

Article

Models Explaining the Levels of Forest Environmental Taxes and Other PES Schemes in Japan

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Abstract: Between 2003 and April 2016, 37 of 47 prefectures (i.e., sub-national local governmental units) introduced forest environmental taxes—local payment for environmental services (PES) schemes. These introductions are unique historical natural experiments, in which local governments made their own political decisions considering multiple factors. This study empirically evaluates models that explain normalized expenditures from forest environmental taxes as well as other PES schemes (subsidies for enhancing forests’ and mountain villages’ multifunction, and green donation) and traditional forestry budgets for Japan’s 47 prefectures based on the median voter model. Results demonstrate that the median voter model can particularly explain forest environmental taxes and forestry budgets. Specifically, the past incidence of droughts and landslides is positively correlated with the levels of forest environmental taxes. The higher the number of municipalities in a prefecture, the lower the amount of forest environmental tax spent on forests. Moreover, the number of forest volunteering groups, possibly an indicator of social capital in the forest sectors, had strong positive correlations with the levels of forest environmental taxes and forestry budgets. Other PES schemes and forestry budgets had unique patterns of correlations with the examined factors.

Keywords: PES; politics; local governments; public finance



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1. Introduction

Payment for environmental services (PES) is considered a solution for ecological degradation of the environment [1,2]. This paper aims to investigate the economic and political mechanisms statistically through which PES schemes and forest environmental taxes can be implemented in Japan, which is an industrialized country.

Japan underwent massive afforestation after the Second World War (WWII), thereby increasing the ratio of plantation area from around 20% of the total forest area in the 1940s to around 40% after the 1980s [3]. Japan’s total forest area is approximately 25 million hectares (ha), and this value has remained consistent over the last three decades (24,950 thousand ha in 1990; 24,958 thousand ha in 2015) [4]. Some parts of afforested areas were originally deforested during and after WWII, and the other parts were hardwood- and fuel-wood-producing forests. These forests gradually lost their commercial value owing to the transition of energy sources of the country from wood to fossil fuels during the 1950s and 1960s [5]. After the 1980s, a large part of these plantation forests, at about 10 million hectares in total, reached a stage wherein they required thinning so that they could grow well [6]. However, many forest owners have not thinned their plantation forests for the following reasons. Forest management through timber production in Japan incurs high costs owing to the steep topography of mountainous forest areas and lush undergrowth under humid and warm climate conditions. Competition with imported timber from South East Asia, North America, and, recently, Europe has led to a decline in timber prices. This made forest management quite difficult economically in terms of timber production in many areas of Japan. In particular, when forests are not thinned, various environmental

problems may occur as highly-dense forests may hinder proper water storage in headwater areas, lead to landslides, and reduce biodiversity by darkening the environment under the forest crown [7].

To address these challenges, by April 2016, the so-called forest environmental tax schemes have been implemented in 37 prefectures, which are sub-national local governmental units in Japan, among the total 47 prefectures. In April 2003, the Kochi prefecture first introduced the forest environmental tax in Japan [8,9]. Through this tax scheme, the prefectural government collects an equal amount of 500 yen (about USD4–5) annually from each taxpayer in the prefecture and spends the revenue on projects that can improve environmental functions of the forests. Some of these projects include thinning of plantation forests and programs that spread awareness among the public about the importance of forests. The projects involving forest practices are implemented as direct public works by the prefectural government or as subsidized projects by municipalities or forest owners' associations in private forest lands. In other prefectures, the landowners may enter into 10- to 20-year contracts, in which they agree to restrictions on land use.

Since 2003, forest environmental tax schemes have been implemented in other prefectures, although they used different names, such as citizens' forest management tax and headwater environment conservation tax. The tax rates range from 300 yen to 1200 yen (USD 2 to USD 11) annually per person, while the majority of prefectures (i.e., 20 prefectures) collect 500 yen, the same as the first adopter's rate. In most cases, forest environmental taxes are also collected from legal parties, such as corporations.

The political climate largely influenced the introduction of forest environmental tax in Kochi and other prefectures [10,11]. The devolution of power law in 2000 awarded the respective governments a large part of power to institute taxes imposed by each prefectural government. Prior to the implementation of this law in 2000, the central government strictly regulated prefectural taxes according to tax laws. However, under severe financial constraints, the prefectural governments were highly motivated to examine this new power [10].

