Title: A Comparative Study of Social Behavior in Irrigated and Rainfed Areas: The Case of Bohol Irrigation Scheme, the Philippines

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Abstract

The purpose of this paper is to investigate the connection between management of canal (gravity) irrigation and farmers' social behavior. From this perspective, we examine the benefits of a rural canal irrigation project, based on our hypothesis that social behaviors of local farmers are influenced by the availability of canal irrigation due to the collective irrigation management required in irrigated societies. The present paper (1) measures social behavior through behavioral game experiments, and (2) estimates the effects of irrigation, neighborhood, as well as individual characteristics. Drawing on the results of dictator game and ultimatum game as the dependent variables, with a household survey on 245 villagers in the province of Bohol, the Philippines, we employ the HLM (Hierarchical Linear Modeling) method which was originally designed to explore neighborhood effects and social contexts. To date, the model has provided quantitative analyses of the latter. Yet, it has not been fully utilized for neighborhood effects studies. Our regression result shows that the level of measured social behavior is fairly associated with 1) access to irrigation water in the village, 2) other neighborhood characteristics (e.g., village-level averages of schooling years, asset, and yield) 3) household's socioeconomic and agricultural characteristics (e.g., household-level schooling years, asset, and yield). The result indicates that the availability of irrigation water in the village does not only improve agricultural productivity but also enhances social relationship among farmers, which would add to the importance of irrigation investment in rural areas.

Keywords – *irrigation, collective action, rural development, Hierarchical Linear Modeling, dictator game, ultimatum game, Bohol, social capital*

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1. Introduction

In general, irrigation projects are conducted for the purpose of enhancing agricultural productivity by improving farmers' access to water resources. Curiously, despite the rising number of studies on the impact assessment of irrigation projects, few studies have attempted to address the social effects of irrigation projects on farmers in the fields. Even so, for the past several decades, many researchers and activists in the area of rural development have realized the role of communities from the perspective of participatory and cooperative activities (Korten 1980). Ostrom (2000), for instance, stresses the importance of unselfish and collective actions in irrigation management, though in qualitative manners. In this context, what is especially interesting from our viewpoint is to empirically and quantitatively examine whether the social effects of an irrigation scheme affect farmers' behavioral patterns, by utilizing the data on irrigation availability and socio-economic characteristics.

2. Theoretical Framework

Before embarking upon our statistical analysis, we briefly explain the theoretical tools employed in this study; 1) behavioral game experiments and 2) hierarchical level model. Our aim is less to provide technical details than to explain the benefits of the game experiments to describe altruistic and retaliating behaviors, and the advantages of hierarchical level modeling when analyzing nested or multi-level data.

2.1 Behavioral Game Experiments

Behavioral game experiments are designed so as to quantify participants' social behavior under strategic situations (Gintis 2003). Among a range of games, this study employs dictator game and ultimatum game, which are developed to explore altruistic and retaliating behaviors, respectively.

2.2 Hierarchical Linear Modeling (HLM)

While ANOVA and OLS analyses are commonly practiced in formal quantitative assessments, care must be taken when the data are nested (Raudenbush and Byrk 1993). HLM[1] methodology is a proper tool to analyze nested and multi-level data. Our survey in Bohol was conducted on randomly selected 245 rice farmers who reside in 3 municipalities and 18 barangays.[2] Therefore, we employ HLM to account for the barangay-level characteristics that are expected to affect individual-level social behaviors.

3. Methodology

3.1 Behavioral Game Experiments

Our dependent variables are obtained from the behavioral game experiments, conducted by the International Rice Research Institute (IRRI). Nine games were played, among which two are used in this study: 1) dictator game and 2) ultimatum game, both of which are commonly practiced in experimental and behavioral economics studies.

3.1.1 Dictator Game

This game is intended to elicit participants' fairness, generosity, or altruism (Hoffman et al., 1996). Under anonymity conditions, a sender and a receiver from the same barangay form a pair, and only the sender is given 100 PHP at the beginning.[3] The sender is then asked to decide on the amount out of the 100 PHP to transfer to the receiver. Since the receiver's payoff is totally dependent on the sender's altruism in this setting, the transferred amount is recorded and interpreted as the altruistic behavior of the sender (Bardsely 2008).

