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What Explains Collective Action in the Commons? Theory and Evidence from the Philippines

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Summary. — I examine the factors that influence collective action in the commons using econometric analyses on a data set of 1958 irrigation associations in the Philippines. I find that collective action is associated with water scarcity, proximity to markets, group size, farm size, and governance structure. Water scarcity has a curvilinear effect on collective action and is mediated by the governance structure. The results suggest the need for a diagnostic approach in the analysis of institutional arrangements in diverse socio-ecological settings. These also suggest that collective action in the commons is more complex than is conventionally assumed in the decentralization literature.

Key words — collective action, commons, decentralization, free riding, irrigation, Asia, Philippines

1. INTRODUCTION

In the last three decades, governments in developing countries worldwide have been transferring—in varying degrees—rights and responsibilities to communities over natural resources such as coastal and inland fisheries, forestry, rangelands, protected areas and water, particularly irrigation and watersheds. This policy shift has been the result of the convergence of several factors including fiscal pressures, donor pressures, demands for democratization and redefinition of the scope and role of government, greater awareness of incentive problems among resource management agencies, and a significant body of evidence on the comparative advantage of communities (Meinzen-Dick, Raju, & Gulati, 2002).

The core of the comparative advantage argument holds that small-scale, local common-pool resources such as forests, watersheds, coastal and inland fisheries, protected areas, surface irrigation and grazing lands are best governed and managed by the users themselves—compared with government bureaucrats—because of motivational and informational reasons. The motivational reason suggests that since these resources are usually salient to the livelihoods of users themselves, they are more likely to have strong incentives to manage these resources more efficiently, equitably, and sustainably than government bureaucrats. Communities are assumed to be better able to solve collective action problems and act collectively to advance their interests when given control of decisions and resources.

The informational reason, on the other hand, has to do with the cost of obtaining information to manage these resources. Resource users in developing countries are more likely to have lower costs of obtaining, assessing, and sharing information about the resource and resource users compared to government bureaucrats. In addition, government officials are frequently embedded in a perverse set of incentives given their meager levels of salaries, the magnitude of the principal-agent problem, and opportunities they have for rent seeking.

The purpose of this paper is to identity some of the factors that influence collective action in the commons. A considerable debate exists among scholars on the factors that facilitate or impede collective action in the commons—a good characterized by rivalry of consumption and difficulty of exclusion. Agrawal (2002) had identified at least two dozen variables regarded by scholars as important, but little agreement exists on the direction, size, and significance of their effects. For instance, scholars disagree on how variations in the physical characteristics of a common pool resource such as its scarcity, size, and proximity to markets, affect the likelihood of collective action (e.g., Bardhan, 1993; Meinzen-Dick *et al.*, 2002; Uphoff, Wickramasinghe, & Wijayaratna, 1990; Wade, 1988).

Scholars also continue to debate on the importance of variations in the characteristics of resource users themselves. For example, Fujiie, Hayami, and Kikuchi (2005) and Ternstrom (2003) disagreed on the effects of the age of the resource user's association. Likewise, Baland and Platteau (1996) and Wade (1988) disagreed on the salience of the resource to the livelihoods of resource users. On the other hand, Meinzen-Dick, Abiad-Shields, and Subramanian (1997) and Coward (1986) have differing views on the importance of land tenure, while Falk, Fehr, and Fischbacher (2002) and Ostrom, Gardner, and Walker (1994) had different take on the importance of face to face communication (see also Bardhan and Dayton-Johnson (2002) for a summary of the empirical literature in irrigation, and Poteete and Ostrom (2004) for forestry).

Understandably, most of the disagreements among scholars arise because of five methodological problems which, in large part, can be attributed to the cost and difficulties of field data collection. This paper hopes to address some of these issues, but will also make clear its own limitations. First, most field studies are faced with a small-N problem. Agrawal (2002) correctly noted that while much has been learnt from individual case studies, they do not have the necessary degrees of freedom to discern how different structural variables affect the likelihood of collective action. The main strength of this article is the use of a large-scale multivariate data set ($N = 1958$) and the application of econometric tests to control for theoretically relevant factors such as the physical characteristics of the resource, characteristics of the resource users and the

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governance structure of the irrigation system. There are, however, limitations in my data set, for example, on soil characteristics, rainfall patterns, and dry season cropping which would have otherwise permitted a more disaggregated analysis of various dimensions of the irrigation system.

Second, many empirical studies do not specify or incorrectly specify the nature of the collective action problem despite efforts stressing the variety of conditions that could influence collective action (Poteete & Ostrom, 2004). In this paper, I attempt to specify the collective action problem by using as a proxy measure the magnitude of monetary and labor free riding among users of a common pool resource, in this case an irrigation system. While not a perfect measure, the magnitude of free riding in both monetary and labor contributions represents a good indication of the problem of collective action in the commons. Furthermore, I also used an irrigation system as a unit of analysis because the structure of interdependencies in this setting gives rise to various potential problems of collective action such as appropriation, assignment, provision and monitoring problems (Ostrom *et al.*, 1994).

Third, empirical studies in irrigation are faced with measurement problems. For instance, the location of a land holding relative to the headwork is sometimes used as a proxy measure of water scarcity. This can be misleading as it ignores institutional factors (i.e., farmers can devise equitable cropping calendars that equally benefit tail-enders). It also ignores hydrologic factors such as water volume and the condition of the infrastructure, which could affect water availability. This article uses a more direct measure, cropping intensity, as a proxy indicator of water scarcity, which is a more reliable measure compared with the practice of using location as a proxy of water scarcity. Ideally, the specification of water scarcity should include disaggregated measures such as dry season cropping, rainfall zoning, use of ground water pumps, and soil type, but disaggregated data at the farm level are not available. Translating the concept of market pressure on the commons into an operational measure is also challenging. This paper used the distance of the irrigation system to market centers as a proxy measure of market pressures, as did Agrawal and Yadama (1997).

Fourth, many empirical studies suffer from a censoring bias, which has led to optimistic conclusions on the abilities of farmers to solve collective action problems (Meinzen-Dick *et al.*, 2002). Censoring bias occurs if the process of selecting observations systematically censors out a particular group of observations—for instance, non-functional irrigation associations which are excluded from the set of observations. I deal with this problem by ensuring that all irrigation associations, regardless of the levels of free riding, are included in the observation group to the extent that data are available. While this approach solves one methodological limitation in the literature, it is not sufficient to totally overcome this common problem without identifying and testing an instrumental variable for the causal effect of unobserved heterogeneity, which occurs when random assignment of observations to treatments is not possible in a quasi experiment.

