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A Comparative Study of Social Behavior in Irrigated and Rain-fed Areas: The Case of Bohol Irrigation Scheme, the Philippines

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IRRI

Introduction

- To investigate the connection between management of canal (gravity) irrigation and farmers' social behavior

(1) Measures social behavior through behavioral game experiments

(2) Estimates the effects of irrigation, neighborhood, as well as individual characteristics.

- Combination of 1) behavioral game experiments and 2) hierarchical linear modeling

- **The availability of irrigation water in the village does not only improve agricultural productivity but also enhances social relationship among farmers**

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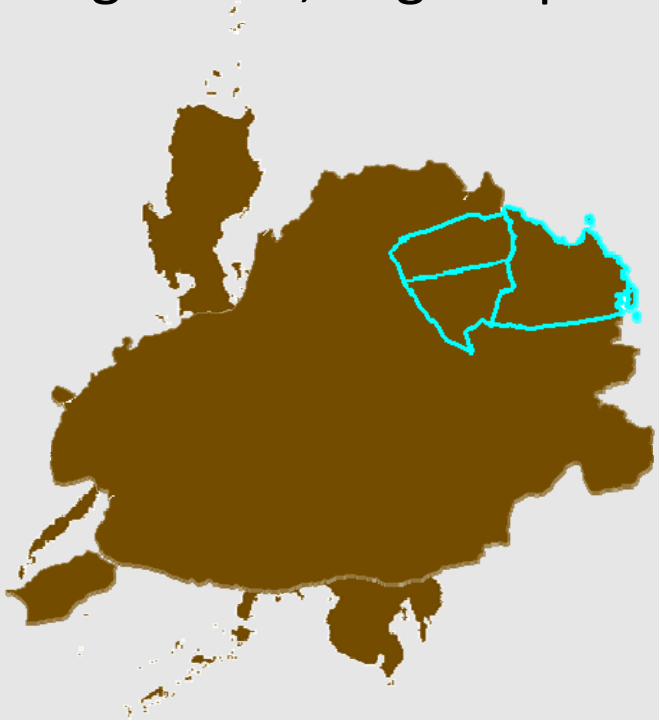
Overview of Bohol Irrigation Project

- The Bohol Irrigation System, located in the northeastern part of Bohol Island about 50 km from the provincial capital city of Tagbilaran, began operation in May 2008



- JICA did feasibility study in 1985
- San Miguel, Ubay, and Trinidad
- Gravity irrigation system by Bayongan dam
- Service Area 3,295ha
- 17.5km of Main Canal

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Structure of Dataset

- IRRI conducted
- Agricultural and Socioeconomic Data (X)
  4 crop seasons from 2009 to 2010
  - 4-season Average

- Behavioral Game Results (Y)
  Sep. 2011
  290 randomly selected farmers
  Irrigated (N = 144) & Rain-fed (N = 146)

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Theoretical Framework

- Behavioral game experiments are designed so as to quantify participants' social behavior under strategic situations (Gintis 2003).

- Employing dictator game and ultimatum game, which are developed to explore altruistic and retaliating behaviors, respectively

