# Games and Economic Behaviour in South African Fishing Communities

Justine Burns and Martine Visser

June 13, 2007

**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 codes:

# 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, 2000), 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 transactions costs of bargaining. Individuals may be more prone to co-operate when others in their group or community are similar to them, since this fosters a strong group identity (Kramer and Brewer, 1984; Kollock, 1998). 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 consensus of the type and quality of public goods and services to be provided (Baland and Platteau (1997a,b); Bardhan et al (1998), Dayton-Johnson and Bardhan (1996), Persson and Tabellini, 1994; Alesina and Tabelini, 1989; Alesina and Drazen, 1991). La Ferrara (1998) 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 transactions costs, thereby raising social capital or trust, and increasing the likelihood of co-operative behaviour in resolving social dilemmas (Knack and Keefer, 1997, Alesina and LaFerrara, 2000, Bardhan 1993; Dayton-Johnson, 1997,Varughese and Ostrom, 2000; Messick and Brewer, 1983, 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, be they 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, 2003) and differences in endowment levels (Chan et al, 1999; Cherry, Kroll and Shogren, 2003; 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, 2003; 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; Sug-

den, 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 co-operate 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 goods games played with a large sample of individuals from fishing

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

communities along the West Coast of South Africa, in which 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 of 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

[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.

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 participants classified themselves as Coloured[3], while most of the remainder classified themselves as Black or "Other", although again, at the community level, there is some variation in these 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 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). Moreover, 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,

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

and on average, they knew two other individuals in their group. This suggests that individuals were known to each other. 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. While we try to control for as much of the variation in observed individual characteristics as possible in our regression analysis, we 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 communites in which we ran the experiments based on 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.

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 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 targetted fishing communities, our sample is dominated by individuals engaged in fishing activities, who tend on average to be poorer. 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 thinking about the generalisability of our of findings.

# 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 during which their details were recorded and they were asked

[4]Note that the results in Column 3 suggest that if we were to focus only on Black and Coloured individuals in these nine communites, 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 additonal 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 distinctions 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 themsevles as "Other".

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 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, the 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

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

in total, each of size four. [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 calculated 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

[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.

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 houshold per capita income. Each experimental session lasted between two and a half to three and a half hours, and were 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 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 attributable to the fact that on average, individuals knew two other group members, and this may have produced greater feelings of solidarity.

[12] In our data, the assumption of independent observations is likely to be violated owing 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.

In the public goods game with punishment (denoted as starting in round 7 in Figure 1), on average, 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) confirms that the average contributions to the public pool are significantly higher in the punishment 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.

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'

[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, 2007.

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 shouldn't 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 measures 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 their 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 differs 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 their community[17], but the interaction term indicates that this association is stronger for individuals

[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.

from households where per capita household income is low. Taking these two 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 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 co-efficients 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 signs on the co-efficients 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 co-efficients of interest retain the same signs and remain statistically significant, they decline in size. Our preferred estimates from Column 6 suggest that the co-efficients are now only

[18] Per capita household income and expenditure measures are correlated at 0.75 for individuals in this 40 token treatment

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 co-efficient 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 co-efficients 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 when the income measure is used.

**Result 4** *Racial and gender diversity in groups impacts negatively 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 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 $i$th race/gender group within the

[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

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 the way in which experimentally induced income heterogeneity affects contributions to the public pool. Here we use the entire sample of 569 individuals, and focus

[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 occur, 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.

on whether inequality induced experimentally through the random allocation of unequal token endowments, affects co-operative 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 think 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]

[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 at least be 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.

# 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, and this is largely due to higher contributions being made by those with lower incomes or lower token endowments. This is consistent with low income or low token endowment players 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 interest to make relatively larger contributions in an effort to signal a willingness to co-operate in the provision of the public good, thereby inducing greater co-operation 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 fishers, 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 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 co-efficient estimates downwards. Thus, our co-efficient estimates should be interpreted as a conservative estimate of the association between income heterogeneity and co-operative 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

[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.

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 houshold 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 in respect of household expenditures than household income, 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 co-efficients 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 owing to sample size constraints. [24] In sum, this suggests to us that our more reliable results are those obtained using houshold per capita income measures as opposed to household expenditure data.

The larger point, however, is that while experimentalists typically use survey instruments to capture socio-economic information about participants, these

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

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 attributable both to budget constraints and time constraints, since the focus on an experimental study is typically on the experimental results, with survey data being used in a secondary sense, and much of the budget is devoted to 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.