3.1.2 Ultimatum Game

Again, a sender and a receiver form a pair under anonymity, and the sender is supposed to transfer some cash out of 100 PHP initially given to him or her. In ultimatum game, the receiver then decides to either accept or reject the transfer. If the receiver accepts it, the cash is transferred just as in dictator game. However, if the receiver rejects it, both the sender and

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[1] We only provide a brief concept of the HLM. For readers who wish to obtain further details, we recommend a reference to Hox (2010).

[2] Barangay is the smallest administrative division in the Philippines after purok. The local government hierarchy in the Philippines consists of 5 levels; purok, barangay, municipality, provinces, and autonomous Regions, in ascending order. Note that not all barangays have puroks.

[3] 100 PHP is equivalent to 2.46 (USD) by Bloomberg currency data, as of 31 January 2013. The Philippines' GDP per capita is $2,370 (2011) as per World Bank data. Given these exchange rate and GDP per capita, 100 PHP is considered sufficient to ensure incentive compatibility for the experiment purpose.

receiver end up with a zero payoff. The receiver is asked to indicate the threshold amount below which he or she rejects the transfer from the sender. The threshold amount is recorded as the result of ultimatum game, and is interpreted as an indicator of the receiver's retaliating behavior or unwillingness to tolerate the level of distribution (Herbert et al., 2003).

3.1.3 Game Results

Table 1 shows the averages of the game experiments results. Judging from the t-test[4], it is clear that there are significant differences in measured level of social behavior between the irrigated and rainfed areas. The irrigated farmers show a higher level of altruism, while the non-irrigated farmers exhibit a higher level of retaliation, suggesting that there is some force in irrigated communities that drives accumulation of "good" social behavior. A more formal testing of the marginal effect of access to irrigation will be tested by regression analyses in the following sections.

Table 1 Results for Behavioral Game Experiments

Type of Anonymous Partner	(1) Irrigated Sample (N=131)	(2) Rainfed Sample (N=114)	(3) t-test for mean difference |(1)-(2)|
Dictator Game			
Someone in Sender's Purok	33.97 (20.59)	27.81 (19.04)	6.16** [0.015]
Someone in Sender's Barangay	32.06 (21.58)	27.11 (18.28)	4.96* [0.053]
Ultimatum Game			
Someone in Sender's Purok	24.43 (15.15)	34.83 (19.61)	10.40*** [0.000]
Someone in Sender's Barangay	25.12 (16.47)	34.47 (21.29)	9.36*** [0.000]

The numbers show the averages, except that the standard deviations are in the parentheses, and the p-values are in the brackets. *** p<0.01, ** p<0.05, * p<0.10.

3.2 HLM

The next step is to find the determinants of social behavior, in particular, the extent of irrigation effects. Table 2 summarizes the explanatory variables to be included in the regression model; i.e., age of household head, years of schooling of household head, household's asset holding, household size[5], and parcel size. In the HLM framework, Level 1 corresponds to the household-level socioeconomic and agricultural characteristics, whereas Level 2 considers the barangay-level averages as neighborhood characteristics. Access to irrigation is represented by the barangay-level irrigation dummy, i.e., the value takes 1 if irrigated, and 0 if non-irrigated.[6]

Table 2 Descriptive Statistics of the Explanatory Variables for Two Levels in HLM

Level 1 (Household Level)					
Variable	N	Mean	SD	Min	Max
Age	238	51.38	12.06	14	87

[4] If the null hypothesis is rejected, the means of the two samples are statistically not different.
[5] Household size is defined as the number of family members.
[6] Irrigation dummy has no variance within the same barangay. Therefore, it is regarded as a barangay-level variable.