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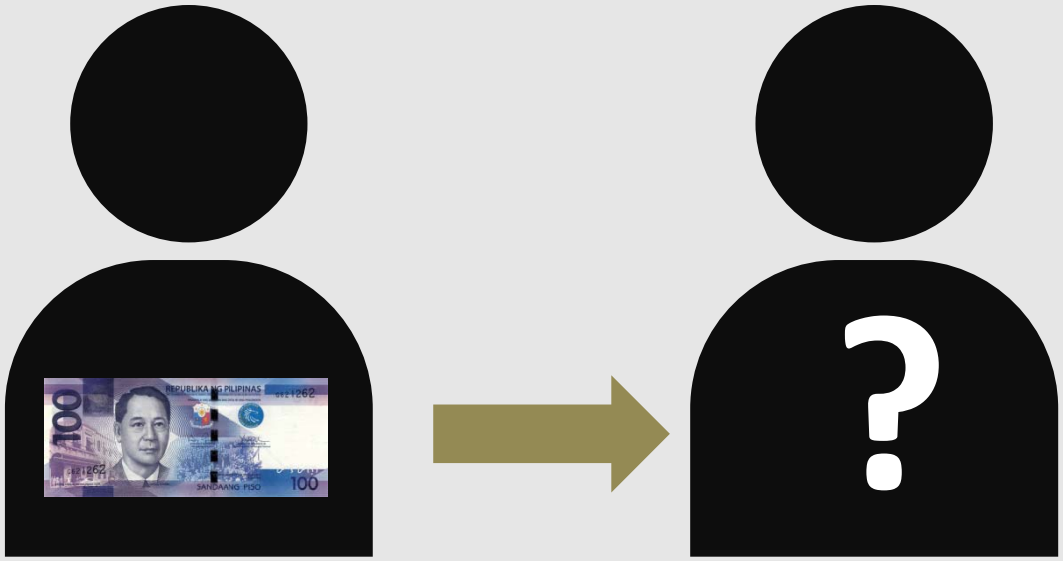
Behavioral Game Experiments

- Dictator Game
- This game is intended to elicit participants' fairness, generosity, or altruism (Hoffman et al., 1996).



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

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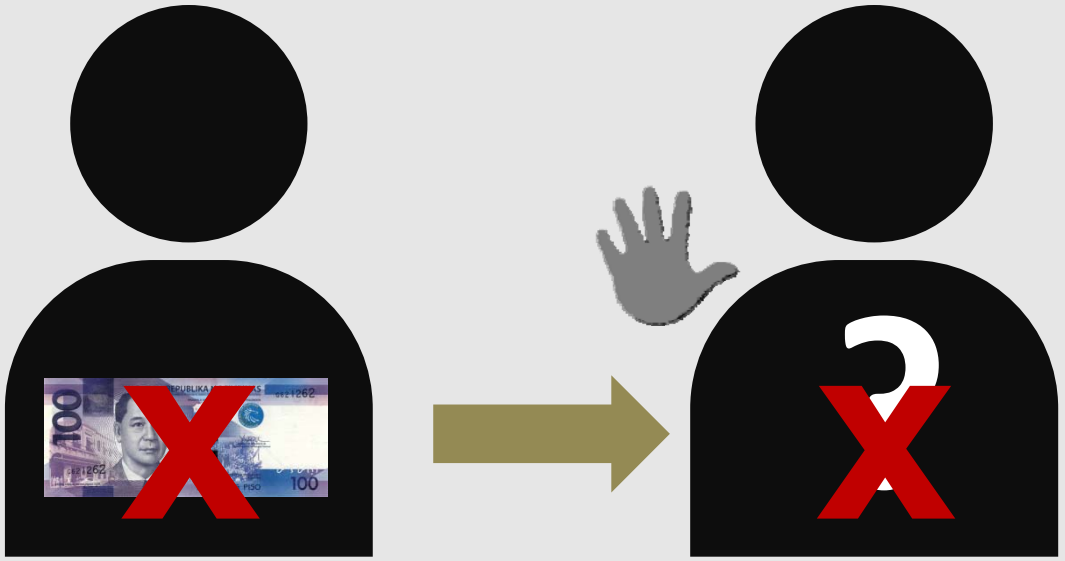
Behavioral Game Experiments

❑ Ultimatum Game

- This game is interpreted as an indicator of the receiver's retaliating behavior or unwillingness to tolerate the level of distribution (Herbert et al., 2003).



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Results for Behavioral Game Experiments