Finally, few empirical studies attempt to examine how the effects of physical variables and group characteristics on collective action are mediated by institutional variables. Understanding these conditional effects is important since many of the characteristics of the resource and resource users are mediated by institutional factors such as the cost of monitoring and rule enforcement (Stern, Dietz, Dolsak, Ostrom, & Stonich, 2002). This article examines how the effects of physical variables and the characteristics of the resource users are mediated by the governance structure of the irrigation system.

The rest of article proceeds as follows. In the next section, I review the literature on collective action in common pool resources. On the basis of this review, I specify in Section 3 a conceptual framework, the various hypotheses to be tested, the regression model and measurement of variables and data collection methods. In Section 4, the findings are presented and discussed, while conclusions, limitations, and policy implication follow in Section 5.

2. THEORY AND EVIDENCE

I use the term collective action problems in a sense used by Ostrom (2005) referring to a setting in which individuals choose actions in an interdependent situation such that if an individual selects strategies based on a calculus that maximizes short-term material benefits, individuals in that setting will take actions that generate lower joint outcomes than could have been achieved. Collective action problems can result from, among others, conflicting interests, inadequate information, and the characteristics of a good (Ostrom, 2005), while for other scholars, collective action is also linked with group size (Olson, 1965).

In the following sections, I briefly review the salient debates in the literature how collective action is affected by the characteristics of the good, the characteristics of resource users, and the institutional context.

(a) *Characteristics of the good and collective action*

Scholars generally agree that the physical characteristics of a resource affect the likelihood of successful collective action in the commons (Ostrom *et al.*, 1994). Different resources, such as water, fishery, terrestrial wildlife, and forest resources, would have different enforcement characteristics and therefore create different incentives for collective action. For public goods, a defining characteristic is the difficulty of exclusion and non-rivalry in consumption, which creates incentives that can lead to the free rider problem. On the other hand, common pool goods such as an irrigation system are characterized by rivalry in consumption and difficulty of exclusion. In the following section, I review the effects of resource scarcity, size of the resource, and proximity to markets on collective action.

(i) *Resource scarcity*

There is general agreement among scholars that collective action among resource users would be unlikely unless they perceive that the resource is moderately scarce. In the case of irrigation systems, Agrawal (2002) and Bardhan (1993) suggested that resource scarcity and collective action are related in a curvilinear manner, that is, cooperation is more difficult when water is abundant and extremely scarce. Uphoff *et al.* (1990) were also of the view that farmers are more willing to manage and maintain systems when water is neither extremely scarce nor extremely abundant but is only moderately scarce.

(ii) *Size of the resource*

Wade (1988) suggested that the size of the resource matters to collective action by arguing that smaller and more clearly defined boundaries of common pool resources are more likely to be associated with successful collective action. This is presumably because of the lower costs of monitoring and enforcement. Meinzen-Dick *et al.* (1997), however, notes a problem of conceptual validity in that irrigation scholars sometimes do not differentiate between the size of the irrigation area and the number of farmer appropriators. This leads to a flawed analysis since an irrigated area may have a large number of farmers owing to small farm holdings, while another may have large land holdings but smaller number of farmer owners.

(iii) *Proximity to markets*

It is generally supposed that increasing integration with markets usually has an adverse impact on the management of common pool resources (Agrawal & Yadama, 1997). Increasing market pressure leads to increasing anonymity among actors, which lessens mutual dependencies, loosens traditional social ties, and reduces the inter-linkages for possible reprisals in the case of adverse behavior (Ostrom & Gardner, 1993). The result is a reduced prospect for cooperation. Another view holds that market penetration can increase the returns to irrigated farming and thereby the farmer's incentives to participate in group undertakings. Meinzen-Dick *et al.* (1997) suggested that the impact is more determined by labor market structure rather than by the degree of commercialization.

(b) *Attributes of resource users and collective action*

In addition to the characteristics of the good, scholars also debate on how variations in the characteristics of resource users influence collective action. For instance, scholars also debate on the effects of the age and origin of the user group, the incidence of poverty among resource users, the size of the user group, the salience of the resource to the livelihoods of the users, and the gender composition of resource users.

(i) *Age and origin of the user group*

Various scholars view the age and origin of resource user group as important factors in explaining collective action. One view is that the age of the resource user group—a proxy for social capital—matters to collective action. As Meinzen-Dick *et al.* (1997) suggest, in older groups, members know what to expect because of the already established patterns of understanding, whereas members of newer groups are less certain about whether cooperation with other farmers will be reciprocated. This view is supported by Fujiie *et al.* (2005) who postulated that a high level of collective action is less likely when the history of irrigated farming is short. A contending view is that the age of the irrigation system has no statistical significance on levels of collective action (Ternstrom, 2003).

The origin of the user group—whether self-organized or organized by a government agency—is also postulated to affect the likelihood of collective action among farmers. Self-organized irrigation associations (IAs) have a stronger sense of "ownership," and thus cooperation among farmers is more likely compared with associations organized by government agencies (Ostrom and Shivakoti, 2002).

(ii) *Wealth*

There is scant literature on the effects of wealth and poverty on collective action in common pool resources. Of the available literature, Ternstrom (2003) came closest to examining the empirical links between poverty and collective action and suggested that wealth inequality makes cooperation less likely. Ternstrom showed that the likelihood of cooperation will be greater if the resource users are relatively well off rather than if they are very poor, but greatest of all in groups of users just managing to get the food they need. When users are poor, Ternstrom suggested that the poorest will not cooperate and when the users are rich, the richest will not cooperate. According to Baland and Platteau (1996, 1999), heterogeneity of asset structure is less likely to be a barrier to collective action than heterogeneity of social background and objectives. I examine this argument by looking at how variations in farm size affect the level of monetary free riding.

