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RESEARCH ARTICLE

Impacts of 150 Years of Modernization Policies on the Management of Common Forests in Japan: A Statistical Analysis of Micro Census Data

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After World War II, Japan's policy makers believed that common forests were underutilized because of their legal status and organization method under customary iriai-type ownership and that modern ownership in the form of group ownership, such as forest producers' cooperatives, or as individual, separate ownership, would improve the situation. Thus, the Common Forests Modernization Act of 1966 was enacted, following successive modernization policies since the Meiji Restoration in 1868. We evaluated the impacts of the past modernization policies on the management of common forests by statistically comparing the performance of modernized and non-modernized 19,690 common forests based on the World Census of Agriculture and Forestry 2000. The performance measures for comparison included planting, weeding, thinning, and harvesting activities. We found less modernized, customary holdings are more active in tending activities such as weeding and thinning, while modernized holdings may have an advantage in harvesting and timber sales.

Keywords: census data; common forests; iriai; modernization; Japan

1. Introduction

1.1. Background

Common forests constitute a significant portion of forest management worldwide. Twenty one percent of private forests and seven percent of public forests of the world are managed by communities and indigenous people. (FAO, 2010, p. 122–126) In the past, Japanese governments have tried to intervene in customary (*iriai*-type) common forests for different purposes. This study examines how the past policy intervention including the most recent one, since the 1960s, encouraging common forests obtain more modern legal status such as cooperatives or individual ownership and organize themselves differently, have affected forest management by those common forests.

There were preceding efforts changing Japanese common forest into more modern types of entities. This study concerns the accumulating effects of efforts over the past 150 years. After the Meiji Restoration in 1868, the newly established Japanese government relied on revenue from land taxation for its financial needs, before the industrialization of Japan. The government divided the country's territory into taxable private lands and government lands that represented important assets for the government. Among private lands, forests managed by "hamlets" constituted a considerable portion. In the 1880s, the government decided to consolidate these hamlets into municipalities such as towns and villages with public administrations that could provide services such as education, public works, and agricultural development. This move created inducements for newly established municipalities to take over forests originally owned by traditional hamlets. This could be one reason why "Public (Hamlet) Forest Reorganization and Unification Project" was promoted from 1910 to 1939 (Handa, 1988; p. 212). The central government played an active role in this project, under the centralist constitutional

set-up of that time. In fact, the governors of prefectural governments were appointed by the central government. Flooding in 1907 and 1910 was another impetus for pushing the transfer of lands from hamlets to municipalities, since hamlets were thought to manage their lands unsustainably (Ministry of Agriculture and Forestry, Minister's Secretariat, 1963; Editorial Committee for 100 Year History of Ministry of Agriculture, Forestry and Fisheries, 1972).

After World War II, Japan's recovery from destruction and its subsequent industrial development presented policy makers with a new challenge, namely, the disadvantaged position of the agricultural and forestry sector compared with Japan's fast-growing industrial sector. Policy makers believed that common forests were underutilized from the perspective of timber-producing, plantation forestry, due to their legal status under customary *iriai*-type ownership; and that modern ownership, in the form of group ownership such as forest producers' cooperatives, or as individual, separate ownership, would improve the situation (Matsushita, 2012). In fact, under *iriai*-rules, important decisions, such as sales of the common forests and termination of their rights, have to be made based on consensus; majority-based decision making is legally impossible on such crucial issues. The plantation ratio of *iriai*-type common forests, 28.8 %, was in fact lower than that of private owners' forests, 35.5 %, by 6.7 points. (Ministry of Agriculture and Forestry, Department of Survey and Statistics, 1962; p. 16)

After several years of research by and discussion among governmental bureaucrats and experts, the Common Forests Modernization Act of 1966 was enacted. (Hereafter, we call this Act "the 1966 Act" or "the Act"). The Act stipulates that "the prefectural staff may handle the complicated procedures of official registration, which is not required for customary *iriai* right, and the registration tax shall be exempted or reduced" (Handa, 1988).

In Japan, since the enactment of the Act, around 30 to 40% of 1.6 million ha common forests as of the year 1960 have been placed under modern types of ownership such as individual private ownership, forest producers' cooperatives, joint ownership, or other types, such as non-profit associations (Takahashi, Matsushita, and de Jong, 2017). The series of the above-mentioned policies including the enactment of the Act and the ensuing policy support in Japan are major state interventions and facilitations in commons-type ownership in an industrialized country. It is worth analyzing and evaluating these major policy interventions and facilitations.