Schooling Years	238	6.33	3.02	0	14
Asset Holding (Log PhP)	238	10.61	1.09	6.21	13.31
Household Size	238	5.93	2.32	1	12.5
Parcel Size (ha)	238	1.45	1.02	0.12	8.12
Level 2 (Barangay Level)					
Variable	N	Mean	SD	Min	Max
Irrigation Dummy	18	0.61	0.5	0	1
Age	18	51.3	4.5	43.56	61
Schooling Years	18	6.37	0.93	4.46	8
Asset Holding (Log PhP)	18	10.57	0.52	9.44	11.53
Household Size	18	5.99	1.1	4.65	8.76
Parcel Size (ha)	18	1.31	0.46	0.58	2.19

We adopt the bottom-up approach[7] in performing HLM, starting from the intercept-only model (unconditional model) specified as

$$Y_{ij} = \gamma_{00} + u_{oj} + e_{ij} \tag{1}$$

where Y_{ij} is the social behavior measurements for the head of household i in barangay j, γ_{00} is the intercept term, u_{oj} is the barangay-level residual, and e_{ij} is the household-level residual. The intercept-only model is used as a specification test to decide whether or not to adopt HLM. The Intraclass Correlation (ICC) is defined as:

$$\mathrm{ICC} = \frac{\sigma_{u0}^2}{(\sigma_{u0}^2 + \sigma_e^2)} \tag{2}$$

where σ_{u0}^2 is the variance of u_{oj}, and σ_e^2 is the variance of e_{ij}. Typically, when ICC is less than 0.05, OLS is preferred to HLM.

Table 3 shows the result of the specification test by the intercept-only model. The ICC indicates that 8.5% of the variance in dictator game result and 12% of the variance in ultimatum game result are explained by the between-barangay variance in the respective game results.[8] The p-values and ICC both suggest the use of HLM for our analyses.

[7] There are two strategies for building HLM. The top-down approach is to start by including the maximum number of variables and then remove some of them. For empirical analyses, however, the bottom-up approach, which starts with the simplest formula and then adds variables, is often adopted. (Hox, 2010)
[8] ICC typically ranges from 0.05 to 0.25 in social science studies.

Table 3 Estimates for Intercept-only Model

Random Coefficient	St. Dev.	Variance Component	*d.f.*	χ^2	*p*-value	ICC
Dictator Game						
Intercept 1, u_0	5.830	33.989	17	38.817	0.002	0.085
Level-1, r	19.079	364.008				
Ultimatum Game						
INTRCPT1, u_0	6.668	44.463	17	49.456	<0.001	0.120
Level-1, r	17.725	314.163				

Proceeding to the HLM estimations, the Level-1 and Level-2 equations are specified as below:
[Level-1 Equation]

$$Y_{ij} = \beta_{0j} + \beta_{1j}\,(Age_{ij}) + \beta_{2j}\,(Schooling\ Years_{ij}) + \beta_{3j}\,(Asset_{ij}) + \beta_{4j}\,(Household\ Size_{ij}) + \beta_{5j}\,(\text{Parcel Size}_{ij}) + r_{ij}$$

[Level-2 Equation]

$$\beta_{0j} = \gamma_{00} + u_{0j},\ \beta_{1j} = \gamma_{10} + u_{1j},\ \beta_{2j} = \gamma_{20} + u_{2j},\ \beta_{3j} = \gamma_{30} + u_{3j},\ \beta_{4j} = \gamma_{40} + u_{4j},\ \beta_{5j} = \gamma_{50} + u_{5j}$$

At Level-1, the explanatory variables are centered around the barangay means, which is useful in analyzing the within-barangay effects of the variables. Level-2 specifies the effects of barangay-level characteristics to account for the between-barangay effects.
In Table 4 presents the estimates for Level-1 equation, in which β_0 (intercept) includes the contribution from the barangay effects. Age has a significant and negative effect on altruism, suggesting that older farmers tend to be less generous.

