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Impact of Participatory Development Projects on Social Capital: Evidence from Farmland Consolidation Projects in Paddy Areas of Japan

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Abstract

This study examines the impact of Japan's participatory development projects, in which communities design proposals for farmland consolidation projects (FCPs), on community-level social capital. The analysis uses large-scale community data that include detailed information on social capital for 29,179 communities (of which 8,067 communities implemented the project and 21,112 did not). We provide propensity score matching estimates. The results reveal a positive impact on bonding social capital, although there is limited evidence of a negative effect on bridging social capital. Further, FCPs increase the number of community meetings held. Treated communities opt for governance that requires higher cooperative levels for irrigation management. Focusing on social ties outside the community, FCPs negatively affect holding direct sales of rice products among urban residents.

Discipline: Agricultural economics
Additional key words: impact evaluation, propensity score matching

Introduction

Promoting beneficiary participation through community development projects and local decentralization has become a central tenet of development policy (Mansuri & Rao 2012). During these processes, local communities are involved in decision-making and the implementation of project design, which directly impacts their daily lives. Participation is expected to result in better outcomes through improved targeting of the poor, reduced project costs, increased project maintenance, and allocative efficiency (Labonne & Chase 2011). In addition, the projects are expected to enhance social capital in beneficiary communities, a lack of which is considered a major obstacle in economic development (for example, see Dasgupta & Serageldin 2000, Grootaert & van Bastelear 2002, Woodhouse 2006, Woolcock 1998).

While there is ample literature on the effects of social capital in development projects, few studies analyze the impact of participatory development on social capital. As a result, the determinants of social capital remain poorly understood (Gugerty & Kremer 2002, Miguel et al. 2006). In particular, it is challenging to generalize institutional impact as projects widely vary by their context, objective, design, and the nature and scale of activities (Casey et al. 2012, World Bank 2002). In each project area, the effects of participatory development on social capital are mixed (Casey et al. 2012, Feigenberg et al. 2013, Gugerty & Kremer 2002, Labonne & Chase 2011, Vajja & White 2008, World Bank 2002).

This study explores the impact of farmland consolidation projects (FCPs)—a participatory development project in Japan—on community-level social capital. Under this project, farmers in rural communities must prepare farmland consolidation proposals that aim at improving labor and land productivity by physically merging and reshaping several small plots of farmland into one large-scale plot. Generally, FCPs are undertaken in combination with *Kanchi*, which means that new single areas of farmland created by FCPs are reallocated through plot exchange among farmers due to changes in farmland sections along with FCPs. If more than two-thirds of the farmers (including landowners) who cultivate in the project area agree, the project is mainly implemented by the prefectural government or a group as a public project. FCPs require farmer involvement in all the stages, from

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project design to implementation.

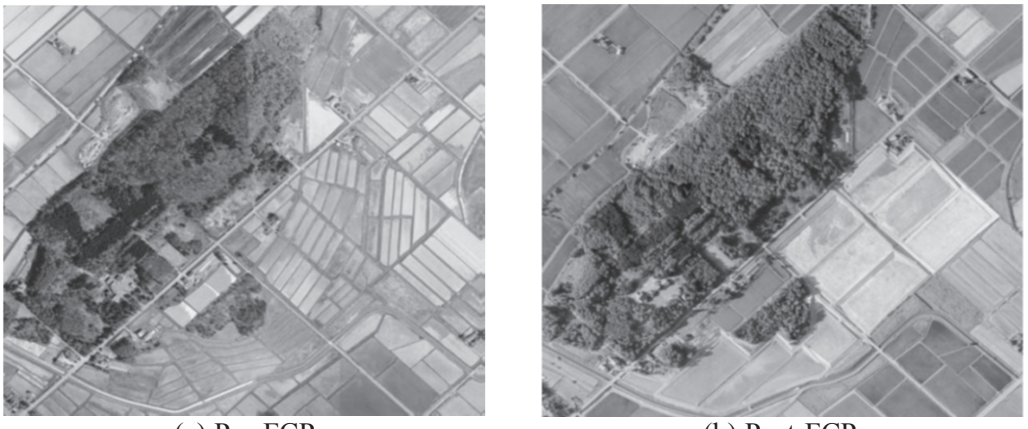
A major contribution of this research is the quantitative analysis of Japan's experiences, which can provide implications for developed countries facing decreasing social capital in rural areas. Rural communities in Japan accumulate social capital through collective action, such as maintaining irrigation facilities for rice production and operation for water allocation. In particular, the experience of operation for water allocation under severe water scarcity enhances social capital, which is also required to face such a challenge. However, the recent trend of declining population in rural areas and the changes in group coordination (e.g., farmer, non-farmer) among rural communities have led to a deterioration of social capital. Rural communities must recover social capital because the combination of accumulated social capital and improved agricultural productivity is relevant for community development (Woodhouse 2006). However, the extent to which FCPs help rural communities accumulate social capital is largely unknown in literature, particularly under the abovementioned circumstances. Therefore, this research examines the relationship between FCPs and social capital. Moreover, in most cases, farm ditches, farm drains and farm roads are improved as part of FCP implementation. It is thus possible that FCP implementation could also deteriorate social capital due to fewer opportunities for collective action on irrigation maintenance and water allocation, once the irrigation canal maintenance schemes are simplified as part of the process. Thus, the possible reduction of social capital induced by FCPs warrants a new policy to ameliorate this decrease in rural areas.

