 presents census estimates that arise when one restricts the census to include only Black and Coloured individuals.

Table 2: Comparison Statistics by Communities based on Census data

Variable	Sample (All)	Census (All)	Census (Coloured & Black)
	%	%	%
Male	0.58	0.49	0.49
Coloured	0.66	0.70	0.82
White	0.02	0.14	
Black	0.17	0.15	0.18
Indian	0.00	0.00	
Other	0.14		
Afrikaans as first language	0.88	0.74	0.73
English as first language	0.09	0.12	0.11
Xhosa as first language	0.03	0.13	0.15
Years of education	8.37	8.80	8.23
Fishing as main activity	0.56	0.13	0.14
Involved in fishing activities in some capacity	0.86	0.11	0.16
Fraction reporting they have a job	0.48	0.60	0.60
Annual household income brackets (in Rands)			
Zero	0.01	0.09	0.09
1-4800	0.22	0.03	0.04
4801-9600	0.26	0.09	0.11
9601-19200	0.27	0.17	0.19
19201-38400	0.19	0.24	0.26
38401-76800	0.05	0.21	0.21
76801-153600	0.01	0.12	0.08
153601-307200	0.00	0.04	0.02
307201 and above	0.00	0.00	0.00

On the basis of the census comparisons, it would appear that our sample is quite distinct in a number of respects, relative to the broader demographic profile of the communities from which they were recruited. Men are slightly over-represented in our sample, and while Whites are under-represented, the relative representation of Coloured and Black individuals in our sample is in line with broader trends in these communities[4]. Moreover, individuals in our sample appear to have levels of

[4]Note that the results in Column 3 suggest that if we were to focus only on Black and Coloured individuals in these nine communities, Coloured individuals would constitute 82% of the sample according to census estimates. Comparing this to our own sample estimates in Column 1, note that while 66% of the sample clearly identified themselves as Coloured, an additional 14% identified themselves as "Other", a category also relating to mixed race individuals. Adding these two categories together suggests that 80% of our sample could in fact be classified as Coloured. The discrepancy in the way that individuals classify themselves may have to do with historical distinc-

education reflective of educational attainment in these nine communities. However, individuals in our sample are less likely to report being employed, and appear to come from poorer households on average. This is evident if one considers the distribution of individuals in our sample across the income brackets specified in the Census data.

These differences may be attributable to our recruiting strategy. Since we targeted fishing communities, our sample is dominated by individuals engaged in fishing activities, who tend on average to be poorer on average. Moreover, workers in this domain tend to be mainly Coloured or Black. Thus, in short, our sample appears to be a good representation of relatively poorer, Afrikaans speaking, Black and Coloured individuals from these nine communities. This should be borne in mind when considering the generalisability of our of findings.

4 Experimental Design

Participants were recruited through the use of community leaders, fishers associations, and flyers and adverts in community centres and harbours. At least one month prior to the experiments, potential participants were asked to attend an initial session during which their details were recorded and they were asked to complete a questionnaire that elicited information on their socio-economic background, employment activities, fishing experience and a range of attitudinal questions. These individuals were then randomly allocated to groups for the public goods games which occurred one month later, and were typically run during the day in local community centres. Random allocation of individuals to groups is crucial for the validity of our results, in order to ensure there is no systematic correlation between socio-economic characteristics of individuals and the treatment to which they were assigned. This is, in fact, the case for our data.

On the day of the experiments, participants were directed to their groups. Each group initially played a simple linear public goods game as adapted by Isaac, Walker and Thomas (1984) which lasted for six rounds[5]. After a short break, the same group reconvened to play a public goods game with punishment[6]. In both games,

tions where individuals of Malay descent may more naturally classify themselves as "Coloured", while individuals who are the product of a mixed race union may classify themselves as "Other".

[5]Given low literacy rates, a linear framework was adopted in order to keep the game as simple as possible. There were two practice rounds at the start of the game, but participants were not paid for these rounds.

[6]We did not test for order effects by reversing the order of the games. Available evidence from

the marginal per capita return (MPCR) was set at 0.5, and the structure of the game ensured that the Nash equilibrium was for individuals to contribute nothing to the public pool, whilst the social optimum for the group was achieved if every individual contributed their full endowment to the public pool. The key contribution of our work, however, is that we introduce inequality in token endowments for some groups (called the Unequal Treatment), and compare this to the behaviour of groups where all group members received the same number of experimental tokens (called the Equal Treatment). In the Equal Treatment, all players received 40 tokens in each round of the game. In the Unequal treatment high endowment players were allocated 50 tokens in each round of the game, while low endowment players were allocated 30 tokens. There were 143 groups in total, each consisting of four individuals[7]. Of these, 73 groups participated in the Unequal treatment while 70 were assigned to the Equal Treatment.

Endowment status was randomly allocated and not earned[8]. In the Equal Treatment, the experimenter then announced to the group that everyone in the group had been allocated 40 tokens, while in the Unequal treatment, the experimenter announced that two individuals had been allocated 50 tokens, while the other two had been allocated 30 tokens. However, the actual identity of high and low endowment players was not publicly revealed within the group[9]. Individuals maintained the same endowment status throughout the experiments, and payoffs were calcu-

Fehr and Gächter (2000) suggests that the order of treatments with these particular games does not affect the results in any significant way.

[7]The sample includes five groups of size three. The MPCR in the games for these groups was kept at 0.5 as for groups of size four, and their inclusion in the analysis does not alter the results in any qualitative way.

[8]In all groups, at the start of the simple public goods game, players were asked to randomly select an envelope which contained all the protocols and record sheets for the game, as well as information about the number of tokens they had been allocated. Once participants had selected their envelopes, they were asked to open their envelopes but keep their information private.

[9]In each group, players were seated with dividers in between them so that they could not see the decisions made by others, nor could they communicate with others in the group. During each round, players would first record their information on their personal record sheets before proceeding one at a time to the front of the room where a privacy booth had been set up. Individuals then recorded their decision onto a large template in the privacy booth. To ensure anonymity, the template was designed so that the player could only view her own entries and not those of the other group members. This was done by using Velcro to seal cardboard flaps over each person's corresponding line in the template. To begin, the cardboard flaps were all sealed. When an individual entered the booth, they would locate their entry line by looking for their player identification number, and then unseal the cardboards flap on that line. Had they attempted to raise a second flap, the sound made by the Velcro was sufficient to make this publicly known. The order of player identification numbers on the templates for each round were randomised. Once all four players had recorded their decisions onto the template, the experimenter then entered the booth to retrieve the information sheet under the cardboard template, and calculated the total contribution in the public pool before announcing the return from the pool.

lated according to the function $\pi_{1i} = (y - g_i) + 0.5 \sum g_i$, where y is the initial token endowment, and g_i is the individual's contribution to the public account.

In the public goods game with punishment, the protocols used in the public goods game without punishment were maintained. However, once all participants had made their contributions to the public account, and the return from the pool had been announced, participants were asked to return to the privacy booth one at a time. Once inside the booth, the individual contributions made by each group member were revealed. Once again, the actual identity of the group members was not linked in any way to the revealed contributions. Each participant was then given the opportunity to assign punishment points to others in the group if they so desired. The cost of assigning a punishment point was 1 token, and this cost was borne by the punisher. For each punishment point assigned to an individual, the recipient of the punishment point lost 5 tokens[10]. Given low literacy levels, we simplified the game in that no individual could ever have negative earnings at the end of the punishment round. Thus, once the cost of assigning punishment points and the cost of receiving punishment points had been taken into account for any individual, their minimum earnings at the end of any round could only ever be zero[11].

Each token was worth 10 cents (US 2 cents), and on average, participants earned R110 (US$22) for their participation, which is approximately two days' wages, 12% of median monthly household income or one-third of household per capita income. Each experimental session lasted between two and a half and three and a half hours, and was completed in August and September 2004. In some communities, two or three sessions were scheduled each day.

[10]In the pilot version of these games, the cost of assigning punishment points was set equal to 1 token, and the recipient's income was reduced by 2 tokens. However, our analysis suggested that these ratios were too low to induce low endowment players to engage in punishment. Consequently, we raised the ratio to 1:5.

[11]On average, 10% of participants would have had negative earnings at the end of any one round, had we not applied the zero minimum. This was higher in the Equal treatment, where on average, 14.5% of participants had negative earnings at the end of a round, compared with only 6.3% for participants in the Unequal treatment. This feature of our design does not seem to have had any negative impact on the *average* propensity of participants to over-punish or engage in very high levels of free-riding. On average, participants awarded 3 punishment points in a round, which translates into 6% of their earnings from the first stage of the game. The average number of punishment points received (after multiplying by five) in a round was 18, which is 31% of first stage earnings. However, this behaviour is different for the group of individuals who would have experienced negative earnings had the zero minimum not been in place. On average, these individuals awarded 12 punishment points per round, approximately 22% of their first stage earnings. Moreover, they received 83 punishment points (after multiplying by 5) per round, approximately 1.5 times their first stage earnings.

5 Results

Since we are interested in the impact of observed heterogeneity in actual income on contributions to the public good, we limit our analysis here to participants assigned to the Equal Treatment, where every individual received 40 tokens. Since the token endowment does not vary across individuals, it is possible to neatly isolate the effect that differences in actual incomes have on the decisions made by participants, without having to worry about the confounding effect that unequal token endowments might have on the outcome as well. In our regression analysis, we present coefficient estimates obtained from both pooled OLS regressions, as well as those obtained using multilevel or hierarchical regression techniques that account for clustering at the group and individual level[12].

Result 1 *Offers to the public pool are significantly higher in the punishment treatment than in the simple public goods game.*

Figure 1 demonstrates that on average, players begin by contributing 18 tokens (just less than 50% of their token endowment) in Round 1 of the simple public goods game. While there is some variability in the average contributions made to the pool, this declines to 16 tokens (40%) by the final round of the simple public goods game. These magnitudes are consistent with the large body of evidence concerning initial contributions in other public goods games (Ledyard, 1995; Marwell and Ames, 1980; Isaac, Walker and Thomas, 1984), although the rate of decline in contributions to the public pool is not quite as large in this sample as has been reported in other cases. This may partly be attributed to the fact that on average, individuals knew two other group members which may have produced greater feelings of solidarity.

On average the public goods game with punishment (denoted as starting in round 7 in Figure 1), initial contributions are higher at 49% (or 19 tokens) and decline to 43% by the final round of the punishment game. Both a simple t-test (t=-3.50, p=0.00) and a Wilcoxon matched pairs signed rank test (z=-11.92; p=0.00) confirm that the average contributions to the public pool are significantly higher in the punishment

[12]In our data, the assumption of independent observations is likely to be violated due to dependence among contributions to the public good made by individuals in the same group. Moreover, since any single individual makes repeated decisions, individual decisions over the course of each game are not independent of each other. Our estimates are obtained using the xtmixed command in STATA.

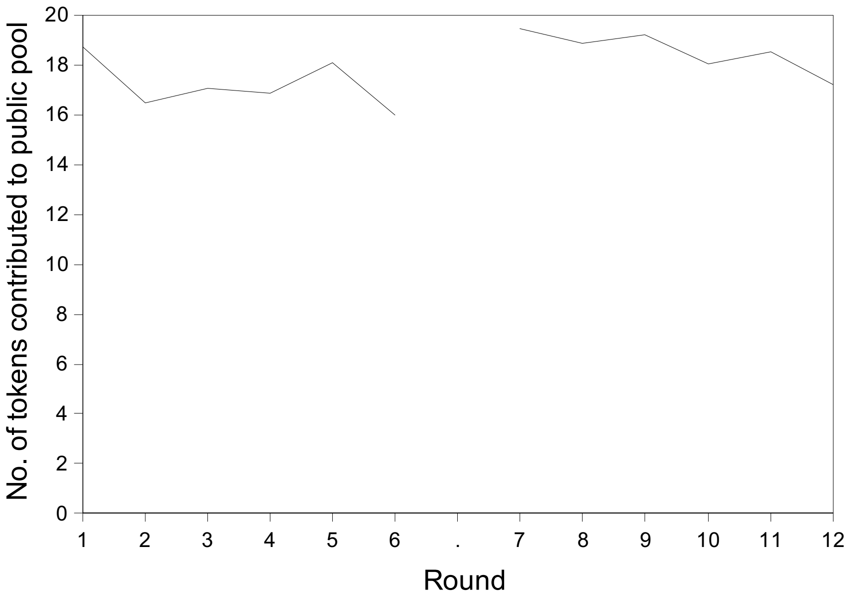

Figure 1: Average number of tokens contributed to public pool in each round, by treatment.

game relative to the simple public goods game without punishment[13]. Importantly, average contributions made to the public pool in the final round of the simple public goods game are significantly lower than the average contributions made in the first round of the public goods game with punishment (Wilcoxon signrank test z=-5.096; p=0.00; t-test t=-3.65; p=0.00), indicating the presence of a restart effect at the beginning of the public goods game with punishment. In other words, individuals viewed the punishment game as a new game and not merely a continuation of the first game[14].

5.1 Controlling for income heterogeneity

We use three measures to examine the impact of income and income heterogeneity on contributions to the public pool. Household per capita income (logged) is the first measure and is a level effect which allows us to examine whether the absolute income status of individuals affects their contribution decisions.

[13]Moreover, a Kruskal-Wallis test confirms that the distribution of average contributions to the public pool are significantly different across the simple public goods game and the punishment game treatments ($\chi = 12.977; p = 0.00$).

[14]For a detailed analysis of the punishment games data, the reader is referred to Visser and Burns (2006).

The second measure is Income Gap, which is calculated as the absolute distance in logged per capita household incomes between the individual and the mean for all others in the community in which they live. Note that here, we differ from Cardenas (2002) who uses an Income Distance measure of the wealth difference between the individual and others in his/her *group*. In Cardenas' design, groups comprised 8 individuals, and thus the impact of missing observations pertaining to wealth or income for some group members presents less of a problem in calculating a reliable income distance measure at the group level than in our design, where groups comprised only four individuals. Hence, we choose to focus on income differences between individuals at a *community* level. Since individuals are randomly allocated to groups, there should not be any significant difference between this income distance measure being calculated at the community level (which affords a more robust measure in the presence of missing data for some individuals in a group), and the actual income distance between the members of any particular group.

Note that our Income Gap measure allows us to examine the extent to which *relative* income status matters for individual decision making in this strategic setting. Since there is experimental evidence (as cited earlier) to suggest that individuals do take information about the characteristics of other players into account in these strategic games, we think it plausible that individual contribution decisions might also be affected by a comparison of one's own income status to that of other participants.

The third variable is an interaction of these first two variables and provides a measure of whether the impact of income differences between the participant and others in his/her community on contributions made to the public pool differs according to their absolute income level. Effectively, inclusion of this interaction term allows us to distinguish whether the contribution decisions made by individuals who are far from the community mean differ if the individual is above (high absolute income) or below (low absolute income).

Result 2 *Income heterogeneity is associated with higher contributions towards the public good in a simple public goods game without punishment, especially by those at the lower end of the income distribution.*

Table 3 presents both pooled OLS regression results as well as estimates obtained from hierarchical regression models that control for clustering at the group level (HLM1), and then clustering at both the group and individual level (HLM2) respectively. While we present estimates for each of these models for purposes of comparison, our preferred set of results relates to Column 3 and Column 6; that is, the hierarchical model that controls for clustering at both the group and individual level. Panel A of Table 2 presents the results when household per capita income is used as the measure of household wealth, while Panel B presents the results obtained when household per capita expenditure is used. All regressions include additional controls for age, gender, race, years of education, round, and the number of individuals in the group known to the individual, but these are not reported since these are not the focus of our investigation.

To begin, we focus on the results obtained from the simple public goods game without punishment. Given the inclusion of the interaction term, we have to consider the partial derivatives of the variables of interest, evaluated at the mean. In Panel A[15], the pooled OLS results in Column 1 indicate that individual contributions to the public good are associated with increases in the level of (logged) per capita household income[16]. Similarly, contributions to the public pool are positively associated with increases in the (logged) per capita household income gap between the participant and others in his/her community[17], but the interaction term indicates that this association is stronger for individuals from households where per capita household income is low. Combining these results together suggests that contributions to the public good are increasing in income levels, and that while income heterogeneity is associated with greater contributions towards the public good, this is especially true for those at the lower end of the income distribution. Columns 2 and 3 of Table 2 present estimates for the same model using hierarchical linear modelling techniques to control for nesting, first at the group level (Column 2:HLM1) and then at the group and individual level (Column 3:HLM2). Our results remain robust once we control for clustering, and the coefficients of interest are significant in all cases.

In Panel B, we run the same regressions, replacing the income measure with per capita monthly household expenditure as an alternative measure of household well-being[18]. In the simple public goods game without punishment, we obtain the same

[15]Note that the regressions in Panel A and B both use the absolute number of tokens contributed to the pool as the dependent variable. Since all players received 40 tokens, it makes no qualitative difference to the results if we use this measure as opposed to the fraction of tokens contributed to the pool.

[16]The partial derivative is $\frac{\delta C}{\delta YPC} = 4.56 - 2.19YG$, where C is the contribution to the public pool, YPC is per capita household income, and YG is the income gap. Evaluating this at the mean (logged) income gap of 1.14, gives a value of 2.06.

[17]The partial derivative is $\frac{\delta C}{\delta YG} = 13.30 - 2.19YPC = 1.56$ evaluated at the mean, where C is the contribution to the public pool, YPC is per capita household income, and YG is the income gap.

[18]Per capita household income and expenditure measures are correlated at 0.75 for individuals

Table 3: Pooled OLS and hierarchical model regression results.

	Simple Public Goods Game			Public Goods Game with Punishment		
A: No. of tokens to public pool	Pooled OLS	HLM1	HLM2	Pooled OLS	HLM1	HLM2
	(1)	(2)	(3)	(4)	(5)	(6)
Per capita HH income $^{\psi}$	4.56 ***	5.54 ***	7.19 *	-0.84	1.00	4.88 *
	(1.77)	(1.62)	(2.59)	(1.75)	(1.67)	(2.92)
Absolute income gap $^{\psi}$	13.30 ***	14.78 ***	17.27 *	3.84	6.30 ***	11.93 *
	(3.74)	(3.58)	(5.74)	(3.77)	(3.71)	(6.46)
Income gap $^{\psi}$ x p.c. HH income $^{\psi}$	-2.19 ***	-2.51 ***	-3.06 *	-0.31	-0.85	-2.08 *
	(0.75)	(0.71)	(1.14)	(0.75)	(0.74)	(1.28)
Racial diversity in group	10.75 ***	-2.87	-4.07	-9.47 *	-2.73	-5.19 *
	(4.08)	(2.67)	(2.87)	(5.11)	(3.00)	(3.00)
Gender diversity in group	1.34	-5.17	-5.89 ***	-0.61	-5.83	-6.54 *
	(5.00)	(3.24)	(3.35)	(6.53)	(3.65)	(3.47)
n	888	888	888	888	888	888
R2	0.41			0.41		
Chisquare		147.77	262.3		155.02	332.2
B: No. of tokens to public pool						
Per capita HH expenditure $^{\psi}$	4.13	2.23	1.69	8.81 ***	2.84	-0.39
	(3.20)	(2.15)	(2.88)	(3.04)	(2.23)	(2.97)
Absolute expenditure gap $^{\psi}$	19.83 ***	12.72 ***	10.90 ***	32.13 ***	14.69 *	6.41
	(7.95)	(5.06)	(6.57)	(7.18)	(5.36)	(6.83)
Exp. gap $^{\psi}$ x p.c. HH exp. $^{\psi}$	-3.69 ***	-2.50 ***	-2.19 ***	-6.30 ***	-3.11 *	-1.54
	(1.49)	(0.94)	(1.24)	(1.37)	(1.00)	(1.28)
Racial diversity in group	-7.01	-3.60	-4.92 ***	-14.37 ***	-3.63	-4.28
	(5.23)	(2.78)	(2.97)	(5.40)	(3.31)	(3.31)
Gender diversity in group	-20.05 ***	-11.23 ***	-10.35 *	-22.20 ***	-13.15 *	-11.69 ***
	(7.28)	(3.41)	(3.45)	(7.21)	(4.09)	(3.96)
n	582	582	582	582	582	582
R2	0.42			0.50		
Chisquare		47.89	99.88		95.59	133.6
C: Fraction of tokens to public pool						
Unequal treatment	0.10 *	0.05 **	0.05 **	0.18 ***	0.10 *	0.10 ***
	(0.05)	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)
Unequal treatment x 50 tokens	-0.04 ***	-0.04 ***	-0.03 ***	-0.05 ***	-0.05 *	-0.05 **
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
Racial diversity in group	0.27 ***	-0.01	-0.02	0.06	-0.07	-0.07
	(0.06)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)
Gender diversity in group	0.00	0.00	0.01	0.10	0.01	0.02
	(0.06)	(0.05)	(0.05)	(0.07)	(0.05)	(0.05)
n	3107	3107	3107	3108	3108	3108
R2	0.25			0.33		
Chisquare		400.0	923.9		644.9	1413.9

HLM1 controls for clustering at the group level; HLM2 controls for clustering at the group and individual level. Additional controls for age, gender, race, years of education, round and the number of individuals in the group known to the individual are included but not reported here. Significance ***=1%; **=5%; *=10%

$^{\psi}$ Logged variable

signs on the coefficients of interest, yet the results suggest that the absolute level of per capita household expenditure has no statistically significant association with contributions to the public good. However, it remains the case that contributions to the public good are increasing in the per capita expenditure gap between the participant and others in the community, and this association is once again significantly stronger for those in households with lower monthly per capita expenditures.

Result 3 *The association between real income heterogeneity and contributions to the public good is muted in the presence of punishment.*

Columns 4–6 in Table 2 present similar regression results for the public goods game where punishment was allowed. Beginning with panel A, where the income measure is used, it is apparent that while the coefficients of interest retain the same signs and remain statistically significant, they decline in size. Our preferred estimates from Column 6 suggest that the coefficients are now only two-thirds of what they were in the simple public goods game. Since we have demonstrated that participants in these games did experience a "restart" effect when beginning the public goods game with punishment, this decline in coefficient size cannot be attributed to some kind of learning effect. In other words, we do not think it plausible that this decline can be attributed to an individuals experience of the game being such that it renders their personal attributes less important in subsequent play[19].

As before, the results obtained using household per capita expenditure data are weaker, and in the final specification in which we control for nesting both at the group and individual level, none of the coefficients are statistically significant. This stands in contrast to the results from the simple public goods game. However, the economic significance of the coefficients is the same as the case where the income measure is used.

Result 4 *Racial and gender diversity in groups negatively impacts on contributions to the public good, and this becomes more pronounced in the presence of punishment.*

To examine the effect of racial or gender diversity in groups on the individual decision

in this 40 token treatment

[19]Fear of being punished and utilisation of the punishment mechanism are both plausible explanations for this change in behaviour. However, since we did not debrief subjects after the games due to time and resource constraints, we cannot ascribe behaviour to any particular motive with any certainty.

to contribute towards the public pool, we adopt the Herfindahl concentration formula, a measure frequently adopted by economists interested in studying the impact of ethnic heterogeneity on economic growth (Easterly and Levine, 1997; Fedderke and Klitgaard, 1998). This measure is given by:

$$R = 1 - \sum_{i=1}^{n} \left(\frac{n_i}{N}\right)\left(\frac{n_i - 1}{N - 1}\right), \tag{1}$$

where n_i is the number of members of the ith race/gender group within the experimentally assigned group of four, and N is the total number of individuals in each experimental group. This measure reflects the likelihood that two individuals chosen at random in a group will be from different race groups or of different genders. While Posner (2000) highlights a number of critical flaws in this measure, these arguments are largely not applicable in this instance[20].

Once again, we focus on our preferred estimates from Columns 3 and 6. In line with the view that heterogeneity may undermine group cohesion and result in lower levels of public good provision, our results suggest that racial and gender diversity[21] within groups are associated with lower contributions to the public good. This is exacerbated once the possibility of punishment is introduced, and this result is particularly robust in relation to gender diversity. While the same trend holds true for our measure of racial diversity, the results are not robust when the expenditure measures are used as a measure of well-being instead of the income measures. It is unclear why this should be the case, and may be attributable to measurement error or missing data, an issue to which we return below.

Result 5 *Experimentally induced income heterogeneity affects contributions to the public pool in the same way as real world income heterogeneity.*

Panel C of Table 2 presents regression results in which we examine how experimen-

[20]Posner's (2000) arguments relate to the use of this formula as a measure of ethnic fractionalization in cross-country growth studies. Problems include the difficulty of correctly specifying the boundaries along which ethnic fractionalization occurs, but more importantly, the problem of ethnic fractionalization being endogenous to social, political and economic institutions, which in turn affect growth. Moreover, Posner argues that this index ignores the dynamics of inter-group competition and conveys no information about the extent of the divisions between members of different race groups. However, as the focus in this paper is simply on providing a measure of the racial or gender diversity within each group (where both race and gender are visible, fixed traits and are reported by individuals in a pre-game questionnaire), these concerns are largely not relevant for this study.

[21]Note that our index of racial diversity takes on one of 5 values: 0;, 0.5, 0.67, 0.83, 1. Our index of gender diversity takes on one of four values, namely 0; 0.5; 0.67 or 0.83.

tally induced income heterogeneity affects contributions to the public pool. Here we use the entire sample of 569 individuals, and focus on whether inequality induced experimentally through the random allocation of unequal token endowments, affects cooperative behaviour. We are interested both in whether average contributions are higher in "Unequal" groups (namely, those where two players were randomly allocated 50 tokens and two were allocated 30 tokens) relative to "Equal" groups (where everyone received a token endowment of 40), as well as whether those individuals who received larger token endowments exhibit a tendency to over- or undercontribute to the public good relative to others. While we do not wish to claim that unequal token endowments are a perfect representation of real income differences between participants, we do believe that examining whether participants respond to differences in their relative token endowments in the *same* direction as they respond to differences in real incomes is instructive.

The coefficient estimates from the pooled OLS regression (Column 1) for the public goods game without punishment demonstrate that contributions to the public good are significantly higher in unequal groups, and this is largely driven by the relatively higher contributions made by low endowment players (that is, those who were allocated 30 tokens). These results are confirmed in the hierarchical regression estimates in Columns 2 and 3. The same holds true for the estimates pertaining to the public goods game with punishment. Contributions to the pool are higher in the presence of endowment inequality, and this is largely driven by the high contributions of low endowment players. These results are consistent with the results from Panel A and Panel B of Table 2[22].

