

Factors affecting the creation of modern property ownership of forest commons in Japan:
An examination of historical, prefectural data

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(ABSTRACT)

Forest commons in Japan are known as *iriai*, and they represent a century old communal forest management arrangement. In 1966, the government of Japan enacted the *Iriai* Modernization Act, which aimed to assign legal ownership to forest *iriais*. It gave forest users the option to choose between individual or collective ownership. The paper explores the implementation of the act and whether if the choices for *iriai* modernization and group or individual ownership can be linked causally to characteristics of the forest user group. By the year 2010, 36.5% of the area of forest *iriais* had been modernized. The size of forest *iriai* user group and the ratio of plantation forest appeared negatively correlated with the conversion to modern property ownership, but the unity among user group members appeared positively correlated with *iriai* modernization. The persistence of following customs and traditions of the user group correlated with modernization towards group ownership under the act, while past labor contribution by group members appeared positively correlated with modernization towards individual ownership. The case of forest *iriai* modernization in Japan is relevant for the expanding debate on the interrelations between a state's natural resource use reforms and how forest commons are incorporated in this process.

(Keywords)

commons; modernization; state; statistical analysis; quantitative analysis; Japan

1. INTRODUCTION

A significant proportion of the global forests are managed as common property. When it concerns forestlands that is controlled by communities, in which case it often concerns common property according to customary rules, the legal status of such forestland is often ambiguous. Much of the related academic inquiry on forest common property clarified self-governance, for instance on the internal mechanisms of governance of commons (e.g. Ostrom, 1990 and 2009). More recent research has highlighted linkages with state regimes (Berkes 2002:300). This has now been addressed in major research projects, including for instance in Asia (Yanagisawa, 2015). In this paper, we examine modernization policies of forest commons in Japan (*iriai*), triggered by the government Iriai Modernization Act of 1966, and we analyze implementation of this acts for a period of five decades

The term *iriai* refers to a natural habitat that is of shared interest to a community and held under a customary common property arrangement. *Iriais* emerged since before the Edo Era (McKean and Cox, 1982), an era that lasted from the 1603 until 1867. Already since the Edo era, local governance of commons was affected by efforts of the ruling *shogunate* to subject the country to a shared rule of law. After the Meiji Restoration of 1868, the newly established Japanese government tried to subject forest *iriais* to a regime that allowed including them into tax collection schemes. Rather autonomous hamlets were during this time incorporated into municipalities and the latter took control of forests as part of the “Public (Hamlet) Forest Reorganization and Unification Project” which lasted from 1910 to 1939 (Handa, 1988:212).

The latest effort to adapt forest *iriais* to a modern public administration has been the 1966 “Act for Modernization of *Iriai*” (hereafter called *Iriai* Modernization Act or the Act). This represents efforts of central government and prefectural governments to convert *iriai* forest groups, their governing organization, and the rules under which they operate into modern legal entities such as forest producers’ cooperatives or agricultural producers’ cooperatives (*nougyouseisan houjin*) who comply by the regulations that concerns them. Together with reforming collective groups as owners of former *iriai* forest, the policies also promoted dividing forest *iriais* into privately owned woodlots.

Our paper is divided into five parts. Section 2 provides more details on the phenomenon of forest *iriais* and their histories. Section 3 describes the methods of the underlying research, including a number of hypothesis that we test. Section 4 presents the results and the analysis and the paper ends with a discussion and conclusion in section 5.

2. Background: Forest commons modernization in Japan

The Japanese forest *iriais* have a complex and long history. McKean and Cox (1982) describe the tumultuous pre-Tokugawa history of Japan, which sees the decline of influence of the Kyoto based Imperial Court over Japan’s territory, followed by a decline of influence of court nobles and temples who had taken over control of the previous imperial and public lands over that same territory. During this time prominent members of villages became in charge of managing lands nominally still owned by feudal rulers. According to McKean and Cox’ analysis, the 16th century internal wars gave power to the rural population as warlords dependent on their support to achieve their political objectives. This is the underlying political process of Japan that explains why village common lands became a prominent natural resource governance form throughout rural Japan and between the 14th and 16th century.

Tokugawa managed to impose a strict “totalitarian administrative structure” (McKean and Cox, 1982:68), which was ruthlessly enforced, but under this regime forest *iriais* did not lose their independence or self-control. Some of the elements of the Tokugawa rule of law enforcement, like for instance mechanisms to assure collective responsibility, actually were adopted by *iriai* member groups. The desire of the Tokugawa government to control the

daimyos, their feudal lords who implemented the Tokugawa rules, diminished the incentives for them to exploit villagers, and this strengthened village independence. And finally, during the Tokugawa era a construction boom increased the demand for timber. While this demand encouraged daimyos to control forest with high quality timber, it also led to the recognition of communal rights over resources including over forest *iriais* (McKean and Cox, 1982).

Iriai lands played an important role in rural livelihoods until the 1950s economic recovery after the Pacific War (McKean and Cox, 1982). By 1960, the total area of *iriai* forests was estimated by Nakao (1989) to be over 3 million ha. Opinions on how useful or relevant *iriai* modernization have been are viewed critically by scholars (Kasahara, 1996; Noguchi, 2014). Policy makers believed that forest *iriais* were underutilized, due to their legal status under customary *iriai*-type ownership; and that modern group ownership such as forest producers' cooperatives, or as individual ownership, would improve the contributions of these commons to economic growth and wellbeing of the rural population (Ministry of Agriculture and Forestry, Department of Survey and Statistics, 1962).