Farmland Consolidation Projects and Social Capital

1. Farmland consolidation projects

Japanese agriculture faces several problems, such as the decline in core farmers and farmland, the aging of farmers, and more abandoned farmland. Therefore, the concentration of farmland among core farmers, defined as those "already operating or aiming to operate an efficient and stable farm, and expected to lead the agricultural sector" (Arimoto 2011), and the effective utilization of farmland are essential for the sustainable development of Japanese agriculture. Although core farmers tend to expand operational farmland, farmland fragmentation, a phenomenon in which farmers operate many dispersed plots, hinders the effective utilization of farmland. According to a 2006 survey conducted by the Ministry of Agriculture, Forestry, and Fisheries (MAFF), the average core farmers' operational size was 14.8 ha, but farmers' plots were divided into 28.5 separate blocks on average. The problem of farmland fragmentation remains unresolved. Consequently, farmland fragmentation is the key cause of low productivity in Japanese agriculture. Economies of scale are not achieved and farmland fragmentation increases both labor and travel costs, owing to the need to travel between the plots.

In considering the importance of resolving farmland fragmentation, the Japanese government thus began implementing FCPs from 1949. The key objective of FCPs is to improve labor and land productivity by physically merging and reshaping several small plots of farmland into one large-scale plot (Fig. 1). In most cases, such infrastructures as farm ditches, farm drains



(a) Pre-FCPs (b) Post-FCPs

Fig. 1. Farmland Consolidation Projects in Japan
Source: Taisetsu Land Improvement District

and farm roads are improved or developed as part of FCP implementation. Generally, subsequent to farmland being reshaped and merged, farmers can negotiate to reallocate to a new single area of farmland. Throughout the process of plot exchange (*Kanchi*), several small plots of farmland are amalgamated into one or two parcels. FCPs are based on proposals made by farmers in a rural community. If more than two-thirds of the farmers (including landowners) who cultivate in the project area agree on project implementation, the project is mainly implemented by the prefectural government or a group as a public project. The central government primarily funds such projects and the remainder is sponsored by prefectures, municipalities, and farm households. Essentially, in case of implementation of FCPs by the prefectural government, the rate of agreement on project implementation in the area implementing FCPs from 2012 to 2014 was 99% (MAFF 2015). An even higher rate of project implementation is preferred for smooth project implementation and infrastructure management after the project. Therefore, FCPs require farmers' involvement in all the stages, from project design to its implementation.

As a result of the progress made by FCPs, 63.8% of the paddy fields in 2014 were 30a parcels and the size of the average parcel of farmland expanded. Even though there are several existing studies reporting the effects of expansion of the average parcel of farmland through FCPs on rental and farmland concentration, and reduction of production cost, these studies rely on anecdotal case studies or descriptive analyses. The study by Arimoto (2011)—the only one that takes the selection issues of project placement into account—finds that FCPs appear to have promoted structural adjustments in the form of outsourcing without reducing the number of farmers, rather than facilitating farmland concentration through exit and reallocation. However, the relationship between FCPs and social capital remains largely unknown in literature.

2. Effects on social capital

(1) Definition of social capital

FCPs have no intention to enhance social capital within communities. In fact, FCPs could change community social capital or promote changes in the management governance of common pool resources, such as irrigation systems, through the implementation process. However, it is challenging to examine the relationship between FCP implementation and community social capital. In addition to various definitions of social capital, there is also a lack of consensus (Durlauf & Fafchamps 2005). Social capital is a broad concept that includes formal and informal institutions that facilitate community members' collaboration through existing networks along with shared norms, values, and understandings (Labonne & Chase 2011).