(iii) *Salience*

Wade (1988) suggested that salience—the extent to which resource users depend upon a resource for their livelihoods—is an important condition which facilitates collective action in a common pool resource. Baland and Platteau (1996), however, did not consider salience as an important factor, but instead paid more attention to external forces, such as aid and internal factors such as enforcement and leadership. Dietz, Ostrom, and Stern (2003), however, were more explicit when they argued that salience is one of the three main conditions for collective action in the local common pool resources. They argue that the resource must be salient enough to the users that they are willing to invest time and energy to create new institutions.

(iv) *Group size*

The effect of the size of user groups on collective action remains a complex and controversial issue and the literature on this subject is substantial (see Poteete & Ostrom (2004); for a summary in forestry). Group theory and conventional thinking suggest that collective action is difficult as group size increases. However, there is no consensus on what is a small and large group and the role of context in mediating the effects of group size. Olson (1965) argued that unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational self-interested individuals will not act to achieve their common or group interest. As group size increases, Olson argued, individuals will conclude that their marginal contribution will not affect the likelihood that the good will be provided and therefore do not make such contributions. Olson added that when certain resource users, the so-called privileged group, have enough wealth and stake, they will contribute to the solution of a collective action problem even though there are free riders who do not contribute.

In irrigation, Tang (1992) suggested that all other things being equal, it would be easier to organize and maintain collective action in irrigation systems of smaller sizes with smaller number of users. Fujiie *et al.* (2005) also concluded that collective action in irrigation is difficult to organize in IAs with a large number of farmers. A contending view is postulated by Ternstrom (2003) who argued, using an empirical study from Nepal, that group size (which varies from seven to 100 farmers in her study) does not seem to make any statistically significant difference in cooperation.

However, as Meinzen-Dick *et al.* (1997) argued, group size represents a tradeoff between potential economies of scale and increases in transaction costs. On one hand, farmers have incentives to maintain a critical size for purposes of economies of scale in the maintenance of the irrigation system. On the other hand, increase in group size leads to an increase in transaction costs because of the reduced observability of actions and that the marginal social cost of individual defection is negligible compared with the marginal private gains.

According to Agrawal and Gibson (1999), group size and heterogeneity affect the prospects for developing trust among participants, and thus the chances of collective action, because of its effect on the divergence of interests. According to game theorists such as Frohlich and Oppenheimer (1970) and Sandler (1992), the effects of group size on cooperation is contingent on how other variables are affected by changes in the size of a group.

(c) *Collective action outcomes in field studies*

Considering the multitude of variables that could possibly affect collective action, the literature on field case studies suggest four categories of outcomes in the commons (see Ostrom, 1990; Ostrom *et al.*, 1994). First, there are clearly sub-optimal outcomes whereby the behavior of resource users has led to high levels of conflict, overuse, and in some cases to the destruction of the resource. Second, there are long-lived, endogenous monitoring and sanctioning systems where resource users have designed rules regulating entry and appropriation from the resource that are enforced by the resource users themselves. The outcomes may not be optimal but are close enough for the resource users to continue investing in costly monitoring and sanctioning.

Third, there are cases of short-lived, endogenous monitoring and sanctioning systems whereby resource users cease to monitor and sanction after an exogenous shock, such as a major change in factor prices, a dramatic increase in population or a takeover of resource ownership by the government. Finally, there are also cases of short-lived, exogenous monitoring and sanctioning systems whereby external authorities impose rules regulating entry and appropriation, but fail to enforce these rules.

3. FRAMEWORK AND METHODOLOGY

In the following sections, I describe the (1) conceptual framework of the study; (2) research question and hypotheses to be tested; (3) definition and measurement of variables; (4) estimation model and analytic approach; and (5) unit of analysis, study site, population and measurement reliability issues.

(a) *Conceptual framework*

The preceding review of the literature suggests that incentives for collective action in the context of a common pool resource are a function of at least three factors: the characteristics of the good, the attributes of the players, and the micro-institutional and external context (Figure 1).

The framework suggests that collective action outcomes are shaped by the incentive structure faced by the players, which in turn is affected by the context that they face. This context in turn is defined by (1) the physical characteristics of the resource (i.e., water scarcity, size of the resource, infrastructure condition, excludability, and rivalry, among others); (2) the attributes of the players (group size, origin of group, salience of resource, among others); and (3) the internal and external institutional context (e.g., the patterns of authority that internally governs the irrigation system, the political context that structures the distribution of power among irrigation districts, among others). These factors can exert an influence on incentive structures either individually or configurally in combination with other independent variables. A detailed exposition of the framework is found in Ostrom *et al.* (1994).

(b) *Research question and hypotheses*

This study seeks to answer the question: what are the factors thatinfluence the likelihood of collective action among a large and heterogeneous group of users of a common pool resource in diverse physical settings? Based on the literature review and the conceptual framework, three sets of hypotheses are specified in terms of how collective action is affected by (1) the characteristics of the good, (2) the attributes of the players, and (3) the governance structure of the irrigation system. These hypotheses are discussed below.

(1) Hypotheses on the effects of the characteristics of the good on collective action.

(H1a) *Scarcity hypothesis*: We expect that water scarcity—represented by the proxy measure cropping intensity—has a curvilinear effect on monetary free riding, *ceteris paribus*. Collective action is more difficult when water is either abundant or extremely scarce.

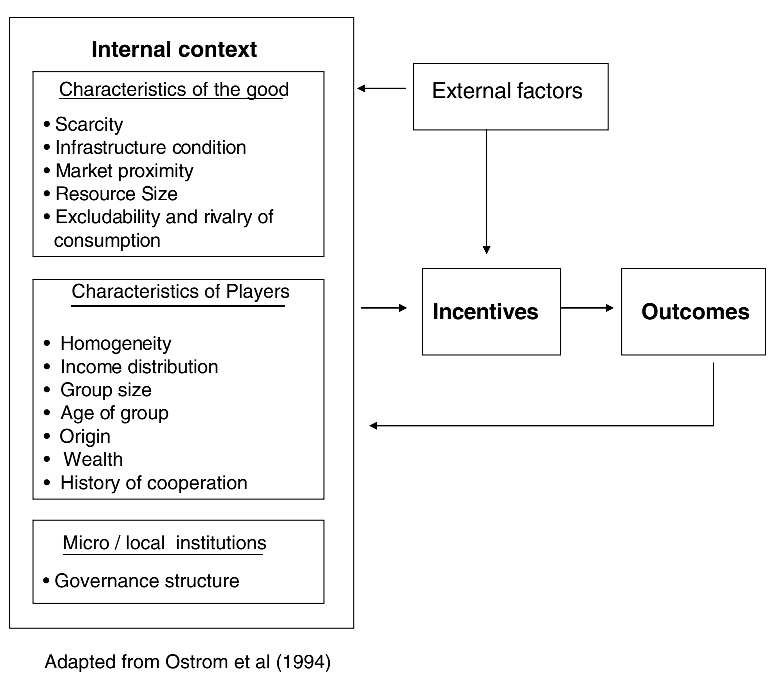

Figure 1. *Factors that influence collective action outcomes in a common pool resource.*

