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Conditions for Collective Land Use by Community-Based Organizations: Case Study of Community Farming Enterprises in Japan

RESEARCH ARTICLE

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ABSTRACT

The small scale of farms and scattered farmland plots in Japanese agriculture have hindered efficient farmland utilization. We used the spatial anticommons problem as the theoretical grounding to study the conditions for collective land use by community farming enterprises. We achieved this by constructing large-scale community-level data, on community farming enterprises and community characteristics, for six prefectures in the Hokuriku and Kinki regions (12,028 rural communities). Then, using regression analysis, we examined the relationship between the collective use of farmland through collective farming enterprises and the variables related to community functions, controlling for the characteristics of rural communities and dummy variables for former municipalities. The results of the descriptive statistics and econometric analysis indicated that the level of farmland improvement projects and the scale of community functions, such as the number of local meetings, are positively associated with the collective use of farmland by community farming enterprises. These factors affecting collective actions are similar to those in the case of common pool resources in the existing literature. This finding suggests that a community-based self-governing mechanism can play an important role for the governance of underused resources, i.e., the tragedy of the anticommons, as in the case of the tragedy of the commons.

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1. INTRODUCTION

The traditional inverse productivity–size relationship is being replaced by a positive relationship in the agricultural sector in East Asian countries, owing to successful industrialization that has absorbed labor into non-agricultural sectors and increased real wages (Yamauchi et al., 2021). In these countries, large farms have increased their productivity by utilizing large-scale machines efficiently, saving increasingly costly labor, and thereby realizing economies of scale.

Japan is a high-income country in East Asia with a small land endowment. The small scale of its farms has led to inefficient farmland utilization. This inefficiency encompasses both the economic and environmental perspectives because agriculture also provides non-commodity outputs such as agri-environment and rural landscapes (OECD, 2001). Another source of inefficiency is farmland fragmentation, in which farming is undertaken over multiple separate plots of land. Kawasaki (2010) argues that fragmentation increases production costs and offsets economies of size. Farmland abandonment is an extreme case of the inefficient use of farmland in Japan, causing economic loss and negative external effects on the environment.

In Japan, the property rights of farmland are privatized and protected. While the private property rights may promote transactions in general, it has been difficult to expand farm size through sale and tenancy because of the postwar land laws, which restricted ownership of farmland and protected the tenancy rights (Hayami & Kawagoe, 1989). The scattered farmland holding inherited from the feudal Tokugawa period has also been entrenched by the postwar land reforms. Although these restrictions have been partly removed, the anticipation of future conversion for non-agricultural use has increased land prices and hampered sales and tenancy (Takahashi, 2012).

This study aims to clarify the conditions for farmland consolidation through community-based organizations that would result in the efficient use of farmland in Japan.[1] The concentration of farmland among principal farms has gradually increased in recent years, with the retirement of old small-scale farmers. However, with principal farms operating leased-in farmlands at a distance from their original plots, the fragmentation of farmland is also increasing. Considering the high transaction costs of farmlands and the problems of supplying farmland-related public goods, it is difficult to achieve farmland concentration and consolidation through market transactions, thus necessitating institutional assistance.[2] Takahashi et al. (2018) examined the conditions for the collective use of farmlands, employing a multi-person non-cooperative game on farmland use. They classified the various types of farmland consolidation into four simplified models and compared their advantages through case studies and econometric analysis.

Community farming is one of the potential models in Takahashi et al.'s (2018) framework for the consolidation of scattered land-holdings in Japan. In this study, we examine the conditions for establishing the community farming enterprise, which is a common practice for community-based farmland management in Japan. The Survey of Community Farming by the Ministry of Agriculture, Forestry and Fisheries (MAFF) defines community farming as farming under an agreement of sharing and unifying part or all of the agricultural production processes in a community.[3] Households participating in a community farming enterprise make an agreement concerning the organizational form of the enterprise, farmland use plan, farm machinery use plan, selection of board members and operators, cultivation methods, and other matters related to community farming. There are various types of community farming in different areas, but the so-called "sole farm management type" of community farming enterprises regards and operates most of the farmland in the community as a sole farm.

According to Iba and Sakamoto (2014), a community farming enterprise can be defined as an organization of members of a community who are collectively engaged, whether partially or fully, in agricultural production. They argue that community farming enterprises are innovative endeavors combining community members' self-help and mutual support to tackle challenges in Japanese rural areas. The consolidation of farmland through community farming has a significant effect on its efficient use. Community farming is important to ensure the efficiency of farmland use and the conservation of local agricultural resources, particularly in areas with no principal farmers and where part-time farming is common. According to Shobayashi and Okajima (2014), community farming can coordinate the interests of various actors because it advances farmland consolidation while maintaining the relationship between landowners and cultivators.

Although many studies have examined the conditions for the formation of community farming in Japan, most are observational or analyze small-scale sample surveys. Similarly, most studies on collective land use in other countries are also based on a small sample of observations. Garcia-Alvarez-Coque et al. (2021), using the framework proposed by Takahashi et al. (2018), discuss multi-actor arrangements for farmland management in Eastern Spain based on a small-scale survey. By comparison, this study uses unique large-scale community-level data to clarify the conditions of successful collective land use by community

farming enterprises. This study provides insights on achieving joint cropland management strategies in both high-income and emerging countries.

Investigating the conditions of collective land use has implications for the management of local resources in general. The inefficient use of farmland caused by scattered plots and numerous landowners is a typical problem of the underuse of resources. Farmland problems in Japan are also related to "the tragedy of anticommons" (Buchanan & Yoon, 2000; Heller, 1998), as individual cultivation associated with the fragmented farmlands of small-scale farmers prevents the efficient use of resources, which is possible when using farmland collectively. Ostrom (1990) investigates community-based self-governing mechanisms for common pool resources. Recent studies, such as those of Miyanaga and Shimada (2018) and Hirahara (2020), examine the underuse of semi-natural grassland as common pool resources and discuss the consequences and causes of underuse. Takamura et al. (2021) and Takahashi et al. (2021) investigate the underuse problem of common property forests in Japan as an anticommons problem. The current analysis discusses the underuse of farmlands, which are private properties that provide economic benefit and agri-environmental public goods when used collectively, and demonstrates how community-based organizations can overcome the tragedy of the anticommons.