This study defines social capital as the ease with which community farmers engage in collective action to produce socially efficient outcomes and avoid inefficient non-cooperative traps, such as the prisoners' dilemma or free-rider problem (Labonne & Chase 2011, Porta et al. 1997). We divide social capital into bonding and bridging social capital. We define bonding social capital as the ease with which farmers within a community collectively action, and bridging social capital as the ease with which community farmers and other communities or stakeholders engage in collective action.

(2) FCPs and social capital

FCPs not only improve agricultural productivity but also encourage meetings to discuss the future use of rural farmland within the project area during the implementation phase. Therefore, FCPs are expected to contribute toward the accumulation of bonding social capital through the agreement of farmers to cultivate post the project implementation and hold meetings regarding future land use, as well as the reallocation process of new plots. However, it is also possible that FCP implementation could deteriorate bonding social capital due to fewer opportunities for collective action on irrigation maintenance and reducing water allocation, once the irrigation canal maintenance schemes are simplified as part of the process. Therefore, FCPs can have a positive or negative effect on bonding social capital. It is possible that FCPs could also affect the accumulation of bridging social capital as they require cooperation with other communities and administrative bodies to implement such projects.

(3) Effects on bonding social capital

FCPs are implemented as public projects under agreements of farmers to cultivate in project areas, including rural communities. This is due to the fact that if a farmland is reshaped as part of an FCP, one cannot avoid reshaping adjacent farmlands owned by other farmers. Moreover, expanding a parcel of farmland by merging small plots in a project area requires coordination among a large number of farmers to cultivate, in order to negotiate individual ownership of the new plots once the farmland is readjusted. Consequently, bonding social capital may be accumulated through consensus building in the project area during project implementation and post-FCP reallocation. While the primary objective of FCPs is to improve productivity, nurturing the development of core farmers in the project area and concentrating farmland have been the major objectives since 1993. Further, the project encourages communities to hold meetings to establish

a consensus on future farmland use to resolve issues, such as fragmentation in the project area. This could also strengthen links within a community, leading to the accumulation of bonding social capital.

However, FCPs may also negatively impact bonding social capital. In Japan, the irrigation systems generally supply water to parcels of paddy fields in succession. Many farmers are the beneficiaries of one irrigation system. Small and fragmented paddy fields adopt plot-to-plot irrigation and the irrigation canals also serve as drainage in the irrigation system. Therefore, interactions among farmers to cultivate are indispensable to water allocation (i.e., timing, amount). Considering such a long period of experience in irrigation management and operation, direct and indirect networks are formed between farmers to cultivate paddy fields in the area. When FCPs are implemented, the size of the average parcel of farmland is expanded and fragmentation is resolved. In addition, the roles of delivery and drainage in the irrigation system are completely separated. As a result, it is possible to perform independent water allocation in only one farmer's paddy field. In this case, the importance of consensus among neighboring farmers in a project area diminishes when adjusting water allocation during normal times. However, this is not the case during a drought, even when FCPs are completed. Thus, it is also possible that bonding social capital could deteriorate; however, it is unclear whether the positive or negative effect of FCPs on bonding social capital will dominate.

(4) Effects on bridging social capital

In most cases, FCPs are implemented as a joint project in an entire district, covering more than one community. In this case, consensus building must occur between communities in the project area. Further, close relationships with relevant organizations, such as municipalities and governments, are essential for FCP implementation. These community activities during project implementation enhance ties between those concerned and other communities or local governments. As a result, the community accumulates bridging social capital through FCP implementation.

Data and identification strategy

1. Data

The data used in this analysis are from the *Rural Community Card, World Census of Agriculture and Forestry 2000*. This census has been taken every five years since 1950, and includes information on agriculture and forestry at the prefecture, municipality, old municipality (area of municipality in 1950), and rural community (smallest unit of regional society in rural villages) levels. FCPs are targeted at the rural community level and their effects are strongly reflected in the rural community-level agricultural data. Hence, we use the community as a unit of observation. We also utilize FCP-related data from 1990 to 2000.

