Does Infrastructure Facilitate Social Capital Accumulation?
Evidence from Natural and Artefactual Field Experiments in a Developing Country*

by

Keitaro Aoyagi

Faculty of Economics
University of Tokyo, Japan

Yasuyuki Sawada**

Faculty of Economics
University of Tokyo, Japan
and
JICA Research Institute, Japan

Masahiro Shoji

Faculty of Economics
Seijo University, Japan

January 2012

Abstract

While social capital is recognized essential for economic activities, its accumulation mechanisms are largely unexplored. We investigate the impact of infrastructure on social capital accumulation. We use unique dataset from an irrigation project in Sri Lanka under a natural experimental situation where a significant portion of irrigated land was allocated through a lottery mechanism. Also, we capture the level of social capital using artefactual field experiments. By combining these two datasets, we find that physical distance embedded by construction of irrigation system explain the trust across irrigation communities. Yet, within-community variation in social capital is driven largely by the years of access to the irrigation and not necessarily affected by social distance between farmers, suggesting that social preference emerges from technological environment by physical access to irrigation.

Keywords: Natural and artefactual field experiments; trust; social capital; irrigation

JEL Classification Number:

* We acknowledge financial supports from Japan International Cooperation Agency (JICA). We thank Michael Carter, Xavier Gine, Michiro Kandori, Taejong Kim, Hisaki Kono, Akihiko Matsui, Craig McIntosh, Alistair Munro, Keijiro Otsuka, Paul T. Schultz, Tomomi Tanaka, Keiichi Tsunekawa, Noriyuki Yanagawa, Chikako Yamauchi, participants of the Korea Development Institute (KDI) conference on 'Economic Development and Impact Evaluation' held in Seoul, Korea on November 15-16, 2010, The sixteenth World Congress of the International Economic Association took place in Beijing on July 4-8, 2011, and 2012 Asia-Pacific ESA Conference at Xiamen University for their constructive comments and Deeptha Wijerathna and enumerators for their valuable cooperation in our data collection and artefactual field experiments.

** Corresponding author: Faculty of Economics, the University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033. E-mail: sawada@e.u-tokyo.ac.jp

1. Introduction

Social capital has become increasingly recognized as an essential element for the economic performance of people, communities, and countries (Dasgupta and Serageldin, 2000). In general, social capital is defined as particular features of the formal and informal institutions and organizations that create shared knowledge, mutual trust, social norms, and unwritten rules. (Durlauf and Fafchamps, 2005; Hayami, 2009). The effects of social capital on socio-economic outcomes have been investigated in a variety of existing studies. Examples of such studies include those on community resource management (Ostrom, 1990; Bouma et al., 2008) and performance of micro-finance participants (Karlan 2005). Also, a number of micro and macro studies find positive returns to social capital in economic outcomes (Knack and Keefer, 1997; Durlauf and Fafchamps, 2005; Fafchamps and Minten, 2002; Ishise and Sawada, 2009).

However, unlike the above-mentioned studies which investigate the consequences of social capital, determinants of creating, accumulating, and maintaining social capital are largely unexplored in the existing literature (Miguel, Gertler, and Levine, 2006). There are only a few exceptions such as Feigenberg et al. (2009) which employs a randomized experiment to uncover the nexus between meeting frequencies of micro-finance programs and the degree of social capital accumulation Attanasio et al (2009) which examines the role of a conditional cash transfer program in Mexico, a.k.a., Progresa, in facilitating cooperation among community members. While there have been descriptive studies hypothesizing the role of communal physical infrastructure such as irrigation systems in facilitating social capital accumulation (Aoki, 2001a, 2001b; Hayami and Godo, 2005; Hayami, 2009), to our best knowledge, there is no rigorous empirical study conducted to uncover the causal impact of infrastructure on social capital.

In this study, we aim to bridge this gap in the literature by investigating the impact of irrigation infrastructure on social capital accumulation. Our hypothesis is that communal physical infrastructure such as an irrigation system enhances the level of social capital because people are physically built-in the irrigation infrastructure system and thus people are forced to interact each other institutionally. The maintenance and productive use of the irrigation system require regular cleaning of the canals, necessitating collective coordination and cooperative work among community members (Aoki, 2001; Hayami and Godo, 2005). By testing this hypothesis, we believe that we make an important contribution to the literature because impacts of infrastructure on social relationships, mutual trust, and social norms are largely unknown (Durlauf and Fafchamps 2005).[1]

Yet, there are two technical difficulties exist in capturing the effect of irrigation on social capital. First, it is generally difficult to identify the causal effect of infrastructure on outcomes because construction of infrastructure is not exogenously given usually. It is unrealistic to design randomized irrigation program placements to identify the causal effects. In the literature, Duflo and Pande (2007) undertake a cleaver identification strategy to use river gradient as an instrument for dam placements across the whole Indian states. Yet, such a strategy may not be applicable to identify the causal impact of irrigation access originated in a particular dam on the degree of social capital in small geographical units. Second, it is difficult to quantify the level of social capital precisely by nature because the concept of social capital, which is a combination of intangible objects such as social relationships, mutual trust, and social norms, has remained elusive. A popular approach is to use questionnaire-base instruments using General Social Survey (GSS) questionnaires. Yet, existing studies pose serious doubt on the strength of such self-reported information (Glaeser et al., 2000).

In this paper, we try to solve these two issues explicitly. To tackle the first problem, we employ unique data set from an irrigation project in Southern Sri Lanka where irrigated land

[1] There are existing studies which investigate the impact of infrastructure on poverty reduction (Duflo and Pande, 2007). In fact, we have companion papers which examine the poverty impacts of irrigation in our study area in Sri Lanka (Sawada et al, 2008).

distribution has been made through a lottery mechanism. By using this natural experimental situation, we believe that we can reasonably identify the causal impact of irrigation construction.

As to the second problem, we use carefully-designed economic experiments and quantify unobservable parameter from behavior of the participants. To this aim, we use instruments of artefactual field experiments (Harrison and List, 2004; Levitt and List, 2009), i.e., trust game developed by Berg et al. (1995), which have been adopted by Glaeser et al. (2000), Cardenas and Carpenter (2008), Karlan (2005), Carter and Casitillo (2009), Ligon and Schecter (2008), Schecter (2007), and Barr (2003), and dictator and risk games to distinguish the role of altruism and risk preference in determining the amount of transfers in trust games, respectively.

In our study area, there are three potential factors affecting trust among people, i.e., physical distance based on irrigation community (Etang et al. 2009); pair-wise mutual trust generated by intimate social relationships (Leider et al. 2009); and general trust based on social preference determined by irrigation or community related activities (Hayami and Godo, 2005). By combining natural experimental data on irrigation placements with artefactual field experiments data, we examine the causal impact of irrigation infrastructure on social capital.

To preview our empirical results, three robust findings emerge. First, in the whole area, physical distance can explain the degree of trust. Second, in each distribution canal, within-community variation of trust is not driven by the bilateral relationships but by the years of access to the irrigation canal, suggesting that social preference emerges from physical constraints on people’s activities created by irrigation infrastructure. Finally, the amount sent in the dictator game also related systematically to the level of trust.

The rest of this paper is organized as follows. In Section 2, we postulate our research strategy including hypothesis to be tested by natural and filed experimental data. Section 3 shows descriptive statistics and empirical results. The final section summarizes concluding remarks.

2. **Research Strategy**

Theoretical Framework

Generally in irrigated farming, substantial collective coordination and cooperative production activities are required among villagers because there are substantial needs for resolution of water conflicts, collective canal cleaning, coordinated use and drainage of water as well as ad hoc joint flood control during heavy rain (Aoki, 2001a, 44; Hayami and Godo, 2005, 322-323; Hayami, 2009). It is practically important to identify the way villagers enforce themselves in the collective control of maintenance and use of irrigation system.

Aoki (2001a, 44-46, 2001b, 108) argues that in spite of the technological nonexcludability of irrigation water within an irrigation system, the potential incentive of free-riding among villagers in the collective work can be effectively mitigated by the credible threat of ostracizing the opportunistic villagers from participating in other spheres of the social, political, and economic life of the village. Aoki (2001a, 47-50, 2001b, 109-113) models this situation by a community norm as an equilibrium of a linked game in which the irrigation game and a community social exchange game are linked over infinite periods. By nature, an irrigation infrastructure locates people physically in space, creating long-term relationship exogenously.[2] Then, a.k.a., the folk theorem, self-interested agents manage to cooperate in such a long-term relationship in a self-enforcing manner in a repeated interaction because any mutually beneficial outcome can be sustained in an equilibrium provided that the discount factor is sufficiently large (Kandori, 2008). Hence, social capital can be defined as the social

[2] Such a situation may be captured by the concept of “social embeddedness” of Granovetter (1985), i.e., the degree to which individuals are enmeshed in an actual social network.

structure in these repeated games in which cooperative transactions are facilitated as equilibrium (Routledge and von Amsberg, 2003).