6 Discussion

The evidence we have presented in this paper suggests that inequality, be it in token endowments or in actual per capita household incomes and expenditures, may be associated with higher levels of public good provision. This is largely due to higher contributions being made by lower income or lower token endowment players, which is consistent with them having a higher marginal utility of income. As they stand to gain relatively more for every rand contributed to the public good, it is in their

[22]Note that the impact of racial and gender diversity in these regressions is not consistent with our earlier results. However, we believe this may be at least partly attributed to the confounding effect of experimentally induced inequality serving to focus individual attention explicitly on this inequality, and to be less concerned with the demographic composition of their groups.

interest to make relatively larger contributions in an effort to signal a willingness to cooperate in the provision of the public good, thereby inducing greater cooperation by others in the group. These associations are muted in the presence of punishment, suggesting that individuals may rely on the punishment mechanism to induce greater co-operation by others in the group, as opposed to the signalling value of their own contributions. To our knowledge, the fact that we find similar results whether we examine the impact of real world income inequality or experimentally induced inequality on contributions in the game is a first, and one that we find encouraging.

However, while our results suggest that inequalities in income may be associated with higher contributions to the public good, they also suggest that racial and gender diversity within groups tend to be associated with lower contributions to the public pool. This is consistent with the body of work cited earlier which argues that diversity along these dimensions undermines group cohesion, thereby reducing contributions to the public pool. These results may reflect the reality that fishing activities in these communities tend to occur in same race or same sex co-operatives. Of the 110 co-operatives named by participants in our study, only 8 had members of both genders. Moreover, during the time of the experiments, there was considerable tension in these communities over recent quota reforms that had granted greater access and larger quotas to female and Black fishers. Taken together, our results suggest that different types of heterogeneity may affect contributions to the public good in different ways, and that individuals bring along their everyday experiences to bear in the games.

However, it is important to remember that our sample is distinct from the demographic profiles of the communities from which these individuals were recruited in some important respects. While our results might be generalisable for relatively poor, non-White communities and individuals engaged in activities associated with fishing or perhaps even other activities reliant on natural resource use, we cannot say whether these same trends would hold true for individuals from more affluent communities less reliant on primary sector activities for their livelihoods.

Secondly, we rely heavily on survey measures of household incomes and expenditures, which are typically plagued by measurement error. To the extent that measurement error is present in our data, it will have served to bias our coefficient estimates downwards. Thus, our coefficient estimates should be interpreted as a conservative estimate of the association between income heterogeneity and cooperative behaviour.

The incidence of missing data as well as zero incomes and expenditures also holds implications for the robustness of our results. In our sample[23], only five households reported zero household income and no households reported zero expenditures. Consequently, we excluded the five zero household income households from the analysis. However, missing data on household incomes and expenditures is more of a concern. In our sample of individuals allocated to groups in which all individuals received 40 tokens, out of a total of 268 individuals, 36 (or 13%) did not report a value for household income, while 111 (41%) did not report any data that allowed us to compute household expenditure. A real concern, therefore, may be that to the extent that there are observable differences between those who reported data on incomes and expenditures versus those who did not, this may further limit the robustness of our results.

Table 4 presents a comparison of sample statistics for those individuals who reported data on household incomes and expenditures and those who did not. The first point to note is that substantially more differences arise between those who reported data relative to those who did not for our household expenditures compared to household income variables, perhaps suggesting that the results based on our expenditure measures be treated with greater caution. Secondly, in relation to household per capita income, those who did not report data were more likely to be Black, to come from larger households, earn lower wages and be less likely to own a radio. Since Black individuals are only 17% of the total sample, it is unlikely that our regression results are being driven entirely by the behaviour of Black individuals in the sample. As a check, we re-run our income regressions limiting the analysis to Blacks only and find that the coefficients on our income and inequality measures retain their economic significance in both the simple public goods game and the game with punishment, but are only statistically significant in the games with punishment. We are unable to perform a similar exercise in relation to our household expenditure regressions due to sample size constraints[24]. In sum, this suggests to us that our more reliable results are those obtained using household per capita income measures as opposed to household expenditure data.

The larger point, however, is that while experimentalists typically use survey in-

[23]Here, we are referring to our sample of groups in which all players received 40 tokens, since this is the sample to which the regression results in Panel A and B of Table 3 pertain. However, the reported numbers do not increase all that much when one considers the entire sample.

[24]Since only 16% of those who report expenditure data are Black, and since coverage on expenditure data is already so limited (168 individuals in total), it is not possible to obtain regression estimates on such a small sample.

Table 4: Comparison of descriptives for those who reported income/expenditure data versus those who did not.

Variable	Household income					Household expenditure				
	Missing		Reported			Missing		Reported		
Age	38.86	(13.44)	40.18	(13.45)		43.80	(13.64)	40.18	(13.45)	*
Male	0.57	(0.50)	0.59	(0.49)		0.60	(0.49)	0.59	(0.49)	
Coloured	0.59	(0.50)	0.65	(0.48)		0.56	(0.50)	0.65	(0.48)	*
White	0.00	(0.00)	0.02	(0.15)		0.03	(0.17)	0.02	(0.15)	
Black	0.28	(0.46)	0.16	(0.37)	*	0.25	(0.44)	0.16	(0.37)	*
Indian	0.00	(0.00)	0.00	(0.06)		0.00	(0.00)	0.00	(0.06)	
Other	0.13	(0.34)	0.16	(0.36)		0.16	(0.37)	0.16	(0.36)	
Yrs. lived in community	30.12	(12.97)	30.81	(13.46)		34.00	(13.41)	30.81	(13.46)	*
Afrikaans	0.91	(0.28)	0.90	(0.30)		0.92	(0.28)	0.90	(0.30)	
English	0.06	(0.24)	0.08	(0.28)		0.06	(0.25)	0.08	(0.28)	
Xhosa	0.03	(0.17)	0.02	(0.13)		0.02	(0.14)	0.02	(0.13)	
Household size	6.04	(2.54)	4.93	(2.29)	*	5.22	(2.60)	4.93	(2.29)	
Yrs. of education	7.61	(2.84)	8.15	(2.54)		7.62	(2.66)	8.15	(2.54)	*
Household pc income			317.73	(370.81)		286.46	(323.46)	317.73	(370.81)	
Household pc expenditure	263.66	(90.77)	395.18	(465.10)				395.18	(465.10)	
Fishing is main activity	0.62	(0.49)	0.56	(0.50)		0.55	(0.50)	0.56	(0.50)	
Employed	0.46	(0.51)	0.46	(0.50)		0.49	(0.50)	0.46	(0.50)	
Individual earnings	426.53	(391.26)	864.60	(1019.64)	*	777.24	(1179.97)	864.60	(1019.64)	*
Own a house	0.61	(0.49)	0.53	(0.50)		0.56	(0.50)	0.53	(0.50)	
Own a boat	0.11	(0.32)	0.10	(0.31)		0.12	(0.32)	0.10	(0.31)	
Own a cellphone	0.28	(0.45)	0.30	(0.46)		0.29	(0.46)	0.30	(0.46)	
Own a radio	0.44	(0.50)	0.58	(0.49)	*	0.49	(0.50)	0.58	(0.49)	*
Own a TV	0.61	(0.49)	0.71	(0.46)		0.70	(0.46)	0.71	(0.46)	
Own a bicycle	0.08	(0.28)	0.09	(0.28)		0.05	(0.23)	0.09	(0.28)	
Own a car	0.11	(0.32)	0.14	(0.34)		0.17	(0.38)	0.14	(0.34)	
Own land	0.11	(0.32)	0.14	(0.35)		0.14	(0.34)	0.14	(0.35)	
Own jewellry	0.14	(0.35)	0.14	(0.35)		0.14	(0.34)	0.14	(0.35)	
Own livestock	0.03	(0.17)	0.02	(0.13)		0.01	(0.09)	0.02	(0.13)	
Own machinery	0.14	(0.35)	0.10	(0.31)		0.08	(0.27)	0.10	(0.31)	
n	36.00		237.00			111.00		168.00		

struments to capture socio-economic information about participants, these survey instruments are nowhere near as sophisticated or comprehensive as surveys used in general household surveys conducted by statistical agencies and large research organisations. For example, many household surveys have entire modules devoted to capturing detailed information on household incomes, expenditures and assets, while our own survey questions were less detailed in this respect. This difference is attributed both to budget constraints and time constraints since the focus in an experimental study is typically on the experimental results, with survey data being used in a secondary sense and much of the budget being devoted to the payment of participants. However, to the extent that experimentalists plan to expand this area of research in which real world attributes of participants are used to predict experimental play, it is vital that greater attention be paid to survey design and implementation. Moreover, incorporating experiments as a component of household surveys is an important next step in this field.

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Contributing My Fair Share: Inequality and the Provision of Public Goods in Poor Fishing Communities in South Africa

Martine Visser and Justine Burns

Abstract

This paper reports the results of linear public goods games played with a large sample of individuals from poor fishing communities in South Africa. The games explicitly examine the impact of income heterogeneity, introduced through the random allocation of different player endowments, on aggregate contributions to the public good at the group level, as well as the differential effect that such heterogeneity has on the contributions of well-endowed individuals relative to less well endowed group members. While we find that aggregate contributions to the public good are marginally higher in groups characterised by income heterogeneity, our results do show that low endowment individuals contribute a significantly larger fraction of their token endowment towards the public good relative to high endowment players. Our results also suggest that individuals do bring preferences for fairness into the experimental setting, but that these preferences depend on one's endowment position. The contributions made by the majority of individuals approximate a proportional fair share threshold, and these preferences persist even in the presence of inequality, with individuals adjusting their offers either upwards or downwards relative to this threshold from round to round. That all of this happens in the absence of communication makes the results even more remarkable.

Keywords: public goods, experimental economics, inequality, punishment JEL classification: C9, D63, H41, Q2

1 Introduction

Economists have become increasingly interested in the impact of heterogeneity on the provision of public goods, but the theoretical and empirical evidence is, at best, mixed. Both theoretical and empirical arguments have been made in support of the view that heterogeneity will undermine the provision of public goods through its erosion of group cohesion, as well as the alternative view that heterogeneity will result in increased public spending on these goods since heterogeneity is associated with median voters who are less well-endowed (Alesina and Drazen, 1991; Easterly and Levine, 1997, Persson and Tabellini, 1994; Alesina and Tabellini, 1989; Alesina and Drazen, 1991; Alesina and Rodrik, 1994; Alesina and Spoloare, 1997). Alongside this work, there is now a growing body of experimental results that have tackled the same question using public goods games (see for example Anderson et al., 2004; Chan et al., 1999; Cherry et al., 2005; Rappoport and Suleiman, 1993), and our work forms part of this tradition. In this paper, we report the results of linear public goods games that explicitly examine the impact of income heterogeneity, introduced through the random allocation of differing player endowments, on aggregate contributions to the public good at the group level, as well as the differential effect that such heterogeneity has on the contributions of well-endowed individuals relative to less well-endowed group members. We find that aggregate contributions to the public good are marginally higher in groups characterised by income heterogeneity, but that low endowment individuals in these groups contribute a larger fraction of their token endowment towards the public good. Interestingly, conditional cooperation appears to have a much stronger presence in interactions within groups characterised by income heterogeneity than in the equal treatment groups.

2 Inequality and the Provision of Public Goods

Income or wealth heterogeneity has been introduced in the public goods setting in a variety of ways, including differences in show-up fees (Anderson et al., 2004) and differences in endowment levels (Chan et al., 1999; Cherry, Kroll and Shogren, 2005; Rappoport and Suleiman, 1993; and Bergstrom et al., 1986). Previous papers in this field by Sugden (1982,1984) and more recently by Buckley and Croson (2006) have derived theoretical predictions concerning the impact of heterogeneity on public goods provision, premised on the assumption that in equilibrium, each individual chooses his/her contribution as a best response to his/her beliefs about the contributions of others. In models of altruism, the individual's utility is an increasing function of his/her own wealth and the wealth of other group members. Since the wealth of other group members is a normal good, as it increases, the individual reduces his/her consumption of it and devotes more resources to private consumption. This implies a negative correlation between an individual's contribution and the contributions of others (Sugden, 1982). Poppe and Utens (1986) find evidence in support of this hypothesis, showing that players contribute less to the public good when the pool is increasing, but increase their contributions when the pool is decreasing. With respect to income heterogeneity, altruism models predict that wealthier group members will make higher contributions than less wealthy individuals in the group as measured in absolute terms (Becker, 1974; Sugden, 1982; Andreoni, 1995). Models of inequality aversion yield similar results since in these models the utility function is increasing in the equality of payoffs between group members. Hence, higher income (or wealth) individuals should contribute a larger share of their income or wealth to the public pool in order to equalize earnings across group members (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999).

However, more recently, Chan et al. (1996) suggest that high income individuals will tend to under-contribute to the provision of public goods relative to the Nash equilibrium prediction while the converse holds true for low income individuals. This is attributed to the fact that participants in experiments may bring additional notions of fairness with them into the experimental setting, which augment the induced payoffs provided by the experiment. Thus, individuals who contribute a larger share of their income than the average contribution for their group may experience disutility, thereby causing them to reduce their contributions to the pool.

In practice, the experimental evidence has focused most attention on the question of how heterogeneity affects contributions to the public good relative to groups where such heterogeneity is absent. At best, the evidence is mixed, with some studies supporting the notion that income heterogeneity is associated with lower contributions to the public pool (see Bergstrom et al., 1986; Ledyard, 1995; Isaac and Walker, 1988; Anderson et al., 2004; and Cardenas et al., 2002b for examples), and others arguing that inequality results in increased aggregate contributions to the public pool (see Cherry et al., 2005; Chan et al., 1996; Walker et al.; 1990 and Cardenas, 2002b). Relatively fewer studies have focused on how income heterogeneity affects the contributions of the wealthier group members relative to the less wealthy. Again, the evidence is mixed, but while earlier studies suggested that wealthier individuals tended to over-contribute to the provision of public goods (Bergstrom et al., 1986), the weight of more recent studies is in favour of the opposite conclusion, namely that less well-endowed players tend to over-contribute to the public pool relative to the wealthier individuals in the group (Chan et al., 1996; Cardenas et al., 2002a; Buckley and Croson, 2006). In this paper, we add to this growing body of evidence by reporting the results of public goods games in which we examine the impact of income heterogeneity both on aggregate contributions to public goods at the group level, as well as differences in contributions by wealthier group members relative to less wealthy group members in respect of a public good.

3 Sample Description

Much of the experimental evidence concerning the impact of inequality on public goods provision comes from studies relying on university students as participants, leaving a dearth of information on the ways in which inequality might affect behaviour amongst other sample groups. Consequently, we choose to study the behaviour of a large sample of individuals from nine different fishing communities along the west coast of South Africa. We chose these communities in order to recruit individuals who would have some real experience of the kinds in social dilemmas presented in a public goods game. Since fishers typically have to resolve the very real cooperative dilemma of not engaging in over-extraction, they presented an interesting and appropriate sample for our purposes.

A total of 569 individuals[1] were recruited, making this a large sample in comparison with other experimental studies of this nature (see Table 1 for sample statistics). In our view, this is a real strength of this work and the results presented here. On average, participants were 40 years old, had lived in their communities for most of their lives and, with the exception of Community 2, almost exclusively spoke Afrikaans as their first language. Just under 60% of the participants were male, although this varied considerably by community. Two-thirds of the participants classified themselves as Coloured[2], while a majority of the remaining classified themselves as Black or "Other", although again, at the community level, there is some variation in these

[1] Of this, 128 were from community 1; 58 from community 2; 91 from community 3; 85 from community 4; 107 from community 5; 23 from community 6; 17 from community 7; 24 from community 8; and 36 from community 9.

[2] In South Africa, the term "Coloured" traditionally refers to an individual of mixed race heritage.

ratios.

On average, participants had obtained eight years of education. Fewer than 2% of our sample reported having no education at all. One third had obtained some primary education (of these, 13% had completed their primary schooling), while 60% reported having obtained some high school education. Of these, only 8% had completed their school leaving exam. Finally, only 6% of our sample had any form of tertiary education. Unemployment amongst participants was high, with only 48% reporting that they were currently employed at the time of the survey. Of those who were employed, more than half reported fishing activities to be their primary source of income. Mean wage income for employed individuals in our sample (after tax) was R920 per month (approx. US$184). Mean monthly household per capita income for the entire sample was R330.48 (approx. US$66) compared with mean monthly household per capita expenditures of R379.93 (approx. US$76). Not only is there considerable variation in these income measures across the different communities in our sample, but the standard deviations associated with these income measures are, in some communities, quite large, suggesting that the concept of inequality as introduced in the game would not have been an unfamiliar concept to many participants.

Finally, note that participants knew at least one other person in their group, and on average, they knew two other individuals in their group. However, the incidence of relatives or work colleagues being allocated to the same group was low, and thus, it is unlikely that kinship ties or work relationships are the primary drivers of our results.

While we have reported the average sample statistics here, it is self-evident from Table 1 that there is considerable observed heterogeneity across the nine communities. We try to control for as much of the variation in observed individual characteristics as possible in our regression analysis, but also include community fixed effects to deal with heterogeneity at this level.

4 Experimental Design

Participants were recruited through use of community leaders, fishers associations, and flyers and adverts in community centres and harbours. At least one month prior to the experiments, potential participants were asked to attend an initial session

Table 1: Sample Statistics by Community.

Variable	ALL n=569	Com1 n=128	Com2 n=58	Com3 n=91	Com4 n=85	Com5 n=107	Com6 n=23	Com7 n=17	Com8 n=24	Com9 n=36
Male (%)	0.58	0.52	0.81	0.93	0.66	0.18	0.64	0.94	0.54	0.43
Coloured (%)	0.66	0.76	0.52	0.64	0.62	0.62	0.55	0.80	0.65	0.86
White (%)	0.02	0.00	0.19	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Black (%)	0.17	0.16	0.30	0.19	0.21	0.13	0.18	0.07	0.13	0.09
Indian (%)	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other (%)	0.14	0.08	0.00	0.17	0.17	0.24	0.27	0.13	0.22	0.06
Afrikaans (%)	0.88	0.77	0.41	1.00	0.92	0.99	1.00	1.00	1.00	1.00
English (%)	0.09	0.22	0.41	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Xhosa (%)	0.03	0.01	0.19	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Age	40.37	37.09	46.59	41.82	34.65	39.13	54.61	45.38	48.54	38.56
	(13.64)	(11.83)	(14.96)	(11.67)	(13.01)	(12.99)	(12.08)	(15.08)	(18.50)	(8.29)
Yrs. lived in Community	30.39	27.81	27.11	34.42	29.42	30.85	40.45	23.68	29.83	32.47
	(13.26)	(7.88)	(18.65)	(14.70)	(12.63)	(13.91)	(12.89)	(9.11)	(12.50)	(11.33)
Household size	5.10	5.38	4.33	5.56	5.19	4.94	4.70	5.43	4.96	4.63
	(2.33)	(2.29)	(2.52)	(2.63)	(2.36)	(2.14)	(1.82)	(2.87)	(2.36)	(1.65)
Yrs education	8.37	8.33	7.76	8.43	8.69	8.96	7.50	7.69	7.33	8.33
	(2.51)	(2.45)	(2.70)	(2.58)	(2.08)	(2.43)	(2.11)	(2.94)	(3.14)	(2.62)
Fishing is main Activity	0.56	0.56	0.63	0.65	0.48	0.58	0.43	0.63	0.33	0.60
	(0.50)	(0.50)	(0.49)	(0.48)	(0.50)	(0.50)	(0.51)	(0.50)	(0.48)	(0.50)
Have a job	0.48	0.44	0.58	0.55	0.46	0.57	0.30	0.38	0.29	0.33
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.47)	(0.50)	(0.46)	(0.48)
Monthly wage (after tax)	920.55	1145.97	929.37	999.61	720.43	846.67	517.50	980.00	520.00	958.21
	(1010.99)	(1201.88)	(709.32)	(1181.4)	(688.09)	(1150.91)	(321.86)	(506.95)	(285.93)	(817.90)
HH per capita Income	330.48	284.25	568.38	287.44	178.98	344.48	333.34	382.07	488.35	454.52
	(455.99)	(366.34)	(904.53)	(411.58)	(149.44)	(337.81)	(346.16)	(338.66)	(520.82)	(526.26)
HH per capita Expenditure	379.93	349.57	432.35	443.40	185.59	362.65	302.81	338.75	716.91	621.22
	(438.95)	(376.31)	(423.27)	(666.99)	(123.68)	(263.27)	(308.69)	(216.94)	(682.56)	(561.95)
No. known in group	2.24	1.72	1.68	2.71	2.62	2.43	1.83	2.63	1.73	2.81
	(1.05)	(1.21)	(1.22)	(0.70)	(0.73)	(0.91)	(0.89)	(0.89)	(1.12)	(0.58)
No. work with in group	0.62	0.37	0.76	0.91	0.72	0.55	0.10	1.06	0.24	0.88
	(1.00)	(0.75)	(1.12)	(1.19)	(1.08)	(0.91)	(0.30)	(1.18)	(0.70)	(1.12)
No. relatives in group	0.27	0.20	0.04	0.42	0.51	0.21	0.10	0.29	0.05	0.41
	(0.65)	(0.46)	(0.20)	(0.82)	(0.85)	(0.60)	(0.31)	(0.83)	(0.22)	(0.80)

Std deviation in brackets

during which their details were recorded and they were asked to complete a questionnaire that elicited information on their socio-economic background, employment activities, fishing experience and a range of attitudinal questions. These individuals were then randomly allocated to groups for the public goods games which occurred a month later, and were typically run during the day in local community centres. Random allocation of subjects is vital in order to ensure no systematic correlation between socio-economic characteristics and one's token endowment. This holds true for our data.

On the day of the experiments, participants were directed to their groups. Each group initially played a simple linear public goods game as adapted by Isaac, Walker and Thomas (1984) which lasted for six rounds[3]. After a short break, the same group reconvened to play a public goods game with punishment[4]. In both games, the marginal per capita return (MPCR) was set at 0.5, and the structure of the game ensured that the Nash equilibrium was for individuals to contribute nothing to the public pool, whilst the social optimum for the group was achieved if every individual contributed their full endowment to the public pool. The key contribution of our work, however, is that we introduce inequality in token endowments for some groups (called the Unequal Treatment), and compare this to the behaviour of groups where all group members receive the same number of experimental tokens (called the Equal Treatment). In the Equal Treatment, all players received 40 tokens in each round of the game. In the Unequal treatment high endowment players were allocated 50 tokens in each round of the game, while low endowment players were allocated 30 tokens. There were 143 groups in total, each consisting of four players[5]. Of these, 73 groups participated in the Unequal treatment, while 70 were assigned to the Equal Treatment.

Endowment status was randomly allocated and not earned[6]. In the Equal Treatment, the experimenter then announced to the group that everyone in the group

[3]Given low literacy rates, a linear framework was adopted in order to keep the game as simple as possible. There were two practice rounds at the start of the game, but participants were not paid for these rounds.

[4]We did not test for order effects by reversing the order of the games. Available evidence from Fehr and Gächter (2000) suggests that the order of treatments with these particular games does not affect the results in any significant way.

[5]The sample includes five groups of size three. The MPCR in the games for these groups was kept at 0.5 as for group sizes of four, and their inclusion in the analysis does not alter the results in any qualitative way.

[6]In all groups, at the start of the simple public goods game, players were asked to randomly select an envelope which contained all the protocols and record sheets for the game, as well as information about the number of tokens they had been allocated. Once participants had selected their envelopes, they were asked to open their envelopes but to keep their information private.

had been allocated 40 tokens, while in the unequal treatment, the experimenter announced that two individuals had been allocated 50 tokens, while the other two had been allocated 30 tokens. However, the actual identity of high and low endowment players was not publicly revealed within the group[7]. Individuals maintained the same endowment status throughout the experiments, and payoffs were calculated according to the function $\pi_i = (y - g_i) + 0.5 \sum g_i$, where y is the initial token endowment, and g_i is the individual's contribution to the public account.

Each token was worth 10 cents (US 2 cents), and on average, participants earned R110 (US$22) for their participation, which is approximately two day's wages, 12% of median monthly household income or one-third of household per capita income. Each experimental session lasted between two and a half and three and a half hours, and was completed in August and September 2004. In some communities, two or three sessions were scheduled each day. Finally, while all participants participated in both a simple public goods game without punishment followed by a public goods game with punishment, in this paper we focus only on the results arising from the public goods game without punishment. For a deeper analysis of the differences between the two games, the reader is referred to Visser and Burns, 2006.

5 Results

We limit our analysis here to the results from the public goods game without punishment. In our regression analysis, we present coefficient estimates obtained from both pooled OLS regressions as well as those obtained using multilevel or hierarchical regression techniques that account for clustering at the group and individual level. In our data, the assumption of independent observations is likely to be violated due to

[7]In each group, players were seated with dividers in between them so that they could not see the decisions made by others or communicate with others in the group. During each round, players would first record their information on their personal record sheets before proceeding one at a time to the front of the room where a privacy booth had been set up. Individuals then recorded their decision onto a large template in the privacy booth. To ensure anonymity, the template was designed so that the player could only view his/her own entries and not those of the other group members. This was done by using Velcro to seal cardboard flaps over each person's corresponding line in the template. To begin, the cardboard flaps were all sealed. When an individual entered the booth, they would locate their entry line by looking for their player identification number, and then unseal the cardboard flap on that line. Had they attempted to raise a second flap, the sound made by the Velcro was sufficient to make this publicly known. The order of player identification numbers on the templates for each round were randomised. Once all four players had recorded their decisions onto the template, the experimenter then entered the booth to retrieve the information sheet under the cardboard template, and calculated the total contribution in the public pool before announcing the return from the pool. The MPCR in each round was set to 0.5 in all groups.