The 1960 World Agriculture and Forestry Census Survey shows the status of forest *iriais* after almost 100 years of industrialization of Japan. Among 109,909 forest *iriais* identified in the survey, 21,920 groups (19.9%) produced forest products, such as timber and fuel wood from February 1959 through January 1960. A total of 11,046 groups (10.1%) produced timber and 13,145 groups (12%) produced fuel wood or charcoal; some groups produced both. Of the 21,920 forest *iriais* that produced forest products, 4,901 (4.5%) distributed the products to their members, while the remaining entities sold these products and kept the cash proceeds in the groups' accounts or distributed the cash proceeds among members. This also shows that by the end of the 1950s, the majority of forest *iriais* members did not rely on forests to contribute to household income or consumption. This trend has continued until today.

After several years of research and discussion among governmental bureaucrats and experts, the *Iriai* Modernization Act of 1966 was approved (Handa, 1988). In Japan, since the beginning of the Act, around 30 to 40% of the area of forest commons have been converted to modern types of ownership such as individual private ownership, forest producers' cooperatives, joint ownership and non-profit associations. The Act was initially conceived as a means of increasing the size of non-industrial private forest ownership by providing additional forest lands to individual owners, as well as establishing cooperative forestry operations managed by former commoners. One could argue that many forest producers' cooperatives that are supposed to be modern legal entities without customary relationships, retain many of their traditional characteristics such as contributions to community expenses or restrictions of membership.

The consequences of the *Iriai* Modernization Act are thought to be two-fold. On the one hand, modernization led to the establishment of forest production cooperatives and individual ownership, which may be theoretically more suited to the for-profit production of forest products. On the other hand, under the increasing decline of forestry activities in Japan, the *iriai* reforms have not resulted in the vigorous for-profit forestry activities anticipated at the time, while it does impose new burdens such as corporate tax payments and obligatory management tasks for the members of cooperatives.

3. METHODS AND HYPOTHESES

We hypothesize that the original conditions of forest *iriais* likely influence their modernization, and the direction that modernization may take. We propose as dependent variables indicators of modernization of forest *iriais*, of which there are three. 1) The total area and numbers of *iriai* forests that modernized, expressed as the percentage of the total number, and the total area of forest *iriais* in 1960, when the last comprehensive survey on *iriai* forest in Japan was conducted. This can be disaggregated into 2) those that modernized into consolidated group ownership, such as cooperatives, corporations or joint ownership, and 3) forest *iriais* that modernized into individual ownership. These modernizations were the

result of the implementation of the *Iriai* Modernization Act for each prefecture, and that were recorded in public statistics (Forestry Agency, 1970-2002, 2003-2012).

We use as data the averages for prefectures of the dependent and independent variables, as only those are available in official statistics. There is no recorded information on all *iriai* forests and their modernization status until 2010. This is because public records provide data for every year of *iriai* modernization for 45 prefectures, hence we could track progress of *iriai* modernization between 1967 and 2010. Data for Hokkaido and Okinawa are not available, because forest *iriais* were not consistently reported. While this limitation constrains our analysis, the information we obtained provide an important number of data points that make it possible to undertake a sound correlation analysis and demonstrate statistical correlations between *iriai* modernization and the factors that we hypothesize below, which explains modernization. We calculated the percentages of modernized forest *iriais* by dividing the areas of modernized forest *iriais* with the areas of forest *iriais* identified in 1960 (Ministry of Agriculture and Forestry, 1962), six years before the enactment of the Act.¹ We used those data as our source to establish the original conditions of forest *iriais* (Ministry of Agriculture and Forestry, 1962). We recorded and analyzed linkages between the original features of forest *iriais* in each prefecture, and explored whether they can statistically be linked to *iriai* modernization. The descriptive statistics for variables related to initial conditions are given in the Appendix to the paper.

3.2 Hypotheses to be tested

Using the conceptualization of possibly causal relations between forest *iriai* characteristics and modernization outcomes, we propose 12 hypotheses, which we tested with the data that characterize independent and dependent variables. The hypotheses guide the kind of features of the forest *iriais* that are relevant and guided data collection. The hypotheses are numbered H1 – H12 and text between brackets is a shorthand for the hypothesis, which is used in the tables.

H1 (Number of members per *iriai*): The number of members (households) of the *iriai* is negatively correlated with the modernization outcome. This is because the costs of coordination and achieving consensus increase when the group that has shared claims over the *iriai* is larger.

H2 (*Iriai* group larger than corresponding hamlet): Forest *iriais* that have a larger number of households than the corresponding agricultural village (hamlet), are less likely to modernize than forest *iriais* where that is not the case. This is also a cost issue; modernization of these forest *iriais* is more costly, than when the number of members is smaller.

H3 (Does not permit new members): *Iriai* member groups that do not permit new members are more likely to go through *iriai* modernization. Such groups have a certain level of cohesion that is conducive to a smooth consensus-building among its members, which makes change easier and thus has a positive correlation with *iriai* modernization.²

¹ In 1960 World Agriculture and Forestry Census Survey forest irais are identified as customary common holdings. With regard to the data regarding group modernization and individual modernization from 1967 through 2010, only the data about areas are published. Given such data limitation, we decided to employ the portions of areas modernized as dependent variable. We interpret the portion of areas modernized as a proxy of iriai modernization in a given prefecture, with more weights for large forest commons.