Forest environmental tax schemes represent a type of PES scheme, which may not involve voluntary transactions of environmental services of forest ecosystems but constitutes political contracts between residents and providers of forest ecosystem services [1,2]. Here, we employ the following definition of PES: "[A] transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources. Such transfers (monetary or non-monetary) are embedded in social relations, values and perceptions, which are decisive in conditioning PES design and outcomes. The transfers may thus take place through a market (or something close to one), as well as through other mechanisms such as incentives or public subsidies defined by regulatory means. Therefore, not all PES are market transactions and even those that may be considered as such tend indeed to be rather imperfect on the ground" [1] (p. 1205). The revenue from these tax schemes, which are managed separately from prefectural forestry budgets, is relatively smaller than the budgets. The revenues amount to only around 10% of the prefectural forestry budgets, among the adopters.

Forest environmental tax schemes in Japan are unique because the 47 prefectural governments, not the central government, decided whether to adopt these schemes and made political decisions after consideration. Here, we consider the cases of 47 prefectures as a natural experiment to determine the factors that contributed to the implementation of PES schemes. Note that the experiment did not assign socio-economic conditions to the prefectures randomly. Furthermore, it is noteworthy that these PES schemes have been implemented in industrialized economies, such as Japan, while the majority of PES schemes are, in general, popular in middle-income developing countries, such as Latin America [12]. Analyzing the types of economic, social, and political factors that might enhance or hinder PES implementation in a country with a developed economy is of

interest, as PES is embedded in a social context [1]. Hence, PES in Japanese society may exhibit unique or universal patterns, compared with other countries.

In developing countries, the overuse of forest resources is often considered a critical issue that affects the environmental functions of forests. In contrast, the underuse of forest resources is considered a critical problem in Japan because thinning costs were originally supposed to be offset by the commercial use of thinned timber, which is difficult with the current timber prices. Hence, the concept of PES in relation to the underuse of forest resources would help us understand the implementation and functioning of PES under diverse conditions in Japan as well as in the world.

The initiation and implementation of PES are challenging tasks owing to the high uncertainty as well as transaction costs [1,13]. To investigate how PES was introduced, we expand a model explaining the levels of PES expenditures on forests and traditional forestry expenditures to the Japanese examples based on the median voter model, which is “one of the most widely used models in the public choice literature” [14] (p. 220). The median voter model intends to explain the levels of public expenditures by considering the utility of a voter with a median income in a certain jurisdiction. As far as we are aware, the application of this model is novel in the field of forest policy analysis. Through this application, we hope to contribute to an in-depth understanding of PES implementation. Other empirical methods, such as the contingent valuation method (CVM), may be able to gauge public demand for the environmental services of forests. We do not have such data from each prefecture and opted to use the median voter model here.

2. Literature

We first position forest environmental tax schemes among other PES schemes by relying on review papers on PES at the global scale. Next, we present the literature on forest environmental tax schemes in Japan. Further, we review the PES literature with a special focus on factors related to the ease of implementation of PES, that is, PES implementation mechanisms.

2.1. Review Articles at the Global Scale and Environmental Tax Schemes in Japan

PES is divided into user- and government-financed schemes [15]. Forest environmental tax schemes can be considered government-financed PES because it is prefectural governments that collect money, instead of users of the environmental services of forests. Under a different classification method [16], forest environmental tax schemes can be considered as subsidy watershed PES (government-financed) because many schemes refer to contributions to sound hydrological processes as one of their major objectives. A notable example of this type is the Chinese government’s Sloping Lands Conversion Program. Meanwhile, forest environmental tax schemes have other objectives as well, such as climate change mitigation and biodiversity. In contrast to the Chinese example, local governments in Japan made independent decisions on forest environmental taxes, such as adoption and design. Therefore, forest environmental tax schemes can be considered local government-financed multifunctional PES.