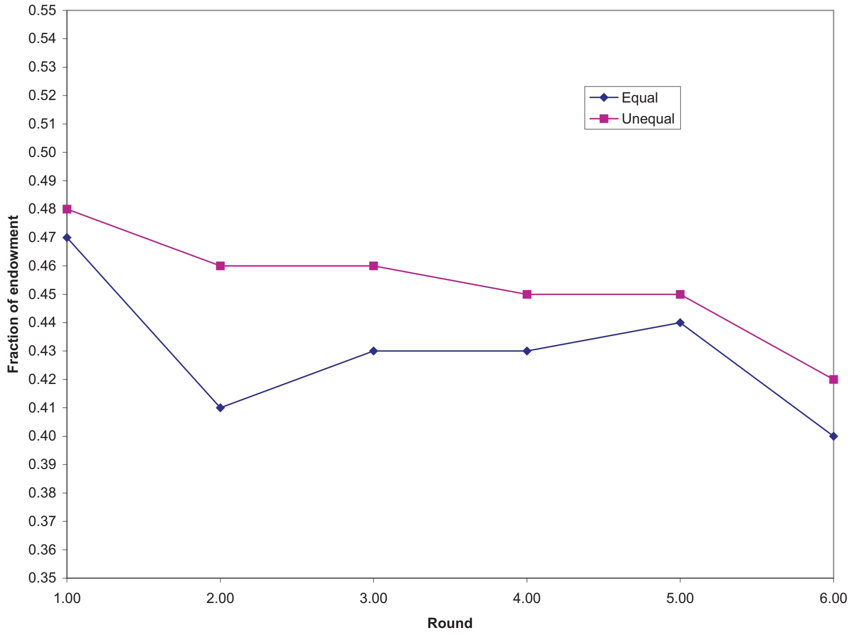

Figure 1: Mean Fraction of Endowment Contributed to Public Pool by Treatment

dependence among contributions to the public good made by individuals in the same group. Moreover, since any single individual makes repeated decisions, individual decisions over the course of each game are not independent of each other. Hence, while we do provide pooled OLS results, these estimates are simply for comparison, and our preferred estimates are those arising from the HLM specifications[8].

Result 1 *Mean contributions to the public pool are higher in unequal groups.*

Figure 1 demonstrates that on average, players in the unequal treatment contributed a larger fraction of their token endowment to the public pool than those in the equal treatment. Players in the unequal treatment begin by contributing 48% of their token endowment on average to the public pool compared to 47% for players in the equal treatment (Table 2, Panel A). These contributions decline as the game progresses, although the extent of the decline is not substantial. By the final round, players in the unequal groups contribute 42% of their token endowment to the public pool compared with 40% for players in the equal treatment (Figure 1 and Table 2, Panel A). These magnitudes are consistent with the large body of evidence concerning initial contributions in other public goods games (Ledyard, 1995; Marwell and

[8]Our estimates are obtained using the xtmixed command in STATA.

Ames, 1980; Isaac et al., 1984), although the rate of decline in contributions to the public pool is not quite as large in this sample as has been reported in other cases. Both a simple t-test (t=-2.49, p=0.01) and a two-sample Wilcoxon ranksum test suggest that the average contributions to the public pool are significantly higher in the unequal treatment relative to the equal treatment (z=-2.995; p=0.0027)[9]. While this result is confirmed in our pooled OLS regression in Column 1 of Table 3, the result is not robust to the HLM specification in Column 2 (our preferred specification), and hence, we do not make any strong claims about the significance of these differences.

Result 2 *Low endowment players make significantly higher contributions to the public pool than all other players.*

While we do not make any strong claims about the significance of the differences in contributions made by equal versus unequal treatment groups, our results do suggest that low endowment players (those allocated 30 tokens) make significantly larger relative contributions to the public pool than all other players (Columns 4 and 6 in Table 3). The results in Column 4 of Table 3 suggest that the contributions made by low endowment players are significantly higher than contributions made by players in the equal treatment groups (those who all receive 40 tokens), and a Wald test confirms that the difference in the coefficients for 30 token players relative to 50 token players is significant (chisquare=2.87; p=0.09). This latter result is affirmed in Column 6, which limits the sample to Unequal treatment groups only, and demonstrates that relative contributions made by high endowment players are significantly lower than those made by low endowment players, albeit at the 10% significance level. However, the actual magnitude of these differences is quite small at 3%.

Result 3 *Contributions by the majority of players approximate a proportional fair share threshold.*

There is evidence to suggest that in public goods settings, players make their contributions in accordance with some reference to a "fair share" contribution or threshold (Buckley and Croson, 2006; Sugden, 1982). Buckley and Croson (2006) examine one

[9]Moreover, a Kruskal-Wallis test confirms that the distribution of average contributions to the public pool are significantly different across these two treatments ($\chi = 8.916; p = 0.0028$).

Table 2: Mean and median contributions.

Round		Panel A: Number of tokens contributed as fraction of endowment				Panel B: Number of tokens contributed as fraction of tokens in pool			
		Player allocated 30 tokens	Player allocated 40 tokens	Player allocated 50 tokens	All Players	Player allocated 30 tokens	Player allocated 40 tokens	Player allocated 50 tokens	All Players
Round 1	Mean	0.50	0.47	0.46	0.47	0.20	0.25	0.30	0.25
	Std. Dev	(0.23)	(0.26)	(0.21)	(0.24)	(0.10)	(0.13)	(0.12)	(0.12)
	Median	0.50	0.50	0.50	0.50	0.20	0.25	0.29	0.25
Round 2	Mean	0.48	0.41	0.44	0.43	0.20	0.25	0.30	0.25
	Std. Dev	(0.24)	(0.26)	(0.22)	(0.25)	(0.11)	(0.15)	(0.13)	(0.14)
	Median	0.50	0.38	0.40	0.50	0.19	0.26	0.30	0.25
Round 3	Mean	0.46	0.43	0.46	0.45	0.19	0.25	0.31	0.25
	Std. Dev	(0.27)	(0.27)	(0.25)	(0.27)	(0.12)	(0.16)	(0.17)	(0.16)
	Median	0.50	0.40	0.50	0.50	0.19	0.24	0.30	0.24
Round 4	Mean	0.46	0.43	0.43	0.44	0.20	0.25	0.30	0.25
	Std. Dev	(0.28)	(0.29)	(0.25)	(0.27)	(0.11)	(0.16)	(0.16)	(0.15)
	Median	0.50	0.38	0.40	0.40	0.20	0.24	0.31	0.24
Round 5	Mean	0.46	0.44	0.44	0.45	0.19	0.25	0.31	0.25
	Std. Dev	(0.28)	(0.30)	(0.25)	(0.28)	(0.12)	(0.16)	(0.17)	(0.16)
	Median	0.47	0.44	0.44	0.45	0.18	0.24	0.32	0.24
Round 6	Mean	0.43	0.40	0.42	0.41	0.19	0.25	0.31	0.25
	Std. Dev	(0.28)	(0.29)	(0.28)	(0.29)	(0.12)	(0.18)	(0.19)	(0.17)
	Median	0.35	0.38	0.40	0.38	0.19	0.25	0.32	0.24

Table 3: Fraction of endowment contributed to public pool by treatment, between equal and unequal groups, and within unequal groups.

Dep var: Fraction of token endowment contributed to public pool	OLS (1)	HLM (2)	OLS (3)	HLM (4)	OLS (5)	HLM (6)
					Unequal treatment only	
Unequal treatment	.26 ***	.03				
	(0.09)	(0.02)				
Allocated 30 tokens			.29 ***	.05 **		
			(0.09)	(0.02)		
Allocated 50 tokens			.25 ***	.01	-.04 ***	-.03 *
			(0.09)	(0.02)	(0.01)	(0.02)
Round	-.01 ***	-.01 ***	-.01 ***	-.01 ***	-.01 ***	-.01 ***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	.32 ***	.56 ***	.31 ***	.55 ***	.81 ***	.82 ***
	(0.07)	(0.09)	(0.07)	(0.09)	(0.08)	(0.11)
Adj 2	.21		.21		.19	
n	3221.00	3221.00	3221.00	3221.00	1667.00	1667.00
LogL		194.84		196.27		166.99
Wald		46.07		49.08		40.34
No. groups		144.00		144.00		73.00
Chisquare		935.98		931.99		404.89

Significance: ***=1%; **=5%; *=10%. Std errors in brackets
All regressions include additional controls (not reported) for gender, race, years of education, age and age squared.
The OLS regressions include additional fixed effects for groups and communities.
The HLM regressions include fixed effects for communities, and control for clustering at the group and individual level.

potential hypothesis, namely that individuals contribute their fair share, where this is taken to be one quarter of the pool in a group of 4 players. Our data suggests a different possibility, namely that individuals follow some kind of simple heuristic that ensures that their contribution to the public pool reflects the ratio of their token endowment to the total tokens available to be contributed to the public pool. We term this ratio the player's *proportional fair share threshold*, since it represents a focal point which informs the player's contribution decision. For example, in a group of four players where each one is allocated an endowment of forty tokens, this might accord with the majority of players attempting to ensure that their contribution constitutes one quarter of the total in the public pool (since their individual endowment of forty tokens constitutes a quarter of the total tokens available in the game).

In Panel B of Table 2, we present summary statistics on the number of tokens contributed by each individual as a fraction of the total number of tokens in the pool in each round. In other words, this measures the proportion of the public pot attributable to each individual based on the absolute number of tokens he or she contributed. What is remarkable about these mean statistics is their consistency across rounds. The majority of players in the Equal Treatment (40 token players) made a contribution to the public pool *in each round of the game* that amounted to one quarter of the total tokens in the pool. Similarly, in the Unequal Treatment, contributions made by the majority of low endowment players amounted to 19% of the pool in each round (as would be predicted by the ratio of 3/16[10]), while contributions by the majority of the high endowment players amounted to 31% (or 5/16) in each round. Notice, however, that the standard deviation of the proportional fair share threshold for higher endowment players (those with 40 or 50 tokens) is larger than for low endowment players. This variation around the mean increases for the high endowment players as the game progresses, while for the low endowment players, it remains relatively stable.

Result 4 *Adjustments in contributions to the public pool maintain the proportional fair share threshold.*

Table 4 presents additional evidence in support of the argument that participants in these games followed some simple heuristic that resulted in this fair share threshold

[10]The idea is simply that players with 30 tokens should try to ensure their contributions match their relative position in the game, namely, 30 tokens out of a total of 160.

being implemented. In Table 4, we examine whether adjustments in individual contributions in subsequent rounds is influenced by the distance of their offer in the previous round from this fair share threshold. The results suggest that individuals experience disutility from being too far above or below their proportional fair share threshold, and adjust their subsequent offers accordingly[11].

The results presented in Column 1 suggest that changes in subsequent contributions are increasing in the distance between an individual's actual contribution and the fair share threshold[12]. In addition, individuals whose actual contributions were above the fair share threshold adjust their offers downwards, while those below the threshold adjust his/her offers upwards. Interestingly, the magnitude of the adjustment for those above and below this threshold appears to be similar[13].

The results presented in Column 2 focus on whether the adjustment mechanism appears to be any different across equal and unequal treatment groups. The coefficients suggest that while changes in subsequent contributions are increasing in the absolute distance between an individual's actual contribution and the fair share threshold in the previous round, the magnitude of this response is muted in unequal treatment groups, both for individuals above and below the threshold.

Finally, Column 3 presents estimates for the Unequal treatment groups only. The results suggest that the magnitude of changes in contributions across rounds is smaller for high endowment players than low endowment players. Secondly, while changes in subsequent contributions are increasing in the absolute distance between an individual's actual contribution and the fair share threshold in the previous round, the magnitude of the downward adjustment for those above the threshold is larger than the upward adjustment for those below the threshold[14].

[11] Note that we are not claiming that individuals completed the cognitively demanding task of calculating this exact threshold, although we also cannot rule this possibility out. Our goal here is to simply illustrate that adjustments in contributions do appear to be associated with this threshold.

[12] The fair share threshold is different for individuals with different token endowments. Our measure is calculated as the difference between an individual's actual contribution share and the fair share threshold for his/her token status.

[13] If one evaluates the partial derivative of the change in offers with respect to the absolute deviation from the threshold, the coefficient of 0.72 reflects the magnitude of the change for those below the threshold, while the partial derivative for those above the threshold is -0.73 (calculated as 0.72-1.45).

[14] Evaluating the partial derivative with respect to the absolute deviation from the threshold, the coefficient of 0.42 reflects the upward adjustment for those below the threshold, while -0.67 reflects the downward adjustment for those above the threshold.

Table 4: Change in fraction of endowment contributed to public pool.

Dep var: Change in fraction of endowment contributed	HLM (1)	HLM (2)	HLM (3)
			Unequal treatment only
Combined contribution of others in previous round	0.01	0.01	0.13 ***
	(0.03)	(0.03)	(0.04)
Unequal treatment		0.04	
		(0.03)	
Allocated 50 tokens			-0.09 ***
			(0.03)
Round	-0.01 ***	-0.01 ***	-0.01 *
	(0.00)	(0.00)	(0.00)
Absolute deviation from fair share threshold in previous round	0.72 ***	0.86 ***	0.42 *
	(0.08)	(0.10)	(0.24)
Positive deviation from fair share threshold in previous round	-0.03 *	0	-0.02
	(0.01)	(0.02)	(0.03)
Absolute deviation from fair share threshold in previous round x positive deviation	-1.45 ***	-1.67 ***	-1.09 ***
	(0.08)	(0.11)	(0.24)
Absolute deviation from fair share threshold in previous round x unequal treatment		-0.36 **	
		(0.16)	
Positive deviation from fair share threshold in previous round x unequal treatment		-0.05 *	
		(0.03)	
Absolute deviation from fair share threshold in previous round x positive deviation x unequal treatment		0.5 ***	
		(0.17)	
Absolute deviation from fair share threshold in previous round x 50 tokens			0.02
			(0.27)
Positive deviation from fair share threshold in previous round x 50 tokens			-0.05
			(0.04)
Absolute deviation from fair share threshold in previous round x positive deviation x 50 tokens			0.1
			(0.28)
Constant	0.27 ***	0.24 ***	0.39 ***
	(0.07)	(0.07)	(0.09)
n	3216	3216	1666
LogL	214.93	222.95	216.67
Wald	1899.92	1920.19	763.96
No. groups	144	144	73
Chisquare	86.02	88.49	15.22

Significance: ***=1%; **=5%; *=10%. Std errors in brackets
All regressions include additional controls (not reported) for gender, race, years of education, age and age squared. The HLM regressions include fixed effects for communities, and control for clustering at the group and individual level.

6 Discussion

Our results suggest that individuals do bring preferences for fairness into the experimental setting, but that these preferences are proportional to one's token endowment position. Remarkably, in our sample, the contributions made by the majority of individuals appear to approximate a proportional fair share threshold, and these preferences persist even in the presence of inequality. Moreover, individuals appear to adjust their offers either upwards or downwards in relation to this threshold in subsequent rounds, although this tendency is muted in the unequal treatment groups. This muted response in unequal treatment groups may, at least partly, be attributed to greater cognitive difficulties associated with calculating the fair share threshold in the presence of unequal token endowments. Moreover, recall that the standard deviation around this fair share threshold was larger for high endowment players, suggesting that within unequal groups, high endowment players had greater difficulty approximating this level. It is unclear why this should necessarily be the case, but such a trend would also serve to mute this behavioral response.

Of course, we do not wish to claim that participants in these games actually completed the cognitively demanding task of calculating the exact fair share threshold relevant for their token endowment status, although we also cannot rule this possibility out. However, given the low levels of literacy amongst individuals in our sample, we think it far more plausible that individuals adopted some simple heuristic in deciding on their contributions for the next round. For example, consider the following simple rule. Individuals may have made their contribution decisions based on what they think an acceptable distance is between their own absolute token contribution and the mean absolute contribution of others in the group, without paying due regard to differences in token endowments (which would make adjustments in relative contributions the appropriate focal point). Since, at the end of each round, the experimenter announced the total number of tokens in the public pool, it was possible for individuals to compare the absolute number of tokens they had contributed to that total, relative to the mean absolute contribution made by all others in the group. Individuals could have adjusted the absolute number of tokens contributed in the following round accordingly, by trying to maintain an acceptable distance between their own token contributions and the mean contribution of others in the group. This distance would be given by $D_i = t_i - \frac{T-t_i}{3}$, where D_i is the distance between the absolute number of tokens contributed by individual i and the mean absolute number of tokens contributed by others in their group t_i is the absolute number of tokens contributed by individual i, and T is the total number of tokens in the pool at the end of any given previous round.

Table 5: Difference between individual offer and mean offer by others in group, by round and token endowment status.

Round		30 tokens	40 tokens	50 tokens	All
1.00	Mean	-4.97	.25	5.28	.20
	Std. dev	9.28	11.04	11.17	11.25
2.00	Mean	-4.70	.41	5.18	.31
	Std. dev	9.31	11.37	11.70	11.51
3.00	Mean	-5.65	.18	6.43	.27
	Std. dev	10.17	11.87	13.39	12.62
4.00	Mean	-4.89	.07	4.91	.03
	Std. dev	9.77	11.72	13.63	12.28
5.00	Mean	-5.42	.31	5.54	.17
	Std. dev	9.61	12.78	13.23	12.77
6.00	Mean	-5.27	.00	5.42	.03
	Std. dev	9.86	12.69	14.87	13.19
Total	Mean	-5.15	.20	5.46	.17
	Std. dev	9.65	11.91	13.03	12.28

Table 5 presents some preliminary evidence in this regard. The data presented in this table are calculated using the formula defined above. On average, there is no difference between the mean number of tokens contributed by players in the equal treatment groups (who all received 40 tokens). This must be true in order for the fair share threshold to be implemented, with each player contributing 25% of the total pool. If participants were indeed following such a simple rule of thumb as we posit above, this would imply a rule consistent with the notion that in the absence of inequality in token endowments, individuals should try to make similar mean contributions similar to those of their fellow group members, i.e. unequal shares are not acceptable in the presence of equal token endowments. However, regarding the unequal treatment groups, the evidence suggests that low endowment players consistently contributed 5 tokens less than the mean number of tokens in their group, while the converse holds true for the high endowment players. When the mean number of tokens contributed by others in the group is 20, this produces the result that the endowment shares contributed by high and low endowment players is the same at 50%. As soon as the mean number of tokens contributed by others in the group exceeds 20 (which is the case 40% of the time in unequal treatment groups), this rule produces the result that the endowment share contributed by low endowment players exceeds the endowment share contributed by high endowment players, consistent with our regression results. Such behaviour implies a rule consistent with the notion that in the presence of inequality in token endowments, some level of inequality in contributed share to the pool might be acceptable. In this specific instance, it would appear that low endowment players find it acceptable to consistently contribute an absolute number of tokens that is just below the absolute mean token contribution of others in their group, while the high endowment players find it acceptable to contribute an absolute number of tokens that is marginally higher than the group mean. Thus, it would appear that unequal shares are acceptable in the presence of unequal token endowments. That the mean distance for both types of players is 5 tokens on average is interesting and may be suggestive of some kind of focal point.

Of course, this argument is purely speculative. Any one of a number of simple rules could have been adopted by participants, and in the absence of more detailed data and extensive debriefing sessions with participants, it is not possible to definitively identify a specific rule to the exclusion of all others. What is remarkable, however, is that the adoption of a simple rule of thumb is sufficient to implement an outcome where individual contributions to the public pool are consistent with their relative endowment status. In addition, the rules used by individuals to adjust their contribution decisions over rounds work to maintain this contribution threshold. This suggests that there is something about the adjustment mechanisms used that are common across players. That all of this happens in the absence of communication amongst participants makes the results even more remarkable.

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Fairness and Accountability: Testing Models of Social Norms in Unequal Communities

Martine Visser* †

Martine.Visser@economics.gu.se

Abstract

We examine behavioural models involved in the provision of public goods when income inequality exists within groups. Our sample consists of individuals from urban and rural South African fishing communities. We find that behaviour observed in unequal groups does not accord with models of inequality aversion or egocentric altruism which require an equal distribution of final payoffs. On the other hand it is also not the case that individuals completely discount differences in initial allocations of wealth, as proposed by our absolute reciprocity model. Instead our empirical results lends support to a reciprocal model which requires that individuals contribute a proportional share of their initial endowments. Accordingly individuals are only partly held responsible for exogenous differences in initial wealth.

Keywords: Social Norms, Inequality aversion, Altruism, Reciprocity, Public goods JEL classification: C9, C72, D63, D64, H41, Z13

*Göteborg University, Department of Economics, Telephone: +46 (0)31 773 1317. Address: Vasagatan 1, Box 640, 405 30 Göteborg, Sweden.

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1 Inequality and the Provision of Public Goods

Fairness is a moral concept that strongly motivates an individuals' response to social interactions, legal institutions, international disputes, etc. Yet how norms for fairness are defined or what level of inequality is considered as acceptable may differ substantially based on the political institutions (Alesina and Angeletos 2005), cultural norms and social conditions (Henrich 2001, 2005) an individual has experienced.

In this study we investigate how inequality is perceived within communities and the notions of fairness that drives provision of public goods when there is inequality within groups. We specifically focus on the extent to which individuals holds others in their community or group accountable for differences in exogenous levels of wealth, when deciding how much of their endowment to contribute to the public good. To this end we use public good experiments where individuals within groups receive unequal endowments. Instead of assuming individuals to be purely rational, selfish utility maximizers, we consider various models of behaviour where we allow different attitudes or preferences for fairness to enter the individual's utility function.

We use a unique sample of participants from nine different fishing communities along the west coast of South Africa. In subsistence communities normative rules of behaviour can be crucial for sustaining a resource, but also for weaving the fabric of social institutions that influence the functioning of such communities. An advantage of our subject pool is that everyone in these communities have direct or indirect experience of social dilemmas. This facilitates the testing of our models with regard to whether individual behaviour in the experiment is also a function of prior or experiential norms of fairness that individuals bring with them from the community or social context in which they live.

Behaviour in social dilemmas with heterogeneity, be it in terms of income, race or gender, have been studied in some depth in the experimental literature. Common pool resource experiments that have dealt with income heterogeneities among subjects within groups include Walker, Gardner and Ostrom (1990) who use treatments with high and low endowment players within groups and Hacket, Schlager and Walker (1994) who introduce treatments with varying endowments and communication. Cardenas, Strandlund and Willis (2002) explore the same subject but change the context somewhat — in their experiments, subjects face varying pay-off tables and communication.

Both non-linear and linear public goods experiments have been employed to study the effects of inequality in endowments on public good provision. The social-psychological literature dealing with this issue includes Van Dijk and Wilke (1994), as well as, Van Dijk and Grodzka (1992) who study the implication earned versus random inequality for cooperation and also the effects of information on distributional outcomes. Chan et al., (1997, 1999) study the interaction of endowments and information in a non-linear context. Linear public goods designs with varying show-up fees have been used by Anderson, Mellor and Milyo (2004) whereas Cherry, Kroll and Shogren (2005) and Buckley and Croson (2006) used varying endowments in their experimental design.

Very few papers that we know of have tried to explain contribution towards public goods in groups with unequal wealth allocations by formalizing models of behaviour that account for fairness or distributive preferences. In a thought-provoking paper on public goods provision in unequal groups, Buckley and Croson (2006) test and reject both altruist and inequality aversion models in explaining behaviour observed in their experiments. They go on to suggest, using empirical estimation, that behaviour in their study is consistent with a form of reciprocity that requires all individuals to make the same absolute contributions to the public pool, irrespective of their endowments.

In this paper we extend this work by advancing generalized models for inequality aversion, for egocentric altruism, and for absolute and proportional reciprocity. Our empirical results are consistent with the predictions for proportional reciprocity which only holds individuals partly accountable for non-discretionary differences in income.

2 Experimental Design

2.1 Public Goods Experiment — Basic Design

Our experiment uses a linear public goods (PG) framework. The design we use is similar to that of Fehr and Gächter (2000) and Carpenter (forthcoming). We choose a linear design to keep the experimental framework as cognitively simple as possible 1) given that the majority of participants are semi-literate and numeracy skills are low and 2) the effect of inequality on cooperation in a linear setting can be interpreted more clearly.

The experiment consists of two treatment conditions. In the first treatment, each of four group members receive an equal endowment of 40 tokens each. In the second treatment, two individuals in each group receive high endowments (50 ECUs), while 2 receive low endowments (30 ECUs).

The procedure is as follows: 569 individuals are randomly assigned to groups of four and remain in the same group for the entire session (fixed matching). Seventy groups are used in the baseline treatment where all players receive equal endowments (40 tokens). Seventy-three groups receive the unequal treatment where two players are randomly assigned lower endowments (30 tokens) and two players are assigned higher endowments (50 tokens) in every round. Once assigned a lower (or higher) endowment, that endowment is allocated in each of the 6 rounds of the experiment. A "poor" individual therefore remains "poor" throughout both sessions of the experiment.

2.2 Pay-off structure of the VCM treatment

In every round, each of $n = 4$ subjects receives a fixed endowment of E Experimental Currency Units (ECUs) of which they may invest g_i tokens in a public account. The investment decision is made simultaneously by all players. The pay-off function used in the VCM treatment can be expressed as

$$\Pi_i = (E_i - g_i) + a \sum_{j=1}^{n} g_j \quad (1)$$

for each round, where a is the marginal per capita return (MPCR) from public good contributions and is equal to 0.5. The total payoff from the VCM treatment is the sum of the pay-off for each round for 6 rounds of the game.

In the equal treatment, E is fixed for all players such that $E = 40$ ECUs[1]. In the unequal treatment 2 players each receive E_l (=30 ECUs) and 2 players receive E_h (=50 ECUs). The pay-off function for a high endowment player

[1]Given that the focus of this paper is on behaviour in unequal groups, we will not discuss the results of behaviour in equal groups further.

h_i is

$$\Pi_{hi} = (E_h - g_{hi}) + a[g_{hi} + g_h + 2\bar{g}_l], \tag{2}$$

and similarly the pay-off function for a low endowment player l_j is

$$\Pi_{lj} = (E_l - g_{lj}) + a[g_{lj} + g_l + 2\bar{g}_h]. \tag{3}$$

The Nash equilibrium in a one-shot public goods game is for individuals with self-interested preferences to contribute none of their respective tokens to the public good, and to free-ride on the contributions of others. In a repeated game with a finite horizon (as is the case here), where there are only 6 rounds and no incentives to cooperate in the final round, backward induction leads to Nash behaviour in every round.

2.3 Field setting

Our study focuses on rural fishing communities in nine different villages along the west coast of South Africa. In total, 569 individuals participated in both the survey and the experiments, of which about 60% were male and 70.9% were involved in fishing activities. The experiments where conducted in each of the communities in a community center or local school.

The experiment reported here was one of three that were conducted during the session. The experimental sessions lasted for 1 hour. In some communities two or three sessions were scheduled per day[2]. Each experimental token earned the participant 10 cents (US 2 cents) and on average participants earned about 110 South African Rands (US$22) for the entire session which lasted 2–3 hours.

