Cooperation in Collective Action*

Oriana Bandiera† Iwan Barankay‡ Imran Rasul§

April 2005

Abstract

The ability to cooperate in collective action problems – such as those relating to the use of common property resources or the provision of local public goods – is a key determinant of economic performance. In this paper we discuss two aspects of collective action problems in developing countries. First, which institutions discourage opportunistic behavior and promote cooperation? Second, what are the characteristics of the individuals involved that determine the degree to which they cooperate? We first review the evidence from field studies, laboratory experiments, and cross community studies. We then present new results from an individual level panel data set of rural workers.

Keywords: collective action, cooperation, institutions.
JEL Classification: C92, D74, H23, O13.

*Financial support from the RES and STICERD is gratefully acknowledged. This paper has been screened to ensure no confidential information is revealed. We thank the editor, Maitreesh Ghatak, and an anonymous referee for useful suggestions. All errors remain our own.

†Department of Economics, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, United Kingdom; Tel: +44-207-955-7519; Fax: +44-207-955-6951; E-mail: o.bandiera@lse.ac.uk.

‡Department of Economics, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, United Kingdom. Tel:+44-120-687-2729; Fax: +44-120-687-2724; E-mail: itbara@essex.ac.uk.

§Graduate School of Business, University of Chicago, 5807 South Woodlawn Avenue, Chicago IL 60637, USA. Tel: 1-773-834-8690; Fax: 1-773-702-0458; E-mail: imran.rasul@gsb.uchicago.edu.

1 Introduction

The success of many economic endeavours depends on people's ability to refrain from individually profitable actions for the sake of the common good. Such collective action problems have the key characteristic that, because individual actions have externalities on others, private and social optima do not coincide. Key examples are the use of common property resources – where the actions of individuals impose negative externalities on others, and the provision of public goods – where the actions of individuals impose positive externalities on others.

In this paper we review the existing evidence and provide some new results on two aspects of collective action problems. First, which institutions discourage opportunistic behavior and promote cooperation? Second, what are the characteristics of the individuals involved that determine the degree to which they cooperate?

Most of our discussion will focus on collective action problems in developing countries. Institutional design has particular relevance in these countries both because formal institutions that regulate the use of common resources and the provision of public goods are generally absent, and because many of the world's poorest individuals depend on these resources for their livelihood.

The management of forest resources, grazing pastures, and irrigation systems provide important examples of collective actions problems faced by the world's poorest. Around one third of the world's population relies on firewood for energy (Edmonds 2002) and agriculture is the main source of income for the majority of the world's poor. In addition, forests, pastures and irrigation systems are typically locally managed. In all these cases, the collective action problem has two prongs. Extraction by one user creates a negative externality by reducing the amount available to others, while investment into maintenance generates positive externalities for the entire community.

Olson's (1965) seminal work highlights that self-interested behavior precludes cooperation when group rationality is in contradiction with individual rationality. Common resource management can therefore end up 'tragically', as Hardin (1968) put it, if each individual ignores the negative externality that his extraction choices imposes on other group members. However, while such pessimism may be justified in the case of anonymous and infrequent interactions, the folk theorem suggests repeated interaction between the same individuals might increase the likelihood of sustained cooperation in equilibrium. This is especially so if sufficiently harsh and credible punishments are available. Extensive socio-anthropological fieldwork indeed finds evidence that some communities manage to create effective informal institutions, namely rules that govern the use of common resources and contributions to local public goods. Failure, however, occurs as frequently as success.

We present evidence on successful institutions from two sources – field studies of common resource management and laboratory experiments. Several field studies indicate that successful communities typically exhibit well-defined rules, the ability to monitor resource extraction and to punish deviators, the existence of a mechanism for conflict resolution and of a forum for discussions (Baland and Platteau 1996, Lam 1998, Ostrom 1990, Tang 1992, Wade 1988).

The experimental evidence from common resource and public good games is remarkably consistent with the insights of field studies. For example, the ability to monitor and to communicate (even without commitment) is typically found to foster cooperation. In addition, both monetary and non-monetary punishments to deviators and rewards to compliers increase levels of cooperation (Cardenas 2003, Fehr and Gachter 2000, Ledyard 1995, Masclet *et al* 2003).

The second aspect of collective action problems we discuss relates to the characteristics of communities that are able to sustain cooperative behavior. Recent evidence from cross-community comparisons indicates that some community characteristics are systematically correlated with the ability to cooperate. In particular, heterogeneity along the lines of ethnicity, religion and social class is generally found to be detrimental to cooperation. The effect of other characteristics such as wealth inequality and community size is less clear-cut, although in general both inequality and community size seem to reduce cooperation (Baland *et al* 2001, Banerjee *et al* 2001, Banerjee *et al* 2004, Bardhan 2000, Dayton-Johnson 2000, Gugerty and Miguel 2004, Khwaja 2003).

In cross-community comparisons, however, the identification of the causal effect of community characteristics on cooperation is hindered by the presence of unobservable community variables. In addition, the extent to which groups cooperate may itself drive selection or migration into those communities, affecting the community's characteristics.

Here we address these issues using individual level panel data to analyze cooperation among Eastern European workers employed by a UK farm to pick fruit. Workers are paid according to a relative incentive scheme, namely individual pay depends on the ratio of individual productivity to the average productivity of the group of co-workers. Individual effort thus imposes a negative externality on all co-workers by raising average productivity and lowering co-workers' pay, other things equal. In this context, higher individual productivity corresponds to less cooperative behavior, as the social optimum is for all workers to exert the lowest feasible effort level.

We are able to identify the effect of group characteristics on the cooperative behavior of individuals by comparing the behavior of the same individual when they are exogenously assigned to different groups of co-workers.

Moreover, we also observe the same workers working under an absolute incentive scheme – piece rates. This incentive scheme, where the pay of a worker depends only on their own productivity, provides no reason for workers to choose their efforts cooperatively. Hence by analyzing the effect of group characteristics on the productivity of the same individual under relative incentives *and* piece rates, we are able to separate the effect of these group characteristics on cooperation from their effect on productivity *per se*.

The paper is organized into 5 sections. Section 2 reviews field studies and experimental evidence on the institutions that promote cooperation. Section 3 reviews the existing cross sectional evidence on the community characteristics that favour cooperation. Section 4 presents new evidence from the results of our study. In the concluding section we draw together some policy implications and point to avenues for future research.

2 Institutions for Collective Action

That some communities manage to cooperate while others fail naturally raises the question of whether the difference is driven by community level institutions. Some light has been shed on this by field studies of common property resources and results from experiments that recreate collective action problems in the laboratory.

Several extensive field analyses of common resource management have identified a common set of institutional features that promote long-lasting cooperation. First, clear and detailed rules that govern the sharing of costs and benefits from the resource must be agreed upon by all participants. Second, congruence is a key requirement, namely, the share of costs borne by each participant should be proportionate to the share of benefits they derive from the resource. Third, monitoring is essential. Fourth, credible sanctions for deviators should be established *ex-ante* and punishment should be made public. Fifth, there must be a forum to resolve conflicts and discuss changes in rules to adapt to external changes. Namely, good institutions have in-built mechanisms to ensure their successful evolution.[1]

Recent advances in the collection of detailed micro data in developing countries have promoted the use of statistical analysis to complement the case study evidence. Bardhan (2000) analyses data from 48 irrigation systems in the Indian state of Tamil Nadu. He finds that systems are better maintained when guards are hired to monitor and punish deviators, and when costs are shared in proportion to the size of landholdings rather than equally divided among all users. Rule fairness is also the single most important determinant of canal maintenance status in Dayton–Johnson's (2000) study of 51 irrigation system in Mexico.