² New members might prefer modernization to maintaining the original condition; therefore, the correlation might be just the opposite (*Iriai* member groups that do not permit new members are LESS likely to go through *iriai* modernization.). Forest commons in Japan, however, do not usually allow new members in large numbers. Therefore, it is almost inconceivable to assume new members have a large say in the management of forest commons.

H4 (Permits members' relatives or returning members to join the group): Groups that allow relatives of members or old members who return from another area to rejoin the group are positively correlated with *iriai* modernization, for the same reason as under H3.

H5 (Permits new residents): Groups permitting new residents in the hamlet, once they obtained the status of official resident, to join the group will favor modernization of the group. When groups adopt new residents of the hamlet, they can consolidate as forest producers' cooperatives, a joint ownership or non-profit associations. This represents a confirmation and continuations of the traditional *iriai* organization, but with a different name, and related changes in how the group operates.

H3 and H5 represent different situations. Where H3 concerns the categorical denial of new membership, H5 concerns conditional permission of new membership of an *iriai* forest group, if the household obtains membership for the village. The membership of an *iriai* forest group and village membership are two different memberships. In the original survey, the questions regarding these two categories are separate questions.

H6 (Allows trading of shares): Groups permitting someone who has bought shares in commons forests to join the group is negatively correlated with modernization in the form of consolidated group ownership. This practice indicates that the commoditization of forest lands is occurring in the community and as a result, consensus building is likely to be difficult under such conditions (McKean, 1992; pp.261-262). This, thus inhibits progress towards modernization of the *iriai*. However, groups that permit trading of shares can be expected to favor individual ownership, hence are likely to correlate positively with *iriai* cases that modernized towards individual ownership.

H7 (Households leaving the hamlet lose all rights): A wide variety existed in terms of whether the community would still grant rights to commons forest to households who leave the hamlet in which the forest *iriai* is located. The most extreme case is that households lose all rights and will not be compensated. The opposite option is that households who leave the hamlet, maintain all their rights, which is considered under H8. The former option represents a more traditional *iriai* rule. *Iriai* ownership and thus membership is embedded in the community, and cannot be granted, nor maintained by households who cease to reside in the community. Between the two options, actually quite many variations exist and those include: some compensation is facilitated for lost rights or shares can be sold by leaving members. H7 thus postulates that groups which do not allow leaving members to retain any rights, or receive any compensation are more likely to correlate positively to modernization, in the form of recognized group ownership, because these groups share a high respect for the *iriai* institution. The latter will make it easier to find consensus and thus foster modernization towards group ownership (McKean, 1992).

H8 (Households leaving the hamlet retain all rights): Groups that allow departing members to maintain their rights over forest *iriais* correlate negatively with modernization towards various forms of group ownership. The rule to retain rights is an indication that the traditional *iriai* scheme is weakened and as a result, achieving a consensus on adopting a modernization change is quite difficult and not likely to happen (McKean, 1992).

H7 and H8 represent mutually exclusive cases, but that cases that are in between H7 and H8 do exist (i.e., not exhaustive). The correlation coefficient between the variable representing H7 and the variable representing H8 is -0.646, and not -1 (see Table 7 below), which justifies retaining the two hypotheses. H7 includes cases like: lose almost all rights, but receive compensation for losing the rights; must sell rights to the community; can sell rights to community right holders; can sell rights to all community

members; can sell rights to outsiders. H8, on the other hand, represents cases when rights are retained after leaving the community.

H9 (Group management ratio): Groups that own a certain portion of commons forests that is managed under the direct control of the group, rather than being separately managed by individual members, is positively correlated with modernization towards collective user groups. The explanation is that actual collective management enhances the unity of the group, which facilitates consensus building, which favors modernization under the 1966 Act.

H10 (Plantation ratio): The percentage of planted areas in forest *iriais* in 1960 correlates positively with modernization according to the 1966 Act, since past investments encourage members to engage more actively in the management of forests.

H11 (Labor investment): A higher percentage of group members who themselves work in their forests correlates positively with modernization for the same reason as outlined in H10.

H12 (Obligatory labor investment): Groups that demand their members to spend obligatory labor on forest management correlates positively with modernization, for the same reason as mentioned in H10. In addition, the fact that a group demands that its members work in the forests indicates that the cohesiveness of the group is relatively strong, which also encourages smooth consensus building, and thus modernization.

We examined the 12 hypotheses by calculating the correlation coefficients corresponding to the respective dependent and independent variables that are entailed in each of the hypotheses. We do not intend to find complicated relational patterns with a relatively small number of cases from our sample (n=45). Our investigation mainly concerns the linear relationships between variables. As an exception, we investigated the potential non-linear influences of the sizes of the commons on modernization in the latter part of this paper.

We do not exclude that there might be other hidden factors that have influenced forest *iriais* modernization, such as different policies pursued in different prefectures. However, the policy regarding forest commons in Japan after World War II has been led by the central government. The law was enacted by the central government, and instructions were issued by the central government and manuals were published by groups closely associated with the central government. Every year, consultants in each prefecture who cooperate with modernization processes convene and discuss their experiences in Tokyo under the central government's guidance. In addition, the modernization policy had been strongly influenced by the general policy frame of the Forestry Basic Act of 1964 and the accompanying policy target for increasing plantations, which was a shared nationwide policy (Handa, 1988; Matsushita, 2012). In other words, it is acceptable to assume that the policy frame of *iriai* modernization was homogeneous in Japan. Assuming that the other hidden factors are random, in this study we concentrated on the initial conditions of the forest *iriais*, which can be thought of as the most influential factors in modernization. Table 1 summarizes the hypotheses introduced here and indicates its link with *iriai* modernization in general and group ownership.