3 Predictions

In the following section we formulate different models that incorporate other-regarding preferences into the individual's utility function. This allows us to make predictions for contribution behaviour of low versus high endowment

[2]We control for spill-over effects by randomly allocating sessions as equal or unequal for the public goods experiments. We also test for spill-over effects in the regression analysis that follows.

players in public goods experiments where individuals are endowed unequally. Our aim is to illustrate how behavioural models can be adjusted to reflect different preferences for distributional fairness, giving rise to different best response contribution functions based on the set of possible actions of other players.

In an interesting overview of theoretical and experimental work on interdependent preferences, Sobel (2005) points to conceptual difficulties in distinguishing between models with other-regarding preferences. He argues that often linguistic nuances distinguish these models from each other and that on the whole it is not immediately evident how and which arguments should enter the utility function when preferences are interdependent.

We link a model of inequality aversion and egocentric altruism with two models for reciprocity, assuming preferences for similar absolute contributions and relative contributions respectively. We adopt consistent notation between models wherever possible, in order to show that the underlying structure that connects these models with different distributive outcomes relies on the weighting individuals assign to differences in unearned wealth. Predictions are made for optimal behaviour (or contributions) given the fairness norms individuals ascribe to.

3.1 Inequality aversion

The first model we use is based on the inequality aversion model of Fehr and Schmidt (1999), which assumes an individual's utility is increasing with own pay-off but decreasing with the deviation between own and another's pay-off. Here individual i's utility, U_i, is a function of individual i's pay-off, $\Pi_i = E_i - g_i + a\sum_{j=1}^{n} g_j$, with two terms for aversion to disadvantageous and advantageous inequality in income respectively. Hence the individual obtains disutility from either negative or positive deviation in pay-offs from another group member j[3]. Importantly, the individual weights inequality with respect to each member in the group and not with respect to the group average as in Bolton and Ockenfels (2000). Inequality aversion as formulated

[3]In the application of their model to a public goods experiment (see Appendix, p.18) Fehr and Schmidt (1999) formulates aversion in terms of *differences in contributions. Pay-offs* and *contributions* are equivalent in a treatment with equal groups, but clearly not in the context of unequal groups. Hence we express the model explicitly in terms of individual *pay-offs* of low and high endowment players respectively.

by Fehr and Schmidt refers to differences in absolute wealth or pay-offs, placing emphasis on ex-post distributional equity rather than accounting for differences in wealth ex-ante or effort exerted in the production of the common good[4]. In this sense the model reflects a strict egalitarian attitude to distributional justice (Cappelen et al., 2006a&*b*).

Consider the utility function for individual i:

$$U_i = \Pi_i - \frac{\alpha}{n-1}\sum_{j=1}^{n}[\max(\Pi_j - \Pi_i, 0)] - \frac{\beta}{(n-1)}\sum_{j=1}^{n}[\max(\Pi_i - \Pi_j, 0)]. \quad (4)$$

The parameters α and β indicate the intensity of the aversion the individual experiences when player j's pay-off is greater than that of player i, and vice versa, where $\alpha > \beta$[5]. Also $\alpha > 0$ and $0 < \beta < 1$.

Predictions for our model can be derived keeping the same piecewise linear format, but for purposes of comparison with the other models we test, we assume a utility function that is linear in individual payoff and strictly convex in other-regarding preferences such that $U_i'(\Pi_i - \bar{\Pi}) < 0$ and $U_i''(\Pi_i - \bar{\Pi}) > 0$.

We reformulate the utility function shown in equation 4 according to our design and modify the inequality aversion term as stated above. The utility function of a low endowment player U_{lj} who is inequality averse is then:

$$\begin{aligned} U_{lj} = {} & E_l - g_{lj} + a(g_{lj} + g_l + 2\bar{g}_h) \\ & - \frac{\alpha}{n-1}[[(E_l - g_l + a\sum_{i=1}^{n} g_i - (E_l - g_{lj} + a\sum_{i=1}^{n} g_i)] \\ & + 2[(E_h - \bar{g}_h + a\sum_{i=1}^{n} g_i) - (E_l - g_{lj} + a\sum_{i=1}^{n} g_i)]]^2. \quad (5) \end{aligned}$$

The first term therefore describes the pay-off for a low endowment player j who obtains income from a private account (the difference between his endowment E_l and his contribution to the public good g_{lj}) and his pay-off from the public account (the sum of his contribution, the contribution of the other low endowment player in his group, g_l, and the average contribution of the two high endowment players, $2\bar{g}_h$, multiplied with the marginal per capita return a from the public good)[6].

[4]For a good overview see Roemer, 1993.

[5]Note that in the formulation of our model where inequality aversion is expressed as a quadratic term, we do not distinguish between α and β.

[6]In our design a is set equal to 0.5.

Proposition 1: *To equalize pay-offs, an inequality averse high endowment player should contribute exactly the same on average as a low endowment player plus an additional amount equal to the difference in their endowments.*

Proposition 1 implies that both the absolute and proportional contributions of high endowment players are higher than those of low endowment players.

Proof: Low endowment player j's optimal contribution, assuming utility maximizing behaviour, can be derived from first principles:

$$\frac{\partial U_{lj}}{\partial g_{lj}} = 0 \quad \Longrightarrow \quad \frac{1-a}{2\alpha} = g_l - 3g_{lj} - 2E_h + 2\bar{g}_h + 2E_l. \tag{6}$$

Similarly the utility function U_{hi} for high endowment player i who is inequality averse in terms of pay-offs is

$$U_{hi} = E_h - g_{hi} + a(g_{hi} + g_h + 2\bar{g}_l) - \frac{\alpha}{n-1}\Bigg[(E_h - g_h + a\sum_{i=1}^{n} g_i) - (E_h - g_{hi} + a\sum_{i=1}^{n} g_i) + 2\left((E_l - \bar{g}_l + a\sum_{i=1}^{n} g_i) - (E_h - g_{hi} + a\sum_{i=1}^{n} g_i)\right)\Bigg]^2. \tag{7}$$

Again by solving $\partial U_{hi}/\partial g_{hi} = 0$ the utility maximizing contribution for player i is found to be

$$\frac{1-a}{2\alpha} = g_h - 3g_{hi} + 2E_h + 2\bar{g}_l - 2E_h. \tag{8}$$

From equations 6 and 8 we are able to derive the best response function of player j assuming that he knows the best strategies of others in the group, and visa versa:

$$-3g^*_{lj} + g_l - 2\bar{g}_l + 2E_l - 2E_h = -3g^*_{hi} + g_h + 2E_h - 2E_l. \tag{9}$$

$$g^*_{lj} + E_h - E_l = g^*_{hi}. \tag{10}$$

Further generalization of equation 10 for the average high and low endowment player yields

$$\bar{g}^*_h = \bar{g}^*_l + E_h - E_l. \tag{11}$$

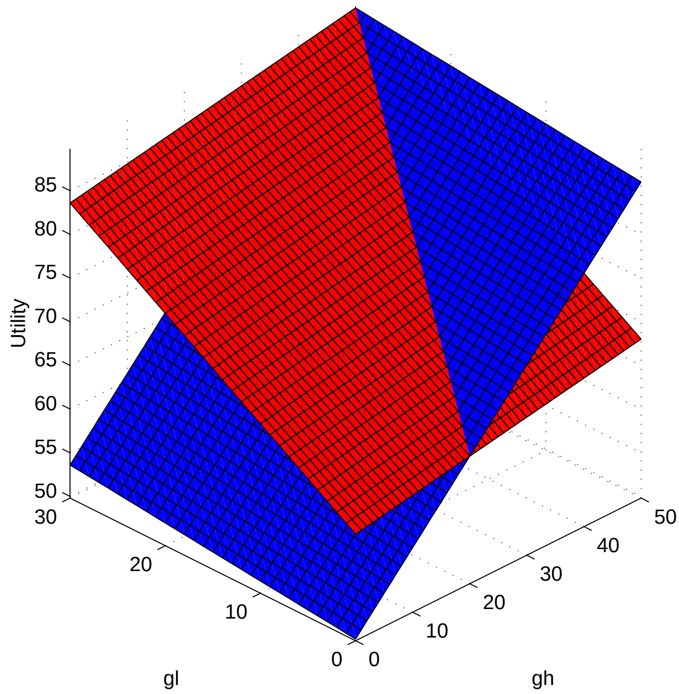
Q.E.D.

By using the same formulation as in Buckley and Croson (See Appendix I) we can verify these findings.

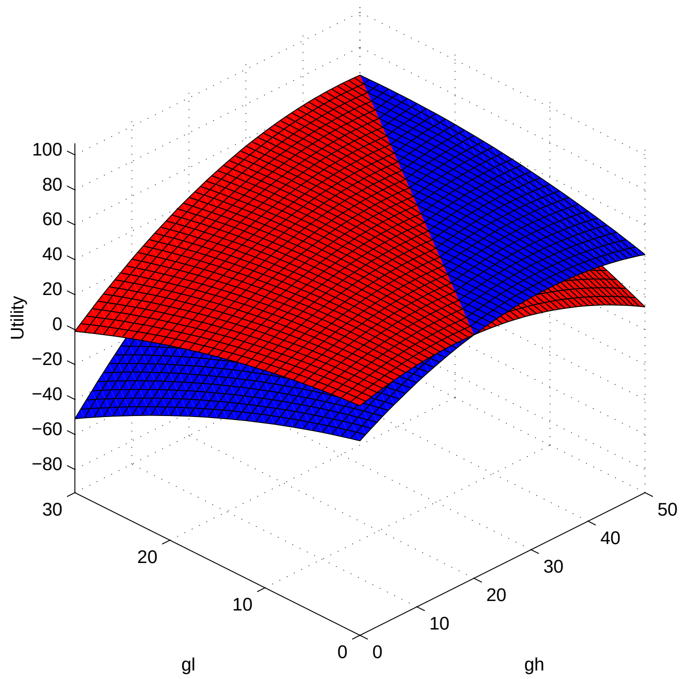
By formulating the individual's utility function in terms of egocentric altruist preferences, we obtain exactly the same predictions as for our inequality aversion model. This is perhaps not surprising given that inequality aversion as formulated by Fehr and Schmidt (1999) is just a more specific case of altruism.

The common premise of models that assume altruistic preferences is that an individual's utility increases in the material consumption or pay-offs of others. Becker (1974) shows that by maximizing utility subject to an individual's budget constraint it can be inferred that individuals' utility functions exhibit constant elasticity of substitution between own and other's income. Individuals are therefore willing to give up one unit of consumption in order to increase their opponent's consumption by one unit at the equilibrium. The intuitive implication for provision of public goods in unequal groups are therefore that individuals will seek to equalize pay-offs between low and high endowment players on average, which is what the inequality aversion model also predicts for our experiment. A number of theoretical models for altruism have added further specificity by assuming additive separability for own and other's utilities or pay-offs (Levine, 1998; Cox and Sadiraj, 2006; Buckley and Croson, 2006 and also see Sobel, 2005). We use the model of Cox and Sadiraj (2006) to derive the best response functions for low and high endowment players. Our derivations for the altruism models are shown in Appendix II.

Figure 1 illustrates the contribution surfaces for high and low endowment players on average, for both inequality aversion and altruist models as discussed here. The lighter surface illustrates the utility obtained by the average high endowment player with a) inequality averse and b) altruist preferences, for all possible contributions given the corresponding action set of the average low endowment player. Similarly the dark surface depicts the utility obtained by the average low endowment player. The intersection of these surfaces shows the best response function with the utility maximizing contribution levels for each player. The contribution surfaces for high and low endowment players respectively can be seen to intersect at that point where the average contribution for a high endowment player should always be exactly 20 ECUs (the difference in their endowments) higher than that of a low



[Egocentric Altruism]



[Inequality Aversion]

Figure 1: Contribution surfaces for high and low endowment players on average.

endowment player. At this point, pay-offs are equalized.

3.2 Reciprocity

In the next section we propose two different models with reciprocal preferences — the first assuming that individuals follow an absolute contribution norm while the second assumes that contributions are considered as fair if players contribute in proportion to their respective endowments. The difference between these two models therefore relies on how individuals perceive fair entitlements and to what extent they adjust for unearned differences in initial endowments between them, with the absolute contribution norm taking a libertarian perspective on distributive justice (see Cappelen 2006a). Both models are formulated in terms of utility functions of high and low endowment players respectively.

3.2.1 Absolute Reciprocity

We start with the simplest possible version of absolute reciprocity — consistent with the formulation of the inequality aversion model put forth earlier.

A high endowment player's utility function is then expressed as

$$U_{hi} = [E_h - g_{hi} + a(g_{hi} + g_h + 2\bar{g}_l)] - \beta(\bar{g}_{-hi} - g_{hi})^2, \tag{12}$$

where the first term indicates that the individual's utility is increasing in his pay-off, and the second term expresses the individual's aversion to positive or negative deviation in absolute contribution from the rest of the group. As with the inequality aversion model we specify that $0 < \beta < 1$, where the parameter β indicates the intensity of the individual's aversion to deviation from the norm. Within the second term $\bar{g}_{-hi}$ represents the individual's belief about the rest of the group's behaviour in this round. Given that all individuals have access to information about the rest of the group's average contribution in the last round, we assume this value to be representative of expectations in the present round.

> ***Proposition 2****: If individuals in unequal groups ascribe to reciprocal preferences based on an absolute contribution norm, the*

best reply correspondence of high and low endowment players are to contribute exactly the same in absolute terms.

Proof: From first order conditions we can derive utility maximizing contribution levels from both high and low endowment players. For a high endowment player

$$\frac{\partial U_{hi}}{\partial g_{hi}} = 0 \quad \Longrightarrow \quad \frac{1+a}{2\beta} = \frac{g_h}{3} - g_{hi} + \frac{2\bar{g}_l}{3}, \tag{13}$$

and for a low endowment player

$$\frac{\partial U_{lj}}{\partial g_{lj}} = 0 \quad \Longrightarrow \quad \frac{1+a}{2\beta} = \frac{g_l}{3} - g_{lj} + \frac{2\bar{g}_h}{3}. \tag{14}$$

Solving for the Cournot equilibrium we can derive the best reply correspondence of both a high and low endowment player as

$$-4g^*_{hi} = -4g^*_{lj}, \tag{15}$$

which can be generalized such that on average:

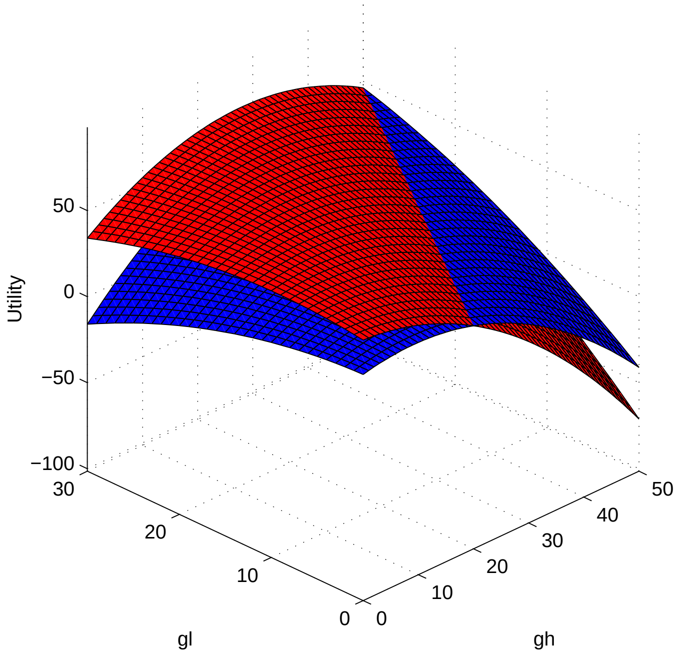
$$\bar{g}^*_h = \bar{g}^*_l. \tag{16}$$

Q.E.D.

Contributions of high endowment players should therefore on average be the same in absolute terms as for low endowment players, implying that the distribution in income remains exactly the same ex-post contribution stage as ex-ante. Once again we present contribution surfaces for high and low endowment players adhering to such preferences (See Figure 2). Although the high endowment players obtain greater utility by playing in accordance with their best reply strategies, the utility maximizing contribution levels for both low and high endowment players, when all players have complete knowledge of the set of strategy profiles available to themselves and other players, are exactly equal.

We add further specificity to this model for our empirical estimation, in line with reciprocity models of Frot (2005) and also that of Akpalu and Johansson-Stenman (2006) who describe the individual's norm in terms of a combination of the individual's intrinsic norm as well as the norm they infer from the group's expected behaviour or their behaviour in the last

[Absolute Reciprocity.]



[Proportional Reciprocity.]

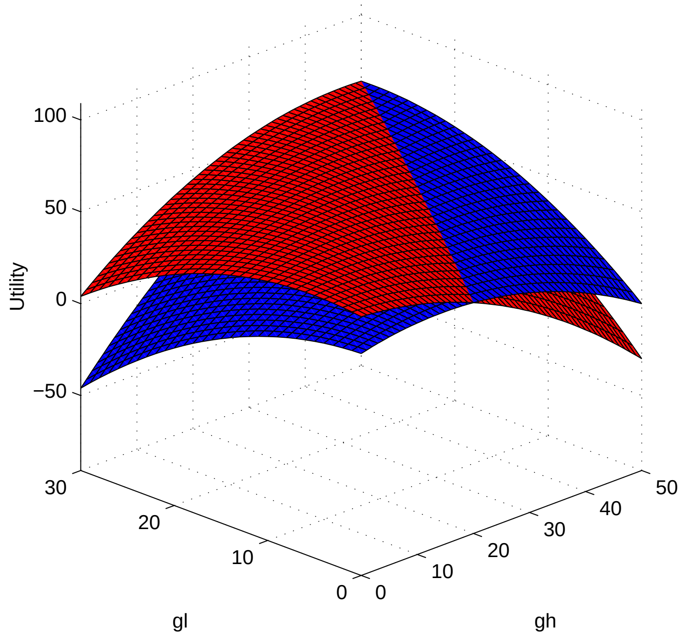


Figure 2: Contribution surfaces for high and low endowment players on average.

round. We use a similar specification, but where the norm is a weighted function of the intrinsic norm g^{ϕ} and that inferred by the group's average contribution in the last round $\bar{g}_{-i}$. We assume that individuals brings with them experiences from the community where they live, the family they grew up in or other morals based on fairness concerns that guide their day to day behaviour. Once they enter the game they adjust their beliefs based on their interaction with the rest of the group from round to round. Both parameters γ and ρ take values between 0 and 1, such that $\rho = (1 - \gamma)$.

A high endowment player's utility function is then expressed as

$$U_{hi} = [E_h - g_{hi} + a(g_{hi} + g_h + 2\bar{g}_l)] - \beta(\gamma g^{\phi} + \rho\bar{g}_{-hi} - g_{hi})^2. \tag{17}$$

The strategy set for a high endowment player who optimizes his utility over such preferences can be derived as

$$g_{hi} = \gamma g^{\phi} + \frac{-1 + a}{2\beta} + \rho\bar{g}_{-hi}, \tag{18}$$

which is an increasing function of β (the aversion parameter), g^{ϕ} (the individual's intrinsic norm), and $\bar{g}_{-hi}$ (the rest of the group's average contribution in the last round).

3.2.2 Proportional Reciprocity

In the second formulation of social preferences for reciprocal contributions, we assume that the fairness norm maintains each individual making a contribution in proportion to his/her endowment. The utility function of a high endowment player with preferences for proportional contributions can be expressed as

$$U_{hi} = [E_h - g_{hi} + a(g_{hi} + g_h + 2\bar{g}_l)] - \beta(\frac{\bar{g}_{-hi}}{\bar{E}_{-hi}} - \frac{g_{hi}}{E_h})^2. \tag{19}$$

> ***Proposition 3****: If individuals in unequal groups ascribe to a proportional contribution norm, the equilibrium condition is for high endowment players to contribute exactly the same share of their endowment as low endowment players.*

Proof: The contribution function that describes the best action set of a high endowment player when considering all possible actions of other groups members is

$$\frac{\partial U_{hi}}{\partial g_{hi}} = 0 \quad \Longrightarrow \quad \frac{g_{hi}}{E_h} = -\frac{1-a}{2\beta}E_h + \frac{\bar{g}_{-hi}}{\bar{E}_{-hi}}, \tag{20}$$

and similarly for a low endowment player:

$$\frac{\partial U_{lj}}{\partial g_{lj}} = 0 \quad \Longrightarrow \quad \frac{g_{lj}}{E_l} = -\frac{1-a}{2\beta}E_l + \frac{\bar{g}_{-lj}}{\bar{E}_{-lj}}. \tag{21}$$

When each player has full knowledge of the set of best actions of other players in his/her group, the best reply correspondences at equilibrium can be derived from equations 20 and 21:

$$\left(\frac{\bar{g}_h}{\bar{E}_h}\right)^* = \left(\frac{\bar{g}_l}{\bar{E}_l}\right)^*. \tag{22}$$

Q.E.D.

Figure 2 maps the best reply correspondences for low (darker surface) and high (lighter surface) endowment players. As is evident from this figure, utility for both players is maximized when the contribution share of each player in relation to the others is constant.

As with the absolute reciprocity model we extend the proportional model to differentiate between the intrinsic norm with which the individual enters the game and the rest of the group's average contribution in the previous round. A high endowment player's utility function is refined so that

$$U_{hi} = [E_h - g_{hi} + a(g_{hi} + g_h + 2g_l)] - \beta\left(\gamma(\frac{g}{E})^{\phi} + \rho\frac{\bar{g}_{-hi}}{\bar{E}_{-hi}} - \frac{g_{hi}}{E_h}\right)^2. \tag{23}$$

The reaction function for a high endowment player in an environment with incomplete information is then

$$\frac{\partial U_{hi}}{\partial g_{hi}} = 0 \quad \Longrightarrow \quad g_{hi}/E_h = E_h\frac{-1+a}{2\beta} + \gamma(\frac{g}{E})^{\phi} + \rho\frac{\bar{g}_{-hi}}{\bar{E}_{-hi}}. \tag{24}$$

The model predicts that contributions as a fraction of the endowment are increasing in β but decreasing in the individual's endowment. This implies that high endowment players will contribute a lower percentage of their endowment to the public good than low endowment players, if the contribution share of the rest of the group in the last round remains constant. This is important given that both the theoretical model defined here and also the empirical estimation thereof assume that individuals' beliefs about the actions of others are at least partly informed by observing their behaviour in the last round. In the event that full information exists, the rest of the group knowing player i's best reply function will also update their behaviour in the next round so that the Nash equilibrium emerges from the best reply correspondences as defined in equation 22.

4 Results of the Experiments

This section we use the experimental data obtained from nine South African fishing communities to test our predictions for each of the models described.

> ***Result 1****: High endowment players contribute more in absolute terms in provision of the public good.*

Panel A in Table 1 shows mean and median absolute levels of contribution for high and low endowment players respectively for each round. The Wilcoxon ranksum test indicates that high endowment players contribute significantly more than low endowment players ($z = -14.287; p < 0.0001$) on average. This result is also verified by Ordinary Least Squares (OLS) and Multilevel Hierarchical Model (MLHM)[7] estimations in Table 2, and is therefore not consistent with predictions for an absolute model of reciprocity as outlined in *proposition 2*. This contrasts with the findings of Buckley and Croson (2006) that for unequal groups contributions of high and low endowment players are the same in absolute terms. Even though high endowment players contribute more than low endowment players on average, as predicted by the inequality aversion and altruism models, the average difference between high and low endowment players is no more than 9.06 tokens (see round 3). An absolute difference of 20 tokens between high and low endowment players is required in order to be consistent with pure inequality aversion (or ego-centric altruism).

> ***Result 2****: Individuals contribute a proportional share of their endowment to the public account.*

[7]Multilevel Hierarchical models control for individual nesting within groups over repeated rounds.

Table 1: Mean and median contributions.

Round		Panel A: Absolute Contributions		Panel B: Number of tokens contributed as fraction of endowment		Panel C: Number of tokens contributed as fraction of tokens in pool	
		Player allocated 30 tokens	Player allocated 50 tokens	Player allocated 30 tokens	Player allocated 50 tokens	Player allocated 30 tokens	Player allocated 50 tokens
Round 1	Mean	15.14	22.79	0.50	0.46	0.20	0.30
	Std. Dev	(7.30)	(10.71)	(0.23)	(0.21)	(0.10)	(0.12)
	Median	15	25	0.50	0.50	0.20	0.29
Round 2	Mean	14.40	21.81	0.48	0.44	0.20	0.30
	Std. Dev	(7.31)	(11.13)	(0.24)	(0.22)	(0.11)	(0.13)
	Median	15	20	0.50	0.40	0.19	0.30
Round 3	Mean	13.89	22.95	0.46	0.46	0.19	0.31
	Std. Dev	(8.13)	(12.42)	(0.27)	(0.25)	(0.12)	(0.17)
	Median	15	25	0.50	0.50	0.19	0.30
Round 4	Mean	13.89	21.26	0.46	0.43	0.20	0.30
	Std. Dev	(8.29)	(12.27)	(0.28)	(0.25)	(0.11)	(0.16)
	Median	15	20	0.50	0.40	0.20	0.31
Round 5	Mean	13.86	22.10	0.46	0.44	0.19	0.31
	Std. Dev	(8.42)	(12.46)	(0.28)	(0.25)	(0.12)	(0.17)
	Median	14	22	0.47	0.44	0.18	0.32
Round 6	Mean	12.83	20.86	0.43	0.42	0.19	0.31
	Std. Dev	(8.45)	(13.79)	(0.28)	(0.28)	(0.12)	(0.19)
	Median	10.5	20	0.35	0.40	0.19	0.32

It is very clear from Table 1 (Columns 1 and 3 of Panel B) that on average the fraction of the endowment contributed by low and high endowment players is very similar. In round 1, low endowment players are contributing 50% of their endowment and high endowment players are contributing 47%. While contributions decrease somewhat over rounds, the relative ratio between low and high endowment players remains more or less the same. In the final round low endowment players' contributions have dropped to 43% of their endowment, whereas those of high endowment players have dropped to 41%. Although none of the players can directly observe the contributions of other players in their group, the total contribution in the pool in the previous round is known to all.