Overall, the field evidence indicates that institutions do play a key role for solving collective action problems, and highlights a common set of institutions that appear to be conducive to cooperation. However, since good institutional features often appear together it is difficult to

[1] In her seminal work, Ostrom (1990) compares the performance of 14 diverse common pool resources ranging from Swiss pastures to Indonesian irrigation systems. Further case study evidence can be found in Tang's (1992) analysis of irrigation systems around the world; in Agrawal's (1984) analysis of forest management in Himalayan villages; in Lam's (1998) study of irrigation systems in Nepal; and in Wade's (1987) study of communal grazing grounds and irrigation canals across villages in the Indian state of Andhra Pradesh.

assess the relative importance of each feature on its own. In addition, the causal effect of institutions on cooperation cannot easily be identified from cross-community data given that the variation in institutional structure might itself be endogenous due to the potential relevance of unobservable community characteristics.

While exogenous institutional changes are rarely observed in the data, they can be, and have been, produced in laboratory experiments that mimic common pool management and the provision of public goods.[2] In the baseline set-up, a group of subjects plays the same game simultaneously, anonymously and repeatedly for a predetermined number of rounds. Subjects cannot see each other nor do they have information on other players' actions. At the end of each round, players learn the aggregate outcome and choose how much to invest in the public good or common pool resource in the next round.

Subjects' behavior in this set-up follows a consistent pattern in a myriad of experiments. In the initial rounds subjects cooperate to some extent so that the outcome is roughly halfway between the self-interested equilibrium and the group optimum. Cooperation falls sharply as the game is repeated and generally by the last few rounds the majority of subjects choose the self-interested equilibrium.[3]

Exogenous changes in the rules of the game allows researchers to assess the impact of institutional features such as communication, monetary punishments, and informal sanctions on cooperation levels.

Cooperation improves when subjects are allowed to communicate at the beginning of the game and it increases even further if they are allowed to communicate at the end of each round. When available, discussion transcripts indicate that subjects used the opportunity to communicate to calculate the optimal group strategy and to agree on a set of rules to achieve the group optimum. Subjects also used verbal sanctions to punish deviators (Cardenas 2003, Ostrom *et al* 1994).

The ability to punish also increases cooperation and its effect is stronger if the same subjects play the game repeatedly as opposed to being matched with different people in each round. However, since subjects must pay a fee to inflict punishment, the ability to punish often reduces group welfare because punishment costs are larger than the gains from increased cooperation. The combination of punishment and communication on the other hand, dramatically improves

[2] The fact that subjects of laboratory experiments are generally undergraduate students who self select into participating raises the issue of whether experimental results have external validity. Recent studies have enrolled subjects from different backgrounds to investigate differences in behavior (Gachter *et al* 2004, List 2004a). Relatedly, List (2004b) provides evidence to compare how the same individuals behave in the market place and in the laboratory. For a review of these issues see Harrison and List (2004).

[3] Fehr and Schmidt's (1999) meta-study of public goods experiments shows that in the initial stages of the game, contribution levels are typically 40 to 60 % of the initial endowment. In the final periods however, 73% of all participants choose to contribute nothing to the public good with the other players also exhibiting low contribution levels. Ledyard (1995) also provides a review of this extensive literature.

efficiency (Fehr and Gachter 2000, Ostrom *et al* 1994).

Masclet *et al* 2003 show that non-monetary sanctions, whereby subjects are allowed to dispense 'disapproval' points, which do not lower their or the recipients' monetary payoff, also foster cooperation. Finally, the introduction of rewards, which decrease the monetary payoff of the giver and increase the receiver's, also foster cooperation albeit to a lesser extent than monetary punishment. Higher cooperation is achieved when monetary rewards and punishments can be used jointly (Andreoni 2003, Sefton *et al* 2001).

3 Group Determinants of Cooperation

The second question we address deals with the community characteristics that promote cooperative behavior. We briefly review the empirical literature while the next section presents new evidence from our recent study. Given space constraints, we forsake a fully comprehensive survey in favour of a small selection of studies that highlight the key issues, both methodological and substantive, for developing countries. The evidence we review relates to a variety of collective action problems, at different levels of geographical aggregation and across different continents. All of these studies present evidence on the three community characteristics that have received most attention in this literature, namely socio-ethnic heterogeneity, income and asset inequality, and community size. In addition, the studies reviewed, in line with most of the literature in general, use cross-community variation to identify the effect of community characteristics on cooperation. An exception to this is Banerjee *et al* (2001) who use panel data to study the effect of variation in wealth inequality within Indian districts on institutional performance.

3.1 Ethnic Fragmentation and Social Heterogeneity

The theoretical literature has identified several reasons why the social composition of a community might affect its ability to provide public goods or manage common resources. The key distinction is between communities that are homogeneous in terms of ethnicity, religion and social class and communities that are not.

First, socially homogeneous communities might be better at solving collective action problems because all members have similar tastes, whereas heterogenous communities find it hard to agree on the characteristics of the common good and are therefore less likely to cooperate in its provision (Alesina *et al* 1999, Esteban and Ray 1999).

Second, individuals might simply dislike working with others outside their group, thus making cooperation less likely in heterogeneous communities (Alesina and La Ferrara 2000).

Third, the different groups in heterogeneous communities might disagree on how to share the private benefits associated with collective action, or value less the benefits accruing to members of the other groups (Vigdor 1994, Banerjee *et al* 2004).

Finally, social heterogeneity might undermine the ability to devise mechanisms that sustain cooperation. For instance, if social sanctions are effective within but not across different groups, heterogeneous communities are less likely to be able to use sanctions as an enforcement mechanism (Gugerty and Miguel 2004).

The existing empirical evidence provides some support to the idea that heterogeneity hampers cooperation in the provision of local public goods and in the management and maintenance of common property resources.[4]

Banerjee *et al* (2004) show that heterogeneity along caste and religious lines is associated with lower local public goods provision across 391 Indian districts. The share of villages with schools, public transport and electricity is significantly lower in more heterogeneous districts. The provision of communication and health facilities is uncorrelated to the level of heterogeneity while water facilities – such as wells and hand pumps – are more likely to be found in heterogeneous districts. The latter finding might indicate that there is some substitution across different public goods, or it might be a symptom of social disunity to the extent that people do not want to share water in particular, with others outside of their own social group.

Evidence from more disaggregated data also indicates that heterogeneity is correlated with lower contributions to local public goods. Using cross-sectional data on 84 schools in Kenya, Gugerty and Miguel (2004) show that in areas that are more fragmented along ethnic lines, monetary contributions to the local school are lower. Interestingly, the amount collected through school fees is of equal size in homogeneous and heterogeneous areas. In the latter, however, voluntary contributions given at public fund-raising events are significantly lower. The estimates indicate that, other things equal, eliminating heterogeneity would raise contributions by 20%. Importantly, lower funding has a real impact in Kenyan schools. Ethnic heterogeneity is indeed negatively correlated with several measures of infrastructure quality and with the availability of textbooks. However, it is harder to assess whether this translates into worse educational outcomes as Gugerty and Miguel (2004) find little or no effect on test scores.

A related strand of the literature analyzes the effect of community characteristics on the management of common property resources. Baland *et al* (2001) use cross-sectional data from 215 rural communities in Nepal to investigate extraction decisions of firewood from the common forest. They find that extraction levels are significantly higher in villages that are more heterogeneous along the lines of caste and ethnicity. The estimates indicate that, other things equal,

[4] Alesina and La Ferrara (2004) model both the positive and negative aspects of heterogeneity on economic performance, and review recent studies on the effect of ethnic fragmentation and social heterogeneity on public goods provision in the United States and economic performance across countries.

eliminating heterogeneity altogether would reduce firewood collection by 17%.