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

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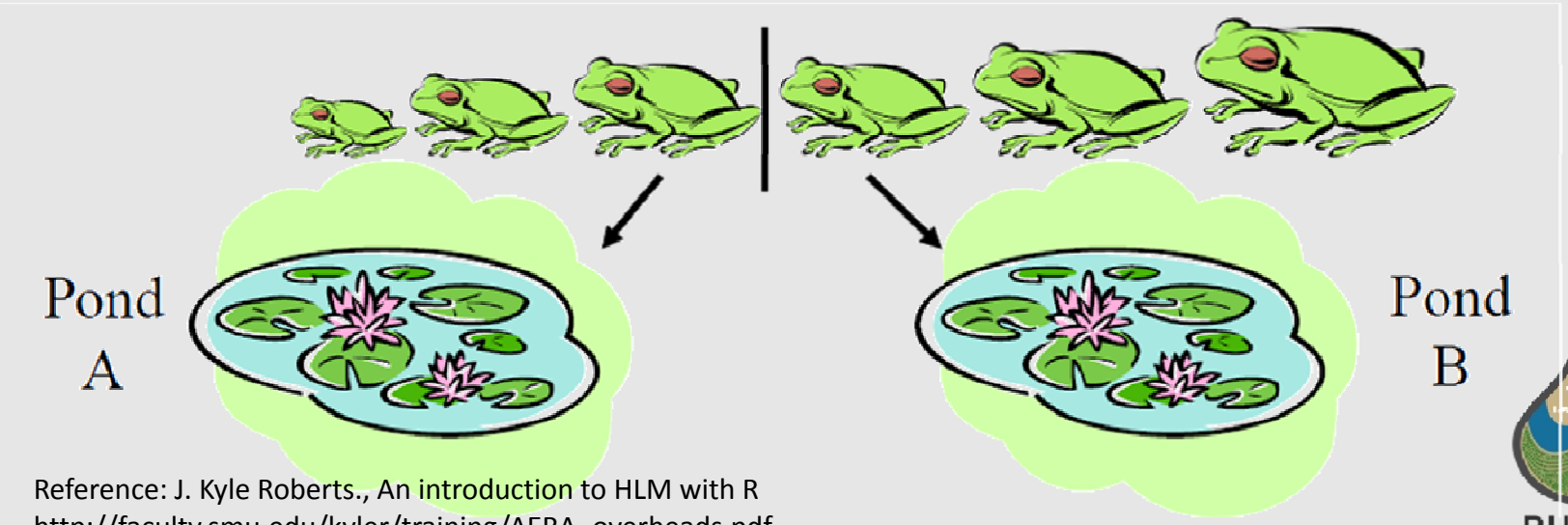
HLM (Hierarchical Linear Modeling)

- While ANOVA and OLS analyses are commonly used in quantitative assessments, care must be taken when the data are nested (Raudenbush and Byrk 1993).
- "**Frog-Pond" Theory**; Robinson(1950) the problem of contextual effects



Reference: J. Kyle Roberts., An introduction to HLM with R
http://faculty.smu.edu/kyler/training/AERA_overheads.pdf

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HLM (Hierarchical Linear Modeling)

- Our data set covers randomly selected 238 rice farmers who reside in 3 municipalities and 18 barangays
- **Altruistic and retaliating behaviors arise from social atmosphere; we try to differentiate individual effects from barangay effects**
- Employing HLM to account for the barangay-level characteristics that are expected to affect individual level social behaviors

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Descriptive Statistics

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

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Estimates for Intercept-only Model

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

$$\text{ICC(Intra Class Correlation)} = \frac{\sigma_{u0}^2}{(\sigma_{u0}^2 + \sigma_e^2)}$$

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				

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Estimates for level-1 Equations

[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]

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

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**

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Estimates for level-2 Equations

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

Game Type	γ_{00} (Intercept 2)	Irrigation Dummy	Age	Schooling Years	Asset	House hold 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**

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Concluding Remarks

- 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

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Concluding Remarks

- TSA
  - private canal construction
  - purchasing machinery
  - providing micro credit

Compared with the rain-fed, irrigated farmers are exposed to more opportunities to meet and discuss public arrangements with their neighbors

- **Dual role:**
  to **boost the rural economy** through increased production, and to accumulate **social capital** among farmers.

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Anecdotal Information

(Inday Salaum)

- Cultivated cassava before irrigation project
- Cultivating Hybrid Rice twice a year
- Three children
  - Crop science
  - Veterinary
  - Agronomy

- Promoting children back to village for agriculture
- Several neighbors' children already back to village for their career

- **Irrigation and modern agricultural technology can prevent brain drain from rural areas.**

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Limitation

- 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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