(H1b) *Market proximity hypothesis*: We expect that free riding will decrease the farther away the irrigation system is from commercial centers, *ceteris paribus*. In irrigation systems farther away from market centers, traditional social ties that bind farmers into mutual dependencies remain strong compared with those close to commercial centers, where farmers acquire greater exit options through the labor market and become less known to each other, thus making enforcement more difficult.

(2) Hypotheses on the attributes of players on collective action.

(H2a) *Age hypothesis*: We expect that free riding will decrease with the age of the IA, *ceteris paribus*. Older and more experienced associations have more opportunities to develop shared understanding and reputation, which lowers the costs of monitoring and enforcement.

(H2b) *Group size hypothesis*: We expect that the likelihood of free riding increases as the size of the user group increases, *ceteris paribus*. As user size increases, the incentive to cooperate decreases given that the marginal social cost of individual defection is relatively small compared with the marginal private gains. Increase in anonymity in a large group also reduces the effects of social pressure and the incentive to cooperate.

(H2c) *Origin of IA hypothesis*: We expect that the likelihood of free riding is less likely among self-organized group of farmers, *ceteris paribus*. Self-organized groups of farmers have a stronger sense of identity, and are more likely to have developed norms that promote trust and reciprocity and thus greater likelihood of cooperation and better enforcement, *ceteris paribus*.

(H2d) *Farm size hypothesis*: We expect that the likelihood of free riding increases as irrigated farm size—a proxy measure of wealth—increases, *ceteris paribus*. Farmers with larger irrigated farms have more exit options because of their wealth. These exit options leave the IA fewer mechanisms to enforce cooperation in a footloose population. I refer to this as the wealth induced exit option hypothesis.

(3) Hypotheses on the governance structure of the irrigation system.

(H3a) Irrigation systems under the full control of the irrigation association are more likely to have a lower level of free riding compared with government controlled systems.

(c) *Definition of variables and limitations*

My dependent variable, collective action, is represented by two proxy measures. The first measures the extent of free riding in the payment of irrigation fees (monetary free riding). The second measures the extent of free riding in terms of labor contribution toward the maintenance of the irrigation system. Monetary free riding—a continuous variable—is calculated as follows:

Monetary Free riding ($ FREERIDE) = total current irrigation fees payable by the IA minus the actual current fees collected divided by the total current fees payable $\times$ 100%.

By law, farmers in the Philippines are required to pay a fixed amount of irrigation fees for the operation and maintenance of public irrigation systems. These fees are collected immediately after each harvest season either by staff of the government irrigation agency or through irrigation associations contracted out for this purpose. Collection of irrigation fees is limited to those who actually benefitted from the irrigation service, that is, those who eventually managed to harvest their crops as a result of the service. Irrigation fees are levied proportionally depending on the level of water service. For instance, farms at the tail end of the system which received only half of what others received are only required to pay the level of service they have received.

A robust system of book keeping is in place to record these accounts, and can be verified in the records of the finance unit of the irrigation agency. To ensure that this cross-sectional observation in 2002 is a consistent pattern overtime and not due to an exceptional event, cross-comparisons were made with the ten-year (1991–2000) national average percentage of 42%. Except for the years 1999–2000 when the policy of collecting irrigation fees was temporarily stopped and the national average dropped to 35%, the level of irrigation fee collection has been consistently declining (Araral, 2005).

The second proxy measure—free riding in labor contribution (LABOR)—has been coded as a binary variable, 0 if at least 75% of the members of the IA contribute voluntary labor for the operation and maintenance of the irrigation system based on the attendance records of the association; otherwise, it was coded as 1. Ideally, this variable should have been coded as a continuous variable, but the binary coding itself was a given constraint in the original dataset, that is, the coding form asked the respondents, in this case IA secretaries, to code 0 if at least 75% of the members of the IA contribute labor for collective operation and maintenance of the irrigation systems and to code 1 if otherwise.

My independent variables and their measurement, on the other hand, are described below, with parentheses referring to the coding of the regression variable:

(1) Cropping Intensity (CRPINT) is a continuous variable and a proxy indicator of water scarcity. It is measured as the proportion of rice farms (ha) that are actually irrigated during the wet and dry cropping seasons divided by the total irrigation service area. Cropping intensity (CI) and water scarcity are inversely related. Lower CI means higher water scarcity and vice versa. Maximum CI in one year is 200%, which means that all irrigable areas in an irrigation system during the wet and dry cropping season were fully irrigated and planted with crops. I assume that labor and input constraints do not affect farmer decisions to farm more or less land. There are several reasons for this, for example the high prices of rice in both the domestic and international markets, production subsidies received by farmers, availability of informal credit, and the large surplus of labor in rural areas in the Philippines (i.e., the underemployed in rural areas in 2001 accounted for 18.7% of total labor force and 8.73% for unemployed (Brooks, 2002)). Ideally, water scarcity should be measured during the dry season and information on the extent of the use of pump irrigation (in contrast to canal irrigation) be reported. However, the data sets available do not permit further aggregation into wet and dry seasons. There are other physical variables that could affect the performance of irrigation systems—for example, soil type, rainfall patterns, size of command area, among others—but these data were not available for the entire population of the irrigation systems studied. In addition, data on the use of irrigation pumps are not included in the data sets as this is not a significant source of water relative to the overall service provided by NIA (Mejia, 2004; Gamboa & Mejia, 2005). Part of the reason for the relatively low level of adoption of pump irrigation is the very high cost of its operation and maintenance and economies of scale do not work in

favor of the farmer. The average size of rice farms in the Philippines is only 1.4 ha.