Also, it may be important to consider the nature of social networks through which people are connected. Following Möbius (2001), consider a Prisoner's Dilemma game played on a graph of size *N* where every agent has exactly *n* connections under two different network types: first, the circle network where everyone is connected to the n/2 nearest neighbors to the right and left; and the random network where agents are simply connected to *n* randomly drawn neighbors. While cooperation is easier to sustain on the circle because defection will be punished by a large number of neighbors, in the random network a neighbor will not necessarily punish my defection because it would cause the defection of all his/her neighbors who have not observed my defection yet. Therefore, cooperation will not be sustainable in the random network unless all agents can observe each others' action history. To compare these two cases from data, we conduct the trust game of Berg et al. (1995) without and with the anonymity setting, which correspond to the circle network and the random network, respectively.

Study Site

Our study area is Walawe Left Bank (hereafter, WLB) in southern Sri Lanka which is the part of Irrigation Development Project in the Uda Walawe area initiated by the Government of Sri Lanka (GOSL) in 1960's. Figure 1 shows a map of our study area. Under the project, the government had an ambition of maximizing the use of lands for cultivation as well as for the generation of hydropower. Construction of the Uda Walawe reservoir was implemented with the GOSL funds from 1963 until 1968, and the development of command area of the right bank was completed with the financial assistance of Asian Development Bank (ADB) under Walawe Development Project (1969-1977) and Walawe Irrigation Improvement Project (1986-1994). While the development of command area of WLB was also started by the GOSL in 1960s, the improvement of canal structure and extension of irrigation facilities to the tail end took significantly longer time than that in the right bank area. Finally, since the mid 1990s, the construction of the canals in the WLB gradually extended from the north toward the south by the assistance of Japan Bank for International Cooperation (JBIC).

Our study area is composed of five blocks in a north-south direction, irrigated Sevanagala block, rainfed Sevanagala block, Kirribbanwewa block, Sooriyawewa block, and Extension Area (Figure 1). While the Extension Area located at the south tail end of WLB was the most recently irrigated area, each block except Sevanagala (irrigated) is now connected to left bank main canal and has own irrigation scheme operation. In the irrigated areas, each water distribution canal (D-canal), the smallest unit of branch canal, has a Farmer Organization which facilitates irrigation management and organizes various activities such as collective procurement of farm inputs and religious festival preparations. Hence, each D-canal can be regarded as the smallest unit of community. A group of D-canal communities comprises a "unit" within each block. Presumably, while farmers in the same unit naturally form close relationships because of their physical proximities, farmers in different units have little relationship by physical nature.

We conducted multi-purpose panel household surveys eight times in the WLB area between 2001 and 2009 and artefactual field experiments in the final round. Initially, we select 858 representative households from approximately 75,000 residents in the whole WLB area by a multistage stratified random sampling strategy using a complete list of all households in each stratum (Sawada, et. al, 2008). We set five strata depending on irrigation accessibility (Figure.2). The first to the fifth rounds data were collected in 2001 and 2002. In 2007, we further conducted the sixth and the seventh surveys for 193 households who were randomly selected from the original 858 households. Finally, in March 2009, we implemented the eighth survey and artefactual field experiments such as trust and dictator games to collect data on the social and household preferences directly. The experiment participants are 268 farmers including the above mentioned 193 households.[3]

Natural Experiments

While the entire area of WLB is agro-climatically and geographically similar, as of 2001, only around 67% of households had access to irrigation (JBIC Institute 2007). Yet, by the end of 2008, almost all households acquired irrigation access. Table 1 summarizes the average duration since farmers acquired access to irrigation for each block. It confirms that the construction of irrigation was implemented in the north first and gradually extended to the south, while there are some exceptions such as block 2 where it is technically difficult to construct irrigation because of its topography.[4] The government provided farmers with 0.2 ha of land for residence, and 1.0 ha of irrigated paddy field or 0.8 ha of other food crop field. However, according to settlers' subjective assessments on land allocation shown in Table 2, around a half of household could claim their preferences on lands at the plot level. While most of them acquired the claimed lands, different distribution rules applied for the remaining households as summarized in the middle of the table. Intriguingly, the government used lotteries to distribute land for the settlement of 30% of farmers. Based on the result of the lottery, households received plots with irrigation access for certain crops regardless of their wills. As a consequence, 34% of households could not obtain their preferred lands as reported in the bottom of the table. Therefore, some community and household characteristics – such as the size of farmers' organizations, neighborhood characteristics, irrigation access, distance to their plots, and the like – are exogenously given in this setting. By using this natural experimental situation, we identify the causal impact of irrigation construction.

[3] Since our experiments involve four members from the same D-canal community, additional farmers are included. Some of them came from original 858 sample households but most of them were newly recruited.

[4] As we can see from Figure 1, the north portion of Kiribbanwewa block is located closer to the reservoir than the southern part of irrigated Seenagala block.

Since the relocation programs were implemented at the level of each block, the level of these household characteristics are expected to be comparable across D-canals within each block and across different locations within each D-canal. To test the exogeneity of land allocation to the settlers, we regress settlers' observed characteristics, some of which will be used later as condition variables in the irrigation evaluation models, on canal location dummy variables such as block and D-canal dummies as well as canal location dummies within each D-canal. The canal location variables are composed of three indicator variables for head, middle, and tail location. As to the dependent variables, we employ time-invariant demographic characteristics of household such as the age of head, head's years of schooling, headcount of males aged 16 or over, and headcount of females aged 16 or over. In this exogeneity tests, we employ the data on the demographic characteristics in the initial survey conducted in 2001. The samples used in this exogeneity test includes 158 out of 268 households who participated in experiments.

Table 3 reports the results of the exogeneity tests. First, we fail to reject null hypotheses that the estimated coefficients on D-canal dummies are jointly zero for the first four dependent variables, i.e., age, education level, number of male members over 15, and number of female members over 15: the p-values of these tests for each specification are 0.1804, 0.8793, 0.2133 and 0.7162, respectively. These results indicate that, while household characteristics are significantly different across blocks, they do not vary within the block across the canal communities. Second, we test the significance of coefficients on the canal location dummies within each D-canal, i.e., two indicator variables for head and tail locations with middle location is taken as the reference. We cannot reject null hypotheses that the estimated coefficients on the location variables are jointly zero for the first four variables: corresponding p-values are 0.8158, 0.8793, 0.6254 and 0.7832, respectively. Third, we find that there are sufficient variations in years of access to irrigation canal because we cannot reject the null hypothesis that years of access to irrigation are the same across distribution canal. These findings provide supportive evidence that households were exogenously allocated to canal communities and within each D-canal in different timings regardless of their observed characteristics. We may conclude that, once we control for block fixed effects, sample selection errors due to selection on the observables are not serious with our data and the conditional independence assumption of the irrigation treatment holds.

Artefactual Field Experiments

In March 2009, we conducted carefully designed artefactual field experiments to capture the degree of social capital. More specifically, we implemented trust and dictator games to quantify the degree of trust and altruism, respectively, using the strategy method. We also conducted risk game to elicit participants' risk preference. In the experiments, participants should make decisions on their behavior toward persons inside and outside the community of each participant. Since the group of farmers in each D-canal is identified as the formal community, we select counterparts of each participant as follows: three persons in the same D-canal identified by showing their names and pictures which we call "identified persons", "unidentified" somebody in the same D-canal, somebody in a different D-canal of the same unit, and somebody in a different unit[5]. In the cases of identified persons, we also asked social relationship with the counterparts of the games, enabling us to capture social distance.

The detailed protocol of our experiments is explained as follows. First, following

---

[5] One person from each household surveyed in the 6th and 7th rounds is invited to participate in the experiments (Case A). Basically, participants are those who are in charge of the important decision making in their households. In cases where the number of participants from one distribution canal is not a multiple of four, new participants must be recruited randomly from the households which were included in 1st to 5th rounds but not surveyed in 6th and 7th rounds (Case B). If it is not possible to invite enough participants, households which has been never included in previous surveys may be invited (Case C). In cases where recruited participants do not show up on the day of experiments, we recruit other participants from the same distribution canal. Out of the total number of 268 participants, Case A, Case B, and Case C include 166, 22, and 80 participants.

Berg et al. (1995), we conduct the standard trust game to measure trust and reciprocity. In our trust game, all participants are endowed with Rs.500 in ten Rs.50 bills initially, which is equivalent to one day wage for a typical farmer in the study area. We employ strategy methods, asking each participant, *i*, as a sender how much they would send to each potential receiver, *j*, i.e., three identified persons in the same D-canal, somebody in the same D-canal, somebody in a different D-canal of the same unit, and somebody in a different unit. We denote this amount of transfer as $\tau_{ij} \in T$ where T= {0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500}.[6] The committed amount of money is tripled and then a randomly selected transfer is implemented according to their stated strategies. We also employ strategy method for receivers. All participants *j*, as receiver this time, know only the tripled amount they received from their partner and nobody is informed of exactly who is his/her partner *i*. In the same way as on sender, all participants decide how much they would send back to each potential sender: the amount returned is denoted by $\tau_{ij}' \in T'$ where T'= {0, 50, 100,⋯, 3τ}. Since the set of zero transfers by a receiver and a sender satisfies sub-game perfect Nash equilibrium, deviation from zero transfers can be interpreted as trust and/or mutual reciprocity.