The indicator of FCP implementation in a rural community is a dummy variable if an FCP was implemented between 1990 and 2000, enabling us to compare treated and untreated communities. Following Arimoto (2011), the dummy variable is set to one, if the area of the readjusted farmland increases *and* the ratio of the readjusted farmland increases by more than a specific number of percentage points (at least 50 percentage points) during 1990-2000; otherwise, it is zero. We adopt a 50 percentage point threshold as it is necessary for the ratio of the readjusted farmland to be larger by a certain degree in the treated communities to observe the effects. For a robustness check, we create indicators for FCP implementation by assessing the rate of increase (percentage points) and the ratio of readjusted farmland using the following four approaches:

(1) The variable is set to one if the area of readjusted farmland increases *and* the ratio of readjusted farmland rises during 1990-2000; otherwise, set to zero.
(2) The variable takes the value of one if the area of readjusted farmland increases *and* the ratio of readjusted farmland rises by more than 50 percentage points between 1990 and 2000; otherwise, set to zero.
(3) The variable is set to one if the area of readjusted farmland increases *and* the ratio of readjusted farmland rises by more than 75 percentage points between 1990 and 2000; otherwise, set to zero.
(4) The variable takes the value of one if the area of readjusted farmland increases *and* the ratio of readjusted farmland rises by 100 percentage points during 1990-2000; otherwise, set to zero.

The outcomes of FCPs are bonding and bridging social capital. However, these concepts are intangible and thus challenging to quantify. We begin by developing a measurement of the degree of bonding and bridging social capital in a community. Bonding and bridging social capital in a community are measured in terms of the collective activities performed by community members.

Community collective activities for bonding social capital include: (a) the number of meetings held by farmers to practice collective activities (excluding meetings regarding FCP implementation); (b) the number of agriculture-related organizations for the youth, women, and elderly (e.g., collective organizations that supply agricultural products, produce processed agricultural products, directly sell agricultural products), and (c) the

governance of collective activities for the management of common pool resources, such as irrigation canals and farm roads (coded as follows: all residents = 4, only farmers = 3, employees = 2, not implemented = 1, and nonexistent = 0). These variables are used as indicators of bonding social capital and are treated as a proxy for collective action taken by a community. Additional bonding social capital is accumulated if a community has many collective organizations involving farmers. Moreover, the management of common pool resources is simply a collective action. The level of collective action is highest for the management of common pool resources by all residents in a community: all community members must participate in the operations and maintenance of these facilities. The management of common pool resources by farm households is characterized by a lower level of collective action as non-farm households are excluded. For the management of common pool resources by employees and "not implemented" groups, intensive cooperation is not essential. In particular, the ranking of "not implemented" group is thus lower as management is not executed or controlled by the community.

Bridging social capital in a community is measured in terms of whether a community engages in collective activities for urban residents. Community collective activities for bridging social capital represent a binary variable for (a) whether the community offers a project that allows urban residents to experience agriculture, forestry, and fisheries; (b) whether the community undertakes the direct sale of agricultural products to urban residents; and (c) whether the community provides study-away opportunities for urban residents in the community. Additional bridging social capital, which represents the connections between the community and different stakeholders, can be accumulated when communities conduct more collective activities for urban residents. Table 1 presents the descriptive statistics for these variables; Table A-1 presents the definitions of these variables.

Following Fujiie et al. (2005), we obtain proxy variables for bonding and bridging social capital by applying a principal component analysis. The principal

Table 1. Descriptive statistics of variables

Variable	Obs.	Year	Mean	S.D.
A. Characteristics				
Agricultural area (urban)	39,652	1990	0.286	
Agricultural area (intermediate)	39,652	1990	0.354	
Agricultural area (mountainous)	39,652	1990	0.198	
Distance to DID (0.5- 1 hr)	39,652	1990	0.247	
Distance to DID (more than 1 hr)	39,652	1990	0.061	
Ratio of elderly farmers	39,652	1990	40.366	15.313
Ratio of part-time farm households	39,652	1990	71.942	21.157
Number of farm households	39,652	1990	17.250	14.321
Gradient (flat)	39,652	1990	0.537	
Gradient (gentle)	39,652	1990	0.320	
Agricultural promotion area	39,652	1990	0.860	
Agricultural promotion area (farmland)	39,652	1990	0.716	
City planning area (urbanization promotion area)	39,652	1990	0.177	
City planning area (urbanization control area)	39,652	1990	0.256	
City planning area (not designated)	39,652	1990	0.258	
Social capital ('90)	39,652	1990	-0.176	1.255
Readjustment dummy	39,652	2000	0.250	
B. Specific outcomes (bonding social capital)				
Number of meetings	29,179	2000	7.461	5.76
Number of agriculture-related organizations for youth	29,179	2000	0.018	0.16
Number of agriculture-related organizations for women	29,179	2000	0.122	0.43
Number of agriculture-related organizations for elderly	29,179	2000	0.030	0.22
Irrigation management	29,179	2000	2.692	1.27
Farm road management	29,179	2000	2.782	1.36
C. Specific outcomes (bridging social capital)				
Experience program for agriculture, forestry, and fisheries	29,179	2000	0.019	
Direct sale of agricultural products	29,179	2000	0.051	
Program for temporary transfer to rural community	29,179	2000	0.005	

component scores are calculated after normalizing each variable by subtracting the average from each individual observation and dividing these differences by the standard deviation. We use the first component score as a composite measure of bonding and bridging social capital. Thus, we use the principal component score, which captures the eigenvalues from one or more components within each category, as a measure of social capital.