2. THEORETICAL GROUNDING

2.1 FARMLAND FRAGMENTATION AS AN ANTICOMMONS PROBLEM

According to Heller (1998), anticommons property is defined as a property regime in which multiple owners hold formal and informal rights of exclusion in a scarce resource. A tragedy of the anticommons occurs when too many rational individuals who have rights of exclusion in a scarce resource collectively waste the resource by under-consuming it, compared with a social optimum. This is the inverse of a tragedy of the commons (Hardin 1968), which occurs when too many rational individuals who have privileges of use over-consume scarce resources.

The symmetry between the commons and anticommons problems is discussed in Buchanan and Yoon (2000) and Parisi et al. (2005). Buchanan and Yoon (2000) argue that the conventional commons problem emerges as more people are assigned usage rights, while the anticommons problem emerges as more people are assigned exclusion rights. Parisi et al. (2005) discuss the duality of commons and anticommons problems: the problem of the commons is related to a negative externality of use rights, while the problem of anticommons is related to a negative externality of exclusion rights. Additionally, Parisi et al. (2005) suggest that commons and anticommons problems are the consequence of a lack of conformity between use and exclusion rights.

We argue that the farmland fragmentation problem is a case of spatial anticommons. According to Heller (1998), spatial anticommons can be defined as "each anticommons owner receives a core bundle of rights, but in too small a space for the most efficient use." Takamura (2018), considering the situation of rural areas in Japan, proposes a variant of spatial anticommons: scattered plots anticommons. Takamura (2018) discusses the difference between the spatial anticommons by Heller (1998) and the scattered plots anticommons. In the scattered plots anticommons, households own multiple small-size plots with scattered distribution, while small-size properties are owned by multiple owners in the spatial anticommons. Both a large number of users and scatteration cause underuse of resources in the scattered plots anticommons. The case studies of farmland fragmentation in Takahashi et al. (2018) show a very similar pattern to the conceptual diagram of scattered plot anticommons in Takamura (2018, p. 79).

2.2 GOVERNING THE SPATIAL ANTICOMMONS

Some previous research, such as the study conducted by Hess and Ostrom (2003), has explored the "legal anticommons (Heller 1998)" in the field of knowledge and suggested measures to overcome its issues through legal and political systems. However, the theory of governing the spatial anticommons in the field of natural resources has not previously been developed theoretically or empirically.

Schlueter (2008) studies the case of small-scale European forestry as a spatial anticommons problem. The forest land is strictly private property, but the products generated are a combination of the production of public and private goods. Schlueter (2008) argues that even if the outcomes of the tragedy of the commons and the tragedy of the anticommons are opposed, analyzing the solutions to the problems requires the same theoretical background: collective action problems. This analysis can be applied to the problem as farmlands are also private property that provides agri-environmental public goods, and are strictly protected by the postwar land laws but suffer from the underuse of resources.

The collective action problem has previously been applied to natural resource management in Japan. Takeda (2015) and Takayama et al. (2018) study the determinants of collective actions in irrigation management systems. However, while the past studies discuss collective actions

on the common pool resources, this study deals with private properties that provide agri-environmental public goods.

2.3 CONDITIONS OF COLLECTIVE LAND MANAGEMENT IN JAPAN

Based on the theoretical grounding above, we discuss the conditions of collective actions for tackling the farmland fragmentation problem in Japan.

The pioneering study by Ishida and Kiminami (1987) has already noted various difficulties in forming and maintaining community farming enterprises. The authors argue that community farming can reduce the economic costs of cultivation by shortening working hours and saving on machinery and facilities. They examine why some communities form and maintain community farming, while others do not. They note that it is necessary to consider not only the economic cost of cultivation but also the cost of building consensus and maintaining the organization necessary for collective actions. Ishida and Kiminami (1987) also find that cooperative relationships in communities lowered the consensus-building costs, as well as costs for maintaining the community farming organization. Their discussion is not based on the anticommons theory but sheds light on the conditions of community-based organizations.

Takahashi et al. (2018) examine the conditions for the collective use of farmlands, employing a multi-person non-cooperative game on farmland use. They identified three parameters for collective land use: (1) profit from collective land use $a(n)$, (2) profit from individual land use, or opportunity cost for collective land use $b(n)$, and (3) transaction costs of collective land use $c(n)$, where n represents the number of participating farmers. They observed that communities switch to collective land use if the change in profits resulting from this switch is larger than the transaction costs ($a–c>b$), and if the group can coordinate the members to switch to collective land use. However, their study, based on small-size data, did not fully identify the factors for each parameter and the conditions for collective actions.

2.4 FRAMEWORK FOR COLLECTIVE ACTION OUTCOMES

Based on the discussion above, we adopt a modified version of Ostrom's Institutional Analysis and Development (IAD) Framework (Ostrom, 2005) to explain collective actions. Existing studies, such as Zang et al. (2019), also adopt the IAD framework to explain collective actions for managing irrigation commons. In the IAD framework by Ostrom (2005), the set of dependent variables is in an action arena, in which participants and action situations interact. Ostrom (2005) proposes several factors that affect the structure of the action arena: (1) rules used by participants, (2) attributes of the biophysical/material conditions, and (3) attributes of the community. Considering the duality of commons and anticommons problems, Ostrom's framework can be applied to the case of collective actions on farmland fragmentation.

We consider the effect of three factors related to the collective actions of communities. In the current analysis, the action arena is in the rural community, because most of the collective actions in rural areas are defined by the boundaries of communities. Figure 1 shows the framework to link the three factors and collective actions.

(1) The first is the physical conditions of the farmland. If the physical condition of farmland is bad, profit from collective land use is low, and the transaction costs of collective land use are high. Therefore, public infrastructure investment can improve the physical conditions of resources. Arimoto (2011) discusses the impact of farmland improvement projects in Japan, which involve farmland readjustment and farmland consolidation. Arimoto (2011) argues that farmland improvement projects lead to the revitalization of agricultural land use through the improvement of cultivation conditions and the equalization of soils.

(2) The second is the formal and informal institutions that affect the rules-in-use for collective actions. While the legal system and the functions of local municipalities are almost homogenous in Japan, the functions of informal institutions—typically informal rules within communities—are varied. We consider the level of social capital as a factor of the rules-in-use for collective actions. Hayami (2009) defines "social capital" as the structure of informal social relationships conducive to developing cooperation among economic actors aimed at increasing social products, which is expected to accrue to the group of people embedded in those social relationships. Iba and Sakamoto (2014) argue that the close relationship and familiarity within the communities—social capital—helped not only lower direct costs but also mobilize community volunteers for less profitable social services and social events. Therefore, we presume that the accumulation of social capital within communities lowers transaction costs and promotes coordination among members.

