



Factors influencing forest landowner enrollment in preferential property tax programs[☆]

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ABSTRACT

One of the most common approaches to conserving forestland in the US are state-run programs offering reduced property taxes on forestland. Although some form of preferential forest property tax program exists in all 50 states of the US, few studies have examined factors associated with landowners' enrollment in such programs. As interest increases in incentivizing forestland owners to address various environmental or ecological goals, such as enhancing carbon storage or ecosystem services via private forest management, the need for improved knowledge about factors that influence landowners to participate in such programs grows. We examined factors associated with NIPF owner enrollment in preferential property tax programs in Oregon (US). Oregon currently has two primary preferential forest property tax programs. The Forestland Program is the default program for most forestland owners, and the Small Tract Forestland Option (STF), which is a voluntary program wherein landowners pay reduced annual property taxes and an additional timber harvest severance tax. We used a survey to gather information from 1190 Oregon Small Woodlands Association (OSWA) members owning between 10 and 5000 acres of forestland in western Oregon. Respondents were asked about their socio-demographic characteristics and forest management, as well as their enrollment status in Oregon's preferential property tax programs. Our econometric analysis of survey data indicate that preferential property tax programs enable long-term forest ownership, extended rotation ages, and investment in stewardship activities, suggesting that these programs are likely an effective tool for encouraging environmental or ecological goals among NIPF owners in Oregon.

1. Introduction

Forest policymakers and managers at state and federal levels increasingly have elevated the protection and enhancement of ecosystem services (e.g., water, habitat, carbon storage, etc.) produced on forest lands among their guiding forestry objectives (e.g., Kline et al., 2013; Smith et al., 2019). Protecting and enhancing ecosystem services on public and private forest lands can involve a mix of different approaches. Although the management of federal and other public forest lands generally fall under the direct control of federal, state, and local forest managers, influencing management on private forest lands

generally relies on indirect approaches such as offering financial incentives and technical assistance to encourage ecosystem services protection and enhancement. An additional challenge concerning private lands are their potential to be converted to more intensive non-forest uses, such as housing and other development, in locations experiencing rapid population growth (Stein et al., 2009). For these reasons, policymakers and managers have sought ways to understand and anticipate the capacity of private forest lands to manage for ecosystem services, and the degree to which different policies can be used to influence private forest management toward that end (e.g., Smail and Lewis, 2009; NCSL, 2021).

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Compared to private industrial owners focused primarily on producing commercial timber, non-industrial private forest (NIPF) landowners often manage their forestlands to meet multiple objectives, including amenity and other nontimber values (e.g., Amacher et al., 2003; Arano and Munn, 2006; Hyberg and Holthausen, 1989; Ma and Kittredge, 2011). As such, their management and land ownership objectives are often aligned with actions that enhance ecosystem services (Ferranto et al., 2011; Newman and Wear, 1993). However, NIPF decisions regarding their multiple objectives can involve tradeoffs. For example, landowners who elect to defer timber harvest can yield both net increases in standing carbon stocks and timber volume over time (Diaz et al., 2018; Law et al., 2018; Oliver et al., 2014), but harvest postponement may come with an opportunity cost for those NIPF landowners seeking timber revenue (Diaz et al., 2018; Sohngen and Brown, 2008). For this reason, encouraging landowners to maintain land in forest cover and manage for ecosystem services often involves providing financial or other incentives to encourage landowners to manage in ways that enhance ecosystem services (Alavalapati et al., 2002).

In Oregon, forests cover half the state, with 34 % privately owned. Although industrial owners hold most private forest land, just under half is held by 70,000 NIPF landowners (Oregon Department of Forestry, 2015). These forest lands are among the most carbon-rich forests in the world (Hudiburg et al., 2009), with significant potential to increase carbon storage through management and forest conservation (Graves et al., 2020) as well as enhance additional ecosystem services, including wildlife habitat (Kline et al., 2016) and water quality (Groom et al., 2011) among others. Policymakers and managers, however, worry that Oregon's NIPF lands could be subject to eventual conversion to non-forest uses, because they are commonly located at lower elevations and in greater proximity to urban and suburban population centers relative to public and private industrial forestlands (Azuma et al., 2002; Kline et al., 2021; Riitters and Costanza, 2019). Although Oregon land use planning offers considerable protection of forest land from development, protection levels vary by context (Kline et al., 2014). Concern in the U.S. about protecting forestland has led to the implementation of a variety of policies and programs that offer incentives to encourage forest landowners to maintain land as forest. These include conservation easements, technical assistance programs, and preferential forest property tax programs (hereafter called "preferential tax programs"), among others (Jacobson et al., 2009). Of these, preferential tax programs are perhaps the most common.