# References


Akerlof, G. [1997]: "Social Distance and Social Decisions," *Econometrica*, 65(5), 100528.

Alesina, A. and Drazen, A. [1991]: "Why are Stabilisations Delayed?", *American Economic Review*, LXXXI, pp 1170-1188.

Alesina, A. and LaFerrara, E. [2000] "The Determinants of Trust", *NBER Working Paper No. W7621*, March.

Alesina, A. and Tabellini, G. [1989] "External Debt, Capital Flight and Political Risk", *Journal of International Economics*, pp199-220.

Alesina, A. and E. LaFerrara [2000]: "The Determinants of Trust," *NBER Working Paper 7621.*

Anderson,L.R.; Mellor, J.M. and J. Milyo [2004]: "Inequality and Public Goods Provision: An Experimental Analysis," *Working Paper 12*, Department of Economics; College of William and Mary, Williamsburg.

Andreoni, James [1995]: "Impure Altruism and Donations to Public Goods: A Theory of Warm Glow Giving," *Economic Journal*, 100, 464–477.

Ayres, I. and P.Sigelman [1995]: "Race and gender discrimination in Bargaining for a New Car," *American Economic Review*, 85(3), 30421.

Baland, J.M. and J.P. Platteau [1997a]: "Coordination problems in local level resource management," *Journal of Development Economics* , 53, 197-210.

Baland, J.M. and J.P. Platteau [1997b]: "Wealth Inequality and Efficiency in the Commons: The Unregulated Case," *Oxford Economic Papers* , 49.

Bhardhan, P. [1993]: "Symposium on Management of Local Commons," *Journal of Economic Perspectives* , 7(4), Fall, 87-92.

Becker, Gary [1974]: "A Theory of Social Interactions" *Journal of Political Economy*, 82(6), 1063-1093.

Bergstrom, Theodore C., Laurence E. Blume, and Hal Varian [1986]: "On the Private Provision of Public Goods" *Journal of Public Economics*, 29, 25-49.

Bertrand, M., and S.Mullainathan [2003]: "Are Emily and Brendan More Employable than Lakisha and Jamal? A Field Experiment on Labour Market Discrimination," *MIT Department of Economics Working Paper No. 03-22*, May.

Bolton, Gary E. and Axel Ockenfels [2000]: "ERC: A Theory of Equity, Reciprocity and Competition" *American Economic Review*, 26(1), 51-74.

Bouckaert, J., and G.Dhaene [2003]: "Inter-ethnic Trust and Reciprocity: Results from an Experiment with Small Businessmen," *European Journal of Political Economy.*

Buckley, Edward and Rachel Croson [2006]: "Income and Wealth Heterogeneity in the Voluntary Provision of Linear Public Goods" *Journal of Public Economics*,90(4-5):11-26 The Wharton School, University of Pennsylvania.

Cardenas, Juan-Camillo [2002a]: "Real Wealth and Experimental Cooperation: Experiments in the Field Lab" *Journal of Development Economics*, 70(2), 263-289.

Cardenas, Juan-Camillo, John Stranlund and Cleve Willis [2002]: "Economic Inequality and Burden-sharing in the Provision of Local Environmental Quality" *Ecological Economics*, 40,379-395.

Chan, Kenneth S., Stuart Mestelman, Rob Moir and R. Andrew Muller [1996]: "The Voluntary Provision of Public Goods under Varying Income Distributions" *Canadian Journal of Economics*, 96, 54-69.

Chan, Kenneth S., Stuart Mestelman, Rob Moir and R. Andrew Muller [1999]: "Heterogeneity and the Voluntary Provision of Public Goods" *Experimental Economics*, 2(1), 5-30.

Cherry, T.L., S. Kroll, and J.F. Shogren [2005]: "The impact of endowment heterogeneity and origin on public good contributions: evidence from the lab" *Journal of Economic Behaviour and Organisation*, 57(3), 357-365.

Coleman, J. [1990]: *Foundations of Social Theory*. Harvard University Press, Cambridge, MA.

Dayton-Johnson, J. and P. Bardhan [1996]: *Inequality and Conservation on the Local Commons: A Theoretical Exercise*, Department of Economics, University of California, Berkeley, mimeo.

Dayton-Johnson, J. [1997]: *Rule and Co-operation on the Local Commons: Theory with Evidence from Mexican farmer-managed irrigation systems*, Department of Economics, University of California, Berkeley, mimeo.