Table 1 Hypotheses tested in the paper.

Initial conditions (Explanatory variables)	Modernization	Group modernization
1. No. of members in <i>iriai</i>	-	
2. <i>Iriai</i> group larger than corresponding hamlet	-	
3. Does not permit new members	+	
4. Permits members' relatives or returning members to join the group	+	
5. Permits new residents		+
6. Allows trading of shares		-
7. Households leaving the hamlet lose rights		+
8. Households leaving the hamlets retain rights		-
9. Group management ratio	+	
10. Plantation ratio	+	
11. Labor investment	+	
12. Obligatory labor investment	+	

4. DATA ANALYSIS AND RESULTS

4.1 Dependent variables

First, we examine the overall picture of modernization following the implementation of the 1966 *Iriai* Modernization Act. Table 2 shows the trend of numbers of forest *iriais* that modernized and the areas that were affected from 1967 until 2010. During 1967 to 1975, 2.7% of the forest *iriais* modernized, and this constituted 18.4% of the area of all forest *iriais*. Between 2001 and 2010 only 0.2% of the original number of forest *iriais* modernized, and this constituted 0.9% of the original area. By the year 2010, 6.0% of the total of forest *iriais* had been modernized, and this represents 36.5% of the total area that was under forest *iriais* in 1960. Consequently, more than 60% of the original forest *iriais* maintained an organization structure which they had before the *Iriai* Modernization Act.

Table 2. Numbers and areas of forest *iriais* modernized under the *iriai* Modernization Act

		Number of approved modernization projects	Percentage	Cumulative percentage	Approved modernization projects in area (ha)	Percentage	Cumulative percentage
1967-1975	(Period 0)	2,997	2.7%	2.7%	290,345	18.4%	18.4%
1976-1980	Period 1	1,396	1.3%	4.0%	125,002	8.0%	26.3%
1981-1985	Period 2	1,037	0.9%	4.9%	74,041	4.7%	31.0%
1986-1990	Period 3	559	0.5%	5.4%	37,951	2.4%	33.5%
1991-1995	Period 4	283	0.3%	5.7%	19,866	1.3%	34.7%
1996-2000	Period 5	186	0.2%	5.8%	13,300	0.8%	35.6%
2001-2005	Period 6	121	0.1%	6.0%	8,312	0.5%	36.1%
2006-2010	Period 7	76	0.1%	6.0%	6,518	0.4%	36.5%

Period 0 is for 9 years while other periods are for 5 years. In the following correlation analysis, Period 0 is for 7 years. In this table, the data for Hokkaido prefecture are included.

Table 3 shows the composition of group and individual modernization for each period. While

both types of modernizations decline over the entire period, because total number of modernizations decline, by Period 3 (1986-1990) the balance between the two shifts, and individual modernization exceeds group modernization. Table 4, with data of the 15 prefectures with the highest percentages of forest *iriais* that modernized between 1967 and 2010, indicates that here are significant differences in modernization patters between prefectures.

Table 3. Composition of group and individual modernization

	Group	%	Individual	%
(Period 0)	182,401	62.8%	107,944	37.2%
Period 1	78,219	62.6%	46,779	37.4%
Period 2	40,700	55.0%	33,344	45.0%
Period 3	18,164	47.9%	19,787	52.1%
Period 4	8,125	40.9%	11,741	59.1%
Period 5	5,935	46.6%	6,814	53.4%
Period 6	2,816	33.9%	5,487	66.1%
Period 7	1,958	30.0%	4,560	70.0%

Table 4. Percentages of forest *iriais* modernized in the top 15 prefectures*#

Prefecture	Initial area of <i>Iriai</i> (ha)	Period 0	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Total (1969-2010)
Saga	6,357	77%	20%	12%	11%	1%	2%	0%	0%	125%
Akita	54,168	44%	25%	20%	6%	3%	1%	1%	1%	102%
Ishikawa	8,275	24%	15%	7%	31%	8%	2%	2%	0%	89%
Miyazaki	29,856	47%	18%	9%	2%	5%	2%	1%	1%	84%
Kochi	18,273	47%	15%	13%	4%	0%	3%	0%	1%	83%
Shimane	11,732	30%	30%	14%	3%	0%	1%	0%	0%	77%
Fukui	34,557	43%	25%	6%	2%	0%	0%	0%	0%	76%
Kumamoto	18,077	13%	9%	19%	6%	11%	10%	1%	4%	74%
Oita	18,426	23%	15%	7%	5%	3%	0%	2%	2%	59%
Niigata	89,490	26%	18%	5%	2%	1%	1%	1%	0%	54%
Iwate	66,287	22%	11%	7%	5%	3%	1%	0%	0%	49%
Nagasaki	20,283	16%	5%	4%	3%	2%	3%	7%	1%	41%
Kanagawa	14,327	27%	4%	3%	0%	0%	1%	0%	2%	37%
Kagoshima	41,521	4%	6%	5%	6%	3%	3%	4%	5%	35%
Nagano	133,466	17%	9%	5%	1%	0%	1%	0%	0%	34%

*In Saga and Akita Prefectures, the percentages for the whole periods (1969-2010) exceed 100 %. This may be due to under-estimation of commons forests in the 1960 census survey.