The 1966 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 villagers. It is often said that, in reality, 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 on membership (Handa, 2001).

The consequences of modernization policies are thought to be two-sided. On one hand, the modernization policy led to the establishment of forest producers' 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 tendency of decline in forestry activities in Japan until today, such an arrangement, in many cases, has not resulted in the vigorous for-profit forestry activities anticipated and includes burdens such as corporate tax payments and management tasks for owners. A large scale survey of the effects of the modernization has not been conducted yet, however.

We can find several examples of common forests that have not been modernized, and relatively well managed by commoners (Kasahara, 2000; Kobayashi, 2013). Several scholars are critical about the modernization policy (Kasahara, 1996; Noguchi, 2014). They claim the modernization policy is not effective in improving forest management practices. We try to evaluate effects of the past modernization policies, relying on large-scale census data.

Since modernization is a complex and controversial concept, some readers may find the use of term "modern" or "modernization" in this manuscript somewhat inappropriate. This manuscript defines "modernization" as the transformation of the right of common into other types of right (e.g., individual ownership, membership of a cooperative, or ownership by the municipality), in line with the definition used by Japanese statistics officials. We ask the reader not to assume any value judgment from the use of the term "modern" or "modernization": indeed, we see modernization as neither good nor bad. For the sake of operational practicality, we use these terms in the sense the Japanese statistics officials use them. Forest holdings with multiple right holders are defined as modernized when those holdings do not have all of the following three customary holding characteristics: 1) use of its revenues for the community (hamlet), 2) customary basis of right holders' right, and 3) the condition that right holders should be residents in the community (hamlet).

In this manuscript, we use terms such as “customary forest holding,” “non-modernized forest,” and “*iriai* forest” (Japanese name for “customary use”) interchangeably, and we also consider both “non-customary” and “modernized” the same type of forestry holdings (i.e., those that do not have “customary” characteristics).

1.2. Use of common forests in Japan

The pattern of utilization of common forests by commoners has changed drastically from the past. Historically, hamlet residents used common forests to gather wood for fuel, to make charcoal, and to use materials as fodder, fertilizer, and building or tool materials mainly for household consumption (McKean, 1992). In the early modern era of Japan, the Edo period (1603–1867), each hamlet or groups of hamlets used certain tracts of forests under a regime of customary rights before land ownership had been established, since the modern concept of sole land ownership was not recognized at that time. After the modernization era began following the Meiji Restoration in 1868, the central government assigned the official ownership of common forests to some hamlets, to members of hamlets, or to the central government itself. On the other hand, the Civil Code of 1896 recognized the customary right of commoners to use common forests, even when they came under the possession of other people or entities. During the industrialization period of Japan in the later 19th century to the beginning of the 20th century, commoners started planting trees for timber harvesting in the future since timber prices were rising due to the expansion of markets. In later years, reliance on common forests for the purpose of gathering fertilizer or fuel wood decreased because commoners started purchasing chemical fertilizer or fossil fuel from merchants.

The 1960 World Agriculture and Forestry Census Survey shows the status of common forests after almost 100 years of industrialization of Japanese society. Among 109,909 common forests identified in the survey, 19.9% (21,920 entities) produced forest products, such as timber and fuel wood from February 1959 through January 1960 (hereafter, we call this period the Year). A total of 11,046 entities (10.1% of all the common forests) produced timber, 13,145 entities (12% of them) produced fuel wood or charcoal wood during the Year. Among the 21,920 common forests that produced timber products, 4,901 entities (4.5% of the forests) distributed the products to their members, while the remaining entities accumulated the cash proceeds in the accounts of their communities or distributed the cash proceeds. The above description indicates that by the end of the 1950s, the majority of common forests were not being used for the daily household consumption of the members. This trend has continued to today.