(2) Distance to market (DISTMKT) is a binary variable which refers to the proximity of an irrigation system to the main commercial center in the province. It was coded as zero if the irrigation system is estimated to be more than one hour away by public transport (buses, jeepneys, and motorbikes) from the commercial center of the province—usually the provincial capitol—and otherwise coded as one. It is used here as a proxy measure of market pressures on collective action.

(3) Age of irrigation association (AGE) is measured in years as reckoned from the date of the incorporation of the IA with the government securities agency with 2002 as reference year, that is, an IA registered in 1990 would be 12 years old in this reckoning.

(4) Group size (GRPSIZE) refers to the number of farmers who are appropriating water at the level of the turnout service area (i.e., the smallest hydrological unit of the irrigation system).

(5) Origin of IA (ORIGIN)—a dummy variable—refers to the origin of the IA. It was coded as one if the IA was self-organized by farmers without assistance from the government irrigation agency, otherwise coded as zero.

(6) Gender (GENDER) refers to the proportion of women members of the IA.

(7) Average size of irrigated farm (FARMSIZE) refers to average size of all irrigated parcels of land (in hectares) for each farmer in each irrigation unit. This variable can be considered as a proxy for wealth since land size is often associated with wealth in rural areas in the Philippines. This is only a proxy measure since there could also be other sources of wealth, such as remittance income from overseas workers.

(8) Governance (GOV) refers to the governance structure of the irrigation system, that is, whether it is under the full control of farmers or the government irrigation agency. Full control—which I coded here as one, else zero—means that the IA owns the irrigation facility (tertiary canals), effectively controls the use of water including sanctions to stop water service, has the authority to impose irrigation fees and disburse them accordingly, and can enforce sanctions against erring members including sanctions to stop water service. In government controlled irrigation systems, the role of the IA is limited as a contractor of NIA in the collection of fees and maintenance of irrigation facilities. IAs do not have effective control over water facilities and have limited enforcement powers.

(d) *Estimation models and analytic approach*

To test these hypotheses, I employ two estimation models. The first is an OLS regression model to estimate the effects of physical, social, and institutional variables on monetary free riding. This model is appropriate given that monetary free riding is a continuous variable and has the advantage of a straightforward interpretation. I preferred the use of the OLS model over tobit regression model since while both have the same assumptions about error distributions, the tobit model is much more vulnerable to violations of those assumptions. In the OLS model with heteroskedastic errors, the estimated standard errors can be small, but this is not the case for tobit model as it estimates the probability of censoring. As a result, coefficients for the tobit model can be badly biased (Madigan, 2007).

On the other hand, I used a binary logit regression model for the binary dependent variable labor contribution. One advantage of the logit link function is that it provides an estimate of the odds ratio for each predictor in the model (Long & Freese, 2001). The odds ratio is the ratio of two events where the odds of an event equals the probability that the event occurs divided by the probability that it does not occur. The odds ratio can be any nonnegative number and the odds ratio equal to one serves as the baseline for comparison. If the ratio is equal to one, this indicates that there is no association between the response and predictor variables. If the ratio is more than one, then the odds of success (i.e., observing free riding) are higher for the reference level of the factor. If the ratio is less than one, the odds of success are less for the reference level.

In addition, interaction effects analysis was undertaken to examine whether the effects of the physical characteristics of irrigation system and the characteristics of the farmers are conditional on institutional factors such as the governance structure of the system. Few empirical studies examine the conditional effects of institutions on physical and social variables.

(e) *Unit of analysis, study site and population*

My unit of analysis is the irrigation association (IA) for which I have 1958 observations taken from the entire population of 196 large-scale public irrigation systems throughout the Philippines. Using the extensive and intensive irrigation data base from the Philippine National Irrigation Agency (NIA)—the government agency responsible for irrigation—I assembled a cross section (2002) multivariate data set of the physical and social characteristics for each of these IAs. Altogether, there are more than 15,000 observations in my data set ($N = 1958$ and 8 variables). It would have been ideal if a panel data set were available, but this is one of the limitations of this study.

To determine the measurement reliability of these data sets, two rounds of ground truthing were undertaken. The first round—undertaken during the summers of 2003 and 2004—involved visits to 13 irrigation systems nationwide (out of 196 systems) which were drawn from purposive sampling. The second round was done during the summer of 2005. Sampling was done such that irrigation systems of different sizes (small (500 ha or less), medium (501–1000 ha), and large (>1000 ha) and geographic regions were covered in the sampling frame.

The 13 irrigation systems visited were deemed sufficient for purposes of the ground truthing which was to establish the quality and independence of the data sets within a reasonable degree of confidence. This was done by determining, based on the sampled irrigation systems, if NIA had a compelling incentive to systematically bias reporting of performance indicators and whether there is a strong evidence to support this belief. For instance, a determination was made regarding the primary source of the data sets and whether the rewards of the NIA staff responsible for coding them was tied to a particular measure of performance. A determination was also made on whether there were any political pressures to report particular performance measures. Based on the overall results of the ground truthing, I have concluded with a reasonable degree of confidence that the data sets obtained from NIA are not systematically biased and that measurement errors are presumed to be random. The details of the sites visited, key informants interviewed, and findings from the ground truthing are available with the author.

4. FINDINGS AND DISCUSSION

(a) *Descriptive statistics*

Table 1 shows a substantial free riding in the payment of irrigation fees by farmers. On average, about 43% of all irrigation fees collectible from farmers in 2002 were not paid.

This figure has been consistent overtime. For the ten-year (1991–2000) national average, 42% of all irrigation fees were not paid and this varies from year to year between a minimum of 33% and a maximum of 65%. The lowest levels of irrigation fee collection occurred in 1998–1999 as a result of a campaign promise by then President Estrada to abolish the collection of the fee. The campaign promise was half-heartedly carried out by NIA as it would directly affect its budget and create confusion among farmers who have been used to paying irrigation fees since the 1970s. In early 2000, Estrada was ousted by a people power revolution. A new regime came to power and reinstated the collection of irrigation fees.