(3) The third is the size of the community, one of the important attributes argued in past studies. Olson (1965) argues that the small-size groups are more likely to have successful collective actions because transaction costs increase with group size, further raising the costs of initiating collective actions.

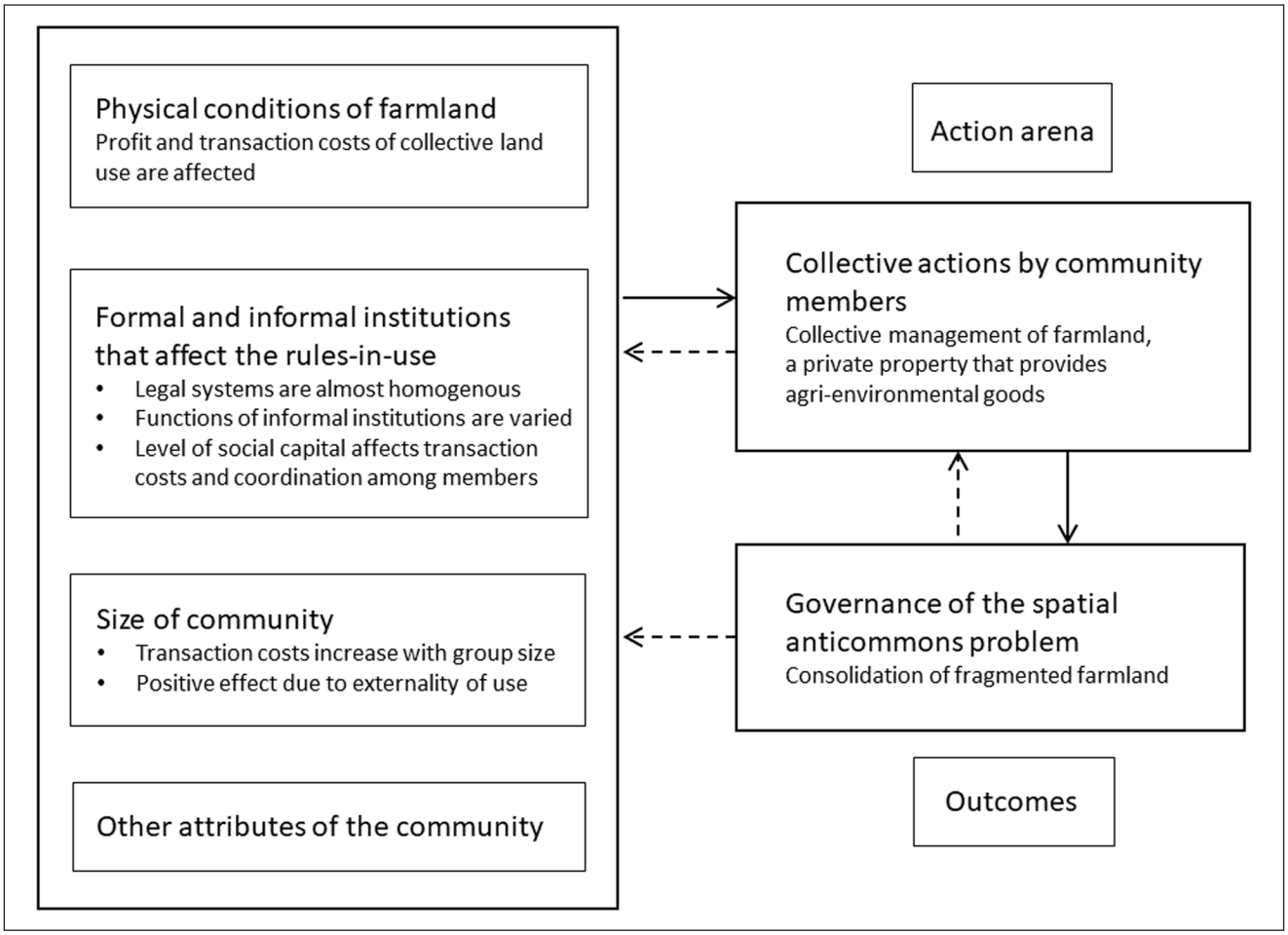

Figure 1 A framework to link factors and collective actions.

Note: The solid arrows represent the direct effects of factors, while the dashed arrows represent the feedback effects.

However, when considering the spatial anticommons, we should also consider the positive effect of the size, because the anticommons problem arises in the case of complements (positive externality of use), as discussed by Parisi et al. (2005). Poteete and Ostrom (2004) review the International Forestry Resources and Institutions research and note that group size can have a non-linear relationship to some forms of collective actions and may be contingent on institutional arrangements. A community with a greater size may be more likely to have collective actions because of the larger profits from collective land use. Takayama et al. (2018) note that collective actions become more difficult as group size increases due to an increase in free riding; however, this difficulty is mitigated due to economies of scale. They detect an inverse U-shaped relationship between irrigation facility management and group size. Takeda (2015) also finds an inverse U-shaped relationship between the maintenance and management of agricultural drainage channels and group size. These studies analyzed the relationship between local resource management and group size; however, a similar relationship may be established when farmland is regarded as a local resource that should be jointly managed by the community.

There are other attributes of communities that affect both the factors above and collective actions, such as geographical and population conditions. There is also the possibility of the feedback effect of collective actions on the rules-in-use and attributes of communities. The possibility of the feedback effect is discussed in Ostrom (2005) and is common in other empirical studies employing the IAD framework, such as Zang et al. (2019).

3. DESCRIPTION OF DATA

3.1 OVERVIEW OF STUDY AREAS

This study analyzes the regions where community farming plays an important role in farmland use: Toyama, Ishikawa,

and Fukui in the Hokuriku region and Shiga, Kyoto, and Hyogo in the Kinki region. We exclude Niigata in the Hokuriku region, where individual farmers mainly manage cultivation, and Osaka, Nara, and Wakayama in the Kinki region, as the first is an urban area and the last two have few paddy fields.