1.3. Literature

We review here the literature on state intervention and facilitation for commons, because past policies for common forests in Japan ranged from a voluntary one (i.e., the 1966 Act) to interventionist ones (i.e., the Public (Hamlet) Forest Reorganization and Unification Project between 1910 and 1939). Dietz et al. (2002; p. 13) summarized the observation prevalent by the mid-1980s that transitions from governance as common property of local communities to state governance had led to a deterioration of the resources involved in Africa, Latin America, and Asia. Berkes (2002; pp. 298–300) classified types of cross-scale interaction for the purpose of strengthening local-level institutions and identified five such forms, i.e., “state legitimization of local institutions,” “enabling legislation,” “cultural and political revitalization,” “capacity building,” and “institution building.” In this paper, Berkes pointed out that commons researchers “lack[ed] theory and guiding principles” (p. 300) in the field of institutional linkages and referred to an opinion stating that “commons literature tend[ed] to concentrate on local-level institutions to the exclusion of the outside world that impacts them and shapes them” (p. 300). Anthony and Campbell (2011) identified the state’s facilitation role in the commons, or in regard to general collective goods, as an extension to the theory proposed in *Governing the Commons* by Elinor Ostrom. Anthony and Campbell (2011) listed four facilitation roles, such as perceived threat of government regulation¹, provision of tangible resources, conferring legitimacy, and transformation of perception, in addition to direct state participation and consultation. Tedder (2010) called for more practical guidance for state intervention and devised an intervention framework that includes the following three elements: 1) an institution failure model, 2) a state intervention typology, and 3) a set of intervention properties. The state intervention typology includes the following five types: obstructionist, absent, facilitating, coordinating, and prescriptive. Tedder also emphasized the lack of research on the role of the state within the commons literature (p. 7).

¹ The perceived threat of regulation could lead actors’ behavior to become more cooperative, since actors take into account the possibility of direct regulation and, under expected regulation, consider cooperative behavior more beneficial than non-cooperation.

Another line of research deals with the situations where the state relinquishes control over common forests in transition economies. Premrl et. al. (2015) discuss the restitution of forests in Slovenia, and Tran and Sikor (2006) analyze the devolution of forest lands in Vietnam. Both groups of researchers identified problems with these governmental policies.

In one of developed countries, Japan, Takahashi, Matsushita and de Jong (2017) examined what factors have influenced modernization processes by a state, and found the ease of consensus building among commoners, the cohesiveness, and past labor investment affected modernization processes positively.

The literature in the above clearly demonstrates that there are needs for further research on state intervention because of its importance in policies for commons, and that this line of research still remains at the level of creating typologies, requiring having more knowledge on effects of state intervention. To our knowledge, our project is the first attempt to examine the impacts of state modernization policies on the management of common forests utilizing the micro data of a national census.

2. Method

We evaluated the impacts of the series of the modernization policies in the past 150 years in Japan on the management of common forests by comparing the performance of modernized and non-modernized forests based on the The World Census of Agriculture and Forestry 2000 (hereafter, the 2000 Forestry Census), the data of which were for the year 2000.² The performance measures for comparison included planting, weeding, thinning, and harvesting activities and timber sales performance. We did not include other aspects of forest-related activities—such as environmental protection and community building—that are found to be important in common forest management in Japan (Mitsumata et al., 2008; Shimada, 2014). That is because data related to activities other than timber production were not collected in the 2000 Forestry Census. In fact, since the main objective of the 1966 Act was promotion of timber-producing, plantation forestry, the focus on timber production in this study can be partially justified.

As the published reports on the 2000 Forestry Census did not provide details regarding customary holdings, we used the micro data of the Census.³ The Census defined customary holdings as the ones responding “Yes” to any one of the following three questions: 1) Part of or all of revenues from the forests are spent for the hamlet as a whole? 2) Common right to the forest is based upon traditional customs? 3) Right holders should be the residents of the hamlet? Non-family, group forest holdings under the titles of shrines and temples, co-ownership, various organizations and cooperatives, property wards, amalgamated (now non-existent) cities, towns, villages, or hamlets with a minimum size of 10 ha were selected for the following analyses. These holdings are more likely to represent former *iriai*-type, customary ownership. Excluded forestry holdings are the ones with titles of corporations, current municipalities, unions of municipalities, prefectures, public corporations, and state. Forest holdings that had plantation areas were selected so we could examine forestry-related activities, as modern Japanese forestry almost always involves plantation areas. In addition, samples with abnormal data were sorted out.⁴ As a result, among 32,908 non-family forest holdings, 19,690 with 1.47 million ha holding areas were selected. Among the 19,690 holdings, 9,482 are customary and 10,208 are non-customary.

We compared modernized and non-modernized “group” holdings because we cannot identify modernized individual, family ownership among individual, family ownership in our data set. Please note that there is heterogeneity in terms of their titles among both modernized and non-modernized holdings. Both the number of holdings and forest area under customary holdings decreased over the past 40 years. One reason for this is the above-mentioned policy for modernization of rights of common forests.

We present herein three alternative hypotheses of how modernization has affected forest management.