We exclude rural communities in the prefectures of Hokkaido and Okinawa, which differ considerably from other prefectures in terms of agricultural conditions, as well as Tokyo, Kanagawa and Osaka, which are mainly urbanized. In addition, we exclude rural communities where upland farming without paddy fields was the mainstay of agricultural production in 1990, as the rural community origin and agricultural production environments differ significantly from those in rural communities with paddy fields. And following Arimoto (2011), we only include rural communities whose ratio of readjusted farmland in 1990 was 0% for the following two reasons. First, the impact of FCPs on social capital does not appear immediately. Hence, if the treated communities completed their FCPs before 1990, we would be unable to separately identify the effects of FCPs implemented before and after 1990. Second, if the untreated communities implemented FCPs before 1990, their effects could appear after 1990. In this case, the communities can no longer be considered "untreated." Consequently, rural communities are limited to those where FCPs were not implemented in 1990. Next, we measure the impact of FCPs on social capital by comparing the rural communities without FCPs to those with FCPs post-1990. Table 2 presents the sample size (treated and untreated communities).

2. Identification strategy

The objective of this study is to explore the impact of FCPs on social capital in Japan. Thus, we estimate the average treatment effect on the treated (ATT), which is defined as:

$$ATT = E(Y_i(1)-Y_i(0)\,|\,D_i=1)=E(Y_i(1)\,|\,D_i=1)-E(Y_i(0)\,|\,D_i=1), \quad (1)$$

where Y_i (D_i) is the outcome variable (social capital indicator) in community i and D_i is a dummy variable equal to one when community i implements an FCP; otherwise, set to zero.

ATT is defined as, given the participation of community i in an FCP, the difference in the expected values of social capital that community i would have achieved with or without FCP. Therefore, the first term on the right side of Eq. (1), $E(Y_i(1)\,|\,D_i=1)$, is observable, whereas the second term, $E(Y_i(0)\,|\,D_i=1)$, is not. If FCPs were randomly assigned to communities, we could replace the second term on the right side of Eq. (1) with the outcome for a community that has not implemented FCPs. However, as described above, FCPs have not been randomly implemented. In order to address this problem, we use the propensity score matching (PSM) method (Rosenbaum & Rubin 1983). This method involves matching each project participant with a similar non-participant by calculating the probability of participation based on observable pre-project characteristics. In this manner, we can match a treated community with an untreated one using a similar probability of implementing FCPs. The probability of implementing FCPs, $P(X_i)$, is the propensity score and estimated using a probit or logit model. If X_i denotes the community characteristics, the PSM estimator of the ATT is defined as:

$$ATT=E(Y_i(1)\,|\,D_i=1,P(X_i))-E(Y_i(0)\,|\,D_i=0,P(X_i)). \quad (2)$$

In addition, given the common support condition, which is a common support or overlap condition that can be relaxed to $P(D_i=1\,|\,X_i)<1$ in the ATT estimation (Khandker et al. 2009), Eq. (2) can be rewritten as:

$$ATT=\frac{1}{N}\sum_{i\in T}[Y_i(1)-\sum_{j\in C}w(i,j)\,Y_j(0)], \quad (3)$$

where N is the number of observations for the treated communities, T and C are the treated and matched untreated communities, respectively, and $w(i,j)$ is a weight determined based on the propensity score. Various matching techniques have been proposed using this weight. We apply the one-to-one nearest neighbor, radius, and kernel matching as the matching methods.

Table 2. Sample size (treated and untreated communities)

	Readjustment dummy	Readjustment dummy (more than 50%)	Readjustment dummy (more than 75%)	Readjustment dummy (100%)
Treated	8,067	6,240	4,851	3,166
Untreated	21,112	21,112	21,112	21,112
Total	29,179	27,352	25,963	24,278

Note: Rates of increase in readjusted farmland between 1990 and 2000 are in parentheses.