Design principles for PES have been proposed in several review articles (e.g., [13,17,18]). These studies suggest that targeting, differentiation, and conditionality constitute the factors that bring a program closer to an ideal PES. Japanese forest environmental tax schemes deviate from the ideal PES to a certain degree. After inspecting the websites for the 30 schemes analyzed here, we found that only 14 schemes explicitly publicized the targeted areas; no differentiation was identified; and site-by-site outcome-based conditionality was not identified. However, we believe that several principles are satisfied practically or collectively. Regarding targeting, internal rules are supposed to prevent funds from being spent on a forest area when the area does not accommodate the proclaimed objective of the schemes. Moreover, diverse types of programs within or outside the schemes could serve as a differentiation factor, as in the cases of European governmental agri-environmental programs (p. 841 in [15]). Regarding conditionality, multi-year and ex-post condition-

ality can be observed. All schemes are temporary measures with time limits (in many cases, five years). When schemes are extended, review processes take place, which may include the inspection of samples of project sites. Several prefectures check for changes in vegetation composition, lightness on forest floors, and soil movements. In addition, 21 out of 30 prefectures set up advisory boards for the schemes. In many cases, these boards publish annual status reports. These review processes constitute both practical and collective conditionality.

2.2. Studies on Forest Environmental Tax in Japan

Several researchers have conducted case studies on the introduction of forest environmental tax schemes. Tekemoto investigated the political process of introducing forest environmental tax in the Kochi prefecture, the first prefecture that introduced the tax, by using the bureaucracy model [8]. This model analyzes policy formation as a political joint product involving conflicts, persuasion, and negotiation among several players within the government and found that the original motivation for introducing the tax was not to find a solution to forest-related problems, but rather to select forests as a cause for taxation, on which many stakeholders can build consensus. Furukawa compared the process of PES's introduction with that of other early adopters (Okayama and Tottori prefectures) and identified that strong opinions and initiatives of concerned citizens influenced the introduction [9].

Public finance scholars examined the theoretical justification of forest environmental tax schemes. Sonoda examined the public financial aspects of forest environmental tax schemes by reviewing previous discussions and characterized these schemes as benefit-based, cooperative cost-sharing tax schemes, which differ from the Pigouvian tax [19]. The Pigouvian tax provides incentives for reducing certain environmentally harmful activities. By contrast, the revenue from forest environmental taxes is spent on certain environmentally desirable activities for forest management, and the tax is levied in proportion to the benefits enjoyed by residents from a healthy forest environment. The benefits are supposed to be enjoyed jointly by the residents.

Several researchers have reviewed the overall pattern of the forest environmental tax schemes in different prefectures of the country. Takahashi examined the timing of agenda setting of forest environmental taxes by prefectural governments (i.e., setting up a committee that examines the possibility of the introduction) and found that insufficient thinning, higher levels of budgetary support for forestry activities, and deterioration of financial situations of local governments led to an earlier agenda setting [10]. The study employed Kingdon's policy window framework and identified that only problem-related variables are influential, and not political or policy-related variables. Takai reviewed the overall patterns of forest tax initiatives and found that prefectures with higher forest cover ratios were more likely to introduce taxes; in general, the revenue sections of prefectural governments are responsible for the introduction among the early adopters, whereas forest sections are responsible for the late adopters [11].

In summary, the respective prefectural governments underwent independent and thorough political processes before considering the introduction of the taxes.

2.3. PES Implementation Mechanisms

Regarding factors that encourage or hinder the implementation of PES, Wunder proposed several preconditions for PES: (1) economic preconditions: benefits exceed costs of incremental service provision; (2) cultural preconditions: user and provider motives for action; and (3) institutional preconditions: trust, transaction costs, and tenure [12]. In particular, the first and third preconditions are relevant to the current study. The larger the expected benefits, the more likely PES would be implemented (the first precondition). Moreover, the lower the transaction costs and clearer the tenure, the more likely PES would be implemented (the third precondition). Muradian et al. suggest practitioners consider the following "complexities and constraints of PES": the implications of information costs,

uncertainties in service provision, inequities in access to resources, the high leverage of intermediaries, and the broader institutional and cultural settings [1]. In a more recent study, Wunder et al. proposed the following factors that influence a PES scheme's emergence: (1) expected added environmental services (ES) value, (2) payment can be organized, (3) implementer/intermediary institutions are seen as legitimate, and (4) potential ES providers have sufficiently clear property rights to their land and resources [13]. Here, the first and second factors are expected to be relevant because the third and fourth factors are satisfied to a certain extent in Japan, a modernized and democratic country.