Second, in order to distinguish trust behavior from altruism and risk attitudes, trust games are accompanied by dictator game and risk game (Ensminger, 2000, Carter and Castillo 2006, Cardenas and Carpenter 2008, Schechter 2007). Similar to the trust game, the dictator game is also composed of two players, a dictator and a receiver. The dictator is provided with Rs.500 of the initial endowment that he/she can either keep or allocate to the receiver. Hence, dictator must decide how much to transfer to his receiver from the possible transfer amounts, i.e., {0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500}. Also, the receiver obtains the

[6] In fact, participants are never paired with people from other communities. The money is transferred within the people from same community. Even if participants were paired with a person from same community, strategy method with potential persons from other community was convincing because there were participants from other communities in the experimental field.

amount transferred from his dictator passively. Since there is no self-interested reason for the sender to transfer money and the sender's zero transfers satisfy Nash equilibrium, actual amount of transfer is interpreted as measures of altruism. We also adopt strategy methods, asking all participants as sender how much they would send to each potential receiver as before.

While dictator and trust games we employ are standard, our study is different from the existing ones in that our participants play the games with people from three groups constructed based on the physical distance measured by common use of irrigation infrastructure as mentioned above. We also incorporate social distance by including two sub-groups within the same D-canal: three identified persons in the same D-canal and somebody in the same D-canal. Under such a partially non-anonymous setting, we observe whether behavior changes depending on the spatial and social distance between each pair.

The risk game intends to measure risk aversion under the quite similar framework to that of dictator and trust games (Schechter 2007). However risk game is played by each person as an investor. Each investor is given an initial endowment and the option of how much (if any) to invest. In our setting, an initial endowment is the same amount he/she is given in the dictator and trust games, Rs.500, and investable amount is the same ten choices. The investor then rolled a dice with six colors on each side to determine the investor's payoffs. Experimenters relate each color to number 1 to 6 in advance. A color related to one meant the investor lost his investment, two meant he recovered only half his investment, three meant he recovered his investment, four meant he earned 1.5 times his investment, five meant he doubled his investment, and six meant he earned 2.5 times his investment. Since the risk game is designed to replicate the first move in the trust game with risk but without trust, as the payoffs are decided by rolling a dice, invested amounts are interpreted as measures of risk attitude.

3. Data and Empirical Results

Table 4 shows descriptive statistics of variables used in this paper. Panel A to C reports the results of experiments, participant characteristics, and the relationships with their partners, respectively.[7] It appears that, in the trust and dictator games, the amount of cash to send and return to partners are correlated with the physical distance between them. The amount is highest when sending or returning to individuals living in the same D-canal and declines as the distance becomes further. Furthermore, it is shown that the anonymity of partners affects the result of experiments. The amount becomes even higher when we give identities of the actual partners than the case where we only inform that the partners came from the same D-canal.

This pattern is confirmed by Figure 3 which depicts the cumulative density function (CDF) of the sending amounts in the trust game, suggesting the first-order stochastic dominance. To test formally the pattern, we conduct the two-sample Kolmogorov-Smirnov test for each pair of CDFs. Table 5 presents the test results, showing that CDFs of sending amount are differentiated in terms of first order stochastic dominance. Comparison of the other statistics – returning amount in the trust game and sending amount in the dictator game – also shows the same patterns.

In panel C of Table 4, we present bilateral social relationship variables. 77 % of participants answer that they join the same farmer organization with their partners.[8] As for the data on knowing telephone number of partners, we asked the following question with four answer options: "*do you know your partner's telephone/mobile number?* (1) *yes,* (2) *No, but I know that …… has a telephone/mobile,* (3) *I do not know whether …… has a telephone/mobile,*

---

[7] Sample size in Panel C is slightly smaller than the number of actual pairs because some farmers who had not participated in the experiments answered the question on social relationship with their partners and we drop these farmers from analysis.

[8] Normally each D-canal community has only one organization and all households are required to join it. Around 23% of participants answered that they join different farmers organization but these answers were derived possibly because some participants are not household head.

and (4) *I know that …… has no telephone/mobile.*" This variable takes one if the participants answered (1). Therefore, this could be considered an approximation of easiness to communicate rather than that of how much the participants know about their partners.

Estimation Results for the Whole Area

As we have seen in Table 2 and 3, to a large extent, settlement location and its timing were exogenously determined by the local government. Hence, we can utilize this natural experimental situation to identify the causal impact of irrigation access on social capital accumulation. Results of trust game presented in Table 4 and Figure 3 suggest that social capital has been accumulated among the adjacently located farmers. To investigate this location effect in social capital accumulation across communities, we estimate a linear regression model of the degree of trust as follows:

$$(1)\qquad \tau_{ij} = \alpha_1 + \alpha_2 IRR_i + \alpha_3 Identified_{ij} + \alpha_4 SameDC_{ij} + \alpha_5 DifDC_{ij}$$
$$+\alpha_6 (IRR_i \times Identified_{ij}) + \alpha_7 (IRR_i \times SameDC_{ij}) + \alpha_8 (IRR_i \times DifDC_{ij}) + \boldsymbol{X}_i \beta + u_{ij},$$

where τ_{ij} is participant *i's* amount sent in trust game to each potential partner *j*; *IRR* represents years since the participant *i* received access to irrigation facilities; dummy variables capturing partner *j*'s identity to the sender *i are* denoted by *Identified*, *SameDC*, and *DifDC* which takes the value one if, to the sender *i*, partner *j* is identified person, somebody in the same D-canal, somebody in a different D-canal but in the same unit, respectively; $\boldsymbol{X}_i$ is a set of the sender's characteristics such as the degree of altruism, risk preference, dummy for household head, age, sex, and education level; and u_{ij} is a error term. Risk preference parameters, which are elicited by risk experiments under a similar setting to trust game, are included in the econometric model of Equation (1). Presumably, by including the risk parameters, we can control for potential confounding factors arising from correlation between the level of trust and the degree of risk aversion. In some specifications we also add block, D-canal, or individual fixed effects.

Table 6 summarizes empirical results using pooled data of four trust games. From specifications (1), (2), (3), and (4), the indicator variable of "identified" or non-anonymous counterpart takes positive and statistically significant coefficients. These estimation results are robust even when we control for unobserved heterogeneities using block, D-canal, or individual fixed effects. These results suggest that, within the whole area, adjacent social relationships, captured by the "identified" variable, explain the degree of trust. Moreover, within the whole area, geographical proximity variables, captured by the same distribution canal dummy, are all positive and statistically significant except the specifications with the block fixed effects. Also the different DC variable has largely positive coefficients which are mostly significant statistically with the lottery sample (Table 6). Considering that the default variable for DC is a dummy for different canal unit, these results imply that the geographical proximity can also account for a part of variations in degree of trust. In contrast, coefficients on the year of irrigation access variable and its interaction terms with the canal dummy variables are statistically insignificant except the specifications with the block fixed effects.[9]

Since the full sample employed for these analyses may involve endogeneity bias arising from non-random placements of irrigation accessibility, we limit our analysis to those who obtained land by lottery mechanism. Table 7 reports the results with lottery samples. As we can see the main qualitative results are maintained and, in addition, the year of access to irrigation facility variables have positive and reasonably significant coefficients.

[9] The sample used in Table 6 includes both non-anonymous and anonymous counterparts. Since, by construction, "someone in the same D-canal" includes the "identified" non-anonymous members, this may affect the estimation results. To handle this potential problem, we also estimate the models using the sample without "identified" counterparts. All the qualitative results which are not reported in this paper are maintained even if we omit the "identified" samples.

Intriguingly, in both Table 6 and 7, the sending amounts in trust games is significantly and positively related to the degree of altruism quantified by the dictator game results. The results are robust across different specifications and sample. Moreover, the degree of risk aversion affects the amount of trust with marginal levels of statistical significance in Table 6.

Estimation Results for Each Community

To incorporate social relationship between each pairs, we utilize the dyadic data set with which we can investigate relationships among non-anonymous individuals. We focus on the social distance measured by intimacy of various bilateral relationships. The main specification is

$$\tau_{ij} = \gamma_1 + \gamma_2\, IRR_i + \boldsymbol{X}_i\, \Phi_1 + \boldsymbol{X}_j\, \Phi_2 + \boldsymbol{D}_{ij}\Phi_3 + \varepsilon_{ij}, \tag{2}$$

where $\boldsymbol{X}_j$ is a set of the receiver's characteristics such as age, sex, education level, and dummy for a leader of farmer's organization; $\boldsymbol{D}_{ij}$ is a set of bilateral relationships between participant *i* and *j* reported by *i*. We also have specifications including block, D-canal, or individual fixed effects.