Empirical results

1. Propensity score matching

Prior to employing PSM, the propensity score is estimated using a probit model. Panel A in Table 1 reports the community characteristics in 1990 used as independent variables in the probit model. The independent variables are selected according to Arimoto (2011), which studies the determinants of FCP implementation in Niigata prefecture. In particular, he indicates that communities with relatively favorable conditions (e.g., flatter gradients, close to urban areas, urbanization or agricultural promotion area) tended to implement FCPs. Further, we include a measure of bonding social capital in 1990 to control the effects of social capital accumulated in a rural community on FCP implementation. This measure is the principal component score obtained on the basis of the number of meetings held by farmers, and the method of management for irrigation canals and farm roads.

Table 3 presents the marginal effects of the determinants of FCP implementation. The probit regression results can be summarized as follows: First, communities in mountainous, urban, and city planning areas have a lower probability of implementing FCPs, while those with flat slopes or located far from a densely inhabited district in an agriculture promotion area have a higher probability of doing so. Communities without favorable agricultural conditions are less likely to implement FCPs. Second, communities with a high number of elderly farmers have a lower probability of implementing such projects, whereas those with many farmers and part-time farm households have a higher probability of doing so. These results are consistent with those of Arimoto (2000) on Niigata prefecture.

We match treated communities with untreated ones with a similar probability of implementing FCPs using the propensity score derived from the probit regression. When matching, we apply the one-to-one nearest neighbor, radius, and kernel matching, imposing the common support condition. We adopt distribution as the kernel function and set the bandwidth to 0.06. If the difference between the treatment and control groups in terms of the propensity score is within a radius of 0.01, we match it by applying radius matching. Further, we conduct a balancing test to check whether the matched treated and untreated communities are similar in terms of their distributions of community characteristics. We perform Sianesi's (2004) balancing test and find no difference between the treated and untreated communities after matching, where our matching strategy proved successful.

2. Aggregate indices

Table 4 lists the PSM estimates for the ATT from Eq. (3). The standard errors are obtained by bootstrapping with 100 replications. The results can be summarized as

Table 3. Probit estimates of project placement

	Marginal effects	S.E.
Agricultural area (urban)	-0.078 ***	0.007
Agricultural area (intermediate)	-0.037 ***	0.007
Agricultural area (mountainous)	-0.032 ***	0.008
Distance to DID (0.5-1 hr)	0.055 ***	0.006
Distance to DID (more than 1 hr)	0.050 ***	0.011
Gradient (flat)	0.126 ***	0.007
Gradient (gentle)	0.070 ***	0.008
Agricultural promotion area	0.036 ***	0.009
Agricultural promotion area (farmland)	0.106 ***	0.006
City planning area (urbanization promotion area)	-0.005	0.008
City planning area (urbanization control area)	-0.044 ***	0.006
City planning area (not designated)	-0.020 ***	0.006
Ratio of elderly farmers	-0.001 ***	0.000
Ratio of part-time farm households	0.001 ***	0.000
Number of farm households	0.003 ***	0.000
Social capital ('90)	0.007 ***	0.002
Observations	39,652	
LR $chi^2(16)$	2,165.88	
Log likelihood	-21,194.97	
Pseudo R^2	0.049	

Note: *** denotes significance at the 1% level.

follows: First, regardless of the matching methods, FCPs positively impact bonding social capital, and are robust relative to the rate of increase in readjusted farmland between 1990 and 2000. However, note that this result captures the overall effect of FCPs. As the effect of FCPs on bonding social capital has both positive and negative aspects, the result implies that the positive effect is larger than the negative effect. If FCPs are implemented in all the paddy areas (100% readjustment dummy), the reduction in bonding social capital that is larger than the other indicator, which is the positive effect, reduces as irrigation maintenance and water allocation are simplified in the treated community. Second, there is limited evidence of a negative impact on bridging social capital. Note that this set of results is not robust to the matching methods and the rate of increase in readjusted farmland for 1990-2000.

3. Specific outcomes

We now focus on the specific outcomes in terms of bonding and bridging social capital (Table 5). We only report the results for the readjustment dummy as the estimates are similar in sign and size, regardless of the treatment indicator. Notwithstanding the matching methods, FCPs positively affect the number of meetings. Prior to FCPs being implemented, communities have the opportunity to establish an agreement among farmers to cultivate in the project area and determine the nature of future farmland use in the project area.

Ever since the Agricultural Management Basis Improvement Law was enacted in 1993, the major objectives of FCPs have shifted from improving the productivity of individual farms to nurturing the development of core farmers in the project area and concentrating farmland among them. Therefore, subsequent to FCPs, it is possible that the treated community in a project area increases the number of meetings in order to attain this objective. These opportunities can lead to the activation of a treated community and increase meetings in treated communities as a result of project implementation.