Figure 2 illustrates the location of the study area. These prefectures are semi-rural and near large cities such as Tokyo and Osaka. The location, as well as labor-saving machinery technologies of rice production, have enabled small-sized and part-time farmers to continue their livelihoods in rural communities. Ando (2008) considers Toyama and Shiga as areas lacking principal farmers and as being dominated by part-time farmers and argues for the role of community farming in these areas.

The six prefectures have the most community farming enterprises per rural community in Japan. The ratio of the number of community farming enterprises to the number of rural communities is 27.7% and 28.8% in Toyama/Ishikawa/Fukui and Shiga/Kyoto/Hyogo, respectively. Another characteristic of the analyzed area is that most community farming enterprises are composed of a single rural community: 83.4% and 93.2% of community farming enterprises in Toyama/Ishikawa/Fukui and Shiga/Kyoto/Hyogo, respectively. This indicates that most of the community farming enterprises in the analysis area are based on territorial groups defined by the boundaries of rural communities. This feature suits the current analysis because we examine the association between the characteristics of the rural community and the community farming activities.

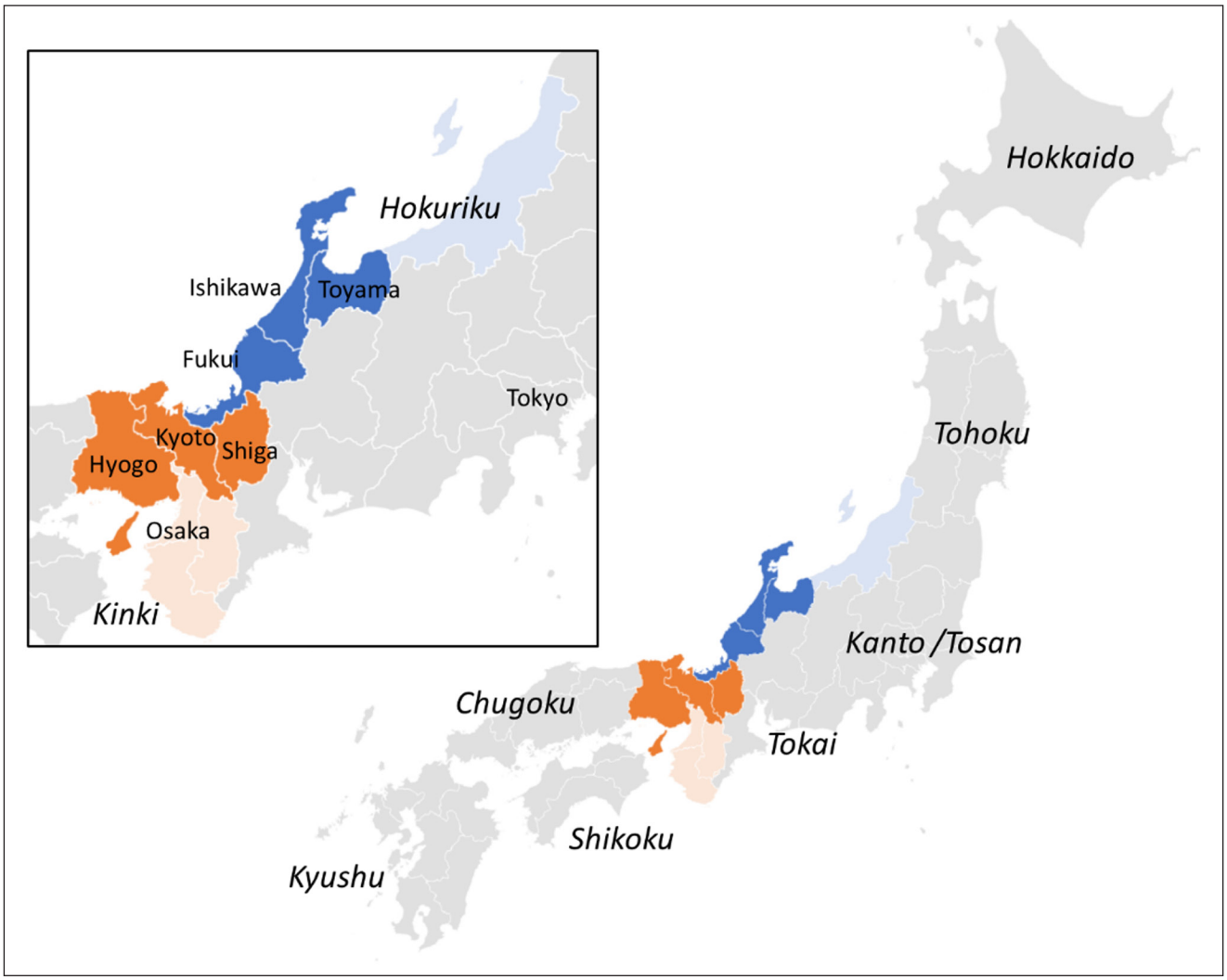

Figure 2 Location of study areas.

Note: The blue area represents the Hokuriku region, and the orange area represents the Kinki region. The dark-shaded area represents the study areas in the two regions. The areas in italics show the location of agricultural regions.

3.2 DATA SOURCES

We use the raw data of several official statistics, which were archived by the Digital Archive of Statistics on Agriculture, Forestry and Fisheries, Kyoto University, based on the original data provided by the MAFF. Fujie (2016) also uses this database to study community farming in Japan.

We use the 2014 Survey of Community Farming to obtain the data on activities by community farming enterprises. This survey is the complete enumeration by the MAFF on community farming enterprises as of February 1. The survey also specifies the location of community farming enterprises. To obtain the data on the located communities, we use the 2015 Census of Agriculture and Forestry. The Census is the complete enumeration by the MAFF of all rural communities as of February 1. In addition, to obtain the data on the physical conditions of farmland, and geographic and population conditions, we use the Database of Regional Agriculture published online by the MAFF. The database combines several official statistics, such as the Status of Cultivation of Paddy Field and Upland Fields and the National Land Information.

We match raw data from these data sources using community codes that are common to all data sources as keys. The procedures for matching these data are described in the Appendix. As a result, we compiled the data on 12,028 rural communities as well as community farming enterprises in each community.