Easterly, W. and R.Levine [1997]: "Africa's Growth Tragedy: Policies and Ethnic Divisions," *Quarterly Journal of Economics*, November, 12031250.

Eckel, C and P.Grossman [1996]: "Altruism in Anonymous Dictator Games," *Games and Economic Behaviour*, 16, 181191.

Eckel, C. [1998a]: "Are Women Less Selfish Than Men? Evidence from Dictator Experiments," *Economic Journal*, 108(448), 72635.

Fedderke, J., and R.Klitgaard [1998]: "Economic Growth and Social Indicators: An Exploratory Analysis," *Economic Development and Cultural Change*, XX(455-489).

Fehr, Ernst and Klaus M. Schmidt [1999]: "The Theory of Fairness, Competition and Co-operation" *The Quarterly Journal of Economics*, August.

Fershtman, C. and U.Gneezy [2001]: "Discrimination in a Segmented Society: An Experimental Approach," *Quarterly Journal of Economics*, CXV, 351377.

Fershtman, C., U.Gneezy, and F.Verboven [2002]: "Discrimination and Nepotism: The Efficiency of the Anonymity Rule," *Discussion Paper*, Eitan Berglas School of Economics, Tel Aviv University.

Glaeser, E., D.Laibson, J.Scheinkman, and C.Soutter [2000]: "Measuring Trust," *Quarterly Journal of Economics*, 115(3), 811846.

Goldin, C and L. Katz [1999]: "The shaping of higher education: the formative years in the United States, 1890 to 1940", *Journal of Economic Perspectives*, Winter, Vol 13, No. 1, pp 37-62.

Isaac, R. Mark and James M. Walker [1988]: "Communication and Free-Riding Behaviour: The Voluntary Contribution Mechanism" *Economic Inquiry*, 26: 51-74.

Knack, S. and P. Keefer [1997]: "Does social capital have an economic payoff? A cross-country investigation". *Quarterly Journal of Economics*, 112, pp 1251-1288.

KRAMER, R. AND M.B.BREWER [1994]: "Effect of Group Identity on Resource Use in a Simulated Commons Dilemma," *Journal of Personality and Social Psychology*, 46, 10441057.

KOLLOCK, P. [1994]: "The Emergence of Exchange Structures: An Experimental Study of Uncertainty, Committment, and Trust," *American Journal of Sociology*, 100, 313345.

LEDYARD, J. [1995]: "Public Goods Experiments" in (eds) J. Kagel and A. Roth; *Handbook of Experimental Economics*, Princeton University Press, Princeton, New Jersey.

MARWELL, GERALD AND RUTH AMES [1980]: "Experiments on the Provision of Public Goods II: provision Points, Stakes, Experience and the free Rider Problem" *American Journal of Sociology*, 85, 926-937.

MESSICK, D., AND M.BREWER [1983]: "Solving Social Dilemmas: A Review," in *Review of Personality and Social Psychology*, ed. by L.Wheeler. Sage, Beverly Hills.

MESSICK, DAVID; HENK WILKE, MARILYN BREWER, RODERICK KRAMER, PATRICIA ENGLISH ZEMKE, AND LAYTON LUI [1983]: "Individual Adaptations and Structural Change as Solutions to Social Dilemmas" *Journal of Personality and Social Psychology*, 44, 294-309.

POSNER, D. [2000]: "Ethnic Fractionalisation in Africa: How Should it be Measured? What does it explain about economic growth," *Discussion Paper*, University of California, LA.

RAPPOPORT, AMNON AND RAMZI SULEIMAN [1993]: "Incremental Contribution in Step Level Public Goods Games with Asymmetric Players" *Organizational Behavior and Human Decision Processes*, 55: 171-194.

SUGDEN, ROBERT [1982]: "On the Economics of Philanthropy" *The Economic Journal*, 92: 341-350.

Sugden, Robert [1984]: "Reciprocity: the Supply of Public Goods Through Voluntary Contributions" *The Economic Journal*, 94: 772-787.

Varughese, G. and E. Ostrom [1984]: "The Contested Role of Heterogeneity" *Workshop in Political Theory and Policy Analysis*,Indiana University.

Visser, M. and J. Burns [2007]: "Bridging the Great Divide in South Africa: Inequality and Punishment in the Provision of Public Goods" *Working Paper*, School of Economics, University of Cape Town.

Zack, P., and S.Knack [2001]: "Trust and Growth," *Economic Journal*, 111(1), 295321.