While there is evidence of a positive effect on management governance for irrigation systems, it remains limited for the negative effect on the management governance of farm roads. Treated communities opt for governance that requires higher cooperative levels for irrigation management and lower levels for farm road management. In case of irrigation management, as a result of FCPs implementation, operation and maintenance activities for irrigation systems are more simplified. Nevertheless, collective activities of operation and

Table 4. Project effects on bonding social capital (propensity score matching estimates)

	Before matching	One-to-one NN matching	Radius matching	Kernel matching
Bonding social capital				
Treated vs. untreated	0.160 ***	0.092 ***	0.114 ***	0.118 ***
	(0.013)	(0.023)	(0.015)	(0.017)
Treated (more than 50%) vs. untreated	0.168 ***	0.080 ***	0.119 ***	0.123 ***
	(0.017)	(0.025)	(0.019)	(0.019)
Treated (more than 75%) vs. untreated	0.169 ***	0.109 ***	0.116 ***	0.121 ***
	(0.020)	(0.028)	(0.020)	(0.019)
Treated (100%) vs. untreated	0.146 ***	0.091 ***	0.102 ***	0.105 ***
	(0.027)	(0.033)	(0.005)	(0.025)
Bridging social capital				
Treated vs. untreated	-0.010	-0.029	-0.011	-0.012
	(0.013)	(0.021)	(0.014)	(0.015)
Treated (more than 50%) vs. untreated	-0.023	-0.006	-0.024	-0.025
	(0.016)	(0.021)	(0.019)	(0.018)
Treated (more than 75%) vs. untreated	-0.032	0.004	-0.031 **	-0.033 **
	(0.018)	(0.024)	(0.016)	(0.016)
Treated (100%) vs. untreated	-0.028	0.006	-0.029	-0.030
	(0.020)	(0.028)	(0.022)	(0.220)

Note: ** and *** denote significance at the 5% and 1% level, respectively. The standard error (in parentheses) for nearest neighbor matching is the variance estimator suggested by Abadie and Imbens (2016). The standard errors (in parentheses) for Radius and Kernel matching are obtained from bootstrapping with 100 repetitions.

maintenance by community members are required, similar to the previous situation, due to the fact that both cannot be performed by only a few farmers, particularly the activities for irrigation systems and water allocation. In addition, treated communities select governance that requires higher cooperative levels for irrigation management results from community revitalization through FCP implementation. Conversely, the implementation of FCPs simplified the farm road structure and changed unpaved farm roads to paved roads. Collective activities for farm road management are not required as the burden of farm road management is reduced. Moreover, farm road management by farmers is no longer required as there are also cases where parts of farm roads are being transferred to municipal management after FCPs.

Focusing on the elements for bridging social capital, FCPs negatively affect holding direct sales of agricultural products. As this analysis is limited to FCPs of paddy fields, it is possible that FCPs ameliorate the low agricultural productivity of rice, increase the production of rice, and encourage farmers to ship rice to an agricultural cooperative association for cooperative marketing, making it unnecessary to directly sell rice products to the consumers.

Conclusion

In this study, we examined the impact of FCPs, a participator development project, on social capital in Japan by applying a propensity score matching estimation to a community-level dataset. Our results indicate that FCPs led to changes in community-level social capital and institution dynamics. In addition, we found evidence of a positive impact on bonding social capital, but limited evidence of a negative impact on bridging social capital. FCPs also increase the number of community meetings held. Treated communities opt for governance that requires higher cooperative levels for irrigation management. Focusing on social ties outside the community, FCPs also negatively affect holding direct sales of agricultural products. Our findings suggest that communities must design approaches to strengthen social ties with those outside the community, while maintaining bonding social capital along with FCP implementation, as the combination of accumulated social capital and

Table 5. Project effects on bonding social capital, specific outcomes (propensity score matching estimates)