#Period 0 in this Table indicates seven years from 1969 through 1975

4.2 Independent variables

We examined why in some prefectures more forest *iriais* modernized to a new type of ownership than in others prefectures. We calculated Pearson's correlation coefficients between modernization percentages and variables that might be related to modernization, using the initial, pre-*Iriai* Modernization Act conditions of 1960. We also examined the interrelationships between the coefficients (Table 5). We use the modernization percentages for each of the seven periods as well as the modernization percentage for the whole 42-year period. The variables that we hypothesized to be related to modernization are derived from the twelve hypotheses explained above. After having completed these calculations, we then identified the variables with statistically significant coefficients.³

³ Since Japan has only 45 prefectures with consistent *iriai*-forests statistics—a relatively small number—we counted correlation coefficients with less than 15 % statistical significance in order to explore the existence of relationships.

Table 5. Correlation coefficients from analyses

Indicators of modernization	Period	1. No. of members in iriai	2. Iriai group larger than corresponding hamlet	3. Does not permit new members	4. Permits members' relatives or returning members to join the group	5. Permits new residents	6. Allows trading of shares	7. Households leaving the hamlets lose rights	8. Households leaving the hamlets retain rights	9. Group management ratio	10. Plantation ratio	11. Labor investment	12. Obligatory labor investment
No. of approvals	0	0.008	-0.028	0.072	0.182	-0.016	0.018	-0.026	-0.111	-0.130	-0.190	0.031	0.121
	1	0.026	0.017	0.080	0.120	-0.003	0.020	-0.021	-0.103	-0.031	-0.227 -	0.088	0.152
	2	0.051	0.036	0.132	0.015	-0.017	0.045	-0.076	-0.091	-0.050	-0.179	0.161	0.204
	3	0.049	-0.021	0.195	0.069	-0.146	0.159	-0.208	-0.073	0.089	-0.186	0.192	0.310 **
	4	0.105	0.096	0.228 -	-0.007	-0.163	0.151	-0.244 -	-0.008	0.116	-0.192	0.302 **	0.388 ***
	5	0.112	0.067	0.326 **	-0.008	-0.282 *	0.113	-0.334 **	0.138	0.216	-0.129	0.346 **	0.469 ***
	6	-0.037	-0.044	0.114	0.053	-0.077	0.119	-0.136	-0.024	0.158	-0.215	0.225 -	0.321 **
	7	0.146	-0.004	0.147	0.102	-0.178	0.134	-0.229 -	0.111	0.038	-0.022	0.404 ***	0.441 ***
Whole	0.037	0.006	0.123	0.112	-0.045	0.052	-0.081	-0.091	-0.045	-0.208	0.127	0.209	
Areas approved	0	-0.196	-0.062	-0.087	0.169	0.099	0.001	0.056	-0.099	-0.128	-0.117	-0.024	0.064
	1	-0.250 *	-0.173	-0.160	0.260 *	0.136	-0.010	0.129	-0.135	-0.124	-0.205	-0.016	0.090
	2	-0.215	-0.039	0.047	0.030	0.018	0.082	-0.070	-0.030	-0.180	-0.102	0.129	0.229 -
	3	-0.197	-0.383 ***	-0.213	0.078	0.244 -	-0.053	0.128	-0.165	-0.060	-0.069	-0.029	0.058
	4	-0.097	-0.114	-0.053	-0.017	0.038	0.109	-0.064	-0.022	-0.093	0.032	0.207	0.260 *
	5	-0.106	-0.076	0.038	-0.018	-0.044	0.031	-0.123	0.153	-0.082	0.075	0.167	0.217
	6	-0.104	-0.096	0.025	0.048	-0.083	0.230 -	-0.060	-0.023	0.219 -	-0.078	0.143	0.209
	7	-0.045	-0.034	0.093	0.063	-0.144	0.126	-0.137	-0.039	-0.039	0.080	0.318 **	0.350 **
Whole	-0.253 *	-0.163	-0.110	0.174	0.121	0.027	0.052	-0.107	-0.142	-0.135	0.042	0.156	
Group modernization (Areas)	0	-0.163	-0.128	-0.188	0.300 **	0.197	-0.081	0.219 -	-0.193	-0.132	-0.185	-0.066	0.020
	1	-0.210	-0.239 -	-0.227 -	0.319 **	0.178	-0.069	0.207	-0.180	-0.089	-0.266 *	-0.085	0.030
	2	-0.211	-0.089	-0.049	0.200	0.150	-0.029	0.131	-0.149	-0.114	-0.242 -	-0.002	0.081
	3	-0.208	-0.384 ***	-0.260 *	0.117	0.288 *	-0.057	0.218 -	-0.250 *	-0.115	-0.082	-0.104	-0.025
	4	-0.046	-0.272 *	-0.280 *	0.279 *	0.297 *	-0.069	0.250 *	-0.283 *	0.003	-0.170	-0.089	-0.029
	5	-0.032	-0.070	-0.014	0.085	0.052	-0.107	0.002	0.107	0.025	0.004	-0.031	-0.067
	6	-0.098	-0.045	-0.073	0.011	0.053	0.092	0.038	-0.099	0.466 ***	-0.066	0.100	0.074
	7	0.009	0.081	0.092	-0.045	-0.127	0.174	-0.001	-0.002	-0.142	0.123	0.238 -	0.181
Whole	-0.214	-0.216	-0.221 -	0.312 **	0.230 -	-0.075	0.238 -	-0.222 -	-0.118	-0.229 -	-0.071	0.031	
Individual modernization (Areas)	0	-0.160	0.049	0.078	-0.068	-0.066	0.106	-0.177	0.063	-0.070	0.019	0.040	0.095
	1	-0.169	0.035	0.041	0.015	-0.011	0.090	-0.071	0.016	-0.108	0.013	0.104	0.135
	2	-0.140	0.016	0.105	-0.116	-0.093	0.140	-0.204	0.075	-0.167	0.046	0.185	0.263 *
	3	-0.159	-0.333 **	-0.134	0.027	0.163	-0.041	0.014	-0.050	0.007	-0.046	0.055	0.141
	4	-0.091	-0.039	0.030	-0.105	-0.052	0.140	-0.148	0.064	-0.102	0.087	0.252 *	0.291 *
	5	-0.095	-0.054	0.052	-0.059	-0.071	0.077	-0.137	0.126	-0.100	0.085	0.187	0.249 *
	6	-0.071	-0.070	0.083	0.034	-0.145	0.232 -	-0.116	0.030	-0.003	-0.054	0.120	0.213
	7	-0.051	-0.072	0.057	0.086	-0.095	0.054	-0.144	0.145	0.022	0.029	0.229 -	0.289 *
Whole	-0.191	-0.032	0.066	-0.060	-0.057	0.134	-0.185	0.071	-0.109	0.031	0.154	0.235 -	