Our estimation results reported in Table 8 which shows two main findings. First, irrigation access year variables have positive and statistically significant coefficients. This result seems to be robust even if we include block or D-canal fixed effects and limit analysis with lottery samples (Table 9). There are two possible channels through which years of access to irrigation access can affect social capital. First, if a person has been embedded into particular physical environment for years, it will affect his/her preference directly. Second, years of access to irrigation can improve income level of a person thereby increase the amount of transfers. To compare these two competing hypotheses, we add income level of the sender in equation (2). According to the estimation results which are not reported in this paper, qualitative results shown in Table 9 are maintained. This finding is consistent with the first hypothesis.

Second, however, the years of sharing the same irrigation canal and intimacy of bilateral relationship captured by the same ROSCA participation, the same farmers organization membership, and frequent labor exchange affect the amount of transfers only mildly. In Table 8, we reject joint significance of bilateral relationships in six out of eight specifications whereas, with lottery samples in Table 9, we cannot reject the joint significance in five out of eight specifications.

These results indicate that while in the larger area, the geographical proximity can account for variations in degree of trust, within-community variation in trust for each irrigation canal is not driven merely by the bilateral relationships. The local variations in trust seem to be driven more by the years of access to the irrigation canal. This implies that social preference emerges from physical constraints on people's activities created by irrigation infrastructure. People are physically built-in the infrastructure system and thus people are forced to interact each other, leading to social capital accumulation.

Effects of Expected Level of Trustworthiness

As Barr (2003) investigates, trusting behavior of a sender should be affected by his/her expected returns to sending a transfer to the receiver. Unlike Barr (2003) who does not have data on each first player's expectation, we have direct subjective assessments on the expected returns to transfers. We add the expected returns as one of the independent variables in Equation (1). Estimation results are reported in Table 10. As we can see, the expected return variable has positive and statistically significant coefficients in all specifications. The indicator variable for the "identified" counterpart in the same D-canal still maintains positive and statistically significant coefficients. These estimation results suggest that the level of trust within the same community involves its reasons beyond the expected return motivation based on a simple investment model of expected returns or short-run immediate reciprocity.

4. Concluding Remarks

In the rich literature on social capital, existing studies have investigated the role of social capital in improving the economic performance of people, communities, and countries. Yet, determinants of social capital accumulation are largely unexplored in the existing literature. This study tries to bridge this gap in the literature by investigating the impact of irrigation infrastructure on social capital accumulation. To identify the causal impact of irrigation, we use unique natural experimental data set from an irrigation project in Southern Sri Lanka where irrigated land distribution has been made through a lottery mechanism. In addition, we capture the level of social capital precisely using carefully-designed filed experiments such as trust and dictator games. By combining these two data sets, i.e., data from natural and artefactual field experiments, we examine the causal impact of irrigation infrastructure on social capital.

We find that, within the whole area, geographical distance as well as adjacent social relationships can explain the degree of mutual trust where trust is also significantly affected by altruism. Moreover, in each distribution canal, within-community variation in trust is not driven by the bilateral relationships but by the years of access to the irrigation canal, suggesting that social preference emerges from physical constraints on people's activities created by irrigation infrastructure.

Reference

Aoki, Masahiko (2001a) *Toward a Comparative Institutional Analysis*, Cambridge: MIT Press.

Aoki, Masahiko (2001b) "Community Norms and Embeddedness: A Game Theoretic Approach," in Aoki, Masahiko and Hayami Yujiro (eds.), *Communities and Markets in Economic Development,* Oxford: Oxford University Press, pp.97-125.

Barr, Abigail (2003) "Trust and expected trustworthiness: experimental evidence from zimbabwean villages," *Economic Journal*, Vol.113(489), pp. 614-630.

Berg, Joyce, Dickhaut John and McCabe Kevin (1995) "Trust, Reciprocity, and Social History," Games and Economic Behavior, Vol.10(1), pp.122-142.

Binzel, Cristine and Dietmar Fehr (2009) "The Limited Effect of Social Distance on Trust: Experimental Evidence from a Slum," mimeo.

Bouma, Jetske, Erwin Bulte and Daan van Soest (2008) "Trust, trustworthiness and cooperation: Social capital and community resource management," *Journal of Environmental Economics and Management*, Vol.56(2), pp.155-166.

Bruhn, Miriam and David McKenzie, (2008) "In Pursuit of Balance: Randomization in Practice in Development Field Experiments", *BREAD Working Paper* No. 189.

Cardenas, Camilo and Jeffrey Carpenter (2008) "Behavioural Development Economics: Lessons from Field Labs in the Developing World," *Journal of Development Studies*, Vol. 44(3), pp.311-338

Carter, Michael and Marco Castillo (2009) "Trustworthiness and Social Capital in South Africa: Analysis of Actual Living Standards Experiments and Artefactual Field Experiments," forthcoming, *Economic Development and Cultural Change*.

Duflo, Esther and Rohini Pande (2007) "DAMS," *Quarterly Journal of Economics,* Vol.122(2), pp. 601-646.

Durlauf, Steven and Marcel Fafchamps (2005) "Social Capital," in Aghion, Philippe and Steven Durlauf (eds.), *Handbook of Economic Growth*, Elsevier, pp.1639-1699.

Dasgupta, Partha and Ismail Serageldin (2000) *Social Capital: a Multifaceted Perspective*. Washington, DC: The World Bank.

Ensminger, Jean (2000) "Experimental Economics in the Bush: Why Institutions Matter," in Menard, Claude (ed.), *Institutions, Contracts and Organizations: Perspectives from New Institutional Economics,* London: Edward Elgar, pp.158-171.

Etang, Alvin, David Fielding and Stephen Knowles (2009) "Does trust extend beyond the village? Experimental trust and social distance in Cameroon," *University of Otago Economics*

Discussion Papers, No.0907.

Fafchamps, Marcel and Bart Minten (2002) "Return to Social Network Capital among Traders," *Oxford Economic Papers*, Vol.54(2), pp. 173-206.

Feigenberg, Benjamin, Erica Field and Rohini Pande (2009). "Building Social Capital through Microfinance," mimeo.

Glaeser, Edward L., David I. Laibson, José A. Scheinkman and Christine L. Soutter (2000) "Measuring Trust," *Quarterly Journal of Economics*, Vol.115(3), pp.811-846.

Harrison, Glenn and John List (2004) "Field Experiments," *Journal of Economic Literature*, Vol. 42(4), pp.1009-1055.

Granovetter, Mark (1985) "Economic Action and Social Structure: The Problem of Embeddedness," *American Journal of Sociology*, No.91(3), pp.480-510.

Hayami, Yujiro (2009) "Social Capital, Human Capital and the Community Mechanism: Toward a Conceptual Framework for Economists," *Journal of Development Studies*, Vol. 45(1), pp.96-123.

Hayami, Yujiro, and Yoshihisa Godo (2005) *Development Economics: From the Poverty to the Wealth of Nations*, Third Edition), New York, Oxford University Press.

Ishise, Hirokazu and Yasuyuki Sawada (2009) "Aggregate Returns to Social Capital: Estimates Based on the Augmented Augmented-Solow Model", *Journal of Macroeconomics*, Vol.31(3), pp.376-393.

JBIC Institute (JBICI) (2007) "Impact of Irrigation Infrastructure Development on Dynamics of Incomes and Poverty Econometric Evidence Using Panel Data from Pakistan," *JBICI Research Paper*, No. 33.

Kandori, Michihiro (2008, "Repeated Games", in Steven N. Durlauf and Lawrence E. Blume, eds., *New Palgrave Dictionary of Economics*, 2nd edition, Palgrave Macmillan,

Knack, Stephen and Philip Keefer (1997) "Does Social Capital Have an Economic Payoff? A Cross-Country Investigation," *Quarterly Journal of Economics*, Vol. 112(4), pp.1251-88.

Karlan, Dean (2005) "Using Experimental Economics to Measure Social Capital and Predict Financial Decisions," *American Economic Review*, Vol.95(5), pp.1688-1699.

Leider, Stephen, Markus M. Möbius, Tanya Rosenblat and Quoc-Anh Do (2009) "Directed Altruism and Enforced Reciprocity in Social Networks," Vol.124(4), pp.1815-1851.

Levitt, Steven and John List (2009) "Field experiments in economics: The past, the present, and the future," *European Economic Review*, Vol.53(1), pp. 1-18.

Ligon, Ethan and Laura Schechter (2008) "The value of social networks in rural Paraguay," mimeo.

Miguel, Edward, Paul Gertler, and David I. Levine (2006), "Does Industrialization Build or Destroy Social Network?" *Economic Development and Cultural Change* Vol.52(2), pp. 287-317.