4. VARIABLE SELECTION AND RELEVANT ISSUES

4.1 DEPENDENT VARIABLES REPRESENTING THE COLLECTIVE ACTION LEVEL

We study the farmland use by community farming enterprises, which represents the level of collective actions on farmland fragmentation by rural communities. The Survey of Community Farming provides the following information on farmland use by community farming:[4]

(1) The existence of a community farming enterprise.
(2) The farmland concentration rate of the community farming enterprise: cultivated farmland area (including farmland with outsourcing of farm work) divided by the total area of farmland in the rural community.
(3) Whether the community farming enterprise collectively manages and operates the community farms.

The existence of a community farming enterprise or the farmland concentration rate does not necessarily reflect collective land use, and substantive community farming activities are limited in some cases. Therefore, past studies that only examine the existence of community farming enterprises, such as Kitano (2020), provide limited information on the collective farmland use by community farming. By contrast, collective farm management and operation by community farming enterprises reflect the collective actions for farmland consolidation by community farming enterprises. According to the survey definition in terms of collective farm management and operation, a community farming enterprise fully consolidates and manages the farmland in a community.

The ratio of communities with community farming is 27.7% in the three Hokuriku prefectures and 28.8% in the three Kinki prefectures. However, only a small percentage of community farming enterprises collectively manages and operates farming in the communities in the sample prefectures. The ratio is 11.3% in Toyama/Ishikawa/Fukui and 7.1% in Shiga/Kyoto/Hyogo, representing less than half of the existing rate of community farming enterprises. These figures show the difficulty of collective farm management and operation, even in the study regions with relatively active community farming.

4.2 INDEPENDENT VARIABLES

Based on the theoretical grounding in Section 2, we examine the effect of the following independent variables that denote the characteristics of rural communities. These independent variables are used in studies on the collective management of common-pool resources, such as Takayama et al. (2018) and Zang et al. (2019).

(1) Ratio of paddy fields with farmland improvement projects (ratio of readjusted paddy fields to plots with more than 0.3 hectares).
We examine the effect of the rate of farmland improvement to see the effect of the physical conditions of farmland on collective land use. Arimoto (2011) finds positive effects of the projects on structural adjustment in the form of machinery-work outsourcing. Takahashi et al. (2018) show that the collective use of farmland is more likely to occur in communities with a high rate of farmland improvement.
(2) Community functions: number of local meetings and number of activities for revitalizing communities.[5]
We discuss the effect of social capital within communities to see the role of informal institutions in collective land use. These variables are proxies for the level of social capital within a community. The number of local meetings according to the census denotes meetings held by residents of a rural community

to discuss matters related to regional society and agricultural production in the community; the meeting covers all households or farm households, or otherwise all the representatives in the local units of the community. Therefore, the implementation of local meetings by all households will reflect the quantitative level of social capital in the community. By contrast, the number of activities for revitalizing communities reflects the qualitative level of activities in the community, because the community can implement the specified activities that require strong social capital. Specifically, the number of local meetings and the activities for revitalizing communities are related to bonding social capital (Putnam, 2000), in that the meetings and activities in the census are concerned with the local agendas within the community. Other studies, such as Takayama et al. (2018) and Kitano (2020), also use the number of local meetings as a proxy for social capital in the community.

(3) Human scale of the farmland market: Number of farmland-holding households (= total farmers + farmland-holding non-farmers)[6] and its square, ratio of farmland-holding households to total households.

(4) Areal scale of farmland market: Area of paddy fields and its square.

We introduce the number of farmland-holding households and the area of paddy fields, representing the human and areal scale of the farmland market, respectively, as independent variables for the collective land use by community farming to discuss the effect of the group size of the communities. Considering the possibility that these variables have a non-linear relationship with the community farming variables, because of the positive externality arising from the economies of scale and the transaction costs for collective actions, we introduce a squared term for these variables. Takayama et al. (2018) use the same variables and their squares to study the inverse-U relationship between the group size and collective actions in irrigation management. Kitano (2020) also reveals that there was an inverse U-shaped relationship between community farming formation and the average number of farms per community. We also include the ratio of farmland-holding households to total households to see the effect of the relative size of farmland-holding households.

Table 1 summarizes the dependent and independent variables and shows how variables are related to the theoretical grounding discussed in the previous section.

4.3 CONTROL VARIABLES FOR INDEPENDENT VARIABLES

The variables mentioned above are affected by other characteristics of the rural community. Therefore, we introduce additional control variables related to the geographic and human conditions of the rural community, namely, items (5) and (6). We introduced as many variables as available, which are commonly used in studies based on community-level data, such as Takahashi et al. (2018)

VARIABLES	THEORETICAL GROUNDING	EXPECTED SIGN
Dependent variables		
Existing community farming enterprises	Collective action level for farmland consolidation	
Rate of farmland concentration		
Collective farm management		
Independent variables		
1. Rate of farmland improvement	(1) Physical conditions of farmland that increase profit and decrease transaction costs of collective farmland use	+
2. Community functions	(2) Levels of social capital that affect the transaction costs for collective actions and coordination among members	+
Activities for revitalizing communities		
Number of local meetings		
3/4. Human and areal scale of the farmland market	(3) Size of the community, with negative effect by increasing transaction costs and positive effect by the externality of use	+/– Possibly inverse-U
Number of farmland-holding households		
Ratio of farmland-holding households to total households		
Paddy field area		

Table 1 Correspondence between the selected variables and theoretical conditions.

and Takayama et al. (2018). As our interest lies in the relationship between community functions and community farming activities, we do not discuss the coefficients and significance of these control variables.

(5) Geographic conditions of the community: Ratio of urbanization promotion area (under the City Planning Act), agricultural promotion area (under the Act on Establishment of Agricultural Promotion Regions), and farmland area to total land area; the ratio of paddy fields to farmland area; and whether the community is within 30 minutes of a densely inhabited district (DID).

(6) Demographic conditions of the community: Ratio of the population over 65 years of age; and the ratio of agriculture and forestry workers to the total number of workers.