- 15% significance, * 10% significance, ** 5% significance, *** 1% significance

Period 0 represents the period between 1969 and 1975

4.3 Testing of hypotheses

Table 6 uses the results of the correlation analyses from Table 5 to validate or reject the 12 hypotheses proposed in section 2.

Table 6. Correlation analysis and hypotheses

Initial conditions (Explanatory variables)	Modernization		Group modernization	
	Hypotheses	No. of signs	Hypotheses	No. of signs
		+ -		+ -
1. No. of members in <i>iriai</i>	-	0 2		
2. <i>Iriai</i> group larger than corresponding hamlet	-	0 5		
3. Does not permit new members	+	2 4		
4. Permits members' relatives or returning members to join the group	+	5 0		
5. Permits new residents			+	3 0
6. Allows trading of shares			-	0 0
7. Households leaving the hamlet lose rights			+	4 0
8. Households leaving the hamlet retain rights			-	0 3
9. Group management ratio	+	2 0		
10. Plantation ratio	+	0 4		
11. Labor investment	+	8 0		
12. Obligatory labor investment	+	13 0		

A majority of the hypotheses were supported by the analysis, with the signs of their coefficients corresponding with the predictions of the hypotheses. A few of the hypotheses, however, were not validated with the findings. We interpreted these unanticipated results, however, as statistical properties of the explanatory factors, rather than as adequate proof of the need to reject the original hypotheses. The correlation coefficients that relate to H3 (Does not permit new members), includes four negative coefficients that are statistically significant, while two positive coefficients are significant. Table 7 shows that H3 (Does not permit new members) is negatively correlated with H5 (Permits new residents) and H7 (Households leaving the hamlets loses right). We believe that these negative correlations might be the result of anomalies, rather than reflecting causal linkages. Partial correlation coefficients were calculated among variables 3, 5 and 7, and the variables for group modernization in Period 1, 3, 4 and the whole duration. The negative correlation between variable 3 and the variable for group modernization in Period 4 turned out to be statistically not-significant.

Table 7. Correlation matrix among explanatory variables (initial conditions)

	1. No. of members in <i>iriai</i>	2. <i>Iriai</i> group larger than corresponding hamlet	3. Does not permit new members	4. Permits members' relatives or returning members to join the group	5. Permits new residents	6. Allows trading of shares	7. Households leaving the hamlet lose rights	8. Households leaving the hamlet retain rights	9. Group management ratio	10. Plantation ratio	11. Labor investment	12. Obligatory labor investment
1. No. of members in <i>iriai</i>	1.000	0.461	-0.181	0.051	0.154	-0.062	0.169	-0.235	0.159	0.088	-0.100	-0.145
2. <i>Iriai</i> group larger than corresponding hamlet	0.461	1.000	0.284	-0.366	-0.236	0.030	-0.239	0.216	0.060	-0.044	-0.079	-0.148
3. Does not permit new members	-0.181	0.284	1.000	-0.538	-0.865	0.379	-0.871	0.653	0.076	0.093	0.553	0.528
4. Permits members' relatives or returning members to join the group	0.051	-0.366	-0.538	1.000	0.413	-0.305	0.515	-0.430	-0.098	-0.184	-0.319	-0.240
5. Permits new residents	0.154	-0.236	-0.865	0.413	1.000	-0.615	0.936	-0.612	-0.066	-0.169	-0.555	-0.534
6. Allows trading of shares	-0.062	0.030	0.379	-0.305	-0.615	1.000	-0.591	-0.052	0.026	0.322	0.487	0.494
7. Households leaving the hamlet lose rights	0.169	-0.239	-0.871	0.515	0.936	-0.591	1.000	-0.646	-0.082	-0.165	-0.578	-0.546
8. Households leaving the hamlet retain rights	-0.235	0.216	0.653	-0.430	-0.612	-0.052	-0.646	1.000	0.058	0.146	0.324	0.225
9. Group management ratio	0.159	0.060	0.076	-0.098	-0.066	0.026	-0.082	0.058	1.000	0.020	0.212	0.205
10. Plantation ratio	0.088	-0.044	0.093	-0.184	-0.169	0.322	-0.165	0.146	0.020	1.000	0.396	0.177
11. Labor investment	-0.100	-0.079	0.553	-0.319	-0.555	0.487	-0.578	0.324	0.212	0.396	1.000	0.907
12. Obligatory labor investment	-0.145	-0.148	0.528	-0.240	-0.534	0.494	-0.546	0.225	0.205	0.177	0.907	1.000