Preferential tax programs exist in all U.S. states (Kilgore et al., 2018). They tax forest land at a reduced rate or use special assessment values to reduce the property taxes that private forest landowners would otherwise pay, thereby alleviating some of the financial pressure forest landowners may feel to sell forest land for development (e.g., Hibbard et al., 2003). The specific requirements of preferential tax programs vary considerably from state to state. Some programs, especially in Northeastern states, require management plans and specific practices as conditions for enrollment, while other programs simply require that enrolled land remain forested for a specified number of years (Kilgore et al., 2018). Relative to other positive incentive programs affecting forest land, preferential tax programs tend to have higher enrollment rates (Butler et al., 2016) and are thus recognized for their potentially significant influence in forestland conservation (Frey et al., 2019).

Past studies have investigated forest landowners' willingness to participate in various forestry incentive programs involving carbon (e.g. Amacher et al., 2003; Kilgore et al., 2008; Kim and Langpap, 2015). However, surprising little is still known about what factors might influence enrollment in preferential tax programs affecting forestry (Kilgore et al., 2018). This is critical information, given the popularity of these programs and the potential for transferring their design elements to other incentive programs. We sought to build on past research by examining factors associated with enrollment in Oregon's preferential property tax programs and their potential implications for carbon

sequestration. Our objectives were to: (1) Examine characteristics of forest landowners enrolled in preferential tax programs in Oregon; and (2) Identify factors associated with program enrollment in Oregon. We addressed these research questions by conducting a survey of NIPF owners in western Oregon concerning their enrollment in Oregon's preferential tax programs, and used these data to identify individual and forest ownership characteristics that appear to influence the likelihood that forest landowners enroll in these programs. Our analysis includes consideration of forest landowners' overarching land ownership objectives (e.g., Kline et al. 2000, Fischer et al. 2013), which to our knowledge have not often been included in previous analyses of forest landowners' willingness to participate in preferential tax programs.

2. NIPF landowners and preferential tax programs

Previous research suggests that NIPF landowners generally are concerned about property taxes, but evidence of whether these concerns influence their land management and land tenure decisions is varied. Previous research suggests that forest property taxes can both incentivize and disincentivize various land management practices, as well as decisions of whether to retain forest or develop land to non-forest uses. In particular, property tax systems yielding high tax burdens have been shown to incentivize landowners to divide their land into smaller parcels, often leading to conversion of some forestland parcels to developed uses (Argow, 1996; Butler et al. 2010; Haines et al., 2011, 2019; Mehmood and Zhang, 2001; Mundell et al., 2010; Sampson and DeCoster, 2000; Stone and Tyrrell 2012).

From a theoretical perspective, increased taxes on forestlands generally disincentivize landownership for forest management purposes when there are profitable alternatives, such as selling land for development (Cushing and Newman, 2018). Conversely, preferential tax programs that incorporate penalties on landowners who withdraw from programs have been shown to delay development (England and Mohr, 2003). These studies suggest that landowners consider forest property taxes when making land management and land tenure decisions. Other studies, however, offer less conclusive findings. Williams et al. (2004), for example, found that Tennessee's Forest Greenbelt Program did not alter landowner decisions with regard to forestland conversion. Additionally, two studies found higher rates of preferential tax program enrollment in rural counties compared to counties with higher development pressure (Brockett and Gebhard, 1999; Dennis and Sendak, 1992). In West Virginia, Fortney et al. (2011) found that landowners in high development areas were more likely to enroll in the State's preferential tax program. Inconsistent results suggest that relationships between preferential tax programs and development can be both program-specific and regionally unique.