As will be discussed in Section 3, the median voter model predicts that the median income is related to the amount of public goods provided (i.e., the implementation of PES). Choumert examined green space provision by 161 French municipalities and found that the median voter model can partially explain the differences among those municipalities [20]. Schlöpfer also relied on the median voter model to estimate the budget expenditure for agri-environmental policies of 25 Swiss cantons (sub-federal) and the national (federal) government. The results indicate that both cantonal and national expenditure reflected local demand and that the income elasticity for landscape management demand services was high, while price elasticity was low [21]. The current study is the first application of the median voter model in the field of forest policy as far as we know.

3. Method

The model claims that under the assumption of a single peaked distribution of voters' opinions, the provision of public goods is determined to ensure that the utility of a voter with median income would be maximized. The utility function for a voter with a median income can be represented as follows:

$$U_i = U(x_i, z_i, v_i), \quad (1)$$

where U_i is the utility of a voter with median income in prefecture i , x_i represents private goods, z_i is the amount of provision of public goods, and v_i represents the characteristics of the local area influencing the levels of utility from the public goods.

A budget constraint can be represented as follows:

$$M_i = x_i + t_i \cdot z_i, \quad (2)$$

where M_i is the median income and t is the tax rate (i.e., the price of public goods).

By maximizing utility function (1) under constraint (2), we obtain the following demand function for public goods:

$$z_i = z_D(M_i, t_i, v_i). \quad (3)$$

We further posit a supply function of the public goods.

$$z_i = z_s(t_i, v'_i), \quad (4)$$

where the vector of variables, v'_i , represents the characteristics of the local area, which determine the costs of public goods provision.

Finally, from functions (3) and (4), we derive a function that determines the level of the public goods provision, given the median income and the characteristics of the local area.

$$z_i = z_{derived}(M_i, v_i, v'_i) \quad (5)$$

We estimated function (5) using the data described below.

We used the following as dependent variables. The forest environmental tax revenue per hectare of non-national forest for each prefecture was calculated. The prefectural government is responsible for non-national forests, private and local government/community-owned forests, which comprise about 70% of forest lands in Japan. Hence, the tax revenue

was normalized by dividing it by the area of non-national forests in the respective prefecture (ENVTAX_HA, million JPY). In addition, the traditional forestry budget normalized by dividing it by the area of non-national forests in the respective prefecture was calculated and used as a dependent variable (FORESTRY_HA, million JPY). By approximating public good provision with spending intensity on forest lands, we aim to determine how the patterns of public goods provision differ between forest environmental tax schemes and traditional forestry budgets. (Since forest environmental tax budgets are usually balanced, we can approximate spending with revenue.)

In addition, we included other payments from PES schemes. These include subsidies for enhancing forests' and mountain villages' multifunction (multifunctionality payment) (MULTIFUNCTION_HA, thousand JPY) and green donation (GREEN_HA, thousand JPY). The multifunctional payment is administered by the Forestry Agency, a central government department, and supports forest management activities by local residents. The Forest Agency distributes funds to each prefecture [22]. After reviewing applications from local residents at the prefectural level, funds are allocated to groups of local residents. Green donation is a national fundraising scheme run by the National Land Afforestation Promotion Organization [23]. This organization is closely related to the government, and the Speaker of Japan's House of Representatives and the President of the House of Councilors serve as President and Chief Advisor, respectively. The payment amounts of these two PES schemes are determined not by political processes, but by bureaucratic processes at the Forestry Agency of the central government and government-related organization.

We tested our model in 2010, except for the multifunctionality payment scheme, as around half of the prefectures instituted forest environmental tax schemes; this suggests that innovators, early adopters, and the early majority adopted this policy [24] (p. 262). These prefectures are more likely to have adopted this tax scheme based on their political processes, while other prefectures were likely to be largely influenced by adopting prefectures. As the multifunctionality payment scheme was fully implemented in 2013, we employed the data as of 2013.

We employed the following as independent variables. The median income (M_i in Equation (5)) was derived from governmental statistics (MEDIAN_INCOME). We expect positive signs for the coefficients of this variable because environmental services from forests can be considered normal goods.