Bardhan's (2000) study of 48 irrigation systems in Tamil Nadu reveals that the probability of conflict about water use is significantly higher in villages where there is no dominant caste, but caste heterogeneity has no significant effect on the frequency with which water allocation rules are broken.

Finally, other studies look at the maintenance of common assets, a collective action problem that shares elements of both the provision of public goods and the extraction from common resources. In his study of irrigation systems in Mexico, Dayton-Johnson (2000) finds that social heterogeneity, measured as the number of different groups using the same irrigation system, is negatively correlated with the system's maintenance status. Similarly, Khwaja (2003) shows that heterogeneity along clan, political, and religious lines is negatively correlated with the maintenance status of common infrastructure projects across 91 communities in Pakistan.

Overall the existing findings indicate that heterogeneity along caste, religious or ethnic lines is correlated with lower contributions to public goods, higher extraction levels from common resources and poorer maintenance of common infrastructure. That notwithstanding, evidence on the mechanisms through which social heterogeneity affects cooperation remains scarce. Gugerty and Miguel's (2004) analysis of school committee minutes provide some support to the claim that social sanctions are less effective across different ethnic groups. In their data, schools located in more ethnically homogeneous areas were more likely to impose sanctions on low contributors. Using data from Indian districts, Banerjee and Somanathan (2001) show that heterogeneity is correlated to political fragmentation. In heterogeneous districts more candidates run for the State Assembly and the share of votes for the winning party is lower. This, in turn, lends some support to the hypothesis that different ethnic groups have different preferences.[5]

3.2 Asset Inequality and the Distribution of Net Benefits

Asset or income inequality might affect collective action for two reasons. First, to the extent that inequality generates distinct group identities such as social classes, increasing inequality is akin to increasing the level of social heterogeneity which affects cooperation as discussed above.[6] Second, asset inequality is often related to the distribution of benefits from the provision of the public good or conservation of the common resource. For instance, large landholders are more likely to benefit from investment in common irrigation systems because large holdings use more

[5] Duflo and Chattopadhyay (2004) and Pande (2003) show that in India mandated political representation of women and scheduled castes, at the local and state level respectively, shifts the composition of public spending towards public goods that are more heavily used by these groups.

[6] La Ferrara (2003) provides some evidence that people of different wealth classes do not mix. Using household data from rural Tanzania, she finds that asset inequality at the village level reduces the likelihood that households belong to economic groups.

water.

Theoretically the effect of inequality is ambiguous and largely depends on the characteristics of the good in question. With increasing returns to scale due to large fixed costs, inequality can favour collective action. This is Olson's (1965) well known argument that if a single individual reaps a sufficiently large share of the benefits he would be willing to bear the full cost of the public good.[7] The presence of market imperfections and decreasing returns to productive assets, however, can generate the opposite result, namely aggregate contributions decrease as the level of inequality increases (Bardhan *et al* 2001). Moreover, to the extent that the distribution of assets determines the level of control each member has over the common good, inequality might favour rent seeking and reduce efficiency (Banerjee *et al* 2001).

Three of the studies reviewed above, present evidence on the relationship between asset (land) inequality and collective action. The balance of evidence indicates that land inequality is negatively correlated with maintenance status for irrigation systems (Bardhan 2000, Dayton-Johnson 2000) and for infrastructure projects (Khwaja 2003). In all cases the relationship is non-linear; the effect is weaker at higher levels of inequality. However, Baland *et al* (2001) find no correlation between income inequality and firewood collection in their study of Nepalese villages.

The evidence on the mechanisms that link asset inequality and collective action is somewhat more mixed. Banerjee *et al*'s (2001) results from Indian sugar cooperatives are consistent with the hypothesis of rent-seeking by large landowners. Dayton-Johnson (2000) shows that communities where the distribution of landholdings is unequal choose water allocation rules that favour the rich while, to the contrary, Bardhan (2000) finds that more unequal communities choose fairer rules. The results are not necessarily contradictory, both because the effect of inequality might be non-linear and because the measure of inequality – typically the Gini coefficient – might not capture all the relevant information on the income distribution.[8]

3.3 Group Size

An unresolved issue is whether small or large groups are more able to successfully cooperate in collective action problems (see for example the discussion in Esteban and Ray 2001). Olson's (1965) argument in favour of small groups is actually a corollary of the effect of inequality. Namely small groups are more likely to be successful because the distribution of benefits is more likely to be unequal and so as discussed above, it is more likely that there is some individual who

[7] Wade (1988) also stresses the importance of local elites in the provision of public goods in India.

[8] For instance, in the rent-seeking model of Banerjee *et al* (2001), increasing the share of small owners has two effects. On the one hand large owners have more resources to expropriate. On the other hand, small owners gain control over the cooperative thus reducing rent-seeking opportunities.

is willing to pay the full cost of the public good. Size, however, can also have direct effects. On the one hand, the institutional features that make collective action successful, such as monitoring, are more easily implemented in small groups. On the other hand, there might be economies of scale in large groups.

Of the studies reviewed above, only Bardhan (2000) finds a significant correlation between group size and collective action. His evidence indicates that the negative effects of group size on cooperation prevail. In larger communities the maintenance status of irrigation systems is worse, conflicts over water allocation are more frequent and rules are more likely to be broken. The other studies find that group size has no significant effect on cooperation, which may however be because the positive and negative effects of group size offset each other.

4 New Evidence from the Field

Cross-community evidence clearly indicates a strong correlation between community characteristics and measures of cooperation in collective action problems. However, four issues require further attention.

First, causality is difficult to establish given that the characteristics of interests are likely to be correlated with other unobservables at the community level. Second, measuring the extent of cooperation outside of the laboratory is limited by the difficulty in identifying the social optimum in the data. For instance, while it is generally, and plausibly, assumed that higher contributions to public goods indicate more cooperation, this is only true if provision is below the socially efficient level. Third, there is little evidence on the mechanism through which community characteristics affect collective action.[9] In what follows we present new results from a field study that addresses the first two issues (Bandiera *et al* 2005). The third is key to derive policy implications and is discussed in Section 5.

4.1 Context and Data Description

We use panel data from the personnel records of a farm in the UK to analyze whether individuals behave cooperatively in the workplace. The data records the daily productivity of farm workers hired from a number of Eastern European countries. The workers' main task is to pick fruit, and picking takes place across a number of fields in the farm.

The rationale for cooperation derives from the pay scheme in place. Workers are paid according to a relative incentive scheme, whereby individual pay depends on the ratio of individual productivity to the average productivity of the group of co-workers on the same field and day.

[9] See Banerjee and Somathan (2001) for a discussion of this issue in the case of public good provision.

Individual effort thus imposes a negative externality on all co-workers by raising average productivity and lowering co-workers' pay, other things equal. In this context, the social optimum is for all workers to exert the lowest feasible effort level so that higher individual productivity corresponds to less cooperation.

To be clear, under relative incentives workers face a compensation schedule of the form;

$$\text{compensation} = \beta K_i \tag{1}$$

where β is the picking rate and K_i is the total kilograms of fruit picked by worker i on the field in the day. The picking rate β is *endogenously* determined by the average productivity of all workers in the field on that day, where we define productivity y as the number of kilograms of fruit picked per hour. In particular β is set according to;

$$\beta = \frac{\overline{w}}{\overline{y}} \tag{2}$$

where $\overline{w}$ is the minimum wage plus a positive constant fixed by the management at the beginning of the season, and $\overline{y}$ is the average hourly productivity of all workers in the same field on the same day. At the start of each field-day, the field supervisor announces an *ex ante* picking rate based on her expectations of worker productivity. This picking rate is revised at the end of each field-day to ensure a worker with productivity $\overline{y}$ earns the pre-established hourly wage, $\overline{w}$.