What is surprising in the case of the Philippines is the fact that it has had at least 25 years of internationally renowned model of decentralized management of irrigation starting in the mid-1970s. The expectation then was that a decentralized model involving farmers in decision making would be a more effective approach to irrigation management. This model was widely documented and heralded internationally as a role model and adapted by a number of countries. The World Bank in fact cited NIA as "the finest irrigation agency in Asia and any developing country in the world" (NIA, 1990, p. 57), and its irrigation program is internationally acknowledged as a "venerable tradition of reform" (Briscoe, 2001).

The average cropping intensity (wet and dry season) is 141 or about 70% of the total irrigable areas nationwide in both seasons but the standard deviation at 54 is rather large. An IA on average manages an irrigation hydrologic unit with an area of 284 ha and an average membership base of 181 farmers but again there is a large variation to this. The size of farm holdings—a proxy measure of wealth—is small at about 1.44 ha on average. The average age of the IA is 12 years as reckoned from the date of their incorporation with the Securities Commission. Only 8% of the IA membership is composed of women. Most irrigation systems (81%) are located at least an hour away by public transport from the nearest commercial center which is usually the provincial capital. Finally, only 15% of IAs nationwide have an effective control over their irrigation systems (i.e., they have full authority and autonomy over water and facilities, financial matters, and rule enforcement).

(b) *Regression results*

In the following section, I discuss the regression results on how various attributes of resource users, the different characteristics of the resource, and the governance structure of an irrigation system affect the likelihood of collective action among a large group of heterogeneous farmers. The results—summarized in Table 2—show that cropping intensity (proxy for water scarcity), group size, farm size (a proxy for wealth), and the governance structure of the system have a statistically significant effect (alpha 0.01) on the likelihood of free riding in an irrigation setting. Distance to market centers, a proxy for market pressure, is significant at alpha 0.10. However, the age and origin of the IA and gender distribution were not statistically significant. The results are robust to assumptions underlying the OLS model including endogeneity and specification errors.

(c) *Effects of the physical characteristics of the resource*

How do the physical characteristics of a common pool resource—water scarcity and proximity to markets—affect collective action? As expected, water scarcity—represented by the proxy measure cropping intensity—has a curvilinear effect with the level of free riding and the result is statistically significant. This result is highly consistent with the consensus in the empirical and theoretical literature, for example Agrawal (2002), Bardhan (1993), Dayton-Johnson and Bardhan (1999), Ternstrom (2003) and Uphoff *et al.* (1990). These scholars either claimed or found that, in general, cooperation is more difficult when water is either very scarce (due to potential conflict on water allocation) or is abundant (because of little incentive to cooperate since water is abundant).

I also find that the distance of the irrigation system to commercial centers—a proxy indicator of market pressure—is negatively associated with monetary free riding and the result is statistically significant. Consistent with the hypothesized expectation, irrigation systems that are at least one hour away from commercial centers have lower levels of monetary free riding. In the literature, there are two views on the effects of market pressures on collective action. One view is that market penetration can increase the returns to irrigated farming and thereby the farmer's incentives to cooperate in joint

Table 1. *Descriptive statistics*

Variable	Description	Mean	Std. Dev.	Min.	Max.
Dependent variable	$N = 1636$				
$FREERIDE	Extent of monetary free riding (%)	42.6	19.10	0	85
LABORFREERIDE	Extent of labor free riding (1 = high)	0.15	0.36	0	1
Independent variables					
CROPINT	Cropping intensity (wet + dry season, ha)	141	53.85	0	200
DISTMKT	Distance of irrigation to market centers (time)	0.810	0.39	0	1
AGE	Age of the irrigation association (years)	12.6	5.66	0	42
GRPSIZE	Number of farmers in irrigation system	181.4	110.33	5	618
ORIGIN	Origin of the irrigation association (1 = self-organized; 0 otherwise)	0.021	0.146	0	1
GENDER	Women members of IA (%)	8.6	8.199	0	38
FARMSIZE	Total irrigated lands per farmer (ha)	1.44	0.607	0.1	4.3
GOV	Governance of irrigation system (1 = farmer governed, 0 otherwise)	0.1489	0.356	0	1
IRRISIZE	Size of irrigation system managed by IA (ha)	284.3	206.3	13	1162

Note: Please refer to Section 3(c) for a more detailed description of the variables.

Table 2. *OLS regression results for monetary free riding*

Predictor	Coef.	SE Coef.	*T*	*P*
Constant	63.769	3.971	16.06	0.000***
CROPINT	−0.30194	0.05277	−5.72	0.000***
CROPINT2	0.0006702	0.0002051	3.27	0.001***
DISTMKT	−2.345	1.332	−1.76	0.079*
AGE	0.06250	0.07681	0.81	0.416
GRPSIZE	0.013950	0.004617	3.02	0.003***
ORIGIN	−4.150	3.884	−1.07	0.285
GENDER	−0.00447	0.05891	−0.08	0.940
FARMSIZE	3.5262	0.8380	4.21	0.000***
GOV	−6.738	1.365	−4.94	0.000***

$N = 1636$, $S = 16.4164$, $R^2 = 21.9\%$, $R^2(\text{adj}) = 21.3\%$.
*Significant at 0.10.
**Significant at 0.05.
***Significant at 0.01.

undertakings (Tubpun, 1986). However, Meinzen-Dick *et al.* (1997) suggested that the impact is more determined by market structure rather than by the degree of commercialization. Irrigation systems with low labor market activity are more likely to rely on direct participation and labor in-kind contributions from members. In contrast, irrigation systems closer to highly commercialized areas, and thus benefiting from higher labor market activity, are more likely to employ specialists for daily operations with members making cash contributions. These studies, however, deal largely with free riding in terms of labor contribution but not with monetary contribution.

Another view, one which is consistent with the findings in this paper, holds that increasing market pressure leads to increasing anonymity among actors which lessens mutual dependencies, loosens up traditional social ties, and reduces the inter-linkages for possible reprisals in the case of adverse behavior (Ostrom & Gardner, 1993). The result is a reduced prospect for cooperation (Bardhan, 1993).

(d) *Effects of the attributes of resource users*

Several attributes of resource users were also found to be associated with levels of monetary free riding. As Table 2 shows, group size and size of irrigated land holdings are both positively associated with monetary free riding and the effects are statistically significant. However, this is not the case for gender and the origin of the IA.