We hypothesize that several variables characterizing respective prefectures (v_i in function (5)) will influence the provision of public goods because certain factors increase the utility levels of the median voter.

The natural characteristics of prefectures may influence the utility levels. The forested areas per capita in each prefecture may increase benefits accruing to each resident (FOREST_PER_CAP, ha per capita). Takai suggests that an observation indicates a general tendency that prefectures with higher forest ratios are more likely to introduce forest environmental tax schemes [11]. We employed per capita figures so that we could take populations into consideration. Concentrated distribution of forested areas may decrease benefits to each resident (FOREST_VAR, ratio), as forests are located in remote areas to a large number of residents. If forested areas are concentrated in certain cities, towns, or villages within the prefecture, residents living in cities, towns, or villages with lower forest ratios are less likely to enjoy benefits from forests. FOREST_VAR represents the coefficients of variation in forest-cover ratios in municipalities.

Residents living in prefectures with higher risks of flood, drought, or landslides may enjoy enhanced forest management in the future, as these residents tend to have peace of mind from expected projects (i.e., FLOOD, DROUGHT, LANDSLIDE). The riskiness of flood, drought, and landslides was measured by the degrees of incidence of respective problems in the past. FLOOD (million JPY) represents the sum of monetary damages caused by floods in the past 10 years (1991–2000). DROUGHT (days) represents the sums of days under water use restriction in the past 36 years (1965–2000). LANDSLIDE (counts) represents the number of incidences of landslides in the past eight years (2008–2015).

In addition, we considered economic and political factors that may be related to the political decisions regarding forest environmental tax schemes. Larger numbers of municipalities in the prefecture may hinder consensus building regarding forest environmental tax schemes (N_MUNICIPALITIES, counts). Residents in urban areas (DID areas, densely inhabited districts) may require more recreational opportunities and amenities from forests than rural residents (URBAN_RATIO, ratio). Forest volunteers may influence political processes that determine the provision of public goods. VOLUNTEERS represents the number of forest volunteer groups, citizens' groups working for forest management and educational activities in each prefecture as of 2000. Since the estimated models concern processes in 2010, endogeneity is of lower concern for this variable.

We also examined the levels of forestry and wood-processing industries in each prefecture. We considered that higher levels of such activities might help governments or certain groups implement environmental forest policies as the activities provide infrastructures such as roads and engineers. In other words, we assumed forestry and forest products industries to lower the supply curve of forest public goods (v_i in function (4)). LOGS (thousand cubic meters) represents the levels of harvesting, and N_WOOD (counts) indicates the number of establishments in the wood-processing industries. Table 1 provides the descriptive statistics of the variables mentioned above.

Notably, the spending levels of environmental taxes, forestry budgets, multifunctionality payments, and green donations vary significantly. If we set environmental tax as the reference (assuming the average spending per prefecture to be 1), forestry budget, multifunctionality, and green donation spending amounted to 27, 0.11, and 0.01, respectively.

The data (v_i, v'_i) were collected from governmental statistics and related organizations. Table 2 presents the correlation matrix of the variables. We did not find a significant level of correlations between the explanatory variables.

Table 1. The descriptive statistics of variables.

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
1. ENVTAX_HA	Forest environmental tax per ha	47	1.83158	3.962371	0	25.45011
2. FORESTRY_HA	Forestry budget per ha	47	50.03876	41.49831	19.63514	257.7618
3. MULTIFUNCTION_HA	Multifunctional payment per ha	47	0.193948	0.343709	0	2.360259
4. GREEN_HA	Green donation per ha	47	0.0242183	0.0438363	0	0.2720565
5. MEDIAN_INCOME	Median income	47	4142.434	608.1918	2780.885	5210.217
6. FOREST_PER_CAP	Forest ha area per capita	47	0.2143308	0.1540931	0.006085	0.6485345
7. FOREST_VAR	Variation in forest-cover ratios in municipalities	47	0.509942	0.302408	0.123864	1.449792
8. FLOOD	Flood damages	47	14204.76	23165.34	167.9769	119357.2
9. DROUGHT	Water use restriction days	47	35.29787	77.01127	0	295
10. LANDSLIDE	Landslide incidents	47	22.51064	39.77539	0	197
11. N_MUNICIPALITIES	Number of municipalities	47	69.12766	30.22856	35	212
12. URBAN_RATIO	Ratio of urban residents	47	0.504274	0.187313	0.248258	0.979862
13. VOLUNTEERS	Number of forest volunteerin groups	47	12.25532	13.55258	0	69
14. LOGS	Harvesting volume	47	365.8085	498.8726	1	2890
15. N_WOOD	Number of wood-processing establishemts	47	332.7021	190.9249	27	843