- a) $H_{(positive)}$: Positive influence. Modernized common forests may enjoy enhanced management owing to various reasons such as improved decision-making mechanisms, intensified attention from local prefectural governments after modernization, or originally active tendencies of

² The statistical office collected the data as of the 1st of February, 2000 for prefectures other than Okinawa, and as of 1st of December, 1999 for Okinawa prefecture. Forest management activities and timber harvesting activity concern about the ones during the previous one year period from these dates.

³ The statistics office publishes only aggregated data. We applied for the “Extended Use (Secondary Use) of Official Statistics” scheme within the jurisdiction of the Ministry of Internal Affairs and Communications, and accessed the data thereafter.

⁴ The abnormal data concern the following holdings; more than 100% of their holding areas were planted, weeded, thinned or harvested, or more than 500 cubic meters of their timber per hectare was harvested in the past one year, all of which activities are supposed due to forest management activities related to natural forests, not plantation forests, our subject in this study.

- modernized forest commons, which enabled them to implement legal modernization.
- b) $H_{(neutral)}$: Neutral influence. Modernized common forests are not so different from non-modernized forests in terms of their management practices because, even though modernized forests went through legal modernization, substantial modernization in the areas of their decision-making and other managerial aspects may not have occurred, in reality. Therefore, we may not be able to identify any substantial differences between modernized and non-modernized forests.
- c) $H_{(negative)}$: Negative influence. Modernization, by imposing new schemes and practices, may have destroyed traditional *iriai* forest management schemes and practices, which would have been effective under certain conditions as self-organizing and self-governing forms of collective action (Ostrom, 2009; van Laerhoven and Berge, 2011). Therefore, contrary to policy intentions, modernized common forests may be *less* active in terms of forest management practices.

First, we cross-tabulated the average performance figures of modernized and non-modernized forest management among the sample, controlling for sizes, agricultural (geographical) regions, and regional groups. Next, we estimated Tobit regression models including a customary-holding indicator as an independent variable for the purpose of examining general tendencies. Since a majority of common forests analyzed here do not practice forest management activities, the Tobit model, which consider zero activities as indicators of negative or no willingness to manage forests, would be appropriate for this analysis.

3. Results

We obtained descriptive statistics for selected group forest holdings, as shown in **Table 1**.

This table shows how much forest lands were modernized. Around 52 % of this sample were modernized in terms of rules governing forest holdings ($v8 = 0.4816$, $1 - 0.4816 = 0.5184$). It was found that, in total, certain forestry activities were not active in the year 2000. Only 0.64% of the total plantation areas were replanted (in Japan, after the year 2000, it has been very likely that tree planting takes place in previously planted areas, not in bare lands or natural forests). Only 0.18% of the total plantation areas were harvested. On the other hand, certain forest tending activities are occurring. Of the total plantation areas, 6.65% and 4.02% received weeding and thinning treatment, respectively.

Correlation coefficients were calculated among the variables. We present the correlations among variables in **Table 2**.

Some indicators representing forest management activities such as thinning and timber sales (from $v1$ to $v5$) were correlated with customary ownership indicator ($v8$).

Next, we present comparative cross-tabulation tables of 19,690 non-family forestry operations, controlling holding sizes, agricultural (geographical) regions, and regional groups according to their advances in terms of modernization.

Table 3 is a cross-tabulation table comparing customary (non-modernized) and non-customary (modernized) holdings in terms of forest management performances. In this table, we controlled the size

Table 1: Descriptive statistics for the selected group forest holdings (N = 19690).

No.	Description	Average	S.D.	Minimum	Maximum
v1	New planting area/Total plantation area	0.0064	0.0621	0	1
v2	Weeding area/Total plantation area	0.0665	0.1875	0	1
v3	Thinning area/Total plantation area	0.0402	0.1362	0	1
v4	Harvesting area/Total plantation area	0.0018	0.0281	0	1
v5	Timber sales volume of standing trees (m ³)/Total holding area (ha)	0.4773	8.3846	0	466.7
v6	Total holding area (ha)	74.7284	393.5792	10	29649
v7	Total plantation area/Total holding area	0.6501	0.3551	0.0005	1
v8	Customary common holdings*	0.4816	0.4997	0	1

* Dummy variables. If "yes", the value is one.