The findings on the effect of group size (in this case an average of 181 farmers per irrigation association) is consistent with expectations in group theory and conventional thinking which suggests that collective action is difficult as group size increases. As Olson (1965) argued, unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational self-interested individuals will not act to achieve their common or group interest. As group size increases, Olson argued, individuals will conclude that their marginal contribution will not affect the likelihood that the good will be provided and therefore do not make such contributions. This view is also shared by other irrigation scholars (Fujiie *et al.*, 2005; Meinzen-Dick *et al.*, 1997; Tang, 1992). This finding is also reinforced by consistent anecdotal evidence taken from focus group discussions among farmers in the field.

However, the effects of group size in the commons literature in general remain controversial. For instance, there remains no consensus on what is a small and large group and what is the role of context in mediating the effects of group size. Frohlich and Oppenheimer (1970) had argued that the effects of group size on cooperation are contingent on how other variables are affected by changes in the size of a group. Thus, future tests would have to be done on how the effect of group size is contingent on (1) wealth (Olson's privileged group hypothesis); (2) shape of the production function (Meinzen-Dick *et al.* (1997) hypothesis on economies of scale and critical mass); (3) the trust and divergence of interests hypothesis of Agrawal and Gibson (1999); and (4) hypotheses about inter-group interaction, elasticity of lobbying costs, and the public–private characteristics of the collective prize.

Regarding the effects of farm size—a proxy measure of wealth—my findings indicate that it has a positive, strong, and statistically significant effect on the levels of free riding. A unit increase in the size of land holdings (ha) leads to a 3.5% increase in levels of free riding, *ceteris paribus*. In the literature, there are at least three causal models in which wealth affects collective action outcomes—generically defined as the maintenance of the common pool resource. First, wealth provides the incentive to contribute toward investments for the maintenance of the resource despite the presence of free riders (as in Olson's privileged group hypotheses). Second, wealth can create exit options for large land owners which make adherence to norms and enforcement more difficult thus making collective action less likely. Third, heterogeneity in wealth creates difficulties regarding agreements on allocation rules, which in turn makes enforcement difficult and thus lessens the likelihood of collective action.

In the case of irrigation in the Philippines, there is plenty of anecdotal evidence regarding the exit option among large land owners who are mostly residents of urban centers and who are detached from the affairs of the IA. This makes adherence to norms and local enforcement more difficult and thus increasing the likelihood of free riding among this sub-group of farmers. Enforcement is particularly difficult in a footloose population (Bardhan & Dayton-Johnson, 2002). This finding is also consistent with those of Ternstrom who found that when the users of a common pool resource are rich, the richest will not cooperate. However, according to Baland and Platteau (1996, 1999), heterogeneity of asset structure is less likely to be a barrier to collective action than heterogeneity of social background and objectives.

(e) *Effects of governance structure*

In addition to the effects of the physical characteristics of the resource and the attributes of the resource users on collective action, I also examined the effects of the governance structure of the irrigation system. In particular, I examined whether an irrigation system that is under the effective control of the irrigation association is better able to solve the monetary free rider problem compared with an irrigation system controlled by government bureaucrats.

As Table 2 shows, the governance structure of the irrigation system indeed matters to collective action. Specifically, irrigation systems effectively controlled by farmers are associated with lower levels of free riding (about 6.7%) compared with government controlled systems, *ceteris paribus*, and the result is statistically significant. This finding is also substantively significant as it shows that a large group of heterogeneous farmers can also solve collective action problems—given full autonomy—in large scale irrigation systems (from 13 ha to 1162 ha with a mean of 284 ha). Most of the literature examined collective action in small-scale irrigation systems (for instance, Dayton-Johnson & Bardhan, 1999; Lam, 1998; Tang, 1992; Ostrom, 1992). Some scholars have questioned whether this is also the case for large scale irrigation systems and my findings suggest that this is also the case.

(f) *Interaction-effects analysis*

How is the effect of the characteristics of the resource and resource users mediated by institutional factors such as the structure of governance in the irrigation system? Few empirical studies have done this type of analysis. In this section, I perform interaction effects analysis to examine how the effects of physical variables are mediated by institutional factors.

I find that the effects of water scarcity and age of the IA on monetary free riding are conditional on the governance structure of the irrigation system and the results are statistically significant (Table 3). This result suggests that fully autonomous IAs are better able to deal with the effects of water scarcity on monetary free riding compared with non-autonomous IAs. This result is highly consistent with the literature, for example, Lam (1998), Tang (1992) and Ostrom and Shivakoti (2002). Furthermore, the effect of age of the IA on monetary free riding is also dependent on governance structure. Monetary free riding is less likely to be found among older IAs that are also fully autonomous and the result is consistent with expectations.

(g) *Free riding in terms of labor contribution*

Thus far, I have only examined the factors associated with monetary free riding. In this section, I examine whether these results would be different if voluntary labor contribution is the subject of collective action among farmers. A binary logit model was used to analyze the effects of various factors on labor free riding. The results are summarized in Table 4.

The focus of the analysis is the odds ratio, which is ratio of two events where the odds of an event equals the probability that the event occurs divided by the probability that it does not occur. The odds ratio can be any nonnegative number and the odds ratio equal to one serves as the baseline for comparison. If the ratio is equal to one, this indicates that there is no association between the response and predictor variables. If the ratio is more than one, then the odds of free riding are higher for the reference level of the factor. If the ratio is less than one, the odds of free riding are less for the reference level. In binary logit regression, the reference factor for interpreting the odds ratio is the variable coded as 1. If the predictor variable is a continuous variable, the reference level refers to the higher levels of a continuous predictor.

As Table 4 shows, eight variables have odds ratios different from one, namely cropping intensity, distance to markets, age of IA, gender, farm size, governance, distance to market interacting with governance, age of IA interacting with governance, farm size interacting with governance, and gender interacting with governance. Of these, only the age of the IA and distance to markets are statistically significant. Variables such as group size and farm size which were found to be significant predictors of monetary free riding, were not significant predictors of labor contribution.