In the case of traditional forestry spending and other PES schemes, we expect that, unlike forest environmental tax, variables representing environmental (FLOOD, DROUGHT, LANDSLIDE) factors would not be correlated with spending levels since those factors are not the major objectives of the schemes. Since the other two PES schemes are not administered politically but bureaucratically, the median income and political factors (N_MUNICIPALITIES, URBAN_RATIO, VOLUNTEERS) should not be correlated with spending.

Because our four dependent variables (ENV TAX_HA, FORESTRY_HA, MULTI-FUNCTION_HA, GREEN_HA) might be determined by interdependent processes, there is a possibility that the error terms are correlated because the variables are all related to forestry. They might be affected by common market shocks or political climates. In the presence of such correlations, known as contemporary correlation, the OLS estimates are inefficient, and Zellner's seemingly unrelated regression (SUR) is the more desirable estimation method.

We conducted the Breusch–Pagan Lagrange multiplier test against the null hypothesis of no contemporaneous correlation [25]. The test statistic rejected the null hypothesis, indicating a contemporaneous correlation. We therefore estimate the SUR model for our analysis.

Table 2. The correlation matrix.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1														
2	0.768	1													
3	−0.0643	−0.0679	1												
4	0.1472	0.1855	0.2044	1											
5	0.3426	0.2923	−0.0582	0.3126	1										
6	−0.3310	−0.3065	−0.1891	−0.4254	−0.4039	1									
7	0.2644	0.2138	0.1644	0.5643	0.491	−0.6946	1								
8	0.0634	0.1177	0.0025	0.1574	−0.1419	−0.0914	0.1357	1							
9	0.2284	0.1331	0.0102	−0.0008	−0.3597	−0.1783	0.0687	−0.0153	1						
10	0.2102	0.1102	−0.1078	−0.1106	0.0072	0.2463	−0.2685	0.086	−0.0415	1					
11	−0.1062	−0.1637	−0.1678	−0.0913	−0.0669	0.0628	0.0092	0.0736	−0.0283	−0.0312	1				
12	0.3463	0.2978	0.2739	0.5839	0.2339	−0.5998	0.5783	0.2552	0.1943	−0.054	0.1355	1			
13	0.6164	0.7829	0.1222	0.2047	0.2394	−0.2271	0.1166	0.1591	0.0477	0.0974	0.0009	0.3623	1		
14	−0.1543	−0.1996	−0.1101	−0.2205	−0.4083	0.4636	−0.3229	0.1618	−0.1822	−0.1185	0.5753	−0.106	−0.0795	1	
15	0.0546	−0.1143	0.2337	0.2603	0.3616	−0.2059	0.4357	0.2246	−0.2414	−0.1178	0.433	0.4715	0.179	0.1716	1

4. Results

We estimated median voter models considering the amount of forest environmental tax revenue per 1 ha of non-national forests in a prefecture (ENVTAX_HA; (1)), forestry expenditures (FORESTRY_HA; (2)), multifunctionality payment scheme (MULTIFUNCTION_HA; (3)), and green donation (GREEN_HA; (4)) as dependent variables using Zellner’s seemingly unrelated regression (SUR) model (Table 3). We ensured that the explanatory variables’ VIF would be less than 5.0.

The results indicate that the coefficients for medium income levels of prefectures (MEDIAN_INCOME) are statistically significant for the environmental tax model and forestry expenditure models with expected positive signs. When we replaced the median income variable with the average income variable, we found that the coefficients for average income were not significant for environmental tax, forestry expenditure, and multifunctional payment models but were significant for the green donation model.

The degrees of concentration of forests among municipalities (FOREST_VAR) have one statistically significant positive sign, and the result with a positive sign is against our expectations.