When dealing with cross-sectional data, as described above, bias may arise from omitted variables not surveyed in the Census of Agriculture and Forestry. We can control for time-invariant variables when using panel data as in Takayama et al. (2018); however, in our dataset, important variables can be obtained only for a single year (in particular, the rate of farmland improvement) in the Database of Regional Agriculture. Therefore, we introduce dummy variables corresponding to the former municipalities (municipalities as of 1950) contained in the Census of Agriculture and Forestry. The former municipalities—those that existed before the merger during the Showa era (mainly during the 1950s)—have been recorded continuously and consistently in the census, regardless of the subsequent municipality mergers. The former municipalities are commonly used as an aggregation unit of the census; they remain the basic administrative units in Japan, with similarities in terms of geography as well as socio-cultural conditions. The 12,028 rural communities we analyze include 1,364 former municipalities. The introduction of former municipal dummies allows us to control the effects of unobserved variables that are common to each former municipality. We compare the results of the econometric analysis with and without the former municipality dummy to discuss the effect of controlling the variables that are common within the municipalities.

4.4 THE ENDOGENEITY ISSUES

While we introduce the control variables and former municipal dummies, we do not control for all the possible time-invariant variables or for all the time-variant variables in each community. Therefore, when discussing the relationship between the variables, it is possible that endogeneity could occur from omitted variables that affect the dependent and independent variables. For example, we should consider the difference in village governance systems. In addition, as we discussed in the theoretical grounding, there is also the possible feedback effect from the dependent variable on independent variables, leading to the possibility of reverse causality. For example, collective actions by communities may involve more active communication and negotiations, leading to higher levels of social capital. Regarding the endogeneity bias from the reverse causality, we expect the positive bias from the ordinary least squares (OLS) estimation when both the direct effect and the feedback effect are positive.

Theoretically, there are two ways to mitigate the endogeneity arising from omitted variables and reverse causality. The first method is to implement a randomized controlled experiment, which requires a different approach from the one we employed, which was the use of secondary statistics of official surveys.[7] The second method is to use instrumental variable estimation. However, it is difficult to obtain valid instrument variables that only affect independent variables from the observational data. Past studies use natural and randomized experiments to obtain the valid instruments for the dependent variables (Angrist and Krueger, 2001). In a relevant study on the social capital and common pool resources, Aida (2019) combines lab-in-the-field experiments to measure social capital and household survey data, while obtaining the instrument variables for the social capital from the experiments, and studies the role of social capital for common pool resource management. However, the quantitative studies on spatial anti-commons are limited.

Instead of detecting the causal effect, we use OLS to study the association between the dependent and the independent variables. This is because the positive association is the necessary condition for the existence of a positive causal effect. The large-scale data from the secondary statistics of official surveys enable us to observe the general associations between many variables in large areas. An area for future research is to examine the associations observed in this study but with natural and randomized experiments that reveal causality in one direction and not in the other.

Therefore, we focus on observing the associations between the dependent and independent variables and take note of the risks of these endogeneity issues. For a robustness check, we conduct descriptive analysis between the dependent and independent variables before econometric analysis to confirm whether the associations are strong enough to make further analysis. We also compare the results of the econometric analysis with

and without the former municipality dummy variables. If the two results differ, we have higher risks of omitted variables bias.

5. RESULTS OF DESCRIPTIVE AND ECONOMETRIC ANALYSES

5.1 RESULTS OF DESCRIPTIVE ANALYSIS

Tables 2 and 3 reveal that the rate of farmland improvement and community functions are related to collective farmland use by community farming enterprises. We see that the collective use of farmland by community farming enterprises tends to be more active in communities with a high rate of farmland improvement and a large number of local meetings. In particular, community farming activity is markedly low in rural communities with 0% farmland improvement and fewer than two local meetings.

5.2 RESULTS OF ECONOMETRIC ANALYSIS

The econometric analysis is performed using OLS. The standard errors are clustered within each former municipality. As the dependent variables other than the rate of farmland concentration are binary, a linear probability model is estimated. To confirm the robustness of the linear probability model, we use a logit model to measure the marginal effects of the coefficients, but the coefficients and statistical significance are almost the same.

Table 4 presents the results of the econometric analysis with the former municipality dummies. The null hypothesis that the estimated coefficients of independent and control variables are zero is rejected at the 1% significance level.

The findings from Table 4 are as follows. First, there is a significant positive association between the farmland improvement rate and the collective use of farmlands by community farms. Therefore, the communities with better physical conditions are more likely to have collective land use. Second, regarding the variables related to community

RATE OF FARMLAND IMPROVEMENT	0	0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1.0	1	AVERAGE
Number of rural communities	6,106	966	413	452	773	1,364	1,954	12,028
(Percentage)	(50.8)	(8.0)	(3.4)	(3.8)	(6.4)	(11.3)	(16.2)	(100.0)
Existing community farming enterprises	19.9	34.9	40.2	38.5	45.3	52.1	50.2	32.7
Farmland concentration rate	8.5	17.2	19.8	19.0	25.4	29.0	26.6	16.3
Collective farm management and operation by community farming enterprises	4.9	11.4	16.9	14.2	18.8	22.9	21.3	11.8

Table 2 Relationship between the rate of farmland improvement and farmland use by community farming enterprises.

Source: Survey of Community Farming, Database of Regional Agriculture, Census of Agriculture and Forestry.

Note: "Number of rural communities" and the percentage indicate the number of classified communities and the percentage of the total number of rural communities, respectively. "Existing community farming enterprises" indicate the percentage of the number of corresponding rural communities to the total number of the classification. For example, 6,106 communities (50.8% of the total) have no farmland improvement, and community farming enterprises exist in 19.9% of the communities with a zero farmland improvement rate.

NUMBER OF LOCAL MEETINGS	0	1–2	3–6	7–12	13–18	19+	AVERAGE
Number of rural communities	211	605	2,408	3,413	2,205	3,186	12,028
(Percentage)	(1.8)	(5.0)	(20.0)	(28.4)	(18.3)	(26.5)	(100.0)
Existing community farming enterprises	4.3	11.4	20.1	31.5	35.2	47.8	32.7
Farmland concentration rate	2.0	5.8	10.1	15.9	17.7	23.6	16.3
Collective farm management and operation by community farming enterprises	2.4	3.5	6.6	11.7	11.8	18.0	11.8

Table 3 Relationship between the number of meetings and farmland use for community farming.

Source: Survey of Community Farming, Database of Regional Agriculture, Census of Agriculture and Forestry.

Note: See the notes for Table 2.