Note that under relative incentives an increase in worker i's effort increases the average productivity on the field-day and thus imposes a negative externality on her co-workers by reducing the picking rate β in (2). The relative incentive scheme creates a wedge between individual and group optima, thus providing a rationale for cooperation.

The data has three key features that allows us to identify the determinants of cooperative behavior.

First, the *same* worker is assigned to different groups of co-workers each day. We therefore identify the effect of group characteristics on individual productivity using variation in the productivity of the *same* worker when working in different groups, while controlling for unobserved time invariant sources of individual heterogeneity that drive worker productivity.

Second, there is daily variation in group characteristics along dimensions that might affect cooperation, such as group size, the national composition of the group, heterogeneity of the group in terms of costs of effort and the personal stakes individuals have to behave cooperatively.

Third, piece rates replaced the relative incentive scheme midway through the season. Hence we observe the daily productivity of the same individual when they are paid according to a relative incentive scheme, *and* according to piece rates. Under piece rates, the compensation schedule workers face is still given by (1), but now the picking rate is set *exogenously* at the start of the day based on the supervisor's expectation of productivity that field-day, and is not revised.

Since there are no incentives for workers to cooperate under piece rates, analyzing the effect of group characteristics on the individual productivity of the same worker under relative incentives and piece rates, allows us to separate the effect of these group characteristics on cooperation from their effect on productivity *per se*.[10]

We use data on workers' productivity for one type of fruit at the peak of the 2002 harvest season, from mid-May until the end of August. We restrict the sample to only include workers that pick for at least ten field-days under both relative incentives and piece rates. Individual productivity is measured for each worker on each field and day they work. Our main sample then contains 10215 worker-field-day level observations, covering 142 workers, 22 fields and 108 days in total.

Workers are hired on a casual basis, namely work is offered daily with no guarantee of further employment.[11] Most workers in our sample are university students from eight different countries in Eastern and Central Europe. As a consequence, workers picking together on a given field-day are generally from different countries and the ethnic composition changes daily.[12]

Workers live and work on the farm together. They are housed in caravans, each hosting between 4 and 6 workers. The organization of the workplace thus provides opportunities for workers to build social ties with others. It also gives workers a variety of mechanisms by which to make transfers or hand out punishments to others. *A priori*, we expect both factors to affect the ability of given group of co-workers to cooperate.

4.2 Descriptive Evidence

Table 1 shows that workers' productivity rose significantly from an average of 5.01kg/hr under relative incentives to 7.98kg/hr under piece rates, an unconditional increase of 59%.[13] This

[10]If workers have ratchet concerns, namely if they think their current behavior can affect the piece rate in the future, there may be gains to them choosing their efforts cooperatively under piece rates as well. Some features of this work environment, however, make cooperation under piece rates unlikely. First, workers face uncertainty over which fields they will be assigned to in the future. Second, workers are uncertain about the identity of their future co-workers. In contrast, under relative incentives workers can observe the behavior and identity of the relevant co-workers – those on the same field and day – that they have incentives to cooperate with.

[11]In order to qualify, individuals must be full-time university students aged between 19 and 25. Workers must return to the same university in the Fall and have at least one year before graduation.

[12]The probability that on a given field–day, two randomly chosen workers are of different nationalities is .67, with a standard deviation of .14. Workers originate from Poland (46%), Bulgaria (13%), Russia (10%), Belarus (10%), Ukraine (6%), Slovakia (6%), the Baltic Republics (4%), Romania (3%) and China (2%).

[13]In Bandiera *et al* (2005) we present evidence that this is a causal relationship – moving from relative incentives to piece rates caused an increase in individual worker level productivity of at least 50%, other things equal. We

suggests workers were less productive under the relative scheme, when they had incentives to cooperate and reduce individual productivity, than under piece rates, when there are no reasons to cooperate.

In Bandiera *et al* (2005) we show that this observed change in productivity is too large to be reconciled with the assumption of non-cooperative behavior but too small to be reconciled with the assumption of *fully* cooperative behavior. This suggests workers are able to cooperate to some extent; on average, individual effort is two thirds of the way between the individual and the group optima. Moreover, the extent of cooperation varies equally across and within a given worker through time, suggesting that the difference is not due to workers' time invariant characteristics.

Figure 1 shows kernel density estimates of worker productivity by each incentive scheme. The productivity of each of the 142 workers in the sample is averaged within each incentive scheme in this figure. The mean and variance of productivity both rise significantly moving from relative incentives to piece rates. The figure highlights the considerable heterogeneity in productivity across workers within an incentive scheme. Hence there is considerable variation in the extent to which, on average, any given worker was cooperating under relative incentives. The empirical analysis sheds light on what group characteristics determine the extent of this cooperation.

4.3 Empirical Method

We identify group characteristics that – (i) lead to more cooperation, and hence lower productivity, under relative incentives; and (ii) have no effect on productivity under piece rates, where there are no incentives to cooperate. This allows us to establish the group characteristics that affect productivity exclusively through their effect on cooperative behavior.

We consider four group characteristics along which we observe variation each field-day. These are the size of the group, and the heterogeneity of the group as defined along three dimensions – nationality, ability, and stakes in the game.

To measure each worker's innate ability, we first assume that effort translates into productivity through a Cobb–Douglas production function. We are then able to calibrate the first order condition for workers' effort under piece rates and retrieve an estimate of each worker's cost of effort, which is negatively related to their ability. The methodology we follow is detailed in Bandiera *et al* (2005).

To proxy for the difference in stakes, we exploit the fact that some workers come to pick fruit

show this baseline result to be robust to a host of factors including natural trends in productivity at the field or farm level over time, the endogenous allocation of workers to picking tasks over time, the endogenous attrition of low yield fields, the anticipation of the change in incentives by workers, and the potential endogenous timing of the change in incentives by management.

as part of an internship programme that gives them credit in their home universities. Interns have higher stakes in the sense that the cost of being caught shirking and sent home is higher because academic punishment is added to the financial loss.

Denoting the productivity of worker i on field f on day t, y_{ift}, we estimate the following panel data regression under each incentive scheme, where all continuous variables are in logarithms;

$$y_{ift} = \alpha_i + \varphi_f + \gamma G_{ft} + \delta X_{ift} + \eta Z_{ft} + u_{ift}. \tag{3}$$

Worker fixed effects, α_i, capture time invariant worker level determinants of productivity such as innate ability, the value of their outside option, and intrinsic motivation. Field fixed effects, φ_f, capture time invariant field level determinants of productivity such as soil quality or plant spacing. We also control for time varying factors at the individual (X_{ift}) and field level (Z_{ft}). These controls are worker's picking experience, a linear time trend to capture farm level changes over time, and measures of each field's life cycle.[14]

The disturbance term, u_{ift}, captures unobserved determinants of productivity at the worker-field-day level. Worker observations within the same field-day are unlikely to be independent since workers face similar field conditions. This is accounted for by clustering standard errors at the field-day level in all productivity regressions.

The group characteristic, G_{ft}, varies at the field-day level. The parameter of interest throughout is γ, which relates how variation in the group characteristic G_{ft} affects the productivity of the *same* worker on the same field over time. A comparison of the estimates of γ under both incentive schemes provides information on the differential effect of G_{ft} under relative incentives, when there are incentives to cooperate, to that under piece rates, when the incentives to cooperate are eliminated.

The *number* of workers allocated to a field varies both across fields, depending on the field size, and within a given field through time, depending on the aggregate quantity of fruit on the field on that given day. This in turn depends on the climate and the stage of its life cycle a field is at. As reported in Table 1, group size on average is around 40, with a standard deviation of 23. This does not change across incentive schemes.

The *composition* of the group also varies each field-day. While workers are not randomly assigned to fields, workers themselves do not choose who to work with. Rather group size and composition are decided by the farm management, on the basis of the amount of fruit that needs to be picked, the demand for workers to perform non–picking tasks, and how close workers live relative to the fields that need to be picked.