Möbius, Markus M. (2001), "Why Should Theorists Care about Social Capital?" mimeographed, Department of Economics, Harvard University.

Olken, Benjamin A. (2009) "Do Television and Radio Destroy Social Capital? Evidence from Indonesian Villages," *American Economic Journal: Applied Economics*, Vol.1(4), pp.1–33.

Ostrom, Elinor (1990) *Governing the Commons: The Evolution of Institutions for Collective Actions*, Cambridge: Cambridge University Press.

Routledge, Bryan and Joachim von Amsberg (2003) "Social Capital and Growth," *Journal of Monetary Economics*, Vol.50(1), pp.167-193.

Sawada, Yasuyuki, Masahiro Shoji, Shinya, Sugawara and Naokom Shinkai (2008) "The Role of Infrastructure in Mitigating Poverty Dynamics: The Case of an Irrigation Project in Sri Lanka," *JBICI Discussion Paper*, No.16.

Schechter, Laura (2007) "Traditional trust measurement and the risk confound: An experiment in rural Paraguay," *Journal of Economic Behavior and Organization*, Vol.62(2), pp.272-292.

Figure 1
A Map of the Study Area

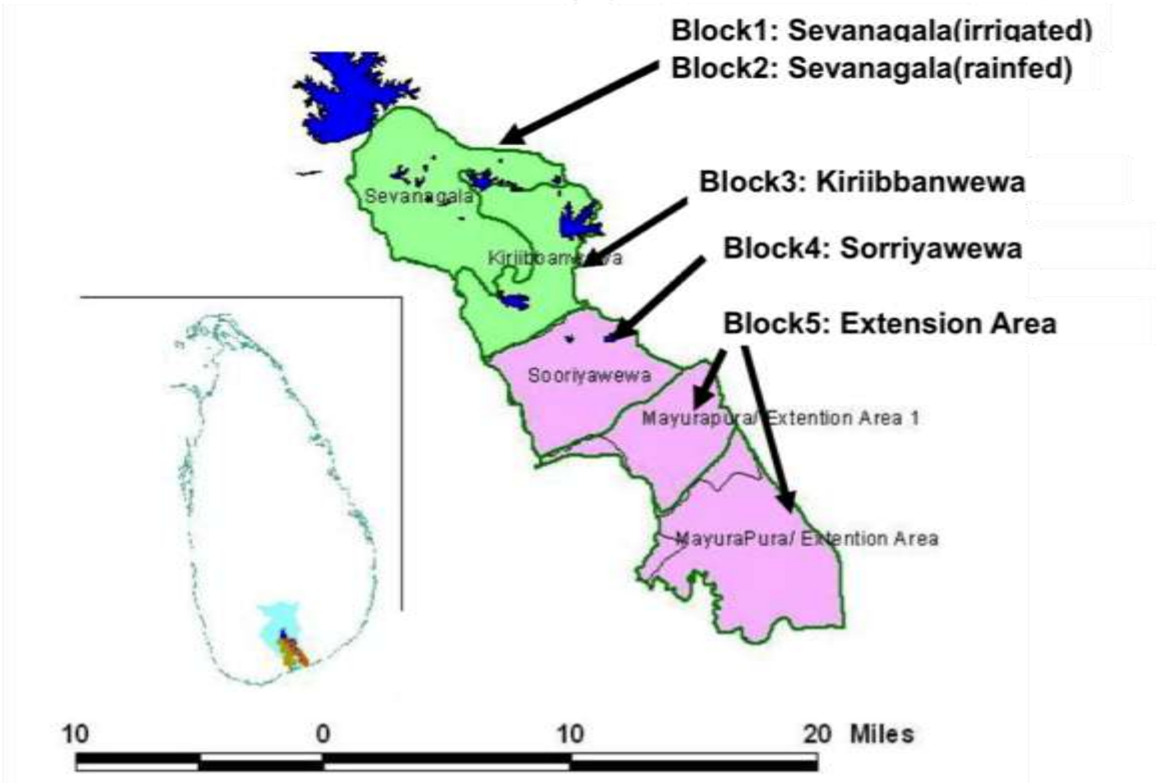

Figure 2
Sampling Scheme

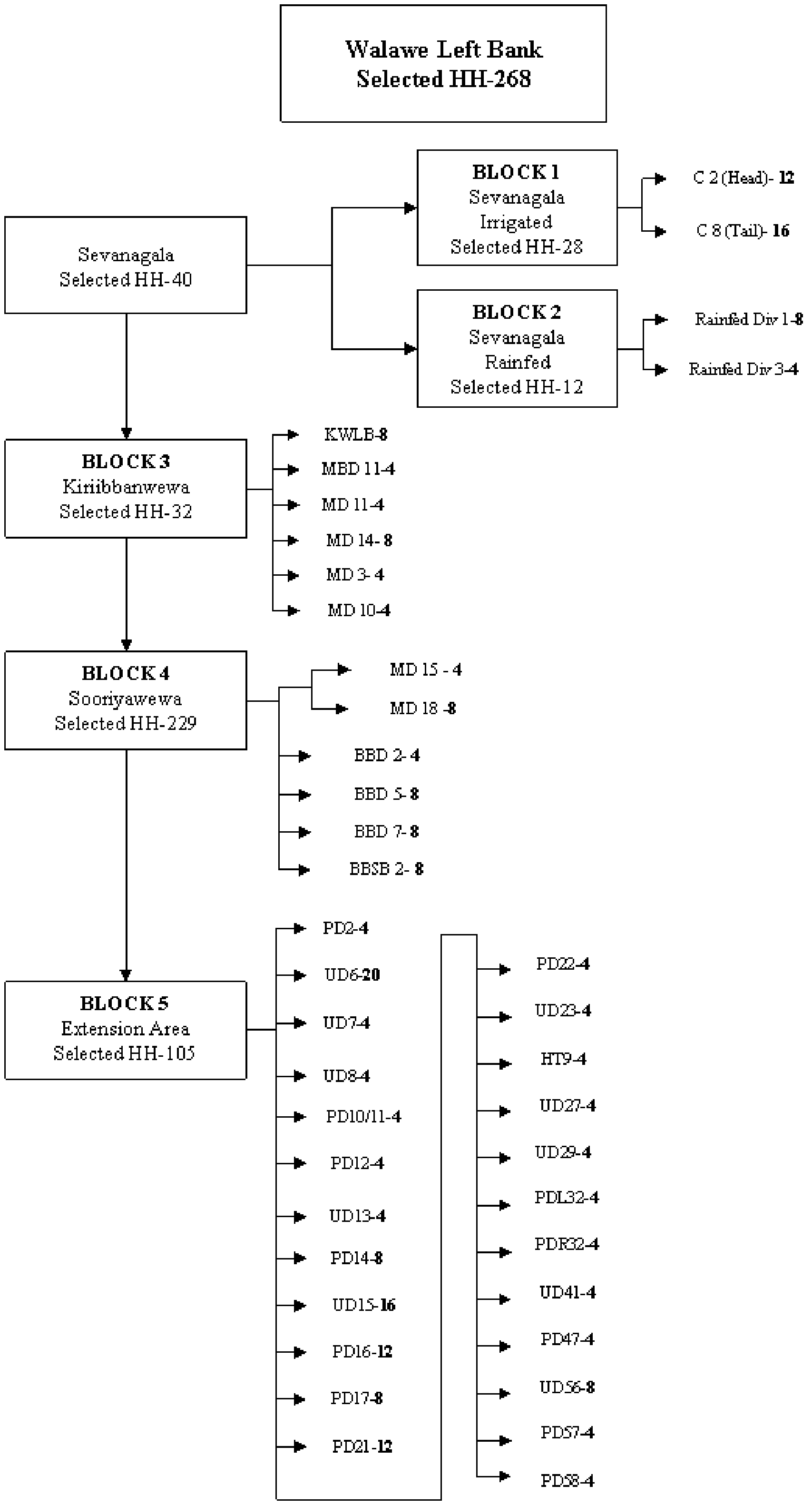

Figure 3
CDF of Results of Experiments

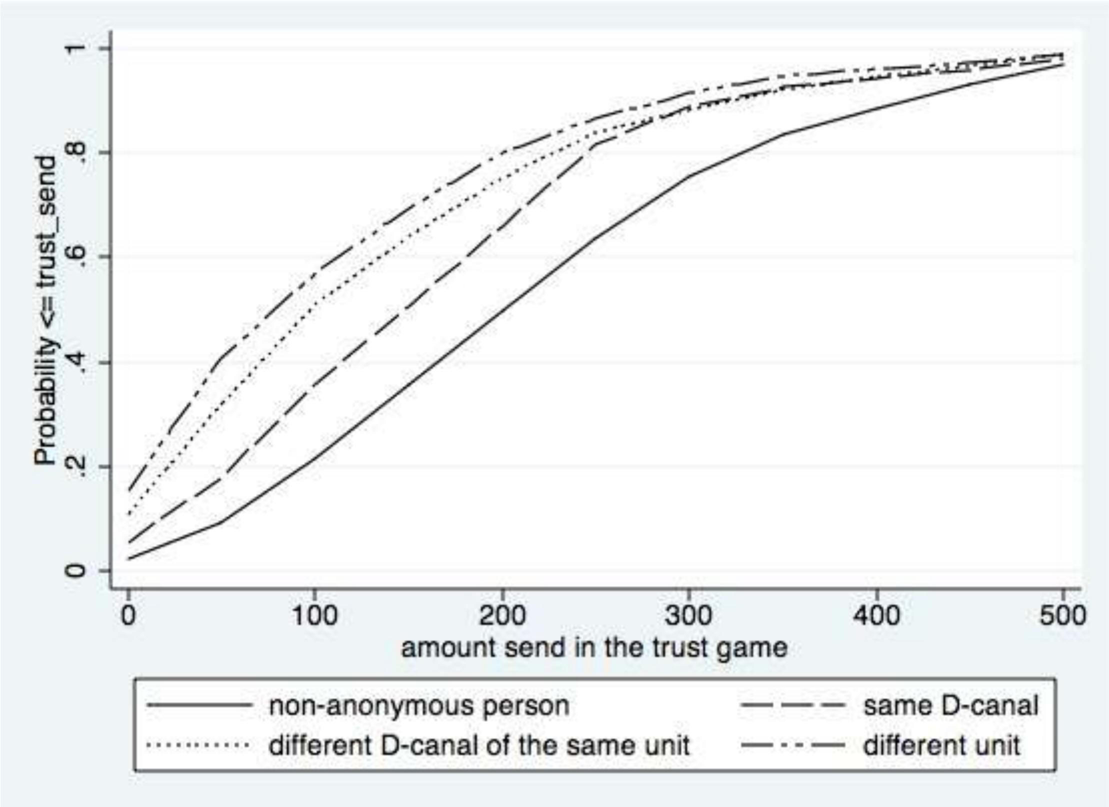

Table 1
Composition of Participants in Experiments

	Block	Freq.	Percent	Average years of access to irrigation
1	Sevanagala (irrigated)	28	10.5	14.79
2	Sevanagala (rainfed)	12	4.5	1.58
3	Kirribbanwewa	32	11.9	18.69
4	Sooriyawewa	40	14.9	16.15
5	Extension Area	156	58.2	6.03
	Total	268	100	9.76

Table 2
Subjective Assessments on Implementation of Land Allocation Using Lotteries

	Residences	Irrigated Plots
Any chance to claim your preferences?	Percent	Percent
Not at all	29.83	32.59
Block level	10.5	11.16
Unit-canal level	2.1	3.13
D-Canal level	1.26	1.79
Plot level	56.3	51.34
Total	100	100
Land allocation process?		
Acquired the preferred area without process	52.77	47.53
Lottery within the claimed area	20	22.87
Lottery including the possibility of outside of the claimed area	5.11	7.17
First come, first serve basis	5.96	8.07
Negotiation among the resettlers	2.98	3.14
No formal permission regarding the land use	8.94	6.28
Others	4.26	4.93
Total	100	100
Did you obtain the land you really wanted?		
Yes	67.80	66.37
No	32.20	33.63
Total	100	100

Table 3 Exogeneity Tests

	Age		Education		Males over 15		Female over 15		Irrigation Access Year	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Canal head	0.04	(2.47)	-0.36	(0.75)	-0.05	(0.21)	0.16	(0.23)	-1.25	(1.76)
Canal tail	-1.27	(2.18)	-0.60	(0.66)	-0.18	(0.18)	0.05	(0.20)	-0.99	(1.55)
Block 1 (* canals)	47.76***	(3.16)	5.42***	(0.95)	1.92***	(0.27)	1.63***	(0.30)	22.32***	(2.25)
Block 2 (* canals)	39.00***	(10.76)	8.00**	(3.25)	1.00	(0.91)	2.00**	(1.01)	0.00	(7.66)
Block 3 (* canals)	59.00***	(7.61)	11.00***	(2.30)	2.50***	(0.64)	2.50***	(0.71)	34.00***	(5.41)
Block 4 (* canals)	53.05***	(5.60)	5.83***	(1.69)	1.57***	(0.47)	1.91***	(0.52)	25.87***	(3.98)
Block 5 (* canals)	47.06***	(3.99)	4.81***	(1.20)	2.02***	(0.34)	1.71***	(0.37)	4.16	(2.84)
D canal 1	-3.50	(4.71)	0.80	(1.42)	-0.60	(0.40)	0.45	(0.44)	-12.55***	(3.35)
D canal 2	-1.23	(13.36)	-1.40	(4.03)	0.68	(1.13)	-1.05	(1.25)	0.99	(9.5)