	EXISTING COMMUNITY FARMING ENTERPRISES		RATE OF FARMLAND CONCENTRATION		COLLECTIVE FARM MANAGEMENT AND OPERATION BY COMMUNITY FARMS	
	COEF.	T	COEF.	T	COEF.	T
1. Farmland improvement rate	0.0886	4.99 ***	0.0646	5.57 ***	0.0616	4.79 ***
2. Community functions						
Community- revitalizing activities	0.0133	4.20 ***	0.0080	3.80 ***	0.0005	0.22
Number of local meetings	0.0025	5.36 ***	0.0016	5.88 ***	0.0017	4.64 ***
3. Human scale of the farmland market						
Number of farmland-holding households	0.0025	4.19 ***	0.0008	2.08 **	0.0009	2.09 **
Squared number of farmland-holding households	−1.5.E−05	3.54 ***	−6.5.E−06	−2.42 **	−8.4.E−06	2.84 ***
Percentage of farmland-holding households	0.0915	4.66 ***	0.0466	3.69 ***	0.0090	0.65
4. Areal scale of farmland market						
Paddy field area	0.0079	9.68 ***	0.0034	6.96 ***	0.0032	5.88 ***
Squared paddy field area	−4.4.E−05	−7.77 ***	−2.2.E−05	−6.67 ***	−1.5.E−05	−4.25 ***
5. Geographic conditions						
Ratio of urbanization promotion area	0.0623	1.90 *	0.0297	−1.52	−0.0263	−1.19
Ratio of agricultural promotion area	0.0355	1.24	0.0179	0.96	0.0049	0.22
Ratio of farmland area to total land area	0.0377	1.04	0.0543	2.23 **	0.0431	1.45
Ratio of paddy fields to total farmland	0.0244	0.85	0.0383	2.10 **	0.0015	0.08
Within 30 minutes of DID	0.0014	0.09	0.0067	0.67	0.0011	0.11
6. Population conditions						
Percentage of population aged 65 and over	0.0260	0.64	0.0290	−1.10	0.0216	0.76
Ratio of population employed in agriculture and forestry	0.0118	0.29	0.0534	−2.06 ***	0.0484	−1.81 *
Value at the top of the inverted U-shape						
Number of farmland-holding households	84.9		62.5		52.1	
Paddy field area	90.2		79.1		105.1	
No. of observations	12,028					
Degree of freedom	10,648					
R-squared	0.492		0.444		0.458	
F-statistics for overall significance (p-value)	47.43 (0.00)		27.73 (0.00)		11.60 (0.00)	

Table 4 Quantitative analysis of farmland use by community farming enterprises.

1. ***, **, and * are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

2. We use standard errors that are robust to the heteroskedasticity and the cluster structure for each former municipality.

3. The value at the top of the inverted U-shape is calculated when the variable and its squared term are significantly different from zero at the 5% level.

4. The notation "−1.5.E-05" in the table represents −1.5 × 0.1 to the fifth power.

5. DID = densely inhabited district.

functions, the number of local meetings has a statistically significant positive association with the collective use of farmlands by community farms in all estimates. The number of community-revitalizing activities has a statistically significant positive correlation with community farming and the farmland concentration rate but not with the collective farmland management. The reason for the insignificant association is not clear, but an interpretation is that the qualitative level of activities in the community does not affect the collective farmland management once the community farming enterprises have been established. Third, variables representing the human and areal scale of the farmland market, such as the area under paddy cultivation and the number of farmland-holding households, have an inverse U-shaped correlation with the collective use of farmland by community farms. There is a positive impact up to a certain level, after which a negative impact dominates. However, the human scale and area size at the top of the inverted U-shape are much higher than the average level for rural communities. Therefore, the larger the human scale and area size, the more active the use of farmland by community farms; however, the positive effect becomes weaker as the size increases. A percentage of farmland-holding households have statistically significant and positive effects on the existence of community farming enterprises and the rate of farmland consolidation. Most variables representing geographic and demographic conditions are not statistically significant in the estimations.

As a robustness check, we compared the estimation results with and without the former municipality dummy variables. The inclusion of the former municipality dummies does not have a significant effect on the coefficients or statistical significance of the independent variables, namely, the farmland improvement rate, community functions, and the size of the farmland market. Thus, the estimation results in Table 4 are robust to the presence of omitted variables that are common to the former municipality level. In contrast, most variables representing geographic and demographic conditions are significant in the estimations without former municipality dummies, whereas they are not significant when we include the former municipality dummies. This is because most of the variation in the geographic and demographic conditions are not within the former municipalities but between the former municipalities. Therefore, our estimation does not imply that the geographic and demographic conditions, such as population age, are not related to collective land use.

We also perform the same regression analysis for the three prefectures in the Hokuriku and Kinki regions separately, but the coefficients show little change. As for the control variables for demographic conditions, overcontrol is a possibility: when the level of community functions affects the demographic conditions, the effects of demographic conditions may absorb the effect of the variables of interest. Therefore, we also estimate the coefficients excluding demographic conditions, but the estimation results for the independent variables do not change significantly.

6. DISCUSSION

As we discussed in the theoretical grounding, farmland is strictly private property, producing a combination of public and private goods. It is worthy of discussion in terms of the spatial anticommons theory, which posits that communities can still achieve the collective use of resources under certain circumstances even with the strong legal protection of property rights. We can draw the following implications from the analysis of community-based organizations for collective land use in Japan.

First, communities with better physical conditions of land are more likely to have collective land use by community-based organizations. This finding indicates that the resolution of fragmented property rights by public institutions can be a remedy to the spatial anticommons. However, the public spending required for farmland improvement projects is very high. The budget for general public works by the MAFF, comprising most of the expense of the farmland improvement projects, was 679.3 billion yen in 2021. General public works spending has decreased significantly due to the extremely difficult financial situation of the Japanese government. In addition, implementing the farmland improvement incurs monetary expenses and transaction costs on landowners and cultivators. Therefore, we should not expect the farmland improvement projects solely to resolve the farmland fragmentation problem.