The odds ratio of 1.66 for distance to market center suggests that we are more likely to find higher levels of free riding among IAs that are closer to commercial centers, *ceteris paribus*. This result is consistent with the hypothesis that in irrigation systems close to commercial centers, farmers acquire greater exit options through the labor market and this result

Table 3. *OLS regression for monetary free riding with interaction*

Predictor	Coef.	SE Coef.	T	P
Constant	64.7480	4.0760	15.89	0.000***
CROPINT	−0.2802	0.0530	−5.29	0.000***
CROPINT2	0.0005	0.0002	2.53	0.012**
DISTMKT	−2.5360	1.3680	−1.85	0.064*
AGE	0.0764	0.0771	0.99	0.322
GRPSIZE	0.0142	0.0049	2.88	0.004***
ORIGIN	−6.8590	8.2210	−0.83	0.404
GENDER	0.0083	0.0649	0.13	0.898
FARMSIZE	2.8648	0.8952	3.20	0.001***
GOV	−0.1910	9.5620	−0.02	0.984
CROPINT * GOV	−0.1395	0.0328	−4.25	0.000***
DISTMKT * GOV	1.6690	6.4760	0.26	0.797
AGE * GOV	−6.6820	3.7920	−1.76	0.078*
GRPSIZE * GOV	−0.0033	0.0139	−0.24	0.813
ORIG * GOV	2.9100	10.0200	0.29	0.771
GENDER * GOV	0.0816	0.1609	0.51	0.612
FARMSIZE * GOV	1.5830	2.6680	0.59	0.553

$N = 1636$, $S = 16.3181$, $R^2 = 23.3\%$ $R^2(\text{adj}) = 22.3\%$.
*Significant at 0.10.
**Significant at 0.05.
***significant at 0.01.

Table 4. *Logistic regression for free riding in labor contribution*

Predictor	Coef.	SE Coef.	*Z*	*P*	Odds ratio	95% CI lower	Upper
Constant	−2.40946	0.678598	−3.55	0.000***			
CROPINT	0.0084483	0.0086964	0.97	0.331	1.01	0.99	1.03
CROPINT2	−0.0000309	0.0000343	−0.90	0.367	1.00	1.00	1.00
DISTMKT	0.504729	0.265536	1.90	0.057*	1.66	0.98	2.79
AGE	−0.0373621	0.0149072	−2.51	0.012**	0.96	0.94	0.99
GRPSIZE	0.0008268	0.0008673	0.95	0.340	1.00	1.00	1.00
GENDER	−0.0154413	0.0114410	−1.35	0.177	0.98	0.96	1.01
FARMSIZE	0.133366	0.147762	0.90	0.367	1.14	0.86	1.53
GOV	0.461255	1.66929	0.28	0.782	1.59	0.06	41.81
CROPINT * GOV	0.0038314	0.0069986	0.55	0.584	1.00	0.99	1.02
DISTMKT * GOV	−1.81918	0.935656	−1.94	0.052 *	0.16	0.03	1.01
AGE * GOV	−0.852201	0.729341	−1.17	0.243	0.43	0.10	1.78
FARMSIZE * GOV	−0.338992	0.701382	−0.48	0.629	0.71	0.18	2.82
GRPSIZE * GOV	0.0034157	0.0027986	1.22	0.222	1.00	1.00	1.01
GENDER * GOV	0.0563878	0.0351604	1.60	0.109	1.06	0.99	1.13

Goodness-of-fit tests

Method	χ^2	DF	*P*
Pearson	1175.78	1175	0.488
Deviance	950.01	1175	1.000
Hosmer–Lemeshow	9.87	8	0.274

Measures of association

Pairs	Number	Percent	Summary measures
Concordant	121,439	66.9	Somers' D 0.35
Discordant	58,544	32.3	Goodman–Kruskal Gamma 0.35
Ties	1457	0.8	Kendall's Tau-a 0.09
Total	181,440	100.0	

$N = 1636$.
*Significant at 0.10.
**Significant at 0.05.
***Significant at 0.01.

is also consistent with the empirical evidence (Bardhan & Dayton-Johnson, 2002). Furthermore, the results also suggest that the effect of the distance of the irrigation system to commercial centers is mediated by the governance structure of the system. In particular, the odds of labor free riding are considerably less for fully autonomous IAs in irrigation systems that are at least one hour away from commercial centers. In addition, the age of the IA also matters to labor contribution. The odds ratio of 0.96 suggests that the odds of free riding in labor contribution are less for older IAs compared with younger IAs, *ceteris paribus,* a result consistent with expectations.

5. CONCLUSIONS AND IMPLICATIONS

The purpose of this paper is to identity some of the factors that influence collective action in the commons whereby consumption is rivalrous and exclusion is difficult. The main contribution of this paper in the literature is in the use of OLS and logit regression models and interaction effects analysis on a data set of 1958 irrigation associations in the Philippines. I also attempted to address some methodological issues in the literature such as problems of small-*N*, measurement, specification, and censoring bias. However, this article has also its own limitations arising largely because of the cost and difficulties of data collection. For example no data were available on soil characteristics, rainfall patterns, and dry season cropping, which would have otherwise permitted a more disaggregated analysis.

My findings suggest that—consistent with expectations and the empirical literature—collective action in the commons depends on the physical characteristics of the resource, the characteristics of the resource users, and the governance structure of the irrigation system. In particular, I find that monetary free riding is associated with cropping intensity—a proxy for water scarcity, distance of the irrigation system to market centers, the number of appropriators, and the size of the farm holdings. I also find that, consistent with the empirical literature, the governance structure of the irrigation system affects the levels of monetary free riding and that it also mediates the effects of other variables, for example, water scarcity and the age of the IA. I also find that water scarcity has a curvillinear effect on monetary free riding, which is also highly consistent with the empirical the literature.

I also find that the effects of these variables differ when labor contribution is required instead of monetary contribution. For instance, we are more likely to find higher levels of free riding in labor contribution among IAs which are closer to commercial centers, *ceteris paribus*, a result consistent with the empirical literature. I also find that the odds of labor free riding are considerably less for fully autonomous IAs in irrigation systems that are at least one hour away from market centers.

What the results of this study imply is the need for a more diagnostic approach in the analysis of institutional arrangements in diverse socio-ecological settings. This approach differs from conventional approaches to resource management that tend to favor panacea solutions which have often led to counter-intentional consequences (Dietz *et al.*, 2003). The study also suggest that while communities may have comparative advantage over government bureaucracies in the management of common pool resources in terms of motivation and information, as is commonly suggested in the decentralization literature, the problem of collective action in the commons is much more complex than is conventionally assumed.

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