[14] We measure the field's life cycle as the number of days the field has been picked at any moment in time divided by the total number of days that the field is picked. Picking experience is defined as the number of field-days the worker has picked for.

While workers' allocation to groups might depend on information that is available to the farm management and not available to the econometrician, we are able to isolate the effect of group characteristics on cooperation to the extent that the omitted variables are orthogonal to the incentive scheme in place.

For instance, both group size and individual productivity are likely to be positively correlated to the amount of fruit ready to be picked on a given field-day, and this is observable to the management but not to the econometrician. However, since the unobservable fruit stock determines group size and productivity under both relative incentives and piece rates, if the estimated relationship between group size and productivity were spuriously determined by the unobservable fruit stock rather than by cooperation, group size should affect productivity under *both* schemes.

Observing the same workers under relative incentives and piece rates then allows us to separate the effect of group composition on productivity through cooperation, which is only relevant under the relative scheme, from the spurious effect of unobservables that determine group composition and productivity under both schemes.

Descriptive statistics for each group characteristic considered are reported in Table 1. With the exception of the share of interns on the field, there is no significant difference between relative incentives and piece rates in how workers are assigned to fields on the basis of the group characteristics we consider.[15]

4.4 Empirical Results

Group Size

In Table 2 we present estimates of (3) by incentive scheme. The first group characteristic, G_{ft}, controlled for is group size – the number of workers that are picking on the field-day. This is the set of workers that determine the average productivity, $\overline{y}$, that endogenously determines the picking rate under relative incentives as given in (2).

The result in Column 1a shows that under relative incentives, worker i's productivity is significantly higher on field-days in which she is working alongside more co-workers. The result is thus consistent with the intuition that larger groups are less likely to cooperate because it is more costly to establish and enforce cooperative agreements other things equal. Moreover, in this context cooperation does not require paying fixed costs, so that the potential advantage of larger groups does not materialize.

Under relative incentives, a one standard deviation increase in group size leads to a 13% increase in productivity. In contrast, group size has no effect on productivity for the same

[15] The reason why the share of interns is lower under piece rates (in the second half of the season) is that interns tend to arrive earlier in the season.

worker under piece rates, when there are no incentives to cooperate (Column 1b).

The result is not driven by differences in group size across incentive schemes, nor by a lack of variation in group sizes under piece rates, as reported in Table 1. As with nearly all the results we report, standard errors under piece rates are smaller than those under relative incentives. Hence the non-significance of group characteristics under piece rates is not driven by these effects being imprecisely estimated.[16]

Next, we explore whether under relative incentives the effect of group size on productivity is non-linear. To do this, we estimate the effect of group size on individual productivity semi-parametrically using the methodology of Hausman and Newey (1995). Figure 2 shows the semi–parametric estimate of group size on individual productivity, where both are measured in deviation from field means.[17]

Individual productivity is non-linearly related to group size. This implies the parametric estimate reported in Column 1a underestimates the true marginal effect of group size on productivity under relative incentives. Workers' productivity initially increases in group size, but in sufficiently large groups, the addition of an extra worker has no affect on individual productivity. The turning point in Figure 2 corresponds to a group size of between 30 and 45 workers.[18]

Heterogeneity 1: Nationality

We now analyze whether individuals are more able to cooperate with co-workers of the same nationality than with others. Many nationalities are represented in our date, and the composition of workers by nationality varies considerably across fields and days.

An increase of the share of workers of the same nationality as worker i can have two effects on cooperative behavior. First, as the national group of i becomes larger relative to others, they are more able to determine the average productivity and hence the picking rate under relative incentives, as given by (2). Moreover, as discussed in Section 3, individuals might internalize the effect of their action more if this hurts their co-nationals rather than other group members. Hence worker i may cooperate more when she works alongside more of her co-nationals other things equal.

Second, as the national group becomes larger in absolute terms, then in line with the previous result on group size, worker i may cooperate less because the cost of making a cooperative agreement within the national group increases.

[16] The results go against the hypothesis that larger groups are allocated to fields where productivity is expected to be higher. If so, there should be a positive effect of group size on productivity under *both* incentive schemes.

[17] This implies the effect of group size further from the overall field mean is identified off field-days when a greater number of workers are present. All field-days are used to identify the effect around zero, hence the confidence bands are tighter close to zero.

[18] The same turning point is identified via a spline regression of productivity on group size. The splines are defined at intervals of size 15 and the effect is of similar magnitude for all group sizes in splines 30-45 and above.

To identify the two effects separately the next specification controls for the share of all workers on the field-day that are of the same nationality as worker i, *and* the number of workers of the same nationality on the field-day.

Columns 2a and 2b of Table 2 report that conditional on the size of the national group, worker i is significantly less productive (more cooperative) on field-days when the share of workers of the same nationality is higher, and that this effect is only present only under relative incentives. Other things equal, a one standard deviation increase in the share of the national group reduces productivity by 16% under relative incentives.[19]

Consistent with the previous result on group size as a whole, we find that conditional on the share of all workers that are of the same nationality, an increase in the number of workers of the same nationality leads to significantly higher productivity under relative incentives. A one standard deviation increase in the number of workers of the same nationality increases productivity by 25%, other things equal.

To summarize – (i) productivity is significantly lower when the share of all workers that are of the same nationality increases, (ii) productivity is significantly higher when the number of workers of the same nationality increases; (iii) the nationalities of co-workers only affects productivity under relative incentives.

Heterogeneity 2: Ability

In Table 3 we explore the relation between the heterogeneity of the group in terms of ability and the extent of cooperation. Differences in ability determine differences in net benefits and more able pickers might find deviations more attractive since the cost of exerting effort is lower for them. As discussed in Section 3, theory suggests more heterogeneous groups should be able to cooperate less, other things equal.

We measure the heterogeneity of the group on a field-day using the standard deviation of their cost of effort, which is negatively related to their ability. We control for the mean cost of effort of workers on the field-day, so that increases in the standard deviation correspond to a mean preserving spread in the costs of effort of workers on the field-day.

Column 1a shows that on field-days when worker i picks among a more heterogeneous group of workers, her productivity significantly increases under relative incentives. A one standard deviation increase in heterogeneity increases individual productivity by 11%. Heterogeneity in ability has no effect on productivity under piece rates (Column 1b).

The next specification analyzes the behavior of the most able workers on a given field-day, since these have the greatest incentives to break any cooperative agreement, other things equal. We control for whether a given worker is among the bottom 5% of workers in terms of their

[19] These results are unchanged if we additionally control for the number of workers of other nationalities. Furthermore, this variable has no significant effect on productivity under either incentive scheme.

cost of effort. Importantly, since group composition changes daily, our measure varies within the same individual over time. The result in Column 2a shows that when worker i is in the bottom tail of the cost distribution, her productivity significantly increases by 23% above that when she is not in the bottom tail.

The sign of this effect is consistent with workers deviating from cooperative agreements when it is most profitable for them to do so. The magnitude of the effect corresponds to an extra $15 in daily earnings, which, at the UK minimum wage, corresponds to two and a half hours of work. Under the assumption that deviators are punished, this amount provides an indication of the upper bound on the monetary value of the punishment.

In Column 3a we control for whether worker i is in the top 5% of the cost distribution on the field-day. We find that workers do not change their behavior relative to days when they are not in the top 5%. This is consistent with these workers have the weakest incentives to break cooperative agreements.

Columns 2b and 3b show that individual productivity does not depend on the position of worker i in the cost distribution on a given field-day when working under piece rates. The findings thus confirm that in the absence of any reason to choose efforts cooperatively, there is no evidence that workers behave as if they have incentives to break cooperative agreements.