Table 2: Correlation matrix among variables (N = 19690).

	v1	v2	v3	v4	v5	v6	v7	v8
	New planting	Weeding	Thinning	Harvesting	Timber sales	Holding area	Plantation ratio	Customary
New planting	v1	1.0000	0.1657	0.0007	0.0846	0.0111	-0.0054	-0.0647
Weeding	v2	0.1657	1.0000	0.1088	0.0375	-0.0017	-0.1112	-0.1158
Thinning	v3	0.0007	0.1088	1.0000	0.0427	0.0484	-0.0084	-0.0023
Harvesting	v4	0.0846	0.0375	0.0427	1.0000	0.0607	0.0031	-0.0293
Timber sales	v5	0.0111	-0.0017	0.0484	0.0607	1.0000	-0.0029	-0.0155
Holding area	v6	-0.0054	-0.0112	-0.0084	0.0031	-0.0029	1.0000	0.0252
Plantation ratio	v7	-0.0647	-0.1158	-0.0023	-0.0293	0.0200	-0.0801	1.0000
Customary	v8	-0.0067	0.0389	0.0173	-0.0037	-0.0155	0.0252	-0.1175

Table 3: Comparison table of forest holdings based on controlling size.

	Size	N	New planting	Weeding	Thinning	Harvesting	Timber sales
Customary	0–25%	2055	0.6%	9.7%	5.2%	0.2%	0.44
	25–50%	2335	0.6%	7.4%	4.2%	0.1%	0.22
	50–75%	2700	0.8%	6.8%	4.3%	0.2%	0.36
	75–100%	2392	0.3%	6.2%	3.5%	0.2%	0.36
Non-customary	0–25%	3269	0.7%	6.4%	3.8%	0.1%	0.62
	25–50%	2858	0.6%	5.8%	3.8%	0.1%	0.69
	50–75%	2392	0.8%	5.9%	3.7%	0.3%	0.27
	75–100%	1689	0.6%	5.4%	3.9%	0.3%	0.89
	(All)	19690					
Diff. Custom-Non-custom	0–25%		–0.1%	3.3%***	1.4%**	0.0%	–0.18
	25–50%		0.1%	1.5%**	0.4%	0.0%	–0.47/
	50–75%		0.0%	0.9%/	0.6%	–0.1%	0.09
	75–100%		–0.2%*	0.8%	–0.4%	0.0%	–0.54/

/: 10%, *: 5%, **: 1%, ***: 0.1% significance levels.

Diff. indicates non-modernized minus modernized holdings. New planting, Weeding, Thinning, and Harvesting are the ratios of areas receiving such treatments to the total plantation areas in one year before February 2000 (for Okinawa, December 1999). Timber sales are the sales volumes (in cubic meters) sold as standing trees (not as harvested logs) per a hectare of holding areas in one year before February 2000 (for Okinawa, December 1999). Size indicates into which size category holdings fall.

of forest land holdings. We ranked all the holdings depending on their holding areas, from the smallest to the largest, and divided them into four categories: 0–25% (more than or equal to 10ha and less than or equal to 15.3ha), 25–50% (more than 15.3ha and less than or equal to 27.5ha), 50–75% (more than 27.5ha and less than or equal to 67.55ha), and 75–100% (more than 67.55ha). The presented figures represent simple mean values for each category. We conducted t-tests between customary and non-customary holdings.

Tables 4 and **5** present similar analyses based on controlling agricultural (geographical) regions and prefecture groups according to their advances in terms of modernization, respectively. In the analysis for **Table 5**, we ranked all prefectures depending on their ratios of modernized areas of the 1960 *iriai* forests from 1969 through 2015, from the largest to the smallest, and divided them into four categories: 124.8–33.5% (Advanced; 15 prefectures), 32.0–24.5% (Middle; 15 prefectures), 23.6–0.0% (Remaining; 15 prefectures), Hokkaido and Okinawa, where usual *iriai*-type customary holdings were not historically recognized. We employed such categorization based on the degree of modernization since certain unobservable prefecture characteristics related to the readiness of modernization may have affected decision-making for common forests.

To summarize these results, we provide **Table 6**, which provide the numbers of the signs of differences between non-modernized and modernized common forests.

We identified several general patterns. First, non-modernized (customary) common forests were thinned more actively than their modernized counterparts were. Out of 17 comparisons, around halves (10 and 8) of the non-modernized minus modernized values (Diff.) for weeding and thinning are positive, respectively. Second, in terms of harvesting and timber sales, comparisons between customary and non-customary holdings are inconclusive. The differences between customary and non-customary have four (Harvesting; 2+Timber sales; 2) positive statistically significant signs and five (1+4) negative significant signs. If we examine only parts of Japan, except for Hokkaido and Okinawa, which have distinct histories before the pre-modern era, we find five negative signs only, which indicate non-customary, modernized forest holdings perform better in harvesting and timber sales.