These findings, augmented by the above statistical explanations of the apparent contradictions, generally support our hypotheses, except for H3. The ease of consensus building has encouraged modernization under the *Iriai* Modernization Act (H1, H2, and H9). But consensus building is inversely correlated with the size of *iriai* forest groups and the direct management of the forest area by individual group members. The cohesiveness of *iriai* forest groups also encouraged modernization (H4 and H9). The strength of traditional customs related to forest *iriais* has led to group-type modernization, rather than to individual-type modernization (H5, H7, and H8). Past investments in forest *iriais* have also led to active modernization (H11 and H12), especially individual ownership.

While a majority of the hypotheses were supported by the findings, H6 and H10 were not. Tentative alternative hypotheses are in order for the two unsupported hypotheses. With regard to correlation coefficients related to H6 (Allows trading of shares), no coefficient was statistically significant. This suggests that many groups that allow trading of shares might have pursued individual-type modernization under the *Iriai* Modernization Act. With regard to H10, the higher the plantation ratio, the more difficult the modernization appeared to be, is contrary to what the hypothesis postulates. This may be related to differences in policy efforts by prefectural governments. Because the original rationale for modernization was the lower plantation ratio among forest *iriais*, which is a reflection of low intensity of forest management, prefectures with forest *iriais* with high plantation ratios may not have aggressively pursued the modernization of their forest commons.

We tried to investigate further the relationship between the size of groups involved in forest *iriais* and progress in modernization. We found negative relationships between group-size and modernization (H1 and H2). However, as suggested by Handa (2006), the relationship might be a non-linear, inverse-U shape type, because the balance of costs and benefits for commoners might change due to economies of scale and congestion phenomena. Table 8 shows the correlation coefficients between group sizes and modernization processes. The group sizes were represented by the percentages of groups with certain numbers of households. It was found that group modernization is enhanced when group sizes are relatively small, i.e. around 11 members, while group modernization is difficult with groups sizes of more than or equal to 301 members.

Table 8. Relationship between group sizes and modernization processes

	>=11 HH	>= 31HH	>= 51HH	>= 101HH	>= 151HH	>= 201HH	>= 301HH	>= 501HH
No. of approved projects	0.159	0.129	0.109	0.033	0.071	0.102	0.145	0.094
Areas of approved projects	0.118	-0.050	-0.129	-0.249 *	-0.219 -	-0.215	-0.166	-0.175
Group modernization	0.229 -	0.107	-0.008	-0.177	-0.175	-0.216	-0.222 -	-0.259 *
Individual modernization	-0.062	-0.211	-0.215	-0.228 -	-0.179	-0.124	-0.033	-0.004

">= 11 HH" indicates the percentage of groups own Iriai commons forests with more than or equal to 11 households.
 - 15% significance, * 10% significance, ** 5% significance, *** 1% significance

We also investigated dynamic aspects of the correlations found in the calculations summarized above. We divided the eight periods into four first-half periods (periods 0 to 3) and four second-half periods (periods 4 to 7) and again counted the statistically significant positive and negative correlation coefficients. Table 9 shows the results of this analysis. We identified twelve pairs of statistically significant coefficients for the first half and second half periods. Among them, five pairs indicate increases (shown by double underlines), six pairs indicate decreases (single underlines), and one pair indicates no-change (no underline). It would be quite natural to expect the initial conditions of forest *iriais* to lose influence in later years. Contrary to this expectation, however, it appears that in several instances the influences lasted for more than 20 years, i.e. during four periods. In particular, labor investments in forest *iriais* display strong relationships with modernization development even after more than 20 years.

Table 9. First half and second half comparison

Initial conditions (Explanatory variables)	Modernization			Group modernization		
	Hypotheses	No. of signs [(1st half)/(2nd half)]		Hypotheses	No. of signs [(1st half)/(2nd half)]	
		+	-		+	-
1. No. of members in <i>iriai</i>	-	0	1 <u>[1/0]</u>			
2. <i>Iriai</i> group larger than corresponding hamlet	-	0	5 <u>[4/1]</u>			
3. Does not permit new members	+	2 <u>[0/2]</u>	3 <u>[2/1]</u>			
4. Permits members' relatives or returning members to join the group	+	4 <u>[3/1]</u>	0			
5. Permits new residents				+	2 <u>[1/1]</u>	0
6. Allows trading of shares				-	0	0
7. Households leaving the hamlet lose rights				+	3 <u>[3/0]</u>	0
8. Households leaving the hamlet retain rights				-	0	2 <u>[0/2]</u>
9. Group management ratio	+	2 <u>[0/2]</u>	0			
10. Plantation ratio	+	0	3 <u>[3/0]</u>			
11. Labor investment	+	8 <u>[0/8]</u>	0			
12. Obligatory labor investment	+	12 <u>[3/9]</u>	0			

* The numbers of significant positive or negative signs do not match the ones found in the previous analysis since the signs for the whole period are excluded in the current analysis.

** [0/0] is omitted for the sake of simplicity.

5. DISCUSSION AND CONCLUSION

We examined modernization policies of forest commons in Japan, triggered by the *Iriai* Modernization Act of 1966, and analyzed outcomes of these policies for a period of five decades. Our main focus in this paper was on the factors that influenced the outcomes of the modernization policies.