	Before matching	One-to-one NN matching	Radius matching	Kernel matching
Bonding social capital				
Number of meetings	0.829 ***	0.649 ***	0.656 ***	0.670 ***
	(0.074)	(0.109)	(0.088)	(0.073)
Number of agriculture-related organizations for youth	0.001	0.001	1.211E-04	1.044E-04
	(0.002)	(0.003)	(0.002)	(0.002)
Number of agriculture-related organizations for women	-0.009	-0.002	-0.008	-0.008
	(0.005)	(0.008)	(0.006)	(0.005)
Number of agriculture-related organizations for elderly	-0.005	-0.004	-0.003	-0.004
	(0.003)	(0.004)	(0.003)	(0.003)
Irrigation management	0.152 ***	0.071 ***	0.107 ***	0.112 ***
	(0.014)	(0.022)	(0.016)	(0.017)
Farm road management	-0.037 **	-0.126 ***	-0.103 ***	-0.099 ***
	(0.017)	(0.019)	(0.018)	(0.018)
Bridging social capital				
Experience program for agriculture, forestry, and fisheries	-0.001	-0.002	-9.200E-05	0.000
	(0.002)	-0.003	(0.002)	(0.002)
Direct sale of agricultural products	-0.007 **	-0.011 ***	-0.009 ***	-0.010 ***
	(0.003)	(0.004)	(0.003)	(0.003)
Program for temporary transfer to rural community	0.001	0.001	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)

Note: ** and *** denote significance at the 5% and 1% level, respectively. The standard error (in parentheses) for nearest neighbor matching is the variance estimator suggested by Abadie and Imbens (2016). The standard errors (in parentheses) for Radius and Kernel matching are obtained from bootstrapping with 100 repetitions.

improved agriculture productivity is relevant for community development (Woodhouse 2006).

There are two caveats in terms of the results of this study. First, our study is limited to a sample where the ratio of readjusted paddy fields is zero in 1990. However, FCPs were implemented before 1990 and the results do not account for the effect of these FCPs. Second, treated communities have varying exposure periods between the completion of their FCPs and the evaluation in 2000; however, we were unable to identify this owing to data limitations. Despite the two limitations above, our results offer useful insights on the future design of participatory agricultural development programs.

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Table A-1. Definition of Variables

Variable	Definition
Characteristics	
Agricultural area (urban)	Dummy = 1 if agricultural area is clasified as urban area and 0 otherwise
Agricultural area (intermediate)	Dummy = 1 if agricultural area is classified as intermediate agricultural area and 0 otherwise
Agricultural area (mountainous)	Dummy = 1 if agricultural area is classified as mountainous agricultural area and 0 otherwise
Distance to DID (0.5-1 hr)	Dummy = 1 if the time distance to a densely inhibited district (city/town/village) is 0.5- 1 hour and 0 otherwise
Distance to DID (more than 1 hr)	Dummy = 1 if the time distance to a densely inhibited district (city/town/village) is more than 1 hour and 0 otherwise
Ratio of elderly farmers	Denominator = total population engaged in farming
Ratio of part-time farm households	Denominator = total number of farm households
Number of farm households	Total number of farm households
Gradient (flat)	Dummy = 1 if gradient is smaller than 1/100 and 0 otherwise
Gradient (gentle)	Dummy = 1 if gradient is between 1/100 and 1/20 and 0 otherwise
Agricultural promotion area	Dummy = 1 if the community is in an agricultural promotion area and 0 otherwise
Agricultural promotion area (farmland)	Dummy = 1 if the community is in an agricultural promotion area and designated as a farmland area and 0 otherwise
City planning area (urbanization promotion area)	Dummy = 1 if the city planning area is an "urbanization promotion area" and 0 otherwise
City planning area (urbanization control area)	Dummy = 1 if the city planning area is an "urbanization control area" and 0 otherwise
City planning area (not designated)	Dummy = 1 if the community is in a city planning area but not designated as an urbanization promotion or control area and 0 otherwise
Social capital ('90)	Social capital of the community in 1990
Readjustment dummy	Dummy = 1 if the area and ratio of readjusted farmland increased between 1990 and 2000 and 0 otherwise
Specific outcomes (bonding social capital)	
Number of meetings	Total number of meetings held by farmers (not include meetings with regard to FCPs implementation)
Number of agriculture-related organizations for youth	Total number of agriculture-related organizations for youth
Number of agriculture-related organizations for women	Total number of agriculture-related organizations for women
Number of agriculture-related organizations for elderly	Total number of agriculture-related organizations for the elderly
Irrigation management	All residents = 4, only farmers = 3, employees = 2, not implemented = 1, nonexistent = 0
Farm road management	All residents = 4, only farmers = 3, employees= 2, not implemented = 1, nonexistent = 0
Specific outcomes (bridging social capital)	
Experience program for agriculture, forestry, and fisheries	Dummy = 1 if an experience program related to agriculture, forestry, and fisheries is offered and 0 otherwise
Direct sale of agricultural products	Dummy = 1 if direct sale of agricultural products is undertaken and 0 otherwise
Program for temporary transfer to rural community	Dummy = 1 if study trips are offered to the rural community and 0 otherwise