Further, we conducted regression-type, Tobit analyses so that we could consider intricate relationships among the variables influencing forest management (**Table 7**).

Table 4: Comparison table of forest holdings based on controlling regions.

	Region	N	New planting	Weeding	Thinning	Harvesting	Timber sales
Customary	Hokkaido	16	0.0%	6.7%	0.6%	6.3%	2.20
	Tohoku	1785	0.5%	7.6%	4.7%	0.2%	0.74
	Hokuriku	665	0.7%	13.2%	2.7%	0.0%	0.05
	Kanto/Tozan	1262	0.5%	5.1%	3.1%	0.1%	0.13
	Tokai	997	0.3%	6.1%	5.2%	0.1%	0.22
	Kinki	1864	0.4%	6.0%	4.2%	0.2%	0.24
	Chugoku	1208	1.1%	8.0%	2.9%	0.2%	0.44
	Shikoku	297	0.4%	3.2%	5.8%	0.4%	0.21
	Kyusyu	1387	0.7%	9.8%	5.8%	0.2%	0.32
Non-customary	Hokkaido	447	1.2%	6.8%	6.2%	0.3%	0.22
	Tohoku	2985	0.7%	6.8%	3.7%	0.2%	0.71
	Hokuriku	393	0.5%	10.6%	2.7%	0.0%	0.03
	Kanto/Tozan	1380	0.5%	5.1%	3.9%	0.2%	1.14
	Tokai	939	0.5%	4.7%	3.7%	0.1%	0.47
	Kinki	821	0.6%	4.4%	3.3%	0.2%	0.16
	Chugoku	1088	1.2%	5.8%	2.4%	0.0%	0.26
	Shikoku	657	0.5%	3.3%	4.0%	0.1%	0.40
	Kyusyu	1498	0.6%	6.4%	4.6%	0.3%	0.83
	(All)	19689					
Diff. Custom-Non-custom	Hokkaido		-1.2%	-0.1%	-5.6%	5.9%***	1.97**
	Tohoku		-0.2%	0.8%	0.9%*	0.0%	0.03
	Hokuriku		0.2%	2.7%/	0.0%	0.0%	0.02
	Kanto/Tozan		0.1%	0.0%	-0.8%	-0.2%/	-1.01*
	Tokai		-0.2%	1.4%/	1.5%*	0.1%	-0.25
	Kinki		-0.1%	1.6%*	0.9%/	0.0%	0.07
	Chugoku		-0.1%	2.2%**	0.5%	0.1%	0.17
	Shikoku		-0.1%	0.0%	1.8%/	0.3%	-0.19
	Kyusyu		0.1%	3.4%***	1.2%*	-0.1%	-0.51

/: 10%, *: 5%, **: 1%, ***: 0.1% significance levels.

Diff. indicates non-modernized minus modernized holdings.

The total number of sample is 19,689 since one case from Okinawa was omitted.

We conducted Tobit regression analyses using performance measures such as new tree planting areas (v1), weeding areas (v2), thinning areas (v3), and harvesting areas (v4) per total plantation areas, as well as timber sales volumes of standing trees (v5) per one hectare of total holding areas (v6) as dependent variables, while using holding areas (v6), plantation ratios (v7), agricultural region dummies, and an indicator of customary, non-modernized holding as independent variables. The variables representing holding areas and plantation ratios were included because they are known to influence decisions by common forests (Takahashi, Matsushita, and de Jong, 2017). We tested the above-mentioned hypotheses regarding whether modernization has affected forestry activities or not, and if so, positively or negatively. The indicator of non-modernization and modernization is the fact that the forest lands was managed under customary rules (v8).⁵

⁵ The customary rules involve the following three ones: 1) use of revenue for the hamlet, 2) customary basis of common right, and 3) commoners should be residents of the hamlet, as described in the Introduction part in this paper.

Table 5: Comparison table of forest holdings based on controlling regional groups according to their advances in terms of modernization.