The variables that indicate drought and landslide riskiness have statistically significant positive signs (DROUGHT and LANDSLIDE) for forest environmental tax, as expected.

The variable for the number of municipalities has one significant and negative coefficients (N_MUNICIPALITIES), as expected.

The variable representing the urban concentration of the population (URBAN_RATIO) has one significant and positive coefficient, as expected.

The number of forest volunteer groups (VOLUNTEERS) is positively correlated with forest environmental tax and forestry expenditures. The variable representing the levels of forestry activities (LOGS) has a statistically and significant positive sign, as expected. Further, the variable for the sizes of wood-processing industries in a prefecture (N_WOOD) has statistically significant negative and positive signs, and the negative sign contradicts our expectations.

We conducted a Tobit analysis for the environmental tax model since there are prefectures that have not introduced the tax, and obtained qualitatively similar results. Further, we applied two-stage least square models to estimate functions (3) and (4) with tax rates as an endogenous variable in the environmental tax model, and again obtained qualitatively similar results.

Models (1) and (2) exhibit a relatively good fit ($R^2 = 0.636$ and 0.781).

Table 4 shows standardized beta coefficients in the four models. These beta coefficients represent the extent to which a change in an explanatory variable by one standard deviation is correlated with a change in the dependent variable in terms of standard deviation. For example, a beta coefficient of 0.5 indicates that a standard deviation change in the explanatory variable leads to 0.5 standard deviation change in the dependent variable. The number of forest volunteer groups have relatively high levels of correlations with the intensities of forest environmental tax and traditional forestry expenditures.

Table 3. The SUR results of the median voter models.

	(1)	(2)	(3)	(4)
	ENVTAX_HA	FORESTRY_HA	MULTIFUNCTION_HA	GREEN_HA
MEDIAN_INCOME	0.00284 ** (0.00107)	0.0177 ** (0.00870)	−0.000275 ** (0.000130)	0.00000282 (0.0000143)
FOREST_PER_CAP	−5.941 (4.661)	−6.863 (37.89)	−0.315 (0.565)	0.0584 (0.0621)
FOREST_VAR	1.726 (2.279)	30.03 (18.53)	0.00196 (0.276)	0.0570 * (0.0304)
FLOOD	−0.00000575 (0.0000199)	0.000121 (0.000162)	−0.00000296 (0.00000241)	0.000000782 (0.000000266)
DROUGHT	0.0205 *** (0.00694)	0.0495 (0.0564)	−0.000659 (0.000841)	−0.0000797 (0.0000925)
LANDSLIDE	0.0307 ** (0.0120)	0.0691 (0.0978)	−0.000231 (0.00146)	−0.0000751 (0.000160)
N_MUNICIPALITIES	−0.0365 * (0.0195)	−0.0821 (0.159)	−0.00397 (0.00236)	−0.000109 (0.000260)
URBAN_RATIO	−1.369 (3.467)	6.379 (28.19)	0.306 (0.420)	0.128 *** (0.0462)
VOLUNTEERS	0.140 *** (0.0341)	2.301 *** (0.278)	0.00250 (0.00414)	0.0000809 (0.000455)
LOGS	0.00393 *** (0.00143)	0.0147 (0.0116)	−0.0000636 (0.000173)	−0.00000742 (0.0000190)
N_WOOD	−0.00182 (0.00321)	−0.0970 *** (0.0261)	0.000821 ** (0.000389)	−0.0000341 (0.0000427)
Constant	−10.21 ** (4.859)	−40.95 (39.50)	1.308 ** (0.589)	−0.0694 (0.0647)
N	47	47	47	47
R ²	0.636	0.781	0.289	0.472

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Standardized beta coefficients.