Heterogeneity 3: Stakes

Table 4 analyzes whether the extent to which workers cooperate depends on the share of co-workers present with exogenously higher stakes. To do so, we exploit the fact that some workers come to work on an internship programme as part of their university course. They face higher costs of being caught shirking and sent home. Therefore interns should cooperate less compared to non-interns, other things equal. Moreover, the presence of interns on the field-day also lowers the returns to cooperation for workers who are not on the programme themselves.

We estimate specification (3) by incentive scheme, where we control for the share of co-workers that are interns on the field-day.

Column 1a shows that the productivity of all workers significantly increases, and thus cooperation decreases, when the share of interns increases. Column 2a shows that the productivity of non-interns significantly increases as a greater share of workers present are on the internship programme. In short, the presence of those that have fewer incentives to cooperate affects the behavior of other workers who would normally cooperate to a larger extent – an increase in one standard deviation in the share of interns, increases the productivity of other workers by 23%.

Columns 1b and 2b repeat the analysis under piece rates and show that, in line with the interpretation that the share of interns determines productivity only through its effect on cooperation, the presence of interns has no effect on the productivity of others under piece rates.

4.5 Summary

We have presented new evidence on the relationship between the characteristics of a group of workers, and the ability of that group to cooperate. There are some particular features of our setting and data that allow us to precisely identify the effect of group characteristics on the cooperative behavior of individuals.

First, there is a clear relation between observed individual behavior and cooperation. In particular, since under relative incentives the group optimum is to exert the minimum feasible level of effort, lower individual productivity corresponds to more cooperative behavior, other things equal. Second, the composition of the group of co-workers changes daily, and for reasons that are exogenous to the behavior of individuals in the past. Third, we observe the same individuals also working under piece rates when there are no incentives to cooperate. We can therefore separate out the direct effects of group characteristics on productivity, from the effects of group characteristics on cooperation.

We find that a given worker cooperates more, namely her productivity is significantly lower under relative incentives, when – (i) she works in smaller groups; (ii) when the share of co-workers of the same nationality is higher; (iii) the group is more homogeneous in terms of their ability (or distribution of net benefits); and, (iv) when she works alongside more co-workers that have less to lose from being caught shirking. None of these group characteristics are found to affect productivity under piece rates, when there is no reason for workers to behave cooperatively. These results are in line with the cross sectional evidence reviewed in Section 3.

5 Outstanding Policy Issues

We have reviewed a large body of evidence from field studies, cross sectional analyses, and experiments that indicates individuals can sometimes cooperate despite the profitability of opportunistic behavior. This body of research has provided clear insights into the design of institutions that foster cooperation, and of the characteristics of communities that are better able at solving collective action problems.

An important set of unresolved questions relate to the policy interventions that can resolve cooperation failures. Some of the existing evidence leads to pessimism on the chances of policy fostering cooperation. Field studies often suggest that government involvement is correlated with collective action failures and that spontaneous community participation is the only key to success.[20] While the importance of community participation is indisputable, the interpreta-

[20] For instance, of the 47 irrigation systems surveyed by Tang (1992), those that are government operated perform worse than those that are locally operated. Similarly, Bardhan (2000) finds that government management or the perception that allocation rules were decided by elites, leads to worse maintenance of infrastructure and a

tion given to these findings is, in cases, too pessimistic. After all, government involvement is endogenous and might be partly determined by the same factors that make collective actions unsuccessful. In particular, if formal authority intervenes only when informal institutions fail, the poorer performance of government projects is at least partly due to the same factors that made collective action fail in the first place.[21]

Our research contributes to the policy debate by providing evidence on how group characteristics relate to institutions and the success of collective action. This is especially important given that many community characteristics – such as ethnic heterogeneity – cannot be changed by public policy, while policy may be able to affect their link with cooperation.

For instance, our finding that individuals cooperate less when they are heterogeneous in terms of the costs and benefits of cooperation provide a rationale for policy measures or project design features to even out extreme differences among individuals or to set up a system of compensatory transfers. Similarly, the finding that smaller groups cooperate more would justify, for instance, the organization of larger communities into smaller subgroups that interact with each other through representatives.

Some suggestive evidence indicates that project design can undo the potentially detrimental effects of ethnic heterogeneity on collective action. Khwaja (2003) indeed shows that socially heterogeneous communities are able to properly maintain projects that require labour rather than monetary contributions, possibly because the latter can be expropriated while the former cannot.

The final key issue for policy is whether cooperation is persistent, namely whether success in one collective action problem facilitates cooperation in other similar situations. For example, Henrich *et al*'s (2001) field study of 15 small-scale 'societies' shows that the degree of cooperation in experimental games is correlated with the structure of everyday social interactions within the group of subjects. Societies that rely on cooperation for their daily livelihood exhibit a higher degree of cooperation in experiments. Cardenas (2003) also shows that individuals who are less likely to interact and cooperate in their everyday life cooperate less in experimental games.

Assessing whether cooperation is self-enforcing is of tremendous importance to correctly evaluate the net benefits of policy measures intended to foster cooperation at the community level. Indeed, to the extent that the ability to cooperate on one project makes future cooperation easier, one-off policy interventions can have a sustained long-term impact.

higher probability of conflict.

[21] To this date there have been few systematic evaluations of policy measures designed to foster cooperation in collective action problems. One exception is Edmonds (2002) who evaluates a nationwide community forestry programme in Nepal. The balance of evidence indicates that government initiated community groups did significantly reduce the extraction of firewood.

References

[1] AGRAWAL.A (1994) "Rules, Rule Making and Rule Breaking: Examining the Fit Between Rule Systems and Resource Use" in Ostrom.E, Gardner.R, and Walker.J.M (eds.), *Rules, Games, and Common-pool Resources*, University of Michigan Press, Ann Arbor: Michigan.

[2] ALESINA.A AND E.LA FERRARA (2000) "Participation in Heterogeneous Communities", *Quarterly Journal of Economics*, 115: 847-904.

[3] ALESINA.A AND E.LA FERRARA (2004) *Ethnic Diversity and Economic Performance*, mimeo, Harvard University.

[4] ANDREONI.J, W.HARBAUGH AND L.VESTERLUND (2003) "The Carrot or the Stick: Rewards, Punishments, and Cooperation", *American Economic Review* 93: 893-902.

[5] BALAND.J AND J.P.PLATTEAU (1996) *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?*, Oxford: Food and Agriculture Organization and Clarendon Press.

[6] BALAND.J, P.BARDHAN, S.DAS, D.MOOKHERJEE, AND R.SARKAR (2000) "Inequality, Collective Action and the Environment: Evidence from Firewood Collection in Nepal", in Baland.J, P.Bardhan and S.Bowles (eds.), *Inequality, Collective Action and Environmental Sustainability,* Russell Sage Foundation & Princeton University Press.

[7] BANDIERA.O, I.BARANKAY, AND I.RASUL (2005) "Social Preferences and the Response to Incentives: Evidence from Personnel Data", forthcoming *Quarterly Journal of Economics*

[8] BANERJEE.A AND R.SOMANATHAN (2001) *Caste, Community and Collective Action: The Political Economy of Public Good Provision in India*, mimeo, Massachusetts Institute of Technology.

[9] BANERJEE.A, D.MOOKHERJEE, K.MUNSHI, AND D.RAY (2001) "Inequality, Control Rights and Efficiency: A Study of Sugar Cooperatives in Western Maharashtra", *Journal of Political Economy* 109: 138-90.

[10] BANERJEE.A, L.IYER, AND R.SOMANATHAN (2004) *History, Social Divisions and Public Goods in Rural India*, mimeo Massachusetts Institute of Technology.