In Panel C of the same table we express the average contributions of low and high endowment players (30 and 50 tokens) as a fraction of the total contributions in the public pool for that round. If players are only concerned with absolute contributions to the public pool and do not consider differences in endowments between players, then the contribution rule for a group of 4 should be that each individual contributes 25% of what is in the pool. While this is the case in our equal treatments where every player received 40 tokens as endowment, for low and high endowment players in unequal groups this rule does not hold.

Instead, low and high endowment players follow a proportional rule, according to which a fair contribution implies that each player's contribution share as a fraction of total contributions in the pool should be equal to that player's endowment as a fraction of the sum of all players' endowments: $\frac{g_{hi}}{g_{hi}+g_h+2g_l} = \frac{E_{hi}}{E_{hi}+E_h+2E_l}$. Such a heuristic would imply that high endowment players contribute $\frac{5}{16}$ (31.25%) of the pool share and low endowment players contribute $\frac{3}{16}$ (18.75%). Panel B (Columns 1 and 3) indicates that on average low and high endowment players start very close to these respective shares in the first round and converge on these shares over 6 rounds of the game.

It is trivial to show that if all players contribute the same share of their endowment, g_i/E_i, it is analogous to all players contributing their proportional share of what is in the pool[8]: $\frac{g_{hi}}{G} = \frac{E_{hi}}{2E_h+2E_l}$.

The histograms in Figure 3 show the density functions for average contributions as a fraction of total contributions in the pool for low and high endowment players respectively. The red lines in each figure indicate the

[8]See Appendix II.

3/16 and 5/16 fair share contributions discussed previously.

> ***Result 3**: Empirical estimation lends further support to proposition 3, such that contributions in unequal groups are consistent with a proportional rather than an absolute reciprocity model of behaviour.*

In Tables 2 and 3 we present estimates for models that assume absolute and proportional reciprocal norms respectively. In Table 2, for the OLS model specification we find that absolute contributions of the other group member in the last round are not significant. While the parameter is significant at the 10% level for the MLHM specification, the size of the parameters (0.09 and 0.089) is in both instances negligible compared to the constant term (16.07 and 18.85). The constant term, which is highly significant, is a combination of two parameters in our model comprising most of the explanatory power. Including an additional dummy for Endowment (see Columns 1 and 3), which should not have any explanatory power according the the absolute formulation of the model (for either the first order condition (equation 17) or the best response function (equation 18)), indicates the contrary. High endowment players contribute significantly more than low endowment players in absolute terms. This refutes the predictions of the absolute reciprocity model (*proposition 2*).

The estimates for our proportional contribution model shown in Table 3 provide strong support in favour of *proposition 3* as predicted by the proportional reciprocity model. All parameters are significant: 1) the constant term representing the intrinsic norm in the community (or some pre-conceived notion by this individual); 2) the endowment term; and 3) the term reflecting the rest of the group's contribution as a share of endowment in the last round.

For both model specifications, the constant term (what we infer to be the intrinsic contribution norm from our model specification) accounts for about 50% of contributions, indicating that the individual brings into the game preconceived notions of fairness that are independent of the behaviour of other players.

The endowment term is significant and negative as predicted by the first order conditions (equations 22 and 23) in our proportional model, rather than by the best response function that requires full information of all strategies of other players. We find that low endowment players contribute a greater share

Table 2: Average Absolute Contributions

Absolute Contribution to the Public Account	OLS (1)	OLS (2)	MLHM (3)	MLHM (4)
Player allocated 50 tokens	8.22 ***		7.95 ***	
	(.505)			
Average Absolute Contribution the rest in last round	0.20 ***	0.06	0.09 **	0.086 *
	(.041)	(.043)	(.044)	(.044)
Constant	12.07 ***	19.45 ***	16.07 ***	18.85 ***
	(1.62)	(1.67)	(2.51)	(2.66)
n	1702	1702	1710	1702
R 2	0.17	0.03		
AdjR2	0.16	0.02		
Wald chi2(20)			119.3	32.2
Log restricted-likelihood			-6143 ***	-6150 **
LR test vs. linear regression:			439.42 ***	614 ***

All regressions include controls for round, community, age, gender and race which are not reported.
MLHM (Multilevel Hierarchical Models) control for individual nesting within groups.
Standard errors in parenthesis.
*** = 1% significance; ** = 5% significance; * = 10% significance.

Table 3: Average Proportional Contribution

Fraction of Endowment Contributed to the Public Account	OLS (1)	MLHM (2)
Player allocated 50 tokens	-0.04 ***	-0.04 *
	(.012)	(.021)
Average Fraction of Endowment Contributed by the rest in last round	0.20 ***	0.09 **
	(.041)	(.044)
Constant	0.50 ***	0.49 ***
	(.043)	(.061)
n	1702	1702
R 2	0.05	
AdjR2	0.041	
Wald chi2(20)		35.27
Log restricted-likelihood		101.07 **
LR test vs. linear regression:		432.45 ***

All regressions include controls for round, community, age, gender and race which are not reported.
MLHM (Multilevel Hierarchical Models) control for individual nesting within groups.
Standard errors in parenthesis.
*** = 1% significance; ** = 5% significance; * = 10% significance.

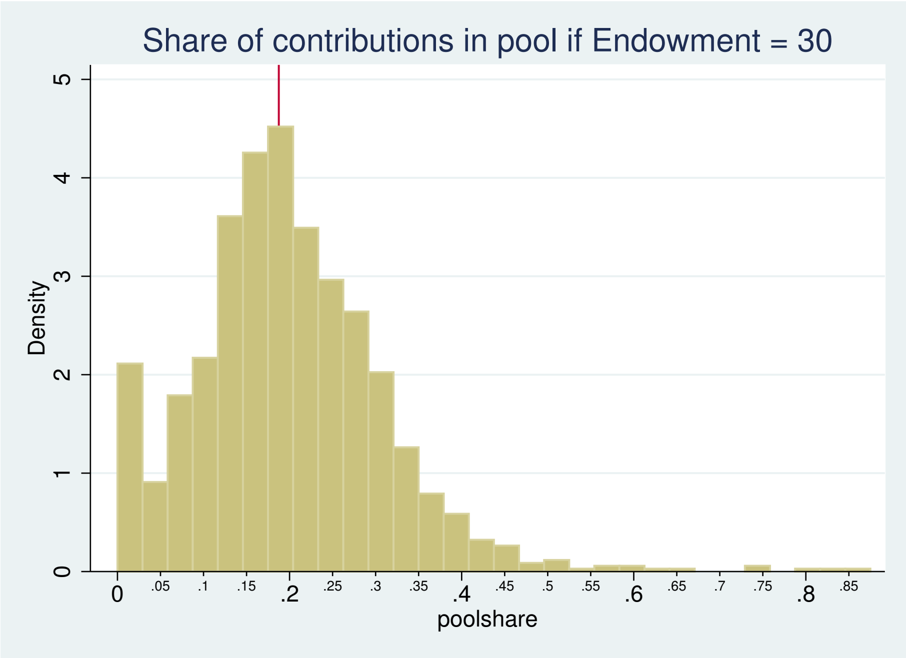
of their endowment to the public good than high endowment players. These results are significant according to the two sample Wilcoxon ranksum test for both treatments (VCM: $z = 1.86$; $p < 0.07$).

> ***Result 4***: *Our inferred intrinsic contribution norm differs across communities and is typically higher than the norm established by the rest of the group.*

Estimation of contributions across communities (see Table 5) yields differing average intrinsic norms (as inferred from our model). In each of the communities the parameters for the intrinsic norm as well as the rest of the group's contributions are highly significant.[9] The endowment term is only significant for one community. Given that limited data for each community does not allow the use of MLHM, these models might be less accurate as they do not account for individual fixed effects or nesting within groups.

[9]Note that the model allows for this term to be positive or negative depending on how the individual adjusts between the intrinsic and group norm.

[Low endowment players.]



[High endowment players.]

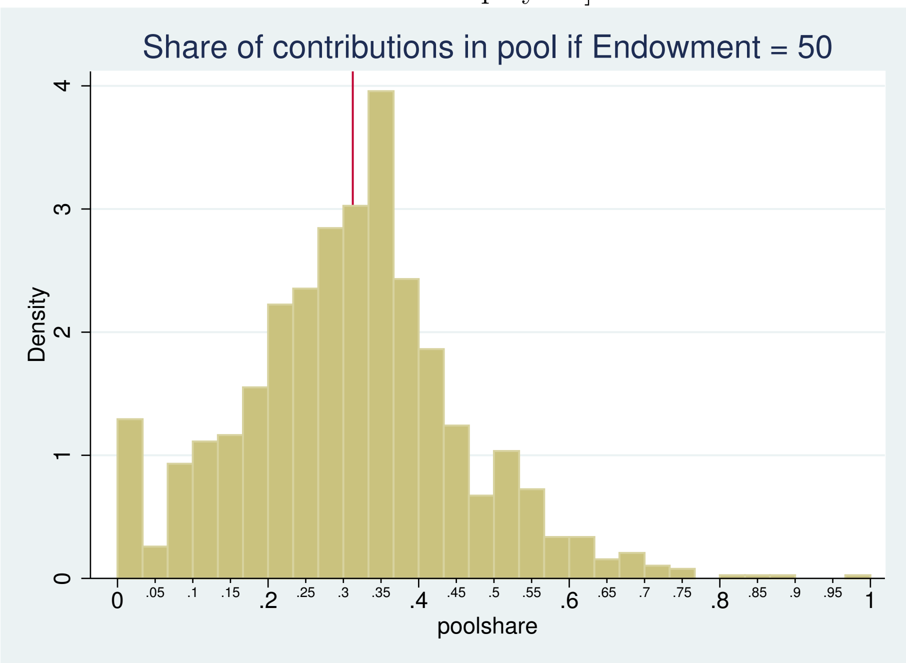


Figure 3: Average contributions of players as percentage of total contributions.

Table 4: Absolute, Proportional and Intrinsic Contribution Norm by Community

	COM1 (OCV)	COM2 (KLB)	COM3 (LBTS)	COM4 (ELDS)	COM5-7 (PSVSH)	COM8 (VLDF)
Intrinsic Contribution Norm in Community (g*/E*)	0.51	0.46	0.52	0.54	0.24	0.35
Average Relative Share - Low Endowment Players (gl/El)	0.52	0.46	0.46	0.44	0.49	0.45
Average Relative Share - High Endowment Players (gh/Eh)	0.45	0.496	0.42	0.493	0.45	0.45
Average Absolute Contribution - Low Endowment Players (gl)	15.38	13.9	14.05	13.9	14.8	13.54
Average Absolute Contribution - High Endowment Players (gh)	22.66	24.83	21.2	22.45	23.19	22.5

Communities 5-7 have been pooled due to proximity and small sample size

Table 5: Proportional Contributions by Community

	COM1 (OCV)	COM2 (KLB)	COM3 (LBTS)	COM4 (ELDS)	COM7 (PSVSH)	COM8 (VLDF)
Fraction of Contribution Contributed to the Public Account	OLS	OLS	OLS	OLS	OLS	OLS
Round	-0.007	-0.005	-0.012	-0.002	-0.004	-0.016 *
	(0.008)	(0.011)	(0.008)	(0.008)	(0.009)	(0.008)
Player allocated 50 tokens (Endowment)	-0.088 ***	-0.014	-0.013	-0.02	-0.033	-0.016
	(0.028)	(0.038)	(0.028)	(0.029)	(0.032)	(0.031)
Rest-of-group share contributed	0.394 ***	0.057	0.273 ***	-0.138	0.219 **	0.075
	(0.077)	(0.135)	(0.089)	(0.119)	(0.106)	(0.095)
Constant (g*/E*)	0.545 ***	0.47 ***	0.605 ***	0.52 ***	0.277 ***	0.454 ***
	(0.091)	(0.130)	(0.094)	(0.094)	(0.100)	(0.113)
n	354	186	305	270	252	335
R 2	0.109	0.141	0.147	0.012	0.104	0.034
Adj R2	0.091	0.106	0.126	-0.014	0.078	0.013

All regressions include controls for age, gender and race which are not reported.
Standard errors in parenthesis.
*** = 1% significance; ** = 5% significance; * = 10% significance.

5 Discussion

We consider four different models of behaviour that incorporate into the utility framework the cognitive dissonance an individual experiences when deviating from an internal or social norm. We distinguish between models of inequality aversion, egocentric altruism (although the predictions for this model turn out to be equivalent to the inequality aversion model), absolute reciprocity, and proportional reciprocity.

In an interesting experimental study by Buckley and Croson (2006) which uses an unequal public goods design similar to ours,[10] no significant difference in absolute contributions of low and high endowment players is observed. This implies that individuals in their sample are only concerned with absolute investments in the public good.

What are considered to be fair contribution to the public good may however be context dependent. Novel work by Van Dijk and Grodzka (1992) found in public goods experiments with heterogenous endowments that subjects informed about inequality between them preferred a proportional distribution of the contributions, while uninformed subjects preferred an equal distribution.

This raises the question as to what fairness norms hold when exogenous differences in wealth exist, and whether the public good mechanism indeed functions as an indirect means of redistribution as claimed out by many authors (Van Dijk and Wilke, 1994; Van Dijk and Grodzka, 1992; Alessina and Angeletos, 2005). While an egalitarian view of fairness would yield predictions similar to our inequality aversion and altruism models, a more libertarian approach to social outcomes would perceive an absolute reciprocity model as fair. Equity theory in turn states that individuals deserve social payments that are proportional to their contribution to society (Walster et. al, 1978; Homans, 1958; Adams, 1965; Selten, 1978), although it does not clearly provide a definition of the nature of inputs to production or contribution. Konow (1996, 2000) extends this concept with the Accountability Principle, by differentiating between discretionary variables that an individual can influence (e.g., work effort) and exogenous variables that an individual does not

[10] The subject pool comprised 24 American university students, with groups also consisting of four members (2 high and 2 low endowment players). In their unequal treatment low endowment players receive 25 tokens and high endowment players each receive 50 tokens.

have control over (e.g., physical handicap) but which affects the perceived fair allocation between individuals[11]. He further proposes an Entitlement Formula that applies when the allocable variable is not produced but rather endowed, such as in our experiments. This formula allows an individual's entitlement to vary in direct proportion to the individual's relevant discretionary variables, while it adjusts for differences in the values of exogenous variables (Konow 2001).

The fixed marginal per capita return in our (and most standard) public goods games does not allow for adjustments in pay-offs to account for deservingness of each member based on his or her contributions, unless punishment is introduced in the second stage of the game. This accords with social preference models that are outcomes-based (like the inequality aversion model of Fehr and Schmidt (1999) and also Bolton and Ockenfelds (2000)) rather than intentions-based (Rabin 1993)

The only way in which all individuals would attain fair entitlements (or adjusted pay-offs) that does not hold one another accountable for exogenous differences in endowments would be if high endowment players contribute the same as low endowment players plus the absolute difference in endowments: $\bar{g}_h = \bar{g}_l + (E_h - E_l)$. In contrast, a contribution norm that holds individuals fully accountable for differences in endowments would require that all players contribute the same absolute amount to the public good irrespective of their endowment: $\bar{g}_h = \bar{g}_l$.

Another possible interpretation of "fair entitlements" may be that the relative wealth difference between low and high endowment players (E_l/E_h) should also be reflected in final pay-offs. This would require that $\frac{g_h}{E_h} = [\frac{g_l}{E_l} - aG\frac{(E_h - E_l)}{E_h E_l}]$, which would also account for the significant difference in contribution shares of low and high endowment players. However, if we consider final pay-offs over the entire experiment for low and high endowment players on average, the ratio of relative wealth for these two groups is 0.8 compared to the ratio of their relative initial endowments, which is 0.6. This indicates that individuals do not expect that the status quo be maintained in terms of a relative distribution of wealth, but that the public goods mechanism is indeed used as a way of redistributing wealth.

Figure 4 represents a mapping of best reply correspondences for low on to

[11]See also Capellen (2005) and (2006a&b) for an interesting discourse and novel experiments covering this subject.

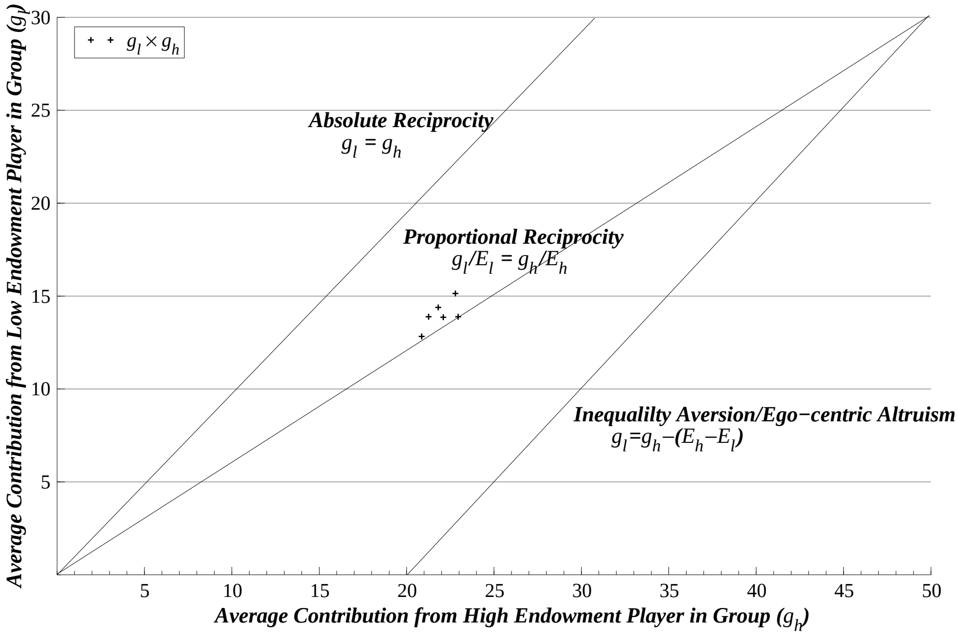


Figure 4: Best reply correspondences for inequality aversion and reciprocity models.

high endowment players, for each of the models we outlined. It is clear the the proportional reciprocity model links the inequality aversion and absolute reciprocity models. At low levels of contributions, the proportionality rule converges on the absolute reciprocity model whereas at high levels of contributions it results in the same outcome as the inequality aversion model.

The average contributions for high and low endowment players in each group are plotted on the graph for all six rounds. From this, as well as from our earlier empirical estimations, it is clear that the average tendency within these groups is to follow a proportional rule. Empirical estimation shows that behaviour in unequal groups accords with the reaction functions of utility maximizing individuals with incomplete information, rather than with the best response correspondences predicted in theory, that require full information regarding the profile of best reply strategy sets of all other players. An individual therefore infers beliefs about the behaviour of other group members by observing their contributions in the previous round, without assuming that other players will also adjust their behaviour given full information of his/her own set of best actions. As Aumann and Maschler (1995) point out: " *Unlike the situations treated in classical game theory, a participant in real life con-*

flict situations usually lacks information of the strategies that are available to him and his opponent, on the actual outcomes and their utility to each of the participants and on the amount of information that other participants possess."

One criticism of the work we present here may be that we do not discriminate between different behavioural types, given that we consider average behaviour of low and high endowment player across groups. We agree that one may observe vast heterogeneity with respect to perceptions of fairness within groups. Disentangling different types of players in this context is however problematic given that the definition of a player's type can only be deduced from his position with respect to other players who decide on their respective contributions simultaneously.

Our model allows us to identify the average intrinsic norm for each of the communities we worked with. It is clear that while individuals are affected by the behaviour of others in a group they encounter, they also bring an intrinsic norm of fairness into each situation. This norm is based on historical interaction within a community or family context. What is considered to be fair across all communities in our sample is not a notional or normative concept of fairness in the Rawlsian sense (1971), but rather an experiential or positivist form of justice based on the more immediate behaviour of group members, and also on previous experience with inequality in their communities. There is certainly an element of self serving bias allowing the rich to justify their differences in endowments, which accords with status value theory (Cook, 1975, Harrod, 1980, Moore, 1991). On the part of the poor, the fact that their marginal utility from income is higher than that of the rich may account for their acceptance of a certain level of inequality. It may also be that individuals partly accept such differences in endowments randomly bestowed upon them, given their familiarity with such situations in real life.

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7 Appendix I: Alternative formulation for inequality aversion model

Using the Buckley and Croson (2006) formulation of inequality aversion: assume player i optimizes her utility by equalizing her pay-off (Π_{hi}) with that of the rest of the group (Π_{-hi}). Player i expects the other high endowment player to contribute $X\%$ of his endowment and the low endowment players to contribute a share of $Y\%$ on average. The pay-off of player i and that of the rest group is

$$\Pi_{hi} = E_h - 1/2g_{hi} + 1/2XE_h + E_l = \Pi_{-hi} = [E_h + 1/2XE_h + 2E_l + YE_l + 3/2g_{hi}]/3$$
$$g_{hi} = 2E_h + XE_h - 2E_l + YE_l + 3/2g_{hi}.$$

The percentage of player i's endowment contributed is then

$$\begin{aligned} p_{lj} &= \left[2 + X - 2\left(\frac{3}{5}\right) + 2Y\left(\frac{3}{5}\right)\right]/3 \\ &= \frac{-6}{5} + X + \frac{6}{5}Y. \end{aligned}$$

Similarly the percentage contribution of low endowment player j is

$$\begin{aligned} p_{hi} &= \left[2 + Y - 2\left(\frac{5}{3}\right) + 2Y\left(\frac{5}{3}\right)\right] \\ &= \frac{-10}{3} + Y + \frac{10}{3}X. \end{aligned}$$

We can show for all possible X and Y we can show that in almost all cases $p_{hi} > p_{lj}$ to be in line with inequality aversion. *Q.E.D.*

8 Appendix II: Altruism

As discussed in earlier parts of this paper we are particularly interested in which fairness norms are applicable in shaping what individuals perceive as fair entitlements, motivating contribution levels in groups with pre-existing wealth heterogeneities. Given that fairness norms are often subject to egocentric biases (Babcock and Loewenstein, 1997; Konow 2000), it may be useful to consider models with egocentric altruism such as that put forward by Cox and Sadiraj (2006). They assume a utility function with the conventional regularity properties of strict quasi-concavity and positive monotonicity in own income Π_i and income of another, Π_j, $j \in \{1, \ldots, n\} / \{i\}$:

$$U_i = 1/\alpha(\Pi_i^\alpha + \theta\Pi_j^\alpha) \qquad \alpha \in (-\infty, 1)/\{0\} \tag{25}$$

$$= \Pi_i\Pi_j \qquad \alpha = 0. \tag{26}$$

The altruism parameter θ determines how much an individual weights the utility of another. In their case the boundary value for θ is assumed to be zero, and hence reverts to a model of self-regarding preferences. Clearly by allowing θ to take values less than zero it is possible to model spiteful preferences as proposed by Levine (1998).

Egocentric bias in Cox and Sadiraj's model is defined such that a person, when faced with two allocations of money (a,b) and (b,a), prefers that allocation which gives them a larger pay-off, so that $u(b, a) > u(a, b)$ for $b > a \geq 0$. We therefore also restrict θ to be less than 1. The utility function of a high endowment player is

$$U_{hi} = 1/\alpha(\Pi_{hi}^\alpha + \theta\bar{\Pi}_{-hi}^\alpha). \tag{27}$$

By solving the utility maximizing contributions for high and low endowment players and then finding each player's best response function at the Cournot equilibrium, we can prove *proposition 1* for this model with altruist behaviour as well.

Proof: From first order conditions we find that for a high endowment player

$$\partial U_{hi}/\partial g_{hi} = 0 \quad \Longrightarrow \quad \left(\frac{1-a}{-\theta a}\right)^{\frac{1}{1-\alpha}} = \frac{\bar{\Pi}_{-hi}}{\Pi_{hi}} \tag{28}$$

and for a low endowment player

$$\partial U_{lj}/\partial g_{lj} = 0 \quad \Longrightarrow \quad \left(\frac{1-a}{-\theta a}\right)^{\frac{1}{1-\alpha}} = \frac{\bar{\Pi}_{-lj}}{\Pi_{lj}}. \tag{29}$$

From equations 28 and 29 we find that

$$\frac{\bar{\Pi}_{-hi}}{\Pi_{hi}} = \frac{\bar{\Pi}_{-lj}}{\Pi_{lj}}, \tag{30}$$

or

$$\Pi_{lj}(2\Pi_l + \Pi_h) = \Pi_{hi}(2\Pi_h + \Pi_l). \tag{31}$$

For the case of the average high and low endowment players we can simplify this to

$$2\bar{\Pi}_l^{\,2} + \bar{\Pi}_l\bar{\Pi}_h = 2\bar{\Pi}_h^{\,2} + \bar{\Pi}_h\bar{\Pi}_l, \tag{32}$$

which simply reduces to

$$\bar{g_h}^* = \bar{g_l}^* + E_h - E_l. \tag{33}$$

Q.E.D.

This prediction is therefore consistent with the intuition provided by Becker's more generalized model and is the same as that derived for the inequality aversion model discussed earlier.

9 Appendix III: Fairshares

> ***Proposition 1:*** *For an individual using a heuristic for a contribution norm, such that "my share of the total in the public pool should equal my share of the total endowments in the group" is equivalent to a proportional share rule with respect to individual endowment.*

Proof:

$$\frac{g_{hi}}{g_{hi} + g_h + 2g_l} = \frac{E_{hi}}{E_{hi} + E_h + 2E_l}$$
$$g_{hi} = E_{hi} * \frac{g_{hi} + g_h + 2g_l}{E_{hi} + E_h + 2E_l}$$
$$g_{hi} = \frac{E_{hi} * g_{hi}}{2E_h + 2E_l} + E_{hi} * \frac{g_h + 2g_l}{E_{hi} + E_h + E_l}$$
$$g_{hi} * [1 - \frac{E_h}{2E_h + 2E_l}] = E_{hi} * \frac{g_h + 2g_l}{2E_h + 2E_l}$$
$$g_{hi} = \frac{2E_h/2E_l}{E_h + 2E_l} * E_{hi}\frac{g_h + 2g_l}{2(E_h + 2E_l)}$$
$$g_{hi} = E_{hi} * \frac{g_h + 2g_l}{E_h + 2E_l}\frac{g_{hi}}{E_{hi}} = \frac{g_h + 2g_l}{E_h + 2E_l}$$

Q.E.D.

Does stake size matter for cooperation and punishment?*

Martin Kocher#

CREED, University of Amsterdam, Netherlands
Department of Economics, University of Innsbruck, Austria

Peter Martinsson

Department of Economics, Göteborg University, Sweden

Martine Visser

Department of Economics, Göteborg University, Sweden

Abstract

The effects of stake size on cooperation and punishment are investigated using a public goods experiment. We find that an increase in stake size does not significantly affect cooperation or, interestingly, the level of punishment.