	(1)	(2)	(3)	(4)
	ENVTAX_HA	FORESTRY_HA	MULTIFUNCTION_HA	GREEN_HA
MEDIAN_INCOME	0.436 **	0.259 **	−0.486 **	0.039
FOREST_PER_CAP	−0.231	−0.025	−0.141	0.205
FOREST_VAR	0.132	0.219	0.002	0.393 *
FLOOD	−0.034	0.067	−0.200	0.041
DROUGHT	0.398 ***	0.092	−0.148	−0.140
LANDSLIDE	0.308 **	0.066	−0.027	−0.068
N_MUNICIPALITIES	−0.278 *	−0.060	−0.349	−0.075
URBAN_RATIO	−0.065	0.029	0.167	0.546 ***
VOLUNTEERS	0.479 ***	0.752 ***	0.099	0.025
LOGS	0.494 ***	0.176	−0.092	−0.084
N_WOOD	−0.088	−0.446 ***	0.456 **	−0.149

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5. Discussion

The expenditure patterns in forest environmental tax schemes appear to conform to our expectations for PES schemes. The median income variable is a positive inducement on expenditure levels, indicating that supposed median-income voters considered budget constraints. In addition, forest environmental tax schemes seem to reflect environmental concerns related to drought and landslide, as well as political difficulties and pressures represented by the number of municipalities and forest volunteer groups.

The findings underscore the proposal that “(1) expected added environmental services (ES) value” and “(2) payment can be organized” are critically important in the emergence of PES [13]. Drought and landslide risks (expected added ES value) were positively correlated with spending in forest environmental tax. The difficulty in organizing political consensus (number of municipalities) was negatively correlated with the spending.

Further, traditional forestry expenditures seem to follow the median voter model, as suggested by the positive sign for the variable for median income. Traditional forestry expenditures did not correlate with the variables for environmental concerns, such as floods, droughts, and landslides. Forestry expenditures seem to be influenced by forest volunteer groups. The negative sign for the number of wood-processing industries contradicts our expectations. We suppose that active wood-processing industries could lessen the necessary support for forest management by providing monetary resources in the form of stumpage.

It is noteworthy that the number of forest volunteer groups was highly correlated with the levels of forest environmental tax and forestry expenditures. Kunugi et al. used the participation ratios in volunteering activities in each prefecture as surrogate variables for social capital to analyze the subjective well-being of residents [26]. By interpreting forest volunteer groups as social capital in the field of forest management, this observation could suggest social capital's importance in forest sectors for determining the levels of payment for forest ecosystem services.

Other PES schemes have unique patterns of correlation with the examined variables. For example, contrary to our expectations, the model for multifunctional payment had negative signs for the median income. This finding may indicate an income redistribution function of the scheme in the area of forest management. The model for green donation indicated that spending is correlated with urban ratios, suggesting that the scheme is more oriented toward urban forestry projects than toward rural projects. These patterns might indicate that the results of the bureaucratic distribution could significantly deviate from our assumed political model of public good provision.

These analyses demonstrate that our median voter model has a certain, but limited, level of applicability for explaining forest environmental taxes and traditional forestry expenditures. We believe that developing models that explain PES can identify techniques to realize PES schemes actually by finding key factors in political or social implementation. Thus, the more clearly we understand implementation processes, the more smoothly we would realize PES schemes.

There are several policy implications from this study. The importance of social capital, indicated by high amount of influence held by the forest volunteer groups, suggests the possibility of implementing policies that invigorate volunteer activities geared towards heightening citizens' awareness of forest policy issues. In fact, several prefectures (Yamagata, Toyama, and Yamaguchi) designate support for forest volunteering activities as main programs [27]. There are prefectures with unfavorable conditions for the introduction of forest environmental tax scheme. For example, prefectures with many municipalities may have difficulty in creating political momentum for the scheme. Such prefectures are advised to prepare for creating consensus among the municipalities.

Lastly, we mention the limitations of this paper. This paper is limited by the relative-small sample size. This is because the decisions on forest environmental tax schemes made by the 47 prefectures are historical and one-shot decisions. Even though we obtained valid results by finding meaningful and significant correlations by employing the median voter models and appropriate data set, further investigation could be pursued. For example, we

might look for other jurisdictions where many entities have made decisions on the adoption of PES under relatively similar circumstances. Under forest environmental schemes, tax rates and total expenditure levels do not change significantly since such decisions have been made politically and are institutionalized by prefectural ordinances. In contrast, specific spending purposes such as thinning, tree protection, and PR may change year by year. Furthermore, local level distributions may change. We may be able to use such data as panel data set and improve the current model by increasing the sample size. With an increased sample size, more realistic models may be estimated, such as those that emulate dynamic multi-process decisions (adoption, design, and implementation) or consider spatial dependence among different decision-making entities.

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