	Regional types by modernization	N	New planting	Weeding	Thinning	Harvesting	Timber sales
Customary	Advanced	3615	0.7%	8.4%	4.4%	0.1%	0.38
	Middle	3911	0.6%	7.1%	4.0%	0.2%	0.33
	Remaining	1939	0.4%	6.1%	4.4%	0.1%	0.28
	Hokkaido, Okinawa	17	0.0%	6.3%	0.6%	5.9%	2.07
Non-customary	Advanced	4074	0.7%	5.8%	4.3%	0.2%	0.54
	Middle	3110	0.6%	6.1%	3.5%	0.1%	0.52
	Remaining	2577	0.7%	5.9%	3.0%	0.3%	0.87
	Hokkaido, Okinawa	447	1.2%	6.8%	6.2%	0.3%	0.22
	(All)	19690					
Diff. Custom-Non-custom	Advanced		0.0%	2.6%***	0.2%	0.0%	-0.16
	Middle		0.0%	1.1%*	0.6%*	0.1%	-0.19
	Remaining		-0.3%	0.2%	1.4%***	-0.1%	-0.58*
	Hokkaido, Okinawa		-1.2%	-0.5%	-5.6%	5.6%***	1.85**

/: 10%, *: 5%, **: 1%, ***: 0.1% significance levels.

These results indicate customary holdings are more active in weeding and thinning since “Customary” variable have statistically significant, positive coefficients in “Weeding” and “Thinning” models. The estimated coefficient for Customary in the Tobit “Weeding” model is 0.0875 (Table 7); this indicates that forestry holdings with customary rules tend to weed more of its plantation area than non-customary ones (by 8.75%). Compared to the average value of 6.65% (Table 1), this value appears to be substantial. With regard to thinning activity, the estimated coefficient is 0.0807 (Table 7); this indicates 8.07% more thinning for customary holdings, while the total average is 4.02%.

“Customary” variable has statistically not-significant coefficient for “New planting”, “Harvesting” and “Timber sales” models in Tobit analyses.⁶

4. Discussions and Conclusions

We obtained apparently surprising results regarding the effects of modernization. That is, less modernized forest (“Customary”) holdings measured with the above-mentioned two criteria are more active in forest tending. We conclude less modernized customary holdings are more likely to practice better forest tending. $H_{(negative)}$ was supported with respect to forest tending. On the other hand, by controlling sizes, agricultural regions, and regional advancement in modernization, in our cross-tabulation analyses, we identified a potential advantage for modernized common forest, i.e., harvesting and timber sales activity.

We tentatively conclude that the modernization policy may have mixed results regarding forest management. In some areas of forest management, possibly areas related to harvesting, the policy may have been partially successful in terms of promoting such an activity, whereas in other areas, possibly such as weeding and thinning, it was not as successful.

We speculate that traditional hamlets may be able to handle forest tending activities better than expected by past policy makers. In fact, in 1984, one hamlet in Northern Japan was awarded a national Prime Minister’s prize of “Vibrant Community Building”, among other efforts, by utilizing the proceeds from customary forest holding for the purpose of improving agricultural and community infrastructure (Matsubara, 1989). The key factors for their success are said to be historically well-organized management scheme and sustaining controlling power over the residents (Matsubara, 1989). Traditional practices and mentality may be well suited for tending forests in the long run. On the other hand, modernized forest holdings may be able

⁶ For the purpose of controlling for endogeneity of modernization decision, we conducted Instrumental Variable (2SLS) regressions and Propensity Score Matching method. We obtained similar results shown here.

Table 6: Summary of comparison tables (statistically significant differences).

Table No.	New planting		Weeding		Thinning		Harvesting		Timber sales	
	+ C > Non-C	- C < Non-C	+ C > Non-C	- C < Non-C	+ C > Non-C	- C < Non-C	+ C > Non-C	- C < Non-C	+ C > Non-C	- C < Non-C
Sizes	0	1	3	0	1	0	0	0	0	2
Regions	0	0	5	0	5	0	1	1	1	1
Regional groups	0	0	2	0	2	0	1	0	1	1
Total	0	1	10	0	8	0	2	1	2	4

Numbers indicate how many differences are statistically significant according to t-tests, by signs of differences. "C > Non-C" indicated the mean for customary holdings is larger than the one for non-customary holdings. "C < Non-C" indicated the mean for customary holdings is smaller than the one for non-customary holdings.

Table 7: Tobit regression (Customary) analyses results (N = 19690).