D canal 3	-9.15	(9.04)	-3.21	(2.73)	-1.46*	(0.76)	-1.34	(0.85)	-13.75**	(6.43)
D canal 4	-1.73	(10.98)	-3.90	(3.32)	0.18	(0.92)	-0.55	(1.03)	-12.01	(7.81)
D canal 5	-4.70	(10.13)	-4.31	(3.06)	-0.45	(0.85)	-1.00	(0.95)	-14.08*	(7.21)
D canal 6	-9.21	(9.56)	-4.58	(2.89)	-1.42*	(0.81)	-1.38	(0.90)	-12.07*	(6.8)
D canal 7	-6.73	(10.98)	-3.40	(3.32)	-0.82	(0.92)	-1.05	(1.03)	1.49	(7.81)
D canal 8	-6.84	(6.77)	0.16	(2.04)	0.21	(0.57)	0.32	(0.63)	-8.52*	(4.81)
D canal 9	-8.00	(7.26)	-0.84	(2.19)	-0.32	(0.61)	-0.35	(0.68)	-3.42	(5.17)
D canal 10	-7.83	(6.80)	-0.32	(2.05)	0.06	(0.57)	0.06	(0.64)	-15.70***	(4.84)
D canal 11	-8.20	(8.31)	2.24	(2.51)	0.22	(0.70)	0.06	(0.78)	-6.21	(5.91)
D canal 12	-7.73	(6.71)	1.70	(2.02)	0.48	(0.56)	0.46	(0.63)	-9.00*	(4.77)
D canal 13	-8.10**	(4.06)	0.25	(1.23)	-0.48	(0.34)	-0.36	(0.38)	2.21	(2.89)
D canal 14	5.90	(8.63)	-2.46	(2.61)	-0.47	(0.73)	-0.87	(0.81)	3.09	(6.14)
D canal 15	0.72	(4.16)	0.88	(1.26)	-0.18	(0.35)	-0.07	(0.39)	3.83	(2.96)
N	158		158		158		158		158	
Joint significance of D canal coefficients (P-values)	0.1804		0.6536		0.2133		0.7162		0.0026	
Joint significance of head and tail coefficients (P-values)	0.8158		0.8793		0.6254		0.7832		0.7192	

Table 4
Descriptive Statistics

Variables	Obs	Mean	S.D.
Panel A: Experiment			
Trust Game			
Sending amount to the identified person (showing pictures and names of partners)	804	215.30	131.48
Sending amount to somebody in the same D-canal	268	161.38	119.73
Sending amount to somebody in a different D-canal of the same unit	268	131.34	126.49
Sending amount to somebody in a different unit	268	111.38	121.06
Returning proportion to the identified person (showing pictures and names of partners)	762	0.30	0.23
Returning proportion to somebody in the same D-canal	254	0.23	0.23
Returning proportion to somebody in a different D-canal of the same unit	254	0.19	0.22
Returning proportion to somebody in a different unit	254	0.16	0.21
Dictator Game			
Sending amount to the identified person (showing pictures of partners)	804	165.05	111.53
Sending amount to somebody in the same D-canal	268	140.11	101.05
Sending amount to somebody in a different D-canal of the same unit	268	104.66	100.50
Sending amount to somebody in a different unit	268	84.51	95.66
Risk Game			
Betting amount to the risk game	268	208.58	121.25
Panel B: Participants Information			
Dummy if household head	268	0.68	0.47
Age	266	48. 33	14.15
Dummy if male	266	0.65	0.48
Years of schooling	265	7.18	3.61
Years of access to irrigation	268	9.76	9.53
Panel C: Relationship with Partners (non-anonymous Setting)			
Years since knowing each other	725	21.27	11.92
Dummy if knowing telephone number	744	0.08	0.28
Years sharing the same irrigation	744	3.25	6.86
Dummy if the same farmer organization	737	0.77	0.42
Dummy if the partner is the leader of FO	719	0.05	0.23
Dummy if the same ROSCA group	743	0.05	0.22
Dummy if the same MFI group (Swayan Bank)	744	0.10	0.30
Dummy if the same funeral group	741	0.38	0.49
Dummy if experience of lending money since 3 years ago	741	0.08	0.27
Dummy if experience of borrowing since 3 years ago	744	0.10	0.29
Dummy if experience of exchanging labor since 3 years ago	744	0.16	0.37