[11] BARDHAN.P.K (2000) "Irrigation and Cooperation: An Empirical Analysis of 48 Irrigation Communities in South India", *Economic Development and Cultural Change* 48: 847-65.

[12] BARDHAN.P, M.GHATAK AND A.KARAIVANOV (2002) "Inequality, Market Imperfections, and the Voluntary Provision of Collective Goods", in Baland.J, P.Bardhan and S.Bowles (eds.), *Inequality, Collective Action and Environmental Sustainability,* Russell Sage Foundation & Princeton University Press.

[13] BOHNET.I AND B.S.FREY (1999). "The Sound of Silence in Prisoner's Dilemma and Dictator Games", *Journal of Economic Behavior & Organization* 38: 43-57.

[14] CARDENAS.J.C (2003) "Real Wealth and Experimental Cooperation: Experiments in the Field Lab", *Journal of Development Economics* 70: 263-89.

[15] DAYTON-JOHNSON.J (2000) "Determinants of Collective Action on the Local Commons: A Model with Evidence from Mexico", *Journal of Development Economics* 62: 181-208.

[16] DUFLO.E AND R.CHATTOPADHYAY (2004) "Women as Policy Makers: Evidence from a Randomized Policy Experiment in India", *Econometrica* 72: 1409-43.

[17] EDMONDS.E (2002) "Government Initiated Community Resource Management and Local Resource Extraction from Nepal's Forests", *Journal of Development Economics* 68: 89-115.

[18] ESTEBAN.J AND D.RAY (2001) "Collective Action and the Group Size Paradox", *American Political Science Review* 95: 663-72.

[19] ESTEBAN.J AND D.RAY (1999) "Conflict and Distribution", *Journal of Economic Theory* 87: 379-415.

[20] FEHR.E AND K.M.SCHMIDT (1999) "A Theory of Fairness, Competition and Cooperation", *Quarterly Journal of Economics* 114: 817-68.

[21] FEHR.E AND S.GACHTER (2000) "Cooperation and Punishment in Public Goods Experiments", *American Economic Review* 90: 980-94.

[22] GACHTER.S, B.HERRMANN, AND C.THONI (2004) "Trust, Voluntary Cooperation, and Socio-economic Background: Survey and Experimental Evidence", forthcoming *Journal of Economic Behavior & Organization.*

[23] GUGERTY.M.K, AND E.MIGUEL (2004) "Ethnic Diversity, Social Sanctions, and Public Goods in Kenya", forthcoming *Journal of Public Economics.*

[24] HARRISON.G AND J.LIST (2004) "What Constitutes a Field Experiment in Economics?", forthcoming *Journal of Economic Literature.*

[25] HARDIN.G (1968) "The Tragedy of the Commons", *Science*, 162: 1243-8.

[26] HAUSMAN.J.A AND W.K.NEWEY (1995) "Nonparametric Estimation of Exact Consumers Surplus and Deadweight Loss", *Econometrica* 63: 1445-76.

[27] HENRICH. J *et al* (2001) "In Search of Homo Economicus: Behavioral Experiments in 15 Small-Scale Societies", *American Economic Review* 91: 73-8.

[28] KHWAJA.A (2003) *Can Good Projects Succeed in Bad Communities? Collective Action in the Himalayas*, mimeo, Harvard University.

[29] LA FERRARA.E (2002) "Inequality and Group Participation: Theory and Evidence from Rural Tanzania", *Journal of Public Economics*, 85: 235-73.

[30] LAM.W.F (1998), *Governing Irrigation Systems in Nepal: Institutions, Infrastructure, and Collective Action*, ICS Press, Oakland: California.

[31] LEDYARD.J (1995) "Public Goods: A Survey of Experimental Research" in Kagel.J, Roth.A (eds.), *The Handbook of Experimental Economics*, Princeton: Princeton University Press, 111-94.

[32] LIST.J (2004) "Young, Selfish, and Male: Field Evidence of Social Preferences", *Economic Journal* 114: 121-49.

[33] MASCLET.D, C.NOUSSAIR, S.TUCKER, AND M-C.VILLEVAL (2003) "Monetary and Nonmonetary Punishment in the Voluntary Contributions Mechanism", *American Economic Review* 93: 366-80.

[34] OLSON.M (1965) *The Logic of Collective Action*, Harvard University Press, Cambridge: Massachusetts.

[35] OSTROM.E (1990) *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press: New York.

[36] OSTROM.E, J.M.WALKER, AND R.GARDNER (1992). "Covenants With and Without a Sword: Self–governance is Possible", *American Political Science Review*, 86: 404-17.

[37] OSTROM.E, R.GARDNER, AND J.M.WALKER (1994) *Rules, Games, and Common-Pool Resources*, University of Michigan Press, Ann Arbor: Michigan.

[38] PANDE.R (2003) "Can Mandated Political Representation Increase Policy Influence for Disadvantaged Minorities? Theory and Evidence from India", *American Economic Review* 93: 1132-51.

[39] SEFTON.M, R.SHUPP, AND J.M.WALKER (2001) *The Effects of Rewards and Sanctions in the Provision of Public Goods*, mimeo, Indiana University.

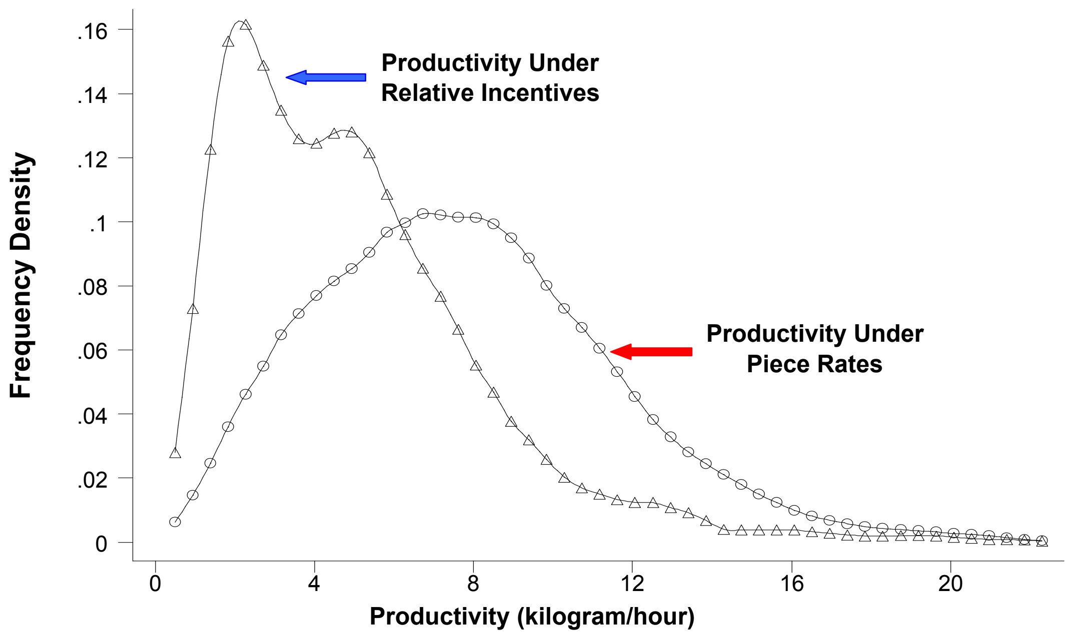
[40] SILVERMAN.B.W (1986) *Density Estimation for Statistics and Data Analysis*, London: Chapman and Hall.

[41] TANG.S.Y (1992) *Institutions and Collective Action: Self–governance in Irrigation*, Institute for Contemporary Studies, San Francisco.

[42] TANG.S.Y (1994) "Institutions and Performance in Irrigation Systems", in Ostrom.E, Gardner.R, and Walker.J.M (eds.), *Rules, Games, and Common–pool Resources*, University of Michigan Press, Ann Arbor: Michigan.