	New planting		Weeding		Thinning		Harvesting		Timber sales	
	Estimated Coefficient	t-value	Estimated Coefficient	t-value	Estimated Coefficient	t-value	Estimated Coefficient	t-value	Estimated Coefficient	t-value
Intercept	-0.6107	-8.99	-0.2563	-9.43***	-0.3792	-11.38***	-0.6682	-11.19***	-145.0108	-8.08***
Holding area	0.0000	1.84	0.0000	1.51	0.0000	1.44	0.0000	2.50*	0.0077	2.06*
Plantation ratio	-0.0849	-2.61**	-0.1096	-8.55***	0.0670	5.34***	-0.0382	-1.00	6.6530	1.74
Customary	0.0136	0.94	0.0875	16.10***	0.0807	8.09***	-0.0099	-0.63	-0.1335	-0.05
(Agricultural regions, Hokkaido and Okinawa cases are the base-line)										
Tohoku	-0.1635	-9.64***	-0.0001	-0.02	-0.0700	-16.25***	-0.0850	-7.19***	10.9713	7.46***
Hokuriku	-0.1639	-7.79***	0.1139	12.91***	-0.1328	-14.29***	-0.2298	-7.01***	-17.1531	-5.69***
Kanto/Tozan	-0.1269	-10.98***	-0.0208	-5.18***	-0.0472	-10.09***	-0.0960	-7.72***	9.6700	7.44***
Tokai	-0.1198	-11.44***	-0.0095	-1.98*	-0.0245	-4.43***	-0.0616	-6.16***	11.5734	6.81***
Kinki	-0.1628	-8.58***	-0.0377	-7.21***	-0.0095	-1.53	-0.0660	-3.92***	-0.0773	-0.04
Chugoku	-0.1182	-7.64***	-0.0451	-13.57***	-0.1639	-17.78***	-0.1730	-7.25***	-5.8549	-3.27***
Shikoku	-0.2309	-10.52***	-0.1589	-31.70***	-0.0636	-13.61***	-0.0576	-9.73***	-0.3828	-0.66
Kyushu	-0.0840	-14.13***	0.0739	9.34***	-0.0157	-2.18*	-0.0115	-2.11*	10.8884	7.26***
Log likelihood	-2805.6		-9649.1		-7687.8		-1260.4		-4757.3	
Pseudo R squared	0.0118		0.0219		0.0196		0.0214		0.0062	

* 5%, ** 1%, *** 0.1% significance levels.
Heteroscedasticity robust standard errors clustered by prefecture were employed.

to handle better drastic decisions such as forest harvesting and timber sales than conservative customary holdings by simplifying decision-making processes.

These results suggest several hints for formulating policies affecting common forests in Japan and other countries in the future.

Here are several caveats. In Japan, during the 1990s and 2000s, forestry activities were stagnating owing to their persistently low productivity and economic downturn. These unfavorable conditions may have influenced the above-mentioned results. Overall, economic conditions may have exerted depressing effects on former common forests. In fact, low levels of investments may have been rather rational responses by modernized, former customary common forests. Second, we only considered moneymaking forestry activities and excluded recreational, or spiritual, community-building aspects of forest management. In fact, many common forests in Japan are related to shrines or temples. Consideration of these other aspects may shed a different light on the modernization policy. Third, as mentioned above, the current study did not investigate individual ownership created out of *iriai* common forests because of data limitation. Individually-divided ownership from former customary common forests may be managed better than customary or non-customary group holdings. A policy document in 1960 clearly stated the ideal direction for common forests, for the purpose of enhancing utilization, was individual privatization (Committee on Fundamental Issues in Agriculture, Forestry and Fishery, 1960). Historically, plantation forests and forests used by individual families were divided among them even without governmental policies. Small sizes after individual privatization, however, may have resulted in inefficiency due to anticommons situation. Inclusion of individual ownership in our analysis is also necessary for comprehensive evaluation of the modernization policy. Fourth, we tried to assess here the overall impact of modernization policies over the past 150 years, including the responses of forest holdings to those policies. Those responses include the transformation or abandonment of customary rules, changes in organizational formats, and divisions into individual ownership or changes to municipal assets. Therefore, all forest holdings—either with or without customary rules—have experienced policy interventions. Although in several analyses we tried to control for the endogeneity effects of decisions made by forest holdings themselves, there is still the strong possibility we measured not only policy effects but also self-selection effects—that is, non-modernized forestry holdings may have inherent characteristics that positively affect forest tending activities, and such characteristics may have led to the results obtained in this study. Fifth, please note that even though we tried to control for size, regional, and past investments (plantation ratios) influences, there could be a possibility that the findings may be influenced by heterogeneity of customary and non-customary forest holdings, respectively.

This study contributes to the study of the commons by giving insights into contemporary status of modernized and non-modernized commons on a national scale and at the micro levels. We hope to investigate this issue further by conducting regression-type analyses that are more sophisticated, as such analyses could provide more answers to important research questions with statistical hypothesis testing. For such analyses, the current study will give guidance in formulating models.

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Competing Interests

The authors have no competing interests to declare.

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