The case of *iriai* modernization in Japan is relevant in the discussion on how the state deals with forest commons. The discussion is relatively new in the literature, but rapidly expanding (e.g. Yanagisawa, 2015). Rather than a somewhat narrow view that states mostly aim to privatize forest commons, recent evidence shows that in many cases states had more open attitudes toward forest commons. However, a common phenomenon is that where states themselves modernized, and revised land and land use policies, and forest policies, they also sought to incorporate and

accommodate forest commons, including their legal status, but often also their inner governance workings, to modern legislation and public administration.

The relevance of this paper in that debate is that responses of individual forest common user to modernization policies may vary and that the variation can be causally linked to the characteristic of the forest common user group, or their own internal governance. As we saw in the case of forest *iriais* of Japan. The *Iriai* Modernization Act allowed the option of continuing to operate as a modernized forest common, or to divide up the forest land into private plots. We detected that forest *iriais* with certain characteristics chose the option of continuing as a forest common, while those with different characteristics chose to privatize.

These findings, we argue, have important policy implications, for Japan, and for policies towards forest commons more in general. First, targeting is important. Modernization policies or intervention policies toward forest commons are likely to have a differentiated outcome. In the case of Japan, key features that influence response are: size of the groups, persistence of following customs and traditions, and the trajectory of labor investment. This strongly suggests, that policies may target certain types of forest commons, or that different options should be included in the policies for forest commons with different characteristics.

We also reflect on forest *iriais* of Japan, and appropriate policies for these culturally still very relevant forest organizations. An important reality of modern Japan's forest sector is its relative low profitability. This questions the relevance of modernization policies that are still including options as private ownership or forest *iriais* being modernized into forest producer cooperatives, because the latter have as their main reason of being to make profits. In contemporary Japan, commoners, in general, have little interest in forest management that emphasizes timber production due to its low profitability. Rather, options should be explored that forest *iriais* can provide other functions, for example, for recreation or education purposes. If such a change of functions can be established and forest *iriai* user groups can be mobilized to engage in delivering these functions, they can regain commitment for their *iriai* and this may revitalize the forest *iriais* of Japan as a vital modern forest management unit, with clear social function, but continuing and keeping alive an age old tradition.

Lastly, we briefly discuss the limitations of the study and the possibilities for further research related to this topic. First, this study used a limited and a relatively small number of samples, i.e., 45 prefectures in Japan. This has as a consequence that the statistical relevance of our analysis is rather weak. A new data source, for example, individual forest *iriai* level data, would strengthen the statistical relevance of the research and the conclusions. Data on modernization policies or intervention policies in other countries might give us new insights into the research questions addressed in this study. Second, this study infers causal relationships from correlations. Causal tracking of individual cases of commons forests would provide a more detailed and nuanced explanation of correlations. Since the majority of modernization projects in Japan took place in the 1960s and 1970s, many participants, including commoners and government officials, are now advanced in age. Interviews with forest *iriai* user groups, which is necessary to reconstruct the processes of modernization, should be conducted as soon as possible. Third, our study did not yet explore other factors that may have influenced the adoption of the modernization projects by commoners. For instance, we assumed that policy frameworks had been relatively homogenous all over Japan or varied randomly, ignoring differences among prefectural governments in terms of modernization efforts. In addition, we did not yet consider the wider economic portfolio of hamlets that held a forest *iriai*, i.e. the relevance of agricultural activities or income from non-agricultural jobs. Those became common during Japan's industrialization period, and may have influenced the modernization processes of forest *iriais*. We also did not examine how modernization policies affected the performance of forest management, production outputs or investments in commons forests. The data for recent years presented above suggest that the modernization process has lost its momentum, and practitioners as well as some researchers have

called for a reform of the modernization policies (e.g., Kasahara, 1996 and 2000). Comparisons between modernized and non-modernized forest *iriais* could provide us with an insight into whether state intervention is desirable, and under what conditions. Further research on the consequences of the modernization policy is waiting to be undertaken.

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Appendix Descriptive statistics of variables for initial conditions (n=45)

	Average	Minimum	Maximum	Standard Deviation
1. No. of members in <i>iriai</i>	67.205	42.329	114.694	14.678
2. <i>Iriai</i> group larger than corresponding hamlet	0.190	0.057	0.363	0.058
3. Does not permit new members	0.288	0.130	0.489	0.084
4. Permits members' relatives or returning members to join the group	0.111	0.038	0.211	0.046
5. Permits new residents	0.399	0.185	0.606	0.101
6. Allows trading of shares	0.141	0.053	0.255	0.046
7. Households leaving the hamlet lose rights	0.575	0.282	0.776	0.115
8. Households leaving the hamlet retain rights	0.199	0.077	0.427	0.063
9. Group management ratio	0.485	0.344	0.835	0.094
10. Plantation ratio	0.365	0.060	0.791	0.176
11. Labor investment	0.487	0.232	0.680	0.095
12. Obligatory labor investment	0.341	0.106	0.533	0.092
Ratios of groups with certain numbers of households				
>=11 HH	0.795	0.670	0.932	0.056
>= 31HH	0.496	0.372	0.658	0.062
>= 51HH	0.320	0.200	0.458	0.055
>= 101HH	0.149	0.075	0.262	0.041
>= 151HH	0.089	0.032	0.166	0.031
>= 201HH	0.061	0.020	0.130	0.025
>= 301HH	0.036	0.008	0.094	0.017
>= 501HH	0.017	0.003	0.050	0.009