Key words: experiment, public goods, punishment, stake size
JEL classification: C72, C91, H41

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# Corresponding author. Martin Kocher, CREED, University of Amsterdam, Roetersstraat 11, NL-1018 WB Amsterdam, The Netherlands. E-mail: martin.kocher@uibk.ac.at. Ph: +31 (0)20 525 4250. Fax: +31 (0)20 525 5283.

1. Introduction

While some experimental economists argue that one of the concerns with data from the laboratory – the effect of stake size – has largely been put to rest, others provide evidence that this issue is still largely in dispute. Several studies that have explicitly tested for stake effects have found that an increase in monetary stakes does not significantly affect the average behavior of decision-makers. It could, however, reduce the variance of subjects' behavior in certain environments (e.g., Camerer, 2003; Camerer and Hogarth, 1999; Smith and Walker, 1993). Further evidence in line with this general conclusion has been provided, for instance, by Cameron (1999), Carpenter et al. (2005) as well as Slonim and Roth (1998) for dictator and ultimatum games, and by Johansson-Stenman et al. (2005) for the trust game.[1] In contrast, critical remarks and counter-evidence can be found in Parco et al. (2002), Slonim and Roth (1998), as well as in List and Levitt (2006). Thus, it would be premature to conclude that the effects of stake size should be neglected in experimental economics in general.

The objective of this paper is to test whether stake size has an impact on cooperation and sanctioning behavior. We study both a standard linear public goods game and a public goods game that is augmented by a punishment stage after the contribution stage (Fehr and Gächter, 2000). Punishment takes the form of informal individual sanctions and is costly both to the punisher and the punished.

To the best of our knowledge, we are the first to analyze the effects of stake size on both voluntary contributions to a public good and on punishment. Most existing experimental evidence on stake size refers to bargaining games. Since social dilemmas are almost ubiquitous in everyday life, and since they often involve an option to sanction other decision-makers, we think that this is a worthwhile endeavor.

We are aware of only one other paper that explicitly deals with a test of stakes on the private provision of a public good. Marwell and Ames (1980) report that people invest less money in the public good when stakes are higher. Their finding, however, is confounded by an experimenter effect and they do not take punishment into account.

[1] In another context, decision-making under risk, Holt and Laury (2002) find no significant effect of stake size on risk attitudes.

2. The public good and our experimental design

Let $I = \{1, 2, \ldots, n\}$ denote a group of n subjects who interact only once in a one-shot simultaneous public goods game *without punishment*. Individual $i \in I$ receives an endowment E, which can be allocated either to a private good or to a public good. The voluntary contribution of individual i to the public good, c_i, must satisfy $0 \leq c_i \leq E$. Let C denote the sum of the contributions of all group members (i.e. $C = \sum_{j=1}^{n} c_j$). Individual member i's payoff from her contribution is given by

$$\pi_i = E - c_i + \gamma C \; . \tag{1}$$

The marginal per capita return (MPCR) from investing, in this standard linear public good is denoted as γ, which satisfies $0 < \gamma < 1 < n\gamma$, meaning that the self-interested choice and the social optimal one are in conflict.

In the public goods game *with punishment*, subjects can punish other group members individually, after they have received information on contribution levels of their group members. The game is now a two-stage game with a simultaneous contribution stage followed by a simultaneous punishment stage. Employing the punishment technology used by Gächter and Herrmann (2006), the unit cost per punishment point is 1, and one unit of punishment results in a deduction of 3 units in terms of payoff for the member who receives the punishment.[2] Each subject can assign a maximum of 10 punishment points to any other member in his or her group.

Taking into account the monetary consequences of the punishment stage yields the following payoff function for member i:

$$\pi_i = E - c_i + \gamma C \; - 3\sum_{k \neq i} p_{ik} - \sum_{h \neq i} p_{hi} \; , \tag{2}$$

where p_{hi} is the cost of punishment by member h to member i, and p_{ik} is the deduction in terms of payoff as a consequence of punishment points from member i to member k.

[2] Previous experiments have shown that punishment behavior follows the law of demand, i.e. the quantity of punishment declines with a rising price of punishment (Anderson and Putterman, 2006; Carpenter, 2006).

Assuming rationality and selfishness, we should not observe any voluntary contributions in either game or any assignment of punishment points in the public goods game with punishment according to the subgame perfect equilibrium. Research shows, however, that subjects punish each other both in one-shot experiments as well as in multi-period experiments with stranger matching (e.g., Fehr and Gächter, 2000; Gächter and Herrmann, 2006; Gächter et al., 2004).

The parameters in our experimental sessions were set up as follows: group size n = 4, endowment of E = 20 Guilders (the experimental currency unit), and MPCR $\gamma = 0.5$.

Each experimental session consisted of two parts. In *Part I*, each subject had to indicate his or her preferred contribution in the one-shot public goods game without punishment. After the decision and without any feedback on the results from this first part – to avoid order effects – subjects received experimental instructions[3] on *Part II*. Part II consisted of a public goods experiment that was augmented by a punishment stage after the contribution stage, according to the description above.[4] It was common knowledge that the group composition in this second part was different from the first part in order to rule out any reputation motives, and it was also announced that group members would remain anonymous.

Our experiment was conducted with 120 high school students (with an average age of 15.9 years) in Cape Town, South Africa, using paper and pen. In order to test for stake effects, the sample was divided into two groups: one with a low stake size treatment (*LOW*) and one with a high stake size treatment (*HIGH*). Most experiments identified in Camerer and Hogarth (1999) – but also more recently conducted stake experiments – use scale factors between 2 to 10 when testing for the effects of stake size.[5] Except for different conversion rates, sessions and instructions in *LOW* were

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[3] The complete experimental instructions for both parts can be found at [URL will be provided for publication]. The instructions were phrased in neutral terms. Participants were not instructed to maximize their earnings and no references to any specific strategies were made.

[4] In Part II of the experiment, the impact of punishment was capped at the amount earned in the contribution stage. However, the punisher incurred the costs of punishing even if it resulted in a loss in Part II. This procedure was common knowledge among subjects, and there was actually no case of a loss in the experiment.

[5] There are, however, exceptions. For example a factor of 25 was used in Slonim and Roth (1998), 20 in Johansson-Stenman et al. (2005) and up to 50 in Cameron (1999). These three experiments were conducted in relatively poor countries (Slovakia, Bangladesh, and Indonesia, respectively).

identical to those in *HIGH*. In *LOW*, 1 Guilder was exchanged for 1.5 South African Rand (ZAR)[6], whereas in *HIGH*, 1 Guilder was worth 7.5 ZAR.

In *LOW*, the average income per hour was intended to be a bit higher than an average hourly salary, while average income per hour in HIGH should correspond approximately to a daily salary. Note that hourly wages for casual and unschooled labor in South Africa range from 5 to 25 ZAR (Department of Labour, South Africa, 2006). Actually, on average, subjects earned 65.45 ZAR in *LOW* and 338.56 ZAR in *HIGH*, and sessions lasted slightly more than two hours. Thus, already the stakes in *LOW* were considerable.

Both treatments were run at the same school, and the treatments were scheduled in overlapping succession to avoid contagious effects by word-of-mouth communication. Participants were randomly allocated into the two treatments, decisions were made anonymously, and communication among participants was prohibited. In addition to instructions detailing each step of the experiment, we used a number of quiz questions to ensure that everybody understood the task completely before participants made their choices. Final payment of experimental profits was made in private and in cash.

3. Results

In Table 1, we show mean contribution levels to the public good in Part I and Part II, separately for the *LOW* and the *HIGH* treatment. As can easily be seen in the table, there are only small differences between the two treatments. In Part I, the average contribution level was 34.4% in *LOW* and 32.9% in *HIGH*, while in Part II it was 41.2% and 40.9% for *LOW* and *HIGH*, respectively. Punishment in Part II was used by 25% of participants in *LOW* and by 17% of participants in *HIGH*. The average amount of punishment points awarded to another group member was rather low, however, namely 0.49 in LOW compared to 0.31 in HIGH. For positive levels of punishment, i.e. $p_{hi} > 0$, average punishment was 1.96 in *LOW* and 1.85 in *HIGH*, respectively. We apply Kolmogorov-Smirnov two-sample tests and Mann-Whitney-U tests to test the null hypotheses that (i) the contributions to the public good, and (ii) punishment points

[6] The exchange rate at the time of the experiment was 6.10 ZAR = 1 USD.

awarded in the two treatments come from populations with the same distribution and have equal means. We cannot reject these null hypotheses at any conventional levels.[7]

Table 1. Levels of contribution to the public good (in parentheses: proportion contributed)

Treatments	*Part I (without punishment)*	*Part II (with punishment)*	*Av. punish-ment points awarded*	*Proportion of punishers* ($p_{hi} > 0$)	*Av. punish-ment points awarded if* ($p_{hi} > 0$)
LOW	6.88 (34.4%)	8.25 (41.2%)	0.49	0.25	1.96
HIGH	6.58 (32.9%)	8.18 (40.9%)	0.31	0.17	1.85
*LOW vs. HIGH: p-values**	0.99/0.94	0.81/0.88	0.80/0.15		0.81/0.64
*LOW vs. HIGH: p-values***				0.26	

*Note. * Based on Kolmogorov-Smirnov two-sample tests before slash and Mann-Whitney-U tests after slash (two-sided). ** Based on two-sample test of proportions.*

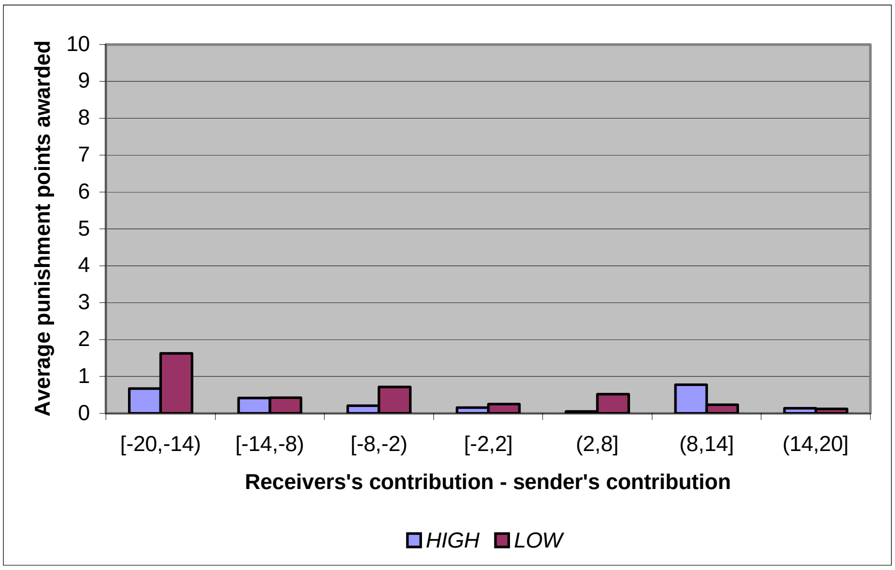
Figure 1 displays the direction of punishment dependent on the difference between the contribution of the punished player and one's own contribution. It shows that punishment in both treatments is predominately directed towards free-riders by high contributors (on the left-hand side of the graph); however, there are also a small number of free-riders who punish contributors. This is in line with the usual pattern observed in other studies on punishment. The only remarkable difference between our two treatments is a stronger punishment reaction for large negative deviations in LOW than in HIGH, although the overall absolute level of punishment is still relatively small. The spike in the HIGH treatment at the interval (8,14] is due to only one subject (who probably made a mistake) choosing the maximum of ten punishment points.[8]

[7] Standard deviations are a little bit smaller in HIGH than in LOW, but the difference is far from significant.

[8] Excluding this subject would not result in an overall significant difference in punishment behavior across the two treatments.

We do not observe any significant effects of important socio-economic variables like gender or age on contributions and punishment or any interaction effect of these variables with stake size.[9]

Figure 1. Direction of punishment



4. Conclusion

This paper analyzes the effects of a stake size variation in a one-shot public goods experiment with and without punishment. The substantial increase in stakes does not significantly affect the mean or variance of the level of contributions in our experiment. It also has no significant effect on punishment. Our results suggest that findings of public goods experiments with standard laboratory stakes can be extrapolated to situations with considerable stakes. Furthermore, evidence from a game show whose setup is related to the public goods game to a certain extent (Oberholzer-Gee and Waldfogel, 2003) shows that our conclusion is also likely to extend to exceptionally high stakes.

[9] Regressions are available from the authors upon request.

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Social environment, cooperative behavior and norm-enforcement [#]

Martin G. Kocher[*], Peter Martinsson[+] and Martine Visser[+]

Abstract: We provide an empirical test of the influence of an individual's social environment on his or her cooperative and norm-enforcement behavior. For this end, a unique data set is created based on a series of public goods experiments conducted in Cape Town, South Africa. Our main empirical results clearly confirm that social capital variables are consistently related with human cooperative and norm-enforcement behavior. Moreover, we find that their impact is even able to overpower typical group variables.

JEL classification: C72, C91, H41, Z13

Keywords: Cooperation, public goods, punishment, experiment, social capital, South Africa

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[*] University of Amsterdam, Department of Economics, CREED. Roetersstraat 11, NL-1018 WB Amsterdam, Netherlands, and University of Innsbruck, Department of Economics. Universitaetsstr. 15/4, A-6020 Innsbruck, Austria. E-mail: martin.kocher@uibk.ac.at.

[+] Department of Economics; Göteborg University, Box 640, 405 30 Göteborg Sweden. E-mail: peter.martinsson@economics.gu.se; martine.visser@economics.gu.se (corresponding author).

1. Introduction

Cooperative behavior is an important component in the daily lives of humans, and ranges from activities such as food sharing and teamwork to keep the environment clean, using common resources diligently, collective action, and voting. In economics, the nature of cooperation and its patterns are usually studied in the context of social dilemmas, with the special case of the private provision of a public good.[1] It is a well-documented fact that people contribute more to public goods, on average, than predicted by the selfish and rational model of the homo economicus, although full cooperation can usually not be sustained. The literature, therefore, also studies how cooperative behavior can be enforced by informal decentralized mechanisms such as sanctions (e.g., Fehr and Gächter, 2000; Andreoni et al., 2003; Masclet et al., 2003; Gürerk et al., 2006).[2] Again, despite the fact that the standard model cannot explain the use of these informal sanctions, they have been shown to be able to increase cooperation significantly.

One very important conclusion from the literature is that individuals are heterogeneous in their inclination to cooperate (e.g., Fischbacher et al., 2001) and to invest in a costly norm-enforcement device.[3] The objective of this paper is to analyze possible origins of that heterogeneity. This is achieved by combining a public goods experiment conducted in four different communities in Cape Town, South Africa, with

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[1] Equivalently, it has been studied in the context of the use of a common pool resource.

[2] In political science or social psychology, related studies have been conducted even earlier by Yamagishi (1986) or Ostrom et al. (1992), for example.

[3] Individual heterogeneity may be manifested in different preferences for fairness (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Falk et al., 2005; Sutter et al., 2006), different preferences for reciprocity (Rabin, 1993; Charness and Rabin, 2002; Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006; Fischbacher and Gächter, 2006), or different emotional responses (Bosman and van Winden, 2002; de Quervain et al., 2004; Hopfensitz and Reuben, 2005).

questionnaire data on individual characteristics and social background (social capital) variables. By controlling for the social background of decision-makers, we are able to go beyond existing studies that take only a limited amount of individual characteristics such as gender, age, and similar variables into account (see, e.g., Ledyard, 1995, and Zelmer, 2003, for overviews). Specifically, we will assess the influence of the following social background variables on cooperative and norm-enforcement behavior: (i) attitudinal and behavioral measures of trust, (ii) behavioral measures of the individual level of integration into one's peer group and community (social integration), and (iii) attitudinal as well as behavioral measures on norm-violation and norm-enforcement in one's peer group and community.

Although it seems intuitive that there is a link between cooperative and norm-enforcement behavior on the one hand, and an individual's environment and (cultural) background on the other, and that this connection is one of the main reasons for the observed heterogeneity of behavior, the scope of the related literature is rather limited. Several studies have assessed cultural differences in cooperative behavior, where the unity of analysis has been at the country level. Some studies such as that of Brandts et al. (2004) and also Burlando and Hey (1997) have compared student samples across countries, while Carpenter et al. (2004) and Henrich et al. (2006) use non-student samples to do similar comparative studies. The results in both Brandts et al. (2004) and Burlando and Hey (1997) are standard, and partly explained by student samples in Western countries. Carpenter et al. (2004) in contrast found extremely high levels of cooperation in Thailand and Vietnam.

Anderson et al. (2004) correlated attitudinal and behavioral trust measures as well as measures regarding the participation in voluntary activities with behavior in a linear public goods game (without punishment), but report some contradictory results for measures that one would intuitively expect to be highly correlated with behavior. In a similar vein, Gächter et al. (2004) analyze the relation between trust and cooperation. They find that the socio-economic background affects trust attitudes, but that there is no separate influence of socio-economic variables on cooperative behavior in a one-shot public goods experiment in Russia. Regarding norm-enforcement[4] and social environment, there is only one more closely related paper that we are aware of, namely Gächter and Herrmann (2006). They again conducted public goods experiments in Russia and found differences between rural and non-rural participants and that the efficiency-enhancing potential of punishment may be culture-specific. More specifically, they reasoned that there might be cultural factors that drive the fraction of spiteful punishers (defined as players who punish other players who contribute *more* than them).[5] A high proportion of spiteful punishers can destroy the positive effects of punishment due to the high efficiency costs associated with it.

For the empirical test underlying our results, we created a unique data set based on a series of experiments conducted in Cape Town, South Africa. Participants in the experiments were high school students with less than two years to graduation, coming from four selected high schools: (i) a school from one of Cape Town's White high income neighborhoods; (ii) a school located within a colored middle income neighborhood; and (iii) and (iv), two schools representing low income African communities: one situated in an older neighborhood where most of the housing development is permanent, while the catchment areas for the other high school are three different neighborhoods where housing development is classified as informal. For purposes of elucidation, the schools are labeled (i) White, (ii) Colored, (iii) African Permanent, and (iv) African Informal. Due to the legacy of Apartheid, high-income and middle-income people on the one hand and low-income on the other are still mostly

[4] The general economics literature on punishment is actually quite extensive. See, for instance, Fehr and Gächter (2002), Botelho et al. (2005), Casari and Luini (2005), Egas and Riedl (2005), Ertan et al. (2005), Nikiforakis and Normann (2005), Page et al. (2005), as well as Sefton et al. (2006) for some evidence.

[5] This kind of punishment is also called *misdirected* or *perverse* punishment in the literature.

divided along ethnic lines; thus, our groups are very homogenous.[6] The first thing to investigate is whether behavior is the same across the communities. We will then in greater detail address the influence of individual characteristics such as age and gender as well as the impact of individual background variables on cooperative and norm-enforcement behavior.

Note that there are two features in our design that make the group variable very salient: First, in contrast to several other experiments, we keep the social distance of individuals constant, i.e. subjects in the experiment know that they interact with members of their own groups. Second, we deliberately chose high school students as subjects since these people are likely to get jobs outside their own local community after finishing high school, which may create additional heterogeneity and therefore weaken the group identity This would be difficult to control for empirically. Finally, it is important to emphasize that the global environment such as the political system and the general economic outlook are identical across our experimental groups. Thus, we are able to keep those complicating effects that are typically relevant in cross-country studies out of our analysis. In fact, the four high schools are located in four different communities located less than 15 kilometers apart.

The remainder of this paper is organized as follows. In Section 2 we present our experimental design. Section 3 presents our subject pools, followed by the results in Section 4. Finally, Section 5 concludes the paper.

2. Experimental design

[6] Due to a combination of the abolishment of discriminatory legislature and employment policies, affirmative action requirements within the government and the private sector and African empowerment initiatives, a percentage of both middle and high income groups from both the Colored and African population has, however, emerged in general.

Our experimental design builds on Gächter and Herrmann (2006). In their design there are two one-shot public goods experiments, one without any possibilities of monetary punishment of other group members and another with monetary punishment possibilities. In both cases, a group consists of three people. An important feature of a one-shot experiment, compared to a multi-period experiment, is that behavior in the former case is not guided by any strategic motives since there is no future interaction.[7] In the one-shot public goods experiment *without* punishment *(Part I)*, i.e. a standard public goods experiment, each individual is endowed with 20 Guilders and the marginal per capita return from the public good is 0.5.[8] Thus, member *i*'s payoff from the public goods experiment without punishment is given by

$$\pi_i = 20 - c_i + 0.5\sum_{j=1}^{n} c_j \ , \qquad (1)$$

where c_i is the contribution to the public good by member *i*.

In the public goods game *with* punishment *(Part II)*, there are two stages: the standard public good experiment, followed by a stage with the possibility to punish other members of the group. We employ the punishment technology as used by Gächter and Herrmann (2006), where the cost per punishment point is 1 Guilder, and each unit of punishment results in a deduction of 3 Guilders for the member who receives the punishment.[9] Each subject can assign a maximum of 10 punishment points to any other member in his or her group. Member *i*'s pay-off when punishment is possible is then

[7] The same argument holds for a multi-period experiment with perfect stranger matching, although it is possible that subjects can indirectly affect others.

[8] By setting the marginal return from the public good equal to 0.5, we create a social dilemma since the marginal return from the public good is less than from the private good, while the marginal social return from the public good exceeds the marginal return from the private good.

[9] Previous experiments have shown that punishment behavior follows the law of demand, i.e. the quantity of punishment declines with a rising price of punishment (Anderson and Putterman, 2006; Carpenter, 2006).

$$\pi_i = 20 - c_i + 0.5\sum_{j=1}^{n} c_j - \sum_{i \neq k} P_{ik} - 3\sum_{i \neq k} P_{ki}\ ,^{10} \quad (2)$$

where p_{ik} denotes the number of punishment points assigned by member *i* to member *k*, and p_{ki} is the number of punishment points assigned by member *k* to member *i*. Assuming rationality and selfishness, we expect neither any contributions to the public goods in the experiments, nor any assignment of punishment points in the subsequent punishment stage of the public goods experiment with punishment. General findings, however, indicate that subjects both contribute to the public good and punish each other in one-shot experiments as well as in multi-period experiments with stranger matching (e.g., Fehr and Gächter, 2000; Gächter and Herrmann, 2006; Gächter et al., 2004). As a result of the introduction of punishment possibilities, an increase in the contribution to the public good has normally been found.

In each high school, the experiment was conducted in a single session with 60 participants to avoid contagious effects by word-of-mouth communication between sessions.[11] The subjects were recruited by public announcements at the schools. In both African schools (which service a larger catchment area than the communities we are focusing on), we directed the announcement only to those from our target communities. The experiment was performed using English, which was also the language used in the schools. In order to ensure complete understanding, Afrikaans-speaking helpers were used in the White and Colored schools, while Xhosa-speaking helpers assisted in the African schools. Upon arrival to the experiment, the subjects were randomly assigned a seat. We used assembly halls to guarantee anonymity and to keep the subjects far apart. The experiment was executed by using paper and pencil.

[10] In *Part II* of the experiment the impact of the punishment was capped at the amount earned in the contribution stage. However, the punisher still incurred the costs of punishing even if it resulted in a loss in *Part II*. This procedure was common knowledge among subjects, and there was actually no case of a loss in the experiment.

[11] In the Colored community we had 69 participants. This gives a total of 249 subjects in the experiment.

After some pre-experimental questions, the instructions for *Part I* (public goods experiment without punishment) were delivered[12]. First the subjects were allowed some time to read the instructions before they were read aloud by the instructor. A quiz was then given to test understanding of the experiment. The correct answers and solutions were explained on the blackboard. Finally, to make sure that everyone had understood the experiment before entering *Part I* of the experiment, we dedicated a significant amount of time to privately answer questions of the subjects. Decisions were made anonymously, and communication among participants was strictly forbidden throughout the experiment. A similar procedure was undertaken before *Part II*, where the focus was on explaining how the punishment worked, including a quiz as well as time to ask questions in private. It should be noted that subjects were re-matched into new groups before *Part II* and that they were clearly informed of this procedure.[13] After their contributions in *Part II* had been handed in, we elicited subject beliefs about the average contributions to the public goods of the other group members in both *Part I* and *Part II*. We then continued with the second stage in *Part II*, which included the possibility to punish other members of the own group. Each member of the group was informed of the contribution of the other two members to the public good in *Part II* (but no information on behavior in *Part I* was revealed). After completing *Part II*, a post-experimental questionnaire to obtain socio-economic and attitudinal variables was handed out, and as a final part of the experiment, everybody was paid privately in cash cheques.[14] We calibrated the experiment, based on pilot studies, such that the subjects on average

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[12] The instructions are included in Appendix B. They were framed in neutral terms and did not contain any laden expressions such as "punishment".
[13] In the instructions we wrote "Note however, that now you will be **in a group with two other people than before**. [bold in instructions – our remark]".
[14] We used cash cheques for security reasons.

would earn a bit more than they would have had they spent the time working.[15] One Guilder in the experiment was later exchanged for 1.5 South African Rand (ZAR).[16]

3. Subject pools

The experiment was conducted at four different high schools in Cape Town, selected to capture differences in socio-economic strata in the South African society. Table 1 gives some background information obtained from the Cape Area Panel Study for Young Adults (Lamb et al, 2006), the 2001 Census (Stats SA, 2003), as well as from our own survey of the communities serving as catchment areas for the four included high schools. The table clearly shows that individuals in the White community are better off than those from the Colored community, which is lagged significantly by both African communities with respect to income, education and employment of parents, as well as housing standards. Individuals in the White neighborhoods have a per capita monthly income of R3750, while in the Colored community individual monthly income is R1100. In the African Permanent and Informal communities, individual monthly income is reported as R374 and R288 respectively. While only 13% and 14.47% of the households in the White and Colored communities are in poverty, 47.56% of the households in the African Permanent community and 45.95% of households in the African Informal community are in poverty.

[15] The hourly wages for casual and unschooled labor in South Africa range from 5 to 25 ZAR (Department of Labour, South Africa, 2006). The subjects earned 58.35 ZAR on average, and the experiment lasted slightly more than two hours.
[16] The exchange rate at the time of the experiment was 6.10 ZAR = 1 USD.