Table 4 Estimates for Level-1 Equations

Game Type	β_0 (Intercept 1)	Age	Schooling Years	Asset	Household Size	Parcel Size
Dictator	28.789***	-0.268***	0.109	-0.658	0.143	0.375
Ultimatum	28.117***	-0.067	-0.578*	-1.984*	-0.427	0.797

*** p < 0.01, * p < 0.10

Using the barangay-average variables, Level-2 equation is further specified as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(Irrigation\ Dummy_j) + \gamma_{02}\,(Age_j) + \gamma_{03}\,(Schooling\ Year_j) + \gamma_{04}\,(Asset_j) + \gamma_{05}\,(Household\ Size_j) + \gamma_{06}\,(\text{Parcel Size}_j) + u_{0j},\ \beta_{1j} = \gamma_{10} + u_{1j},\ \beta_{2j} = \gamma_{20} + u_{2j},\ \beta_{3j} = \gamma_{30} + u_{3j},\ \beta_{4j} = \gamma_{40} + u_{4j},\ \beta_{5j} = \gamma_{50} + u_{5j}$$

Finally, the nested equation is given by:

$$Y_{ij} = \gamma_{00} + \gamma_{01}\,(Irrigation\ Dummy_j) + \gamma_{02}\,(Age_j) + \gamma_{03}\,(Schooling\ Year_j) + \gamma_{04}\,(Asset_j) + \gamma_{05}\,(Household\ Size_j) + \gamma_{06}\,(\text{Parcel Size}_j) + \gamma_{10}\,(\text{Age}_{ij}) + \gamma_{20}\,(Schooling\ Year_{ij}) + \gamma_{30}\,(Asset_{ij}) + \gamma_{40}\,(\text{Household Size}_{ij}) + \gamma_{50}\,(\text{Parcel Size}_{ij}) + u_{0j} + u_{1j}\,(\text{Age}_{ij}) + u_{2j}\,(Schooling\ year_{ij}) + u_{3j}\,(\text{Asset}_{ij}) + u_{4j}\,(\text{Household Size}_{ij}) + u_{5j}\,(\text{Parcel Size}_{ij}) + r_{ij}$$

Table 5 presents the effects of barangay-level characteristics. The irrigation dummy poses significant effects on the results of both types of games. The effect is found to be positive on dictator game result, indicating that the availability of irrigation induces the accumulation of altruistic behavior among farmers. In contrast, the irrigation effect on ultimatum game result is found to be negative, indicating that the availability of irrigation leads farmers to tolerating inequitable distributions of limited resources. The barangay-level asset holding shows effects that are similar to those of irrigation dummy, which suggests that living in wealthier neighborhoods contribute to enhancement in tolerance among farmers.

Table 5 Estimates for Level-2 Equations

Game Type	γ_{00} (Intercept 2)	Irrigation Dummy	Age	Schooling Years	Asset	Household Size	Parcel Size
Dictator	23.387***	9.053*	0.166	-0.259	4.348*	-0.724	6.087
Ultimatum	39.092***	-14.012***	-0.697**	-1.124	-8.585***	0.885	-4.964

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

4. Concluding Remarks

To quantitatively examine the impact of the availability of canal irrigation on farmers' social behavior, this paper has introduced a unique combination of methods: behavioral game experiments and HLM analysis. Although further empirical evidence is awaited to support our findings, the result is highly suggestive of the significant social effects of canal irrigation schemes. The positive effect on altruism and the negative effect on retaliation indicate that the type of social interactions promoted by the necessity for collective irrigation management leads to inducing the accumulation of "good" social behavior among farmers.

One clue to validating the irrigation effect is to consider the existence of TSAs (turnout service associations) in the irrigated communities. After the canal irrigation scheme was introduced in 2008, TSAs were formed in each barangay to perform several roles such as canal maintenance, private canal construction, purchasing machinery, and providing micro credit for the TSA members. Thus, as compared with the rainfed, irrigated farmers are exposed to more opportunities to meet and discuss public arrangements with their neighbors, which is likely to enhance the social relationship in irrigated neighborhood. Hence, canal irrigation seems to serve a dual role: to boost the rural economy through increased production, and to accumulate social capital among farmers.

The limitation of our study needs to be duly noted. Our behavioral game experiments were conducted in 2011 which was after the construction of irrigation. This survey structure prevents us from formulating a difference-in-difference estimator that ensures a more proper impact assessment.

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