Second, we confirm that communities with a high level of social capital, measured by both the quantitative and qualitative level of activities in the community, are more likely to have collective land use by community-based organizations, although we do not find a significant association between the qualitative level and collective farmland management. We demonstrate that a community-based self-governing mechanism for common pool resources, as discussed by Ostrom (1990), can play an important role in the efficient management of farmland. This shows that the remedy for commons and anticommons problems is symmetric, as both problems are the consequence of a lack of conformity of rights (Parisi et al., 2005). The findings confirm that social capital helps develop cooperation, as discussed by Hayami

(2009). Additionally, it confirms the suggestion by Ishida and Kiminami (1987) that socially embedded economic processes within a community are involved in the collective use of farmland by community farming enterprises. These findings are also consistent with the discussions by Garcia-Alvarez-Coque et al. (2021) and Piñeiro et al. (2021) who observed that strengthening social capital is crucial to the success of social innovation for joint farmland management initiatives. Therefore, incorporating the informal institutions for the management of underused resources, as well as strengthening social capital within communities, could be a remedy for the anticommons problems.

Third, we detect a positive and non-linear relationship between the human and areal scale of the farmland market and collective land use by community-based organizations. This indicates that the positive external effect of group size overwhelms the negative effect of group size. This effect becomes weaker as group size increases. This is in contrast with the case of other common pool resources with negative externality of usage. In other words, the marginalized communities with depopulation and small-size farmland are less likely to have community-based organizations.

The results indicate a negative outlook for future land use in Japan because community functions have become more vulnerable and budgetary allocations for farmland improvement projects have been reduced. For example, according to the Census of Agriculture and Forestry in 2015, 6.1% of rural communities do not have local meetings, and 29.6% have local meetings only one to five times per year. It is necessary to emphasize and maintain social relationships within the community and establish the basic conditions to promote farmland consolidation through community farming. Possible policy interventions include making direct payments that contribute to the maintenance of community functions and the implementation of farmland improvement projects. The Japanese government has implemented direct payments for hilly and mountainous areas since 2000, with these payments helping maintain farmland (Takayama et al., 2021) as well as community functions. Other policies revitalizing rural communities may also contribute to the efficient use of farmland. Conversely, in regions where social conditions make it difficult to maintain community functions, the use of farmland should be promoted in a way that does not depend on community functions, and in some cases, "planned withdrawal of abandoned farmland" (Ando, 2010), such as through reforestation or use as extensive pasture, may be ideal.

Finally, we discuss the implications of this study for other East Asian countries. Land fragmentation has become a major constraint for improving production inefficiency in East Asian countries where the farm size has been expanding. For example, the land fragmentation in China is prohibiting the introduction of machines to substitute for labor (Wang et al. 2020) and the governance of common pool resources like irrigation facilities (Zang et al. 2019). While past studies discuss market transactions and institutional arrangements, such as securing land contract rights and establishing land banks in China (Yamauchi et al. 2021), how to solve land fragmentation and achieve consolidation is not fully discussed. We discuss the symmetry of commons and anticommons theory and show that the discussion of governance of common pool resources by Ostrom (1990) and subsequent studies can be applied to the case of farmland fragmentation. The results call for further studies on the role of community-based organizations in solving the farmland fragmentation problem, or other anticommons problems, in Japan and other countries.

7. CONCLUSION

In this study, we examined the conditions for the collective actions on farmland management through community farming, employing the theory of anticommons. While the existing literature has already discussed the theoretical models and case studies of the anticommons problem, the quantitative analysis of the problem is limited. We discuss the factors affecting collective actions on farmland management by analyzing original large-scale data, referring to the existing literature on the governance of commons. The results show a positive correlation between the level of farmland improvement projects, community functions, group size, and the collective use of farmland by community farming enterprises. These have been proven to be important factors influencing collective actions for maintaining common pool resources in past studies. The results imply that the factors affecting collective actions on fragmented private properties that produce a combination of public and private goods are similar to those in the case of shared property rights. The results reiterate past studies' assertions that social structure within a community contributes to collective farmland use by community farming. The present study confirms the role of governance in resolving fragmented farmland problems through community-based self-governing mechanisms. The discussion shows that the empirical evidence of the symmetry of commons and anticommons as collective actions is important to the overuse and underuse of natural resources.

Additional research on methods to achieve farmland consolidation in countries entering a high-income stage

should be conducted, which is especially relevant to East Asia. This study focuses on community farming enterprises, but other forms of community-based self-governing mechanisms are possible, depending on the social and historical structure in the region's rural sector. Our findings do not suggest the community-based approach can be universally applied to the farmland fragmentation problem or the anticommons problem in general. Rather, we demonstrated that communities could play their role when certain social and economic conditions have been satisfied. However, the community-based approach is desirable in most semi-rural areas in Japan, where profit from collective land use is moderate, part-time farming is dominant, and the social structure has been maintained.

As discussed earlier, a limitation of our study is the possibility of endogeneity issues. One way of tackling this issue is the use of panel data, which enables us to control all the time-invariant variables. However, the availability of panel data does not solve the problem of reverse causality and omitted time-variant variables. Therefore, tackling these problems requires a natural experimental approach, such as the use of an exogenous shock that affects only dependent variables but not the collective actions of the community. However, in general, natural experimental approaches tend to be used in small-scale studies. The observation of general associations based on large-scale data in this study lays the foundation for such research.

NOTES

1 We define farmland concentration as the concentration of farmland into large-scale farms, while farmland consolidation refers to farmland concentration and resolution of farmland fragmentation.

2 See Arimoto and Nakajima (2010) and Takahashi et al. (2018) for a discussion on the policy background of farmland consolidation in Japan.

3 Following Iba and Sakamoto (2014), we refer to *Shuraku Eino* in Japanese as a community farming enterprise, as many community farming enterprises are not incorporated organizations.

4 The maximum value for each variable of community farming enterprises is analyzed if there is more than one community farm in a rural community. In that case, categories (1) and (3) should be interpreted as "at least one community farming enterprise" and (2) as "the largest ratio of community farming enterprises."

5 "Activities for revitalizing communities" include eight categories: preservation of traditional festivals, culture, and arts; holding various local events; welfare activities for the elderly; conservation of the environment; green tourism initiatives; initiatives for the diversification of farm activities; initiatives to promote the settlement of residents; and renewable energy initiatives.

6 We use the number of farmland-holding households instead of the number of farmers, because retired farmers could continue to influence farmland use as owners of farmland.

7 Ostrom (2006) provides an overview of the effects of communication on experimental studies of behavior and outcomes in common pool resource dilemmas.

ADDITIONAL FILE

The additional file for this article can be found as follows:

- **Appendix.** Matching procedures. DOI: https://doi.org/10.5334/ijc.1151.s1

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COMPETING INTERESTS

The authors have no competing interests to declare.

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