Table 1. Descriptive statistics of community data.

	Source	White	Colored	African Permanent	African Informal
Monthly per capita income (in ZAR)	CAPS	3750	1100	374	288
Households in poverty	Census	13.00%	14.47%	47.56%	45.95%
Mothers with high school certificate	CAPS	92.30%	46.15%	12.31%	15.15%
Fathers with high school certificate	CAPS	83.33%	53.85%	20.69%	16.59%
Mothers working	CAPS	69.23%	68.75%	23.44%	29.10%
Father working	CAPS	100.00%	84.00%	46.43%	50.94%
Living in permanent building	CAPS	100.00%	86,20%	68,40%	40,50%
Piped water in the house	CAPS	100.00%	97.94%	66.72%	27.46%

Note: Summary statistics are percentages or averages.

Sources: *CAPS*: Cape Area Panel Study for Young Adults in 2002; *Census*: South African census in 2001; *own*: own data from post experimental questionnaire. For more information about the composition of our indexes see Appendix A. Descriptive data has been obtained for the same communities that serve as catchment areas for the schools in our experiments.

Large disparities are noticeable with respect to education as well, with the percentage of parents having attained a secondary (high) school certificate ranging from 83 to 92% for the White community, 46-54[17]% for the Colored community and only 12-21% for the African Permanent and 15-17% for the African Informal communities. Other investigated indicators of socio-economic conditions within the communities include the type of housing development and access to drinking water. This information is helpful in illustrating that there are indeed pertinent differences in the permanency of housing infrastructure between the African Permanent and African Informal communities in our sample, with the majority of housing in the latter case being informal shacks with no in-house access to drinking water.

[17] The lower bound in this case refers to the mother's education whereas the upper bound refers to the father's education.

Table 2. Descriptive statistics of community data and survey data.

	White	*Colored*	*African Permanent*	*African Informal*
Male	0.45	0.20	0.35	0.23
Age	16.32	17.00	18.12	17.33
Currently living with both parents	63.35%	56.52%	23.33%	26.67%
Weekly allowance	83.20	61.42	15.16	45.81
Composite generalized trust index	23.46	21.85	22.05	20.36
Composite social integration index	1.24	0.70	0.80	0.80
Composite household violence index	0.19	0.21	0.32	0.31
Composite community crime index	0.79	1.33	1.59	1.38
Household reading index	3.26	2.42	1.33	1.48

Note: Summary statistics are percentages or averages.

Table 2 provides descriptive statistics of each community for social capital variables such as parental presence in the household, trust, social integration, crime, domestic violence, and exposure to reading. Indices have been constructed using questions from our post-experimental questionnaire.[18] Whereas 63.3% and 56.52% of the individuals from the White and Colored schools live with both parents, only 23.33% and 26.67% of those from the African Permanent and African Informal schools do. There is a marked difference between the White community and the rest, with higher levels of generalized trust, social integration, and also reading among those from the White community. Furthermore, this group features the lowest levels of domestic violence and exposure to crime. Both of the latter indices are noticeably higher for the African communities.

[18] A brief description of these indices, as well as summary statistics are provided in Appendix A.

4. Experimental results

Descriptive overview of basic results

We start by presenting an overview of our results in each of the four communities. Table 3 and Table 4 summarize the average levels of contributions in both public goods experiments and punishment, respectively. In addition, a more detailed analysis is provided in the tables, where we calculate the proportion of zero contribution and punishment as well as conditional contribution and punishment. Behavior in the public goods experiment without punishment (*Part I*) shows that subjects in the White community contribute least; on average only 6.88 Guilders (34.4%) compared to Colored 8.51 (42.6%), African Permanent 9.34 (46.7%), and African Informal 11.27 (56.4%). Our figures can be compared to Gächter and Herrmann (2006), who used a 2*2 design where subjects differed in age (young or mature) and location (urban and rural). In their urban and young sample, the average contribution level was 37%, while in the other three combinations the averages were 50.5%-53.5%. The null hypothesis that the contributions in two tested independent communities are drawn from the same distribution is rejected at a 5% significance level using a Wilcoxon-Mann-Whitney test, except for the pairs (i) Colored and African Permanent and (ii) African Formal and African Informal (see Table A1 in Appendix II).

Introducing punishment possibilities in *Part II* results in an increase in the contribution to the public good in all four communities, which is in line with previous research (with the exception of Gächter and Herrmann, 2006). The average increase was largest in the White community, where the average contribution increased to 8.25 (41.2%) (an increase by almost 7 percentage units or 19.9%). In the other three schools, the increases were more modest: to 8.85 (44.2%), 10.7 (53.5%), and 11.37 (56.8%) for Colored, African Permanent and African Informal, respectively. In pair-wise tests using Wilcoxon-Mann-Whitney test between the communities, we can reject the null hypothesis of the same contributions at a 5% significance level only between the pairs (i) White and African Informal and (ii) Colored and African Informal (see Table A2 in

Appendix). We cannot reject the null hypothesis of same contributions between Part I and Part II at a 5% significance level in each of the four communities using a Wilcoxon-signed-ranks test, except in the White community (see Table A4 in Appendix).

In *Part II*, there was also a punishment stage. Although subjects from the White and the Colored communities on average contributed less to the public good, punishment was also lower among them than among the subjects in the two African Communities (as shown in Table 4). We can reject the null hypothesis of same amount of punishment in pair-wise tests using Wilcoxon-Mann-Whitney test at a 1% significance level, except for the pairs (i) White and Colored and (ii) African Permanent and African Informal (see Table A3 in Appendix).

In Table 3, we also provide a more detailed analysis of contributions by separating free-riders from non free-riders, as well as conditional contribution, i.e. the contribution given that a positive amount has been contributed. As shown in Table 3, the low level of contribution in the White community is a combined effect of a higher proportion of free-riders as well as a lower level of contribution among non free-riders.

In Figure 1 we show the structure of the punishment points assigned to other members in the group in relation to the difference between the contribution of the punisher and the contribution of the punished. A negative number on the x-axis indicates that the punished subject contributed less than the punisher and vice versa. Although there is a tendency of increased punishment of others when the negative difference between own contribution and that of others is increasing, this tendency is not too pronounced. For all groups there is some spiteful punishment, but in the African communities there seems to be a substantial amount of misdirected punishment. In Table 4 we also calculated the degree of spiteful punishment, which is measured as the ratio between mean punishment of non-negative deviations and mean punishment of negative deviations. African Permanent deviates here, and the degree of 0.94 is higher than any of the figures in Gächter and Herrmann (2006) (their highest was urban and mature with 0.78), while in the other three communities they range from 0.42 to 0.53.

Table 3. Average levels of contribution to the public goods, proportion of free-riders and conditional average levels of contribution.

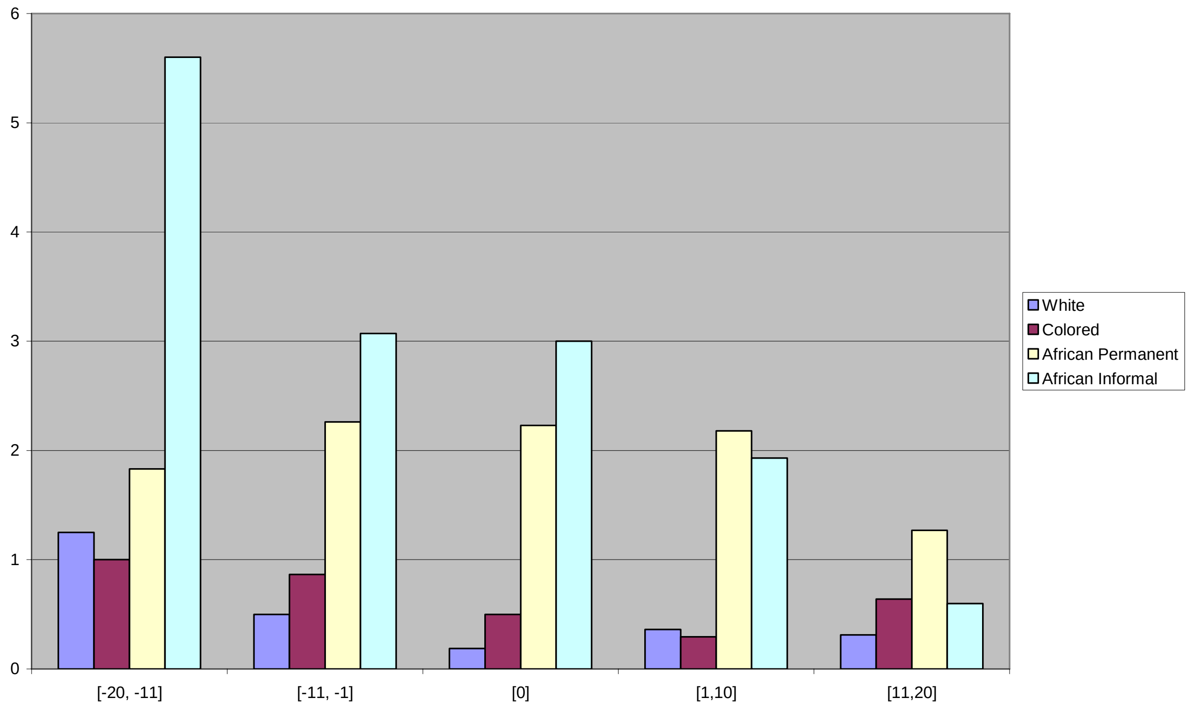
	Average contribution without punishment (Part I)			*Average contribution with punishment (Part II)*		
	Contribution	Proportion zero contribution	Conditional contribution	Contribution	Proportion zero contribution	Conditional contribution
White	6.88	0.30	9.83	8.25	0.17	10.69
Colored	8.51	0.16	10.16	8.85	0.20	11.33
African permanent	9.34	0.12	10.67	10.70	0.06	11.04
African informal	11.27	0.10	12.55	11.37	0.11	12.67

Table 4. Average levels of punishment, proportion of non-punishers, conditional average levels of punishment and degree of spiteful punishment.

	Punishment	*Proportion zero punishment*	*Conditional punishment*	*Degree of spiteful punishment*
White	0.49	0.75	1.97	0.42
Colored	0.62	0.76	2.58	0.46
African permanent	2.09	0.48	4.03	0.94
African informal	2.64	0.41	4.44	0.53

Note: Degree of spiteful punishment is the ratio between the average punishment of non-negative deviators and average punishment of negative deviators.

Figure 1. The structure of punishment.



In Table 5, we present the average total net earnings in Guilders in each part of the experiment at community level. As expected, the African communities have a higher income in *Part 1*. However, the higher levels of punishment among the African communities, which has a negative impact on the earnings of both punishers and the punished, results in their earnings being lower than the White and Colored group in *Part II*. On the other hand, the White and Colored communities earn on average the same in *Part I* and *Part II*.

Table 5. Total net earnings in Guilders.

	Part I	*Part II*
White	23.44	20.19
Colored	24.07	19.39
African permanent	25.03	7.90
African informal	25.91	4.48

Determinants of cooperation

In this section of the paper we study the determinants of cooperative behavior and punishment, by controlling for standard experimental variables, as well as, social background variables, in our econometric analysis. First we analyze what factors explain the amounts contributed to the public good in *Part I* and *Part II*. Then we examine what determines the punishment points assigned to other subjects in the group. In all cases we run tobit regressions, since the dependent variable is censored on both sides.

In Table 6 we analyze what determines the amount contributed to the public good in *Part I*. The first regression only includes the dummy variables for the different communities (where the White community is the reference group) and the beliefs of the average contribution of other group members to the public goods. In the other two regressions we include basic socio-demographic variables, i.e. gender and age, and a battery of other socio-economic variables. Regardless of the model specification, beliefs about the contributions of others seem to be an important determinant of cooperative behavior, much in the spirit of the empirical evidence on conditional cooperation (e.g., Fischbacher et al., 2001; Fischbacher and Gächter, 2006). We find both age and being female to increase contributions significantly in the pooled sample.[19] While it seems at a first sight from the dummy variables for the two African communities that contributions by these two groups are significantly higher compared the White community, controlling for only the most standard individual socio-demographic variables renders the coefficients for the dummies insignificant.

Trust in schoolmates has the expected positive and significant effect on contributions for the pooled sample, and is also significant for the African Permanent community. Generalized trust in others seems to increase contributions, which is in line with related studies. An interesting effect is associated with our social integration index. It comprises several dimensions such as the number of school friends, the number of friends outside school, as well as the number of organizations (including voluntary organizations) and teams an individual belongs to. We find that a higher level of social integration is associated with lower contributions in the public goods game. Although this sounds counter-intuitive at first sight, social integration does not necessarily have to be positively related with unconditional contributions in the absence of a sanctioning system in a one-shot game. Many real-world examples of organizations rely on conditional contributions, a formal sanctioning system and repeated interaction, which is discussed below. The presence of biological parents and, particularly, the presence of the mother in the subject's household do not have a significant effect on the contribution level in the pooled sample. Looking at the individual communities, however, it seems to have a potential influence. Due to the small number of observations (especially in Model [7]) and the ambiguous sign, we want to postpone a more detailed discussion. Note in any case that the structure of African households in South Africa has little bearing on Western type nuclear families, and for a large fraction of our sample, no or

[19] While we focused on students in the last two years of school, there is typically some variation in age due to high failure rates and individuals repeating grades after missing school for extended periods. This is particularly true for the African schools, which have historically been disadvantaged.

Table 6. Determinants of contributions in Part I.

	All	*All*	*All*	*White*	*Colored*	*African Perm.*	*African Inform*
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Expectations	0.304*	0.255*	0.283*	1.662***	-0.045	0.064	-0.100
	(0.159)	(0.154)	(0.147)	(0.484)	(0.336)	(0.181)	(0.304)
Colored	2.628	0.077	-1.200				
	(1.668)	(1.719)	(1.747)				
African Permanent	2.967*	-0.987	-3.457				
	(1.759)	(1.965)	(2.313)				
African Informal	5.706***	2.738	0.320				
	(1.733)	(1.806)	(2.118)				
Age		2.34***	2.15***	-1.45	2.88**	1.78*	2.71**
		(0.628)	(0.616)	(2.817)	(1.212)	(0.894)	(1.119)
Female		3.60***	3.79***	1.97	6.13***	2.51	6.46
		(1.359)	(1.328)	(2.649)	(2.267)	(2.196)	(4.200)
Social integration index			-7.94	-6.83	-18.19**	4.051	0.44
			(4.830)	(10.770)	(8.302)	(9.281)	(11.166)
Household violence index			2.404	9.762	6.633	-0.373	-0.598
			(3.664)	(14.336)	(6.726)	(5.342)	(7.258)
Community crime index			0.154	-0.738	1.919**	-0.459	-0.812
			(0.401)	(1.695)	(0.818)	(0.574)	(0.700)
Presence of mother			-1.248	-1.348	8.281**	-0.967	-5.072*
			(1.469)	(4.403)	(3.650)	(1.985)	(2.759)
Trust school mates			0.937**	0.022	0.787	2.200***	1.083
			(0.363)	(1.000)	(0.592)	(0.601)	(0.691)
Household reading index			-1.407**	-3.520**	-0.804	0.163	-0.224
			(0.589)	(1.482)	(0.745)	(1.421)	(1.538)
Constant	3.9**	-36.0***	-29.9***	30.7	-54.17**	-32.16*	-38.17*
	(1.608)	(10.557)	(11.150)	(46.765)	(23.259)	(17.054)	(21.683)
Observations	243	243	227	59	67	51	50
Log likelihood	-680.9	-672.5	-619	-140.1	-174.6	-141.9	-138.16
LR $chi^2(16)$	15.91***	32.79***	32.79***	22.59***	31.42***	18.21***	12.10
PseudoR^2	0.011	0.024	0.024	0.075	0.083	0.06	0.042

Standard error in parenthesis. Superscripts *, **, *** respectively denote statistical significance at the 10%, 5%, and 1% level.

only one parent is present. Thus, the variable could have had some relevance in explaining cooperative and norm-enforcement behavior. Second, the household reading index (capturing the number of books as well as the presence of an encyclopedia and a dictionary in the household) serves as a proxy for the literacy of subjects, for the education level of a family, and for the extent of intellectuality in the family environment. Its negative effect is particularly strong in the White community where educational attainments of parents are typically higher. Finally, note that we did not find any significant effect of the norm-enforcement and norm-violation indexes (i.e., the household violence index and the community crime index[20]) on cooperation, except the community crime index in the Colored community.

Table 7 presents the determinants of contribution to the public goods in *Part II* of the experiment, using the same models as in *Part I*. The general picture is similar in the two parts, although some of the coefficients lose their significance in *Part II*. The explanation for this is straightforward. Since subjects knew that the contribution phase in Part II would be followed by a punishment phase, the introduction of the institution was possibly able to overshadow individual heterogeneity stemming from the social background. In other words, the introduction of a punishment option homogenizes behavior. Remember that this homogenization cannot be a consequence of learning, since subjects did not receive any feedback on the results of Part I before the end of the experiment.

[20] Community crime is an index for the number of incidences of assault, robbery, shooting, rape, murder, kidnapping, burglary, and housebreaking an individual has heard about in his or her community in the last month. On the whole, community crime incidents are lowest among the White community in our sample. On average 28% of those in the White group, 58% of the Colored group, 55% of the African Permanent and 65% of the African Informal group had heard of a murder in their neighborhood in the last month. Those who reported to have heard of incidents of other violent crimes such as rape were reported to be 15% among the White group, 38% among the Colored group, 45% among the African Permanent, and 53% among the African Informal group.

Table 7. Determinants of contributions – Part II

	All	***All***	***All***	***White***	***Colored***	***African Perm.***	***African Inform***
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Expectations	0.319**	0.305**	0.346**	0.215	0.175	0.432**	0.378
	(0.142)	(0.142)	(0.143)	(0.383)	(0.392)	(0.174)	(0.276)
Colored	0.858	-0.331	-2.260				
	(1.476)	(1.571)	(1.691)				
African Permanent	2.817*	0.67	-2.70				
	(1.558)	(1.790)	(2.243)				
African Informal	3.369**	1.881	-1.563				
	(1.531)	(1.650)	(2.054)				
Age		1.329**	1.170*	0.245	3.141**	2.076**	-0.333
		(0.573)	(0.595)	(2.321)	(1.423)	(0.845)	(0.988)
Female		0.994	1.205	-2.056	5.073*	0.941	6.720*
		(1.234)	(1.274)	(2.234)	(2.698)	(2.050)	(3.705)
Social integration†			-9.023*	-12.859	-19.020*	-0.809	2.609
			(4.653)	(8.978)	(9.678)	(8.722)	(10.109)
Household violence†			1.392	-8.114	3.065	-6.680	20.289***
			(3.576)	(12.677)	(7.683)	(5.046)	(6.630)
Community crime†			0.438	1.065	0.901	0.029	0.117
			(0.391)	(1.472)	(0.944)	(0.535)	(0.642)
Presence of mother			-1.050	-6.865*	1.454	0.924	-3.101
			(1.406)	(3.760)	(3.987)	(1.863)	(2.419)
Trust school mates			-0.031	-1.759**	0.301	0.598	0.812
			(0.346)	(0.844)	(0.683)	(0.550)	(0.610)
HH reading†			-0.899	-2.766**	-0.357	0.645	-1.241
			(0.569)	(1.228)	(0.876)	(1.342)	(1.352)
Constant	5.701***	-16.441*	-7.653	31.386	-49.255*	-31.314*	2.504
	(1.408)	(9.602)	(10.749)	(38.400)	(26.987)	(16.179)	(19.109)
Observations	243	243	227	59	67	51	50
Log likelihood	-702.5	-699.78	-650.12	-158.5	-183.81	-144.6	-142.3
LR $chi^2(16)$	14.6***	19.6***	25.11**	15.32*	17.55**	13.83	12.14
PseudoR^2	0.01	0.014	0.019	0.046	0.046	0.05	0.04

Standard error in parenthesis. Superscripts *, **, *** respectively denote statistical significance at the 10%, 5%, and 1% level.

† Index variable

Determinants of punishment

Table 8 shows the basic regressions for assigned punishment points. Interestingly, punishment is almost uniquely explained by community dummy variables with punishment levels in the African Permanent and the African Informal communities being significantly higher than in the White group. Without discussing this result in greater depth, we proceed by controlling for social background variables, much in the same spirit as for contribution levels, to check whether the significance of the community dummies is a robust phenomenon in explaining punishment behavior.

membership significantly, to the extent that it renders the African Informal dummy insignificant, while the significance of the dummy for the African formal community is lowered substantially. Since punishment can be directed to both other players in one's group, we are now dealing with a higher number of observations and feel rather comfortable claiming that it is a general phenomenon for cooperative and norm-enforcement behavior in our subject pool to be better explained by social environment variables than by pure community membership.

The interpretations of most of our results are rather straightforward. Higher levels of trust might create disappointment that leads to a relative overshooting of punishment behavior, even when we control for the deviations from one's own contributions. Neither is it surprising that women – who had contributed significantly more – have a greater tendency to punish. What we, however, find interesting is the fact that this tendency is most pronounced among the two African communities, indicating that punishment might be a very important mechanism for women to sustain cooperation. There is no unambiguous explanation for the negative impact of the household reading index, but it could be related to a strand of the socio-psychological literature showing that children in households that read are better able to verbalize or express themselves and are, hence, less inclined to violent behavior.

Table 8. Determinants of punishment I

Dependent variable:			
Punishment points	[1]	[2]	[3]
Own contribution	0.223***	0.067	0.059
	(0.064)	(0.061)	(0.062)
Positive deviation from own contr.	-0.012	-0.085	-0.084
	(0.073)	(0.069)	(0.069)
Abs. negative deviation from own contrib.	-0.005	0.079	0.081
	(0.065)	(0.061)	(0.061)
Colored		0.167	-0.202
		(0.785)	(0.825)
African Permanent		3.967***	3.354***
		(0.784)	(0.893)
African Informal		4.868***	4.432***
		(0.787)	(0.836)
Age			0.359
			(0.270)
Female			0.488
			(0.605)
Constant	-3.615***	-4.238***	-10.283**
	(0.859)	(0.918)	(4.593)
Observations	486	486	486
Log likelihood	-729.2	-696.9	-695.9
LRchi^2	25.35***	90***	91.98***
Pseudo R^2	0.017	0.061	0.062

Standard error in parenthesis. Superscripts *, **, *** respectively denote statistical significance at the 10%, 5%, and 1% level.

In Table 9 we control for the same social background variables as in the regression models for cooperation. Even when we control for social background variables, both the African community dummies are significant. Interacting the index for household violence with community dummies diminishes the effect of community

Table 9. Determinants of punishment II

Dependent variable:	***All***	***All***	***White***	***Colored***	***African Perm.***	***African Inf.***
Punishment points	[1]	[2]	[3]	[4]	[5]	[6]
Own contribution	0.022	0.014	0.064	-0.156	0.013	0.197*
	(0.062)	(0.062)	(0.089)	(0.125)	(0.135)	(0.115)
Positive deviation from own contrib.	-0.122*	-0.116*	-0.058	-0.050	-0.334**	0.031
	(0.067)	(0.068)	(0.084)	(0.117)	(0.141)	(0.136)
Abs. negative deviation from own contrib.	0.097	0.093	0.148	0.246**	-0.392***	0.247**
	(0.061)	(0.06)	(0.092)	(0.106)	(0.146)	(0.098)
Colored	-0.001	-0.091				
	(0.849)	(1.607)				
African Permanent	3.273***	2.901*				
	(1.050)	(1.742)				
African Informal	3.760***	0.81				
	(0.972)	(1.736)				
Age	0.219	0.123	0.277	0.158	1.029**	0.222
	(0.266)	(0.268)	(0.696)	(0.654)	(0.460)	(0.401)
Female	1.085*	1.343**	0.775	-0.436	2.773**	5.243***
	(0.598)	(0.609)	(0.713)	(1.201)	(1.158)	(1.595)
Social integration index	2.593	2.423	1.976	-0.345	3.705	4.896
	(2.225)	(2.236)	(2.733)	(4.673)	(4.822)	(4.340)
Household Violence Index (HVI)	2.113	-2.819	-1.305	-2.390	-2.583	11.739***
	(1.643)	(5.747)	(4.212)	(4.141)	(3.027)	(2.983)
Colored * HVI		0.293				
		(7.276)				
African Permanent * HVI		2.376				
		(6.348)				
African Informal * HVI		10.498				
		(6.388)				
Community Crime Index	-0.53***	-0.49***	-0.77	-0.18	-0.59*	-0.54*
	(0.187)	(0.187)	(0.570)	(0.476)	(0.316)	(0.278)
Presence of mother	-0.289	-0.634	-0.060	-0.085	1.764*	-4.634***
	(0.628)	(0.64)	(1.196)	(1.893)	(1.046)	(1.009)
Trust schoolmates	0.514***	0.51***	0.567*	-0.012	1.271***	0.247
	(0.162)	(0.163)	(0.293)	(0.322)	(0.327)	(0.241)
Household reading index (HIV)	-0.500*	-0.597**	0.905**	-0.749*	-1.304	-0.872
	(0.273)	(0.274)	(0.421)	(0.418)	(0.786)	(0.532)
Constant	-8.9038*	-5.798	-12.98	-1.74	-20.18**	-10.83
	(4.912)	(5.096)	(11.792)	(12.328)	(8.809)	(8.170)
Observations	454	454	118	134	102	100
Log likelihood	-624.0		-105.74	-127.55	-172.9	-620.7
LR chi^2	108.0***		18.81*	13.64	40.75***	114.74
Pseudo R^2	0.079		0.081	0.051	0.19	0.085

Standard error in parenthesis. Superscripts *, **, *** respectively denote statistical significance at the 10%, 5%, and 1% level.

As far as our variables that take up the effects of norm-enforcement and norm-violation, we see that the hypothesized effect of the household violence index cannot be substantiated. It is, however, interesting to note that the community crime index is negative and highly significant for both columns with pooled data, as well as, for the African Permanent and African Informal communities. This may indicate – if one wants to speculate – that exposure to community crime is in fact a proxy for norm-violation experience, in so far as more crime experience could intimidate pro-social law-abiding citizens who would otherwise use social sanctioning as a means to enforce cooperation. Note in this context that the variable is only significant for the African communities if we split our sample.