Table 5
Two-Sample Kolmogorov-Smirnov Test

	Identified persons vs. same D-canal	Identified persons vs. same unit	Identified persons vs. different unit	Same D-canal vs. same unit	Same D-canal vs. different unit	Same Unit vs. different unit
Trust Send	0.265***	0.396***	0.440***	0.175***	0.261***	0.090
Trust Return	0.119**	0.172***	0.235***	0.175***	0.261***	0.090
Dictator	0.194***	0.366***	0.474***	0.187***	0.295***	0.108*

Note: D statistics are reported. * significant at 10% level; ** significant at 5% levell; *** significant at 1% level

Table 6 Determinants of Social Capital

Dependent variable: Amount sent in the trust game

	(1)	(2)	(3)	(4)
Method	pooled OLS	Block FE	DC FE	Individual FE
Years of Access to Irrigation	0.606	0.68	0.211	
	[0.676]	[0.127]***	[0.598]	
Identified * Irrigation Access Year	0.904	0.903	0.905	0.973
	[0.633]	[0.386]*	[0.565]	[0.658]
Same DC * Irrigation Access Year	-0.176	-0.176	-0.176	-0.17
	[0.632]	[0.526]	[0.646]	[0.679]
Different DC * Irrigation Access Year	0.215	0.214	0.217	0.307
	[0.521]	[0.315]	[0.489]	[0.521]
Identified	44.203	44.051	44.37	57.098
	[9.591]***	[5.465]***	[7.108]***	[9.27]***
Same DC	14.977	14.862	15.103	24.744
	[10.639]	[11.026]	[11.152]	[10.295]**
Different DC	4.159	4.129	4.19	6.625
	[7.146]	[2.269]	[6.448]	[6.943]
Dictator Game	0.644	0.646	0.642	0.469
	[0.05]***	[0.041]***	[0.041]***	[0.045]***
Risk Game	0.102	0.095	0.071	
	[0.046]**	[0.036]*	[0.048]	
Household Head	-30.694	-31.437	-41.517	
	[16.944]*	[13.43]*	[16.829]**	
Age	-0.178	-0.119	-0.037	
	[0.486]	[0.239]	[0.435]	
Sex (1 = male)	21.957	23.908	25.848	
	[13.989]	[11.205]*	[14.373]*	
Education (highest grade completed)	-0.175	-0.205	-0.048	
	[1.486]	[1.404]	[1.428]	
Constant	47.277	44.343	54.708	72.707
	[27.275]*	[14.742]**	[26.375]**	[5.472]***
Number of observations	1560	1560	1560	1560
Adjusted R-squared	0.40	0.40	0.41	0.39

Note: Robust standard errors in brackets. In column (1),and (5), cluster-adjusted robust standard errors are reported.
* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 7 Determinants of Social Capital (lottery subsample)

Dependent variable: Amount sent in the trust game

	(1)	(2)	(3)	(4)
Method	pooled OLS	Block FE	DC FE	Individual FE
Years of Access to Irrigation	2.434	3.073	0.589	
	[1.349]*	[0.818]**	[1.216]	
Identified * Irrigation Access Year	1.539	1.539	1.570	1.562
	[1.676]	[0.490]**	[1.822]	[1.694]
Same DC * Irrigation Access Year	-1.057	-1.058	-1.124	-1.107
	[1.429]	[2.146]	[1.653]	[1.474]
Different DC * Irrigation Access Year	-0.999	-0.999	-0.942	-0.957
	[0.880]	[1.159]	[0.808]	[0.862]
Identified	69.686	69.719	74.682	73.414
	[20.642]***	[13.022]***	[19.775]***	[20.703]***
Same DC	37.685	37.713	41.868	40.806
	[20.499]*	[30.006]	[19.843]**	[20.107]**
Different DC	33.660	33.667	34.694	34.432
	[14.247]**	[10.696]**	[11.978]***	[14.006]**
Dictator Game	0.537	0.536	0.467	0.485
	[0.095]***	[0.046]***	[0.057]***	[0.091]***
Risk Game	0.146	0.120	0.119	
	[0.103]	[0.102]	[0.160]	
Household Head	12.034	7.401	-53.016	
	[27.775]	[45.447]	[45.633]	
Age	-0.386	-0.251	1.692	
	[0.780]	[0.277]	[1.583]	
Sex (1 = male)	-19.996	-14.378	7.397	
	[29.983]	[24.902]	[39.782]	
Education (highest grade completed)	1.127	1.206	1.871	
	[2.896]	[2.084]	[3.726]	
Constant	14.985	5.967	-31.559	60.401
	[54.914]	[46.843]	[105.603]	[8.973]***
Number of observations	378	378	378	378
Adjusted R-squared	0.43	0.43	0.42	0.47

Note: Robust standard errors in brackets. In column (1),and (5), cluster-adjusted robust standard errors are reported.
* significant at 10% level; ** significant at 5% levell; *** significant at 1% level

Table 8 Determinants of Social Capital using Dyadic Data

Dependent variable: the amount sent in the trust game

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Method	pooled OLS	Block FE	DC FE	Indi. FE	pooled OLS	Block FE	DC FE	Indi. FE
Years of Access to Irrigation (*IRR*)	1.644	2.120	1.444		1.818	2.305	1.491	
	[0.797]**	[0.568]**	[0.703]**		[0.783]**	[0.602]**	[0.661]**	
Respondent characteristics (X_i)								
Dictator Game	0.645	0.655	0.683	0.527	0.634	0.643	0.675	0.474
	[0.055]***	[0.037]***	[0.040]***	[0.053]***	[0.057]***	[0.039]***	[0.046]***	[0.049]***
Risk Game	0.161	0.147	0.110		0.149	0.133	0.098	
	[0.055]***	[0.052]**	[0.063]*		[0.055]***	[0.056]*	[0.065]	
Household Head	-16.522	-15.245	-27.124		-13.877	-13.440	-25.343	
	[20.043]	[11.006]	[16.083]*		[20.468]	[15.288]	[16.869]	
Age	-0.335	-0.291	-0.069		-0.387	-0.336	0.097	
	[0.550]	[0.370]	[0.433]		[0.568]	[0.475]	[0.420]	
Sex (1 = male)	15.810	15.322	16.122		14.713	15.012	13.600	
	[17.556]	[8.842]	[18.365]		[17.623]	[8.171]	[18.888]	
Education (highest grade completed)	-0.304	-0.626	-0.369		-0.604	-0.947	-1.073	
	[1.807]	[2.012]	[2.453]		[1.816]	[2.392]	[2.325]	
Receiver characteristics (Xj)								
Age	-0.228	-0.111	-0.019	-0.307	-0.274	-0.153	0.122	-0.303
	[0.357]	[0.232]	[0.325]	[0.267]	[0.363]	[0.211]	[0.325]	[0.269]
Sex (1 = male)	3.876	4.945	-4.365	-9.847	1.748	2.504	-7.583	-10.037
	[9.095]	[8.060]	[6.209]	[6.752]	[9.230]	[7.818]	[6.864]	[6.949]
Education (highest grade completed)	-1.172	-1.183	-1.277	-0.672	-1.239	-1.265	-1.216	-0.947
	[1.305]	[0.608]	[1.366]	[1.044]	[1.345]	[0.789]	[1.194]	[1.050]
Leader of FO	-7.784	-9.624	-9.784	-6.214	-14.422	-16.289	-17.303	-11.659
	[15.420]	[9.876]	[13.308]	[13.267]	[17.428]	[11.994]	[16.414]	[14.308]
Bilateral relationships (D_{ij})								
Year - Sharing Irrigation	-0.324	-0.536	-0.194	-0.980	-0.253	-0.508	-0.230	-1.010
	[0.814]	[0.208]*	[0.829]	[0.733]	[0.809]	[0.159]**	[0.822]	[0.702]
FO Member	-0.948	-2.886	-7.375	9.847	-6.164	-8.840	-8.709	5.451
	[14.204]	[9.605]	[14.801]	[11.894]	[14.698]	[7.604]	[13.745]	[12.166]
Funeral Group Member	-14.941	-13.507	-9.713	-3.922	-15.627	-14.544	-9.231	-10.905
	[11.571]	[18.718]	[13.443]	[10.072]	[11.847]	[18.382]	[13.814]	[9.947]
Year – know					0.566	0.621	0.205	0.442
					[0.435]	[0.345]	[0.452]	[0.380]
Know Telephone No.					18.068	18.928	25.154	25.428
					[19.616]	[13.922]	[13.041]*	[12.830]**
ROSCA Member					-8.087	-5.120	-2.820	-27.829
					[21.565]	[15.221]	[21.549]	[13.782]**
Swayan Bank Member					4.034	1.731	7.667	39.791
					[18.023]	[7.139]	[20.166]	[19.801]**
Lending Money					36.924	32.418	35.214	34.955
					[25.171]	[26.833]	[23.208]	[19.230]*
Borrowing Money					30.722	33.021	18.798	-14.090
					[23.494]	[7.883]**	[25.090]	[14.773]
Exchange Labor					-19.495	-20.852	-7.436	29.706
					[15.933]	[5.218]**	[16.026]	[13.609]**
Constant	105.495	97.394	105.364	153.985	103.838	95.996	91.640	150.772
	[40.606]***	[18.218]***	[48.867]**	[23.676]***	[41.814]**	[17.885]***	[48.321]*	[25.157]***
Number of Observations	689	689	689	689	671	671	671	671
Adjusted R-squared	0.37	0.37	0.40	0.25	0.38	0.38	0.41	0.28
Joint significance of receiver characteristics (P-values)	0.8812	0.0975	0.2776	0.2885	0.8098	0.0111	0.1859	0.2748
Joint significance of bilateral relationships (P-values)	0.5352	0.2156	0.7665	0.5305	0.4050	0.0271	0.3259	0.0012
Joint significance of receiver characteristics and bilateral relationships (P-values)	0.7832	0.0367	0.2667	0.4294	0.6195	0.0271	0.1702	0.0042