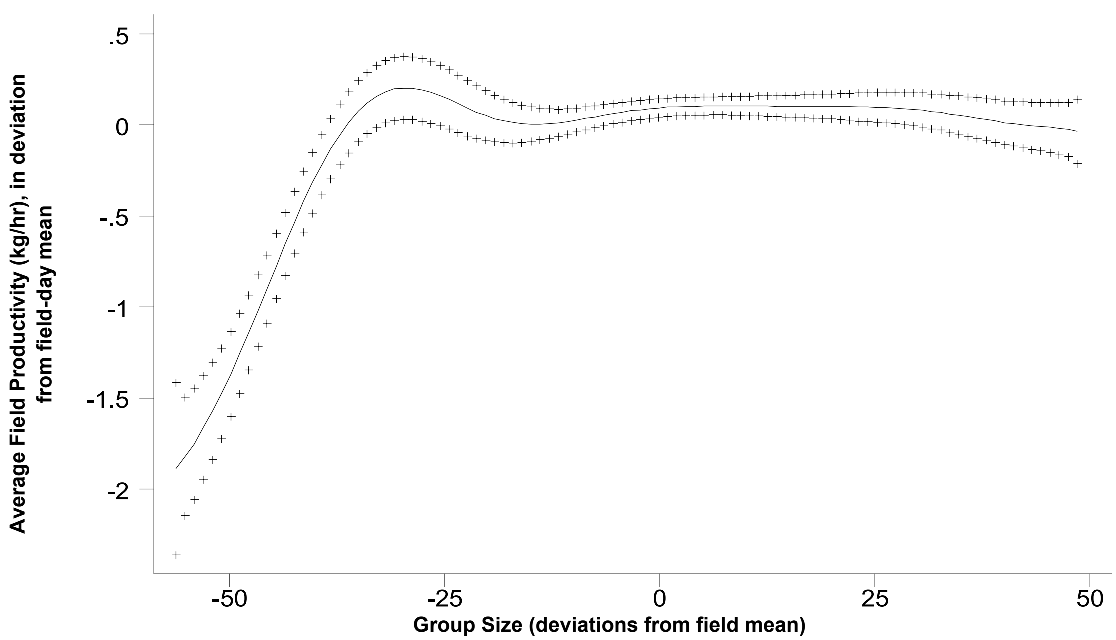
[43] WADE.R (1988) *Village Republics: Economic Conditions for Collective Action in South India*, Cambridge University Press: Cambridge.

Figure 1: Distribution of Productivity (kg/hr) by Incentive Scheme



Notes: The kernel density estimates in figure 1 are calculated using an Epanechnikov kernel, based on 50 grid points and the bandwidth suggested by Silverman (1986, pp38-40).

Figure 2: Semi-parametric Kernel Density Estimate of Group Size on Individual Productivity Under Relative Incentives



Notes: The Gaussian kernel is based on 144 field-day observations, 100 grid points and bandwidth 10. The dotted lines correspond to bootstrapped 95% confidence bands based on 1000 repetitions. The semi-parametric analysis is calculated at the field-day level based on all worker-field-day level observations for workers that work at least 10 field-days under both incentive schemes. The linear part of the model includes the field-day average of worker's picking experience, the field life cycle and a time trend.

Table 1: Descriptive Statistics by Incentive Scheme

Mean, standard deviations in parentheses

	Relative Incentives	Piece Rates
Worker productivity (kg/hr)	5.01 (3.21)	7.98 (3.81)
Group size	41.1 (28.8)	38.1 (18.2)
Share of total workers of same nationality as worker *i*	.175 (.192)	.156 (.150)
Number of workers of same nationality as worker *i*	7.80 (9.93)	6.20 (5.97)
Standard deviation of cost of effort	.142 (.035)	.116 (.041)
Mean cost of effort	.297 (.068)	.291 (.067)
Share of workers on the internship programme	.390 (.184)	.340 (.162)

Notes: Worker productivity is measured at the worker-field-day level. All other variables are measured at the field-day level. Group size equals the total number of pickers on the field-day. The cost of effort parameter is calibrated for each worker as discussed in Bandiera *et al* (2004b). All characteristics except the share of interns do not differ significantly across the two incentive schemes.

Table 2: Group Characteristics and Cooperation - Group Size and Heterogeneity in Nationalities

Dependent Variable = Log of worker's productivity (kilogram picked per hour per field-day)

Robust standard errors reported in parentheses, allowing for clustering at field-day level

	Relative Incentives		Piece Rates	
	(1a)	(2a)	(1b)	(2b)
Group size	.233**		.064	
	(.109)		(.067)	
Share of total workers of same nationality as worker *i*		-.175*		-.038
		(.102)		(.065)
Number of workers of same nationality as worker *i*		.277**		.087
		(.123)		(.082)
Worker fixed effects	Yes	Yes	Yes	Yes
Field fixed effects	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Adjusted R-squared	.4077	.4082	.3163	.3165
Number of observations (worker-field-day)	4063	4063	6152	6152

Notes: *** denotes significance at 1%, ** at 5%, and * at 10%. Robust standard errors are calculated throughout, allowing for clustering at the field-day level. All continuous variables are in logs. The sample is restricted to workers who have worked at least 10 field-days under both incentive schemes. Other controls include worker experience, field life cycle, and a linear time trend.

Table 3: Group Characteristics and Cooperation - Heterogeneity in Ability

Dependent Variable = Log of worker's productivity (kilogram picked per hour per field-day)
Robust standard errors reported in parentheses, allowing for clustering at field-day level

	Relative Incentives			Piece Rates		
	(1a)	(2a)	(3a)	(1b)	(2a)	(3a)
SD of cost of effort	.561**			-.202		
	(.252)			(.177)		
In bottom 5% of cost of effort distribution on field-day		.226***			-.035	
		(.091)			(.056)	
In top 5% of cost of effort distribution on field-day			-.009			.019
			(.088)			(.058)
Mean cost of effort	.014	.382	.412	-.328	-.616***	-.621***
	(.452)	(.490)	(.492)	(.347)	(.201)	(.199)
Worker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Field fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	.4056	.3981	.3966	.3289	.3282	.3282
Number of observations (worker-field-day)	4062	4063	4063	6150	6152	6152

Notes: *** denotes significance at 1%, ** at 5%, and * at 10%. Robust standard errors are calculated throughout, allowing for clustering at the field-day level. All continuous variables are in logs. The sample is restricted to workers who have worked at least 10 field-days under both incentive schemes. Other controls include worker experience, field life cycle, and a linear time trend.

Table 4: Group Characteristics and Cooperation - Heterogeneity in Stakes

Dependent Variable = Log of worker's productivity (kilogram picked per hour per field-day)

Robust standard errors reported in parentheses, allowing for clustering at field-day level

	Relative Incentives		Piece Rates	
	(1a)	(2a) Not on internship	(1b)	(2b) Not on internship
Share of workers on the field-day that are on the internship programme	.377***	.521***	-.021	-.125
	(.106)	(.108)	(.118)	(.111)
Worker fixed effects	Yes	Yes	Yes	Yes
Field fixed effects	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Adjusted R-squared	.4278	.3858	.3035	.3423
Number of observations (worker-field-day)	3984	1042	5913	1894

Notes: *** denotes significance at 1%, ** at 5%, and * at 10%. Robust standard errors are calculated throughout, allowing for clustering at the field-day level. All continuous variables are in logs. Other controls include worker experience, field life cycle, and a linear time trend. The samples in columns 1a and 2a are restricted to workers who have worked at least 10 field-days under both incentive schemes. The samples in columns 2a and 2b are further restricted to only include workers that are not on the internship programme.