5. Discussion and conclusion

This study brings to light new insights into the nature of social norms and their determinants. One-shot public goods games with and without punishment were conducted at four schools in Cape Town, South Africa, each representing communities from different socio-demographic and population groups. By studying normative behavior within one geographical setting, we are able to keep constant differences in formal institutions, legislature, and political system – factors that often affect cross-cultural studies conducted in different countries.

Even though the chosen schools are all within 15 km of each other, we find significant differences in behavior in terms of cooperation and punishment. The four groups in this study draw from the White, Colored, and African populations. Two locations were sampled in the African community in order to distinguish possible differences in the effect of housing development and associated socio-economic conditions on behavior.

We find that both African communities from Permanent and Informal areas contribute and punish significantly more than those from the White and Colored groups, with those from informal areas contributing most. Some studies have indicated that social norms are culturally defined. If cultural norms and tradition are strongly entrenched in the behavior of individuals, one possible explanation to the observed differences would be that one of the most distinct social norms in the African society, commonly known as Ubuntu, is responsible for strong preferences for the pro-social behavior exhibited by both African groups. Ubuntu is a special term in Xhosa for expressing empathy and solidarity with one's group – for the whole being greater than the parts. While this explanation may be intuitively appealing, very little empirical evidence for or against this norm in present-day South Africa is available.[21] But a traditional group-oriented norm such as Ubuntu cannot explain the whole story, given that we also observe significant differences in behavior between the White and Colored groups as well as differences between the African Permanent and Informal groups.

A stronger argument against the relevance of a group-oriented norm, however, is our finding that once one controls for individual social background variables, the community dummies cease to be significant for almost all estimated regression models. This holds for both cooperation and punishment. Thus, we can provide evidence that the average variance of behavior within a given culture or group is at least as relevant as the variance across cultures or groups. Our results also indicate some interesting avenues for further research in the social context of norm development in cooperative and norm-enforcement behavior.

[21] Sociologists in South Africa agree that if a norm such as Ubuntu exists, its effect in modern multi-cultural and pluralist cities may have become highly dispersed, with many other motivations affecting individual behavior. If Ubuntu does exist in present day South Africa, it is thought to be more prevalent among rural subsistence communities.

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Appendix I: Detailed results from statistical tests

Table A1. P-values from pair-wise test of public goods contribution in Part I.

		White	Colored	African Permanent	African Informal
White	Contribution	X	x	x	x
	Proportion	X	x	x	x
	Conditional contribution	X	x	x	x
Colored	Contribution	0.048	x	x	x
	Proportion	0.062	x	x	x
	Conditional contribution	0.363	x	x	x
African Permanent	Contribution	0.029	0.526	x	x
	Proportion	0.022	0.5630	x	x
	Conditional contribution	0.432	0.725	x	x
African informal	Contribution	0.000	0.019	0.123	x
	Proportion	0.007	0.321	0.693	x
	Conditional contribution	0.017	0.029	0.111	x

Note: We applied a Wilcoxon-Mann-Whitney test to test the null hypothesis that the contributions (and conditional contributions) in two tested independent communities are drawn from the same distribution. The null hypothesis of same proportion is tested by using a chi-square test.

Table A2. P-values from pair-wise test from public goods contribution in Part II.

		White	Colored	African Permanent	African Informal
White	Contribution	x	x	x	x
	Proportion	x	x	x	x
	Conditional contribution	x	x	x	x
Colored	Contribution	0.612	x	x	x
	Proportion	0.436	x	x	x
	Conditional contribution	0.667	x	x	x
African Permanent	Contribution	0.057	0.153	x	x
	Proportion	0.004	0.024	x	x
	Conditional contribution	0.911	0.637	x	x
African informal	Contribution	0.010	0.024	0.415	x
	Proportion	0.040	0.163	0.338	x
	Conditional contribution	0.154	0.171	0.105	x

Note: We applied a Wilcoxon-Mann-Whitney test to test the null hypothesis that the contributions (and conditional contributions) in two tested independent communities are drawn from the same distribution. The null hypothesis of same proportion is tested by using a chi-square test.

Table A3. P-values from pair-wise test from punishment in Part II.

		White	Colored	African Permanent	African Informal
White	Punishment	x	x	x	x
	Proportion	x	x	x	x
	Conditional punishment	x	x	x	x
Colored	Punishment	0.894	x	x	x
	Proportion	0.892	x	x	x
	Conditional punishment	0.082	x	x	x
African Permanent	Punishment	0.000	0.000	x	x
	Proportion	0.000	0.000	x	x
	Conditional punishment	0.000	0.024	x	x
African informal	Punishment	0.000	0.000	0.159	x
	Proportion	0.000	0.000	0.250	x
	Conditional punishment	0.000	0.002	0.387	x

Note: We applied a Wilcoxon-Mann-Whitney test to test the null hypothesis that the punishments (and conditional punishments) in two tested independent communities are drawn from the same distribution. The null hypothesis of same proportion is tested by using a chi-square test.

Table A4. P-values from tests between Part I and Part II.

	Contribution	Proportion	Conditional contribution
White	0.063	0.225	0.162
Colored	0.739	0.527	0.462
African Permanent	0.245	0.046	0.718
African Informal	0.909	1.000	0.876
Overall	0.081	0.262	0.231

Note: We applied a Wilcoxon matched-pairs signed-ranks test to test the null hypothesis that the punishments (and conditional punishments) in two tested parts are drawn from the same distribution. The null hypothesis of same proportion is tested by using McNemar test.

Appendix II: Background data and composition of empirical indexes

In Table A-1, we summarize the degree of trust in different dimensions, and worth to notice is the lower degree of trust that is reported in the African Informal community.

Table A-1. Trust towards different groups reported on a five-point scale.

Trust…	**White**	**Colored**	**African Perm.**	**African Inf.**
Extended family	4.49	3.67	4.55	1.68
Neighbors	3.48	3.41	3.21	1.85
School mates	4.35	3.94	3.47	1.78
Members of your own race	3.97	3.47	3.30	1.81
Members of other races	3.70	3.38	3.15	1.72
Strangers	2.08	1.65	2.29	2.00
Local government officials	2.68	3.12	3.12	1.86
National government to keep promises	2.55	2.65	3.34	1.97

We asked how safe the subjects felt in their community on a six-point scale ranging from very safe to very unsafe, with averages of 4.88 in White, 3.90 in Colored, 3.82 in African Permanent, and 3.98 in African Informal. The proportion of subjects who had heard of different criminal incidents in their community over the last month is reported in Table A-2. The main difference is the lower proportion of individuals in the White community who had heard about incidents of murder and housebreaking.

Table A-2. Proportions that have heard of incidents in their community

Type of incident	White	Colored	African Perm.	African Inf.
Assault	32%	49%	47%	50%
Robbery	63%	71%	80%	78%
Shooting	30%	83%	70%	70%
Rape	15%	38%	45%	53%
Murder	28%	58%	55%	65%
Kidnap	13%	26%	25%	23%
Burglary	57%	52%	40%	37%
Housebreaking	62%	61%	82%	90%

Appendix III: Experimental instructions (not necessarily for publication)

Welcome to the experiment

You are about to participate in an economics experiment. Depending on your decisions and the decisions of other people in the room, you may earn a considerable amount of money. The amount you make will be paid to you at the end of this experiment **as a cash cheque, which you can exchange for cash at any ABSA bank**.

The experiment consists of **two independent parts: Part 1 and Part 2**. Your total income from the experiment is the sum of the income in these two parts. The following pages contain the instructions for Part 1. After Part 1 you will receive the instructions for Part 2 of the experiment. **During the entire experiment, communication with anybody except the experimenters is strictly forbidden.** If you communicate with any of the other participants, we will ask you to leave the room and you will not receive any payment for the experiment. Please raise your hand if you have questions. A member of the research team will come to you and answer your question in private.

You will also have to fill in a few questionnaires during the experiments. All your answers **remain confidential and anonymous (private)**. We will use the experiment number tag that you have received on entering the room to identify you during the experiment, and this will also be used to identify you when we pay you your income after the experiment.

During the experiment we will not speak of Rands but rather of Guilders. First your whole income will be calculated in Guilders. At the end of the experiment, the whole amount you have earned in Guilders will be converted to Rand at the following rate and paid out as a cash cheque:

1 Guilder = R 1.50

PART ONE

Procedure of the experiment:

At the beginning of the experiment we are going to divide all participants **into groups of three**. Apart from you, there are two other members in your group. Nobody except for the experimenters will know who is in which group. You will not learn who the other two people in your group are or have been, neither during nor after the experiment.

Each member of a group **receives 20 Guilders** and has to decide where to put these 20 Guilders. You can either (i) put all these **20 Guilders into project A and nothing into project B, (ii) put nothing in project A and all your 20 Guilders into project B or (iii) you can put them partially into project A and project B.** Therefore, each **group member has to decide for himself or herself** how much of his or her 20 Guilders to put into project A and project B. Later we will ask you about your decision. We will ask you how much you would put into project B, and each Guilder you do not put into project B will automatically go towards project A.

For each Guilder that you choose to put in project A, you will earn 1 Guilder. Once every group member has decided how much to contribute to project B, the experimenter will **sum (add together) the Guilders that all group members contributed to project B. The experimenter will then add an extra 50% to the total amount that all three group members contributed to project B,** which will then be **divided between the three group members in equal parts**. This means that the total amount of Guilders contributed to project B is multiplied by 1.5 to increase it by 50%. Thereafter it is divided by 3, since there are three members in a group. **So the income each group member receives from project B is**

$$= \frac{1.5 \times (\textit{the total amount of Guilders that the group put in project } B)}{3}$$

$$= 0.5 \times (\textit{the total amount of Guilders that the group put in project } B)$$

For example, if you contribute 1 Guilder to project B, the experimenter will add half a Guilder. So the amount of 1.5 Guilders will be distributed among all three members of the group in equal parts. Therefore, each group member receives 0.5 Guilders. For every 1 Guilder you put into project B, you will earn 0.5 Guilder. At the same time the income of each other group member will also increase by 0.5 Guilders, since every group member receives the same amount of money out of project B, **no matter**

what his or her contribution was. **If another member contributes 1 Guilder to project B, the same reasoning holds.**

Calculation of your income:

The total income of the three group members from Part 1 of the experiment will be calculated in the same way. Each member's income consists of two parts:

1. Guilders from project A

2. Guilders from project B, which will be calculated in the following way:

*(1.5/3) * (total amount of contributions to project B by all group members) =*

*0.5 * (total amount of contributions to project B by all group members)*

Your **total income is the sum of your income from project A and project B**: So your total income from Part 1 is

= [Income from Project A] + [Income from Project B]

= [(20 – your contribution to project B)] + [0.5 * (the total amount that the group contributed to project B)]

The following examples will help you gain some understanding about the calculation of your income:

Example 1. If the three group members each contribute 0 Guilders to project B, their income will be equal to the 20 Guilders that they put in project A. Nobody receives anything from project B, since nobody contributed to it. The total income of each member is therefore 20 Guilders.

Calculation of total income for each participant:

= [(20 – 0)] + [0.5 * (0)] = [20]

Example 2. If the three group members each contribute 20 Guilders to project B. The income from project A is 0. The total contribution to project B is 60 Guilders. So, each member gets an income from project B of 0.5*60 = 30 Guilders.

Calculation of total income for each participant:

= [(20 – 20)] + [0.5 * (60)] = [30]

Example 3. If you contribute 20 Guilders to project B, the second member contributes 10 Guilders, and the third member contributes 0 Guilders, this will result in the following incomes. Since you and the second member put a total of 30 Guilders into project B and the third member contributed nothing, each of the three group members will get 0.5*30 = 15 Guilders from project B.

Since you contributed all 20 Guilders to project B, you receive a total of 15 Guilders because you have no income out of project A.

The second member put 10 Guilders into project A and therefore gets 10 Guilders from project A. This member also gets 15 Guilders from project B. So she receives 10 + 0.5*30 = 25 Guilders, in total.

The third member, who contributed nothing to project B, gets 20 Guilders from project A, but also gets 15 Guilders from project B, like each of the other members. His total income is therefore 20 + 0.5*(30) = 35 Guilders.

Calculation of your total income:

=	(20 – 20)	+	0.5 * (30)	=	15

Calculation of second member's total income:

=	(20 – 10)	+	0.5 * (30)	=	25

Calculation of third member's total income:

=	(20 – 0)	+	0.5 * (30)	=	35

Example 4. The other two members contribute 20 Guilders to project B; you decide to contribute nothing. The total amount in project B is therefore 40 Guilders, so each person receives 0.5*40=20 Guilders from project B. The other two members put everything in project B, so this 20 Guilders is all the income they receive. You put nothing in project B, so you get 20 Guilders from project A, as well as, 20 Guilders from project B. In this case the incomes are calculated as follows:

Calculation of total income for the 2nd and 3rd member:

=	(20 – 20)	+	0.5 * (40)	=	20

Calculation of total income for you:

==	(20 – 0)	+	0.5 * (40)	=	40

For your decision, you will receive the following sheet (shown here only as an **example**):

Your experiment number: ___________

Decision Sheet – Part 1:

Please write down how many Guilders you want to put **into project B**:

__________ Guilders

(maximum: 20 Guilders; use only whole numbers; the rest is automatically put into project A)

Soon you will be given a sheet, like the one above, and you will be asked to fill in the amount you want to contribute to project B. After you have made your decisions, please put the sheet into the envelope. **Your decision remains confidential and anonymous**. The experimenter will then collect the envelopes. You will receive information about your income after Part 2 has finished. After making your decision we will hand out a form which you should fill in, where we ask you how much you expect the two other members contributed on average from their 20 Guilders to project B.

This part of the experiment will be done only once! In other words we will not repeat this part of the experiment.

Do you have any questions? Please raise your hand; a member of the research team will come to you and answer your question in private.

Questions:

Please answer all the questions and write down your calculations. These are just examples and serve only to help you to understand about the calculation of your income. We will later come and check your answers, and thereafter go through the calculations on the board.

Remember your total income from Part I:

=	Income from Project A	+	Income from Project B
=	(20 – your contribution to project B)	+	0.5 * (the total amount that the group contributed to project B)

Also remember:

1 Guilder = R1.50

Question 1. Each group member has 20 Guilders. Nobody (including you) contributes to project B.

What will your total income be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will the income of each of the other group members be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will your total income be in Rand? _______________

Question 2. Each member has 20 Guilders. You contribute 20 Guilders to project B. The other group members also contribute 20 Guilders to project B.

What will your total income be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will the total income of the other group members be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will your total income be in Rand? _______________

Question 3. Each member has 20 Guilders. You contribute 3 Guilders to project B; the second member contributes 10 Guilders and the third member contributes 17 Guilders to project B.

What will your total income be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will the total income of the second member be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will the total income of the third member be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will your total income be in Rand? _______________

Question 4. Each member has 20 Guilders. You and the second member contribute 20 Guilders to project B; the third member contributes 0 Guilders to project B.

What will your total income be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will the total income of the second member be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will the total income of the third member be in Guilders?

=	(20 –__)	+	0.5 * (__)	=	__

What will your total income be in Rand? _______________

Do you have any questions? Please raise your hand; a member of the research team will come to you and answer your question in private.

PART TWO [handed out after completion of PART ONE]

Part 2 of the experiment will be very similar to Part 1. As in Part 1 of the experiment, you will receive 20 Guilders. **This time you have to make two decisions. The first decision is identical to what you have done in Part 1.** You make a decision about how many of the 20 Guilders you want to put into project B (the rest will automatically go towards project A). The income will be calculated in the same way as it was calculated in Part 1. For each Guilder that you choose to put in project A, you will earn 1 Guilder. For each Guilder that you contribute to project B, you and all the other group members will earn 0.5 Guilders. The same reasoning is also applicable when the other members contribute to project B.

Note however, that now you will be **in a group with two other people than before**. The way we put each of you into a group is completely random. Nobody except for the experimenters will know who is in which group. You will not learn who the other two people in your group are or have been, neither during nor after the experiment. **Part 2 of the experiment will end after the two decisions and it will only be done once. When we are finished with Part 2, the experiment is over.**

What is new in Part 2?

After you have decided how much to contribute to project B (as in Part 1 of the experiment), you **will get information about the contribution to project B of the two other group members within your group**. You will therefore know how much everybody in the group contributed to project B and how much everybody contributed to project A. At this point, **you may, if you want, reduce the income of each other group member by giving deduction (subtraction) points to them.** You can also leave the income of the other members **untouched**. The other group members may also reduce your income if they wish to. The exact procedure will be described below in greater details. Next we will describe what happens to each member's income after the giving of deduction points.

To sum up: There are two decisions in this second part of the experiment:

1. the first decision is about how much you will put into project B (which is exactly the same as in Part 1)
2. the second decision is where you decide if you want to give deduction points to other group members and if so how many

Calculation of your income:

Any deduction point you give to another group member reduces the income of the group member that receives this point by 3 Guilders. This means, if you give 1 deduction point to another group member, his or her income will be reduced by 3 Guilders. If you give 2 deduction points to a member, his or her income will be reduced by 6 Guilders. If you give 9 deduction points to a member, his or her income will be reduced by 27 Guilders, and so on. If you give 0 deduction points to another group member, there will be no change in that member's income. So, the experimenters will reduce the income of a group member by 3 Guilders for each deduction point that member receives.

You can give **a maximum of 10 deduction points** to each member.

If you give deduction points, you will also face a cost. **For each deduction point you give to another group member, you have to pay 1 Guilder.** For example, if you give 3 deduction points, you will pay 3 Guilders. If you give 7 deduction points, you have to pay 7 Guilders, and so on. If you do not give any deduction points, you will, of course, not pay anything.

Your total income from Part 2 of the experiment will be calculated in the following way:
Total income from Part 2 =
(Income from the first decision)
minus 3 * (amount of deduction points that you received from the other two group members)
minus 1 * (amount of the deduction points that you have given to the other two group members)

If the cost of the deduction points you received (3*amount of deduction points you received) is greater than your income from the first decision in Part 2, this difference will automatically be set to ZERO. From this amount the cost for the deduction points that you have given to the other members have to be deducted.

Your total income in Guilders from Part 2 of the experiment has three components: (1) your income from the first decision; (2) three times the amount of deduction points received from other group members and (3) your costs from giving deduction points to other group members. If the amount of deduction points received by you is greater than your income from the first decision, it will be set to zero by the experimenter. Independent of this, you must pay for all deduction points that you give to other members. Your total income from the experiment is the sum of the income in Part 1 and Part 2. The income is calculated in a similar manner for the other group members. Note that the income from Part 2 might be negative. In that case you will have to pay the difference with your income from Part 1.

How do you make your decision about the deduction points?

As in Part 1, all participants will, at the beginning, decide how much to contribute to project B. These decision sheets will then be collected. Before we get to the second decision we will hand out another form that you should fill in. Here we want you to write down how many of their 20 Guilders you expect each of the two other group members on average have contributed to project B. Next you will get the decision sheet back, which now includes information about how many Guilders the other members have contributed to project B and the Guilder income you and the other group members have received from this first decision. We will ask you to study this information and then to turn over this sheet and wait while we hand out another short questionnaire. After you have filled that in and handed it back to us, you will make your second decision. At this point, you must decide, whether and, if yes, how many deduction points you will give to the other members of your group. Below you will see an **example** of the decision sheet.

Decision sheet for the second part of the experiment:

	1st member (you)	2nd member	3rd member
Contribution **to project B** (first decision)	Your contribution ________________	Contribution of the 2nd member ________________	Contribution of the 3rd member ________________
Income from the first decision	Your income ________________	Income of the 2nd member ________________	Income of the 3rd member ________________
	Deduction points that you want to give (max 10 deduction points to each member)	________________	________________

Please decide how many deduction points you would like to give to the others. If you would not like to give any deduction points, please enter a zero. **You can give each group member a maximum of 10 deduction points.** You must, in any case, make an entry into the boxes.

After you have entered your decisions about deduction points on the decision sheet, put your decision sheet in the envelope. The envelope will be collected by the experimenter. After finishing Part 2, we will calculate your total income from both parts of the experiment. In the meantime we will ask you to fill in a questionnaire. When this is finished we will give you a form that contains information about your income from Part I and Part II, as well as a receipt that states your total income for the experiment. You have to sign this receipt and hand it to us when you leave the room. Remember to hand us your experiment number tag, so that we know how much to pay you. You will receive an envelope with a cash cheque stating the amount you have earned when you hand us your experimental number tag.

Do you have any questions? Please raise your hand; a member of the research team will come to you and answer your question in private.

Questions:

Please answer all the questions below and write down your calculations. These are just examples and serve only to help you to understand about the calculation of your income. Please write down the solution in Guilders. We will later come and check your answers, and thereafter go through the calculations on the board.

Question 1. You want to give the second group member 6 deduction points and the third group member 8 deduction points.
What will this cost you in Guilders? _______________
By how much will that reduce the income of the second group member in Guilders? _______________
By how much will that reduce the income of the third group member in Guilders? _______________

Question 2. You want to give the second group member 10 deduction points. You want to give the third group member no deduction points.
What will this cost you in Guilders? _______________
By how much will that reduce the income of the second group member in Guilders? _______________
By how much will that reduce the income of the third group member in Guilders? _______________

Question 3. You do not want to give any deduction points.
What will this cost you in Guilders? _______________
By how much will that reduce the income of the second group member in Guilders? _______________
By how much will that reduce the income of the third group member in Guilders? _______________

Question 4. You earned 10 Guilders from the first decision. You received 2 deduction points from the second member and from the third member, you received 1 deduction points. You did not assign any deduction points to the other two members. In Part I of the experiment you earned 18 Guilders.

By how much do the deduction points you received from other group members and the deduction points you gave to others reduce your income in Guilders? _______________
What will be your total income in Guilders from Part 2? _______________
What will be your total income in Guilders from both Part 1 and Part 2? _______________

Question 5. You received 10 Guilders in the first decision. In the second decision you received 2 deduction points from the second member and 1 deduction points from the third member. You gave 5 deduction points in total to the other two members. In Part I of the experiment you earned 18 Guilders.

By how much do the deduction points you received from other group members and the deduction points you gave to others reduce your income in Guilders? _______________
What will your total income from Part 2 be in Guilders? _______________
What will be your total income in Guilders from both Part 1 and Part 2? _______________

Do you have any questions? Please raise your hand; a member of the research team will come to you and answer your question in private.

APPENDIX IV

Variable	Description	Variable Range
Gender		1: Yes; 0: No
Age		A positive integer value
Trust school mates		1: Do not trust at all – 6: Trust completely (*In original questionnaire order is reversed)
Presence of mother in household		1: Yes; 0: No
Index for Voluntary work by individual	Sum of dummies for uncompensated work done outside the household in last 12 months: Unpaid work in community; Cleaning, fixing and building; Cooking for community celebrations; Meetings and activities of clubs and organizations; Caring for children and adults in other households; Other help to other households; Helping handicapped people in everyday activities; Medical care/counselling to sick/handicapped; Giving training and instruction to community; Keeping law and order in community; Care for and fixing community resources; Organizing cultural or other community events; Collecting money for organizations	1: Yes; 0: No
Index for Participation (Membership in Organizations)	Sum of participation variables: Political club/party; Voluntary/Non-profit organization; Religious organization; School organization; Sports club; Performance and/or art organization (also choir or orchestra or dance)	1: Not member, 2: Non-active member, 3: Active member; 4: On the board (*Normalized to 1)

Variable	Description	Variable Range

Social Integration Index	Sum of social integration variables: Number of close friends in school ; Number of close friends outside of school; Number of organizations or teams you belong to in school;	A positive integer value (*All variables truncated to adjust for outliers and then normalized to 1)
	Voluntary work by individual;	Index for Voluntary work described above.
	Index for participation (Membership in organizations)	Sum of participation variables described above.
Household Violence Index	Sum of domestic violence variables:	
	How often did a parent, stepparent or adult living in your home swear at you, or put you down when you were younger?;	1: Very often, 2: Often, 3: Sometimes, 4: Rarely, 5: Never (*All variables truncated to adjust for outliers and then normalized to 1)
	How often does a parent, step-parent or adult living in your home act in a way that made you afraid you may physically get hurt during a normal week?;	1: Very often, 2: Often, 3: Sometimes, 4: Rarely, 5: Never
	Sometimes parents or adults hurt children – How often does a parent, stepparent or adult living in your home, punch, grab, slap or throw something at you during a normal week?;	1: Very often, 2: Often, 3: Sometimes, 4: Rarely, 5: Never
	How often did a parent, stepparent or adult living in your home hit you so hard that you have marks on you or are injured during last year? ;	1: Very often, 2: Often, 3: Sometimes, 4: Rarely, 5: Never
	When you were growing up, did you live with anyone who was a problem drinker, an alcoholic or was using street drugs? ;	1: No; 2: Yes, but rarely; 3: Yes, part of the time; 4: Yes Always
	When you were growing up, did anyone in your household spend time in prison?	1: No; 2: Yes, but rarely; 3: Yes, part of the time; 4: Yes Always
Community Crime Index	Sum of number of crime incidents in community in the last month: Assault; Robbery; Shooting; Rape; Murder; Kidnap; Burglary; Housebreaking	A positive integer value (*All variables truncated to adjust for outliers and then normalized to 1)
Household Reading index	Sum of dummies for literature in Household: A daily Newspaper; An encyclopaedia ; A dictionary; More than 50 books	1: Yes; 0: No

	White			Colored			African Formal			African Informal			Pooled		
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Age	16.3	15	18	17.00	15	19	18.12	16	23	17.33	15	21	17.18	15	23
Trust schoolmates	23.5	14	37	21.97	11	41	23.02	7	35	22.64	7	37	21.9	0	4
Presence of mother in household	0.88	0	1	0.93	0	1	0.60	0	1	0.70	0	1	0.78	0	1
Index for Voluntary work by individual	3.79	0	13	3.14	0	13	5.58	0	13	7.07	0	13	4.9	0	13
Index for Participation (Membership in Organizations)	1.98	1	4	1.66	1	4	2.26	1	4	2.13	1	3.3	1.99	1	4
Social Integration Index	1.24	0.15	4	0.70	0.08	1.97	0.80	0.05	2.39	0.80	0.15	2.0	0.87	0.5	4
Household Violence Index	0.194	0.09	0.44	0.21	0.09	1	0.32	0.09	1	0.31	0.05	1	0.26	0.05	1
Community Crime Index	0.788	0	4.58	1.33	0.00	6.20	1.60	0	8	1.39	0	8	1.27	0	8
Household Reading index	3.26	1	4	2.42	0	4	1.33	0	4	1.48	0	4	2.13	0	4