Note: Robust standard errors in brackets. In column (1), cluster-adjusted robust standard errors are reported.
* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 9 Determinants of Social Capital using Dyadic Data (lottery subsample)

Dependent variable: the amount sent in the trust game

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Method	pooled OLS	Block FE	DC FE	Indi. FE	pooled OLS	Block FE	DC FE	Indi. FE
Years of Access to Irrigation (*IRR*)	3.973	5.644	2.388		3.867	5.428	2.572	
	[1.568]**	[2.440]*	[1.717]		[1.528]**	[1.628]**	[1.294]*	
Respondent characteristics (X_i)								
Dictator Game	0.499	0.533	0.468	0.547	0.491	0.593	0.508	0.448
	[0.154]***	[0.103]***	[0.077]***	[0.152]***	[0.160]***	[0.126]***	[0.081]***	[0.131]***
Risk Game	0.178	0.088	0.096		0.259	0.145	0.230	
	[0.129]	[0.109]	[0.151]		[0.129]*	[0.057]*	[0.132]*	
Household Head	9.362	-12.060	-82.981		13.465	-26.202	-105.332	
	[40.048]	[31.758]	[34.806]**		[42.411]	[32.935]	[35.979]***	
Age	-0.059	0.274	2.856		0.183	0.980	3.268	
	[1.118]	[0.958]	[1.022]***		[1.115]	[0.454]*	[0.846]***	
Sex (1 = male)	-20.654	-8.077	5.345		-20.549	1.600	1.427	
	[40.963]	[16.952]	[36.966]		[39.464]	[19.597]	[38.597]	
Education (highest grade completed)	1.286	-0.538	-0.431		-0.139	-4.050	-0.878	
	[4.239]	[3.008]	[2.756]		[4.487]	[3.010]	[3.082]	
Receiver characteristics (Xj)								
Age	-0.532	0.104	0.815	1.301	0.411	1.275	1.599	1.295
	[0.884]	[1.051]	[0.780]	[0.765]*	[0.923]	[0.385]**	[0.740]**	[0.744]*
Sex (1 = male)	-1.377	-11.470	-16.181	-2.838	-8.227	-18.259	-16.362	0.559
	[19.715]	[20.049]	[19.457]	[16.705]	[21.290]	[17.470]	[22.849]	[18.328]
Education (highest grade completed)	-2.408	-1.542	2.442	4.278	-1.714	-0.847	2.528	3.161
	[3.335]	[3.555]	[2.782]	[3.001]	[3.405]	[3.393]	[2.714]	[3.127]
Leader of FO	51.339	45.478	29.142	-4.722	49.695	35.854	32.416	-0.037
	[41.449]	[25.153]	[29.149]	[14.551]	[40.071]	[18.941]	[21.448]	[23.939]
Bilateral relationships (D_{ij})								
Year - Sharing Irrigation	0.008	-1.222	-3.639	1.066	1.296	-0.211	-2.959	3.065
	[1.865]	[0.752]	[1.673]**	[1.421]	[2.004]	[1.019]	[2.327]	[1.783]*
FO Member	24.083	5.968	30.336	17.273	27.305	8.062	6.802	-3.916
	[25.434]	[10.765]	[42.608]	[45.638]	[25.701]	[14.167]	[39.380]	[52.241]
Funeral Group Member	22.386	23.887	36.602	16.653	48.055	60.220	50.210	3.263
	[28.001]	[11.391]	[26.854]	[32.476]	[27.799]*	[10.162]***	[25.828]*	[41.024]
Year – know					-0.749	-1.493	-0.629	0.676
					[0.864]	[0.417]**	[0.678]	[0.894]
Know Telephone No.					-32.814	-23.360	-5.659	-5.322
					[38.323]	[19.775]	[23.677]	[37.175]
ROSCA Member					125.268	166.243	125.945	-74.792
					[39.562]***	[29.046]***	[57.737]**	[53.200]
Swayan Bank Member					-97.291	-136.445	-64.772	80.314
					[44.138]**	[8.062]***	[42.713]	[42.246]*
Lending Money					55.628	12.543	0.315	56.062
					[41.245]	[22.767]	[48.152]	[38.722]
Borrowing Money					88.646	105.726	43.681	-18.622
					[57.158]	[26.297]**	[41.649]	[38.561]
Exchange Labor					11.265	-8.274	7.169	13.134
					[27.449]	[15.391]	[21.231]	[32.520]
Constant	84.947	73.509	-43.256	28.176	9.391	-0.661	-100.154	43.286
	[111.709]	[75.924]	[85.792]	[67.008]	[114.804]	[42.471]	[93.414]	[68.684]
Number of Observations	163	163	163	163	160	160	160	160
Adjusted R-squared	0.32	0.35	0.36	0.26	0.39	0.45	0.40	0.24
Joint significance of receiver characteristics (P-values)	0.6672	<u>0.0008</u>	0.4982	0.5276	0.6272	<u>0.0000</u>	0.1664	0.5430
Joint significance of bilateral relationships (P-values)	0.5370	0.1360	<u>0.0162</u>	0.7464	<u>0.0020</u>	<u>0.0034</u>	<u>0.0014</u>	<u>0.0667</u>
Joint significance of receiver characteristics and bilateral relationships (P-values)	0.6633	<u>0.0010</u>	<u>0.0033</u>	0.7661	<u>0.0017</u>	<u>0.0235</u>	<u>0.0001</u>	0.1372

Note: Robust standard errors in brackets. In column (1), cluster-adjusted robust standard errors are reported.
* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table 10 Determinants of Social Capital and Expected Returns (lottery subsample)

Dependent variable: Amount sent in the trust game

Method	pooled OLS	Block FE	DC FE	Individual FE
Years of Access to Irrigation	2.406	3.084	0.640	
	[1.307]*	[0.842]**	[1.195]	
Expected Trustworthiness	98.665	104.519	87.363	27.498
	[30.475]***	[15.906]***	[35.486]**	[35.852]
Identified * Irrigation Access Year	1.283	1.268	1.334	1.487
	[1.641]	[0.664]	[1.863]	[1.644]
Same DC * Irrigation Access Year	-1.177	-1.184	-1.209	-1.133
	[1.538]	[2.020]	[1.717]	[1.481]
Different DC * Irrigation Access Year	-1.030	-1.034	-0.971	-0.980
	[0.891]	[0.839]	[0.770]	[0.852]
Identified	62.109	61.660	66.364	70.750
	[21.682]***	[16.218]**	[22.242]***	[22.879]***
Same DC	28.440	27.892	32.335	37.767
	[21.697]	[28.207]	[21.865]	[22.180]*
Different DC	26.148	25.765	27.273	32.442
	[16.157]	[11.755]*	[14.655]*	[15.971]**
Dictator Game	0.463	0.458	0.424	0.472
	[0.090]***	[0.048]***	[0.058]***	[0.088]***
Risk Game	0.154	0.125	0.141	
	[0.094]	[0.081]	[0.144]	
Household Head	0.514	-5.100	-68.714	
	[26.499]	[39.361]	[42.352]	
Age	-0.098	0.074	2.231	
	[0.768]	[0.226]	[1.500]	
Sex (1 = male)	-16.917	-11.445	13.395	
	[28.264]	[23.432]	[37.626]	
Education (highest grade completed)	1.000	1.234	2.474	
	[2.817]	[1.435]	[3.348]	
Constant	-17.032	-29.370	-82.717	53.305
	[53.038]	[32.883]	[99.897]	[12.603]***
Number of observations	377	377	377	377
Adjusted R-squared	0.45	0.46	0.45	0.47