Research examining the influence of socioeconomic and demographic factors (e.g., education, income, and age), for example, also suggests varied results (Frey et al. 2019). Still other research examining the influence of landowner objectives suggests that managing for timber harvest income was positively correlated with enrollment in Virginia and Texas (Wolde et al., 2016) but not in West Virginia (Fortney et al., 2011) and Tennessee (Brockett and Gebhard, 1999). Concerns over land development and forest property taxes were positively correlated with program enrollment in West Virginia (Fortney et al., 2011), but not in Tennessee (Brockett and Gebhard, 1999).

Results concerning the influence of land characteristics, including ownership history and parcel-level characteristics, also have been mixed (Frey et al., 2019). Forested land area was associated with greater enrollment likelihood in Virginia, Texas (Wolde et al., 2016), and Vermont (Dennis and Sendak, 1992), but not elsewhere (Fortney et al., 2011; Kauneckis and York, 2009; Stevens et al., 2002). Land acquisition via purchase, as opposed to acquisition of land through inheritance or gift, was found to be negatively correlated with enrollment (Fortney et al., 2011; Stevens et al., 2002; Wolde et al., 2016). Land tenure generally has been found to be positively correlated with preferential tax

program enrollment (Ma et al., 2012; Song et al., 2014; Wolde et al., 2016), conceivably due to greater knowledge among long-time forest land owners about preferential tax programs (Frey et al., 2019).

Finally, several studies have examined the potential influence of regional land-use patterns and trends on preferential tax program enrollment. Because many programs were initially implemented to reduce loss of forest land to development, studies have tended to focus on testing the influence of development-related factors such as population density, population growth, and distances to population centers, with varying degrees of potential influence found (Dennis and Sendak, 1992; Kauneckis and York, 2009). Frey et al. (2019) observed that the varied findings of such studies may result from conflicting incentives, whereby landowners receive higher financial benefits from larger tax reductions in areas with high market land values, but that higher benefits are offset by high opportunity costs of foregone development. Kilgore et al. (2018) examined programs with high and low enrollment, and found enrollment to be influenced by combinations of landowners' educational background, land management history, forestland characteristics, and the characteristics of surrounding lands. In particular, forest landowners in programs with the lowest enrollment were more likely to be located near urban areas with high road densities.

3. Methods

3.1. Study context

Oregon's Department of Revenue offers two preferential tax programs through which forest landowners receive reduced property taxes

Table 1
Comparison of forestland and small tract forestland tax programs. Adapted from Elwood et al. (2006).

	Forestland program (Forestland)	Small Tract Forestland (STF) option
<i>Property tax</i>		
Eligibility requirements	Tax lot must contain at least 2 acres of forestland. Land must contain enough trees to meet Oregon Forest Practices Act stocking and species standards.	Must own between 10 and 5000 acres of forestland. All contiguous owned parcels must enroll. Land must contain enough trees to meet Oregon Forest Practices Act stocking and species standards.
Basis	100 % of assessed forestland value	20 % of assessed forestland value
Changing special-assessment programs	Land under the Forestland Program may be put under the STF Option, Wildlife Habitat Conservation Program or farm special assessment without penalty.	Land under the STF Option must remain under STF Option until it is transferred or no longer used as forestland.
Withdrawal penalty	Disqualified lands must pay the difference between tax paid for previous 5 years and tax that would have been paid at real market value (RMV) tax rate.	Disqualified lands must pay the sum of (1) the difference between tax paid under STF Option and tax that would have been paid under Forestland program for the number of years the property has been in the STF Option, up to 10 years, and (2) the difference between the tax that would have been paid under Forestland program for previous 5 years and tax that would have been paid for the same 5-years at RMV tax rate.
<i>STF Severance Tax</i>		
Frequency		Triggered by timber harvest
Rate		Set by Oregon Department of Revenue

in exchange for maintaining forest land in forest uses (Table 1). The Forestland Program is available to landowners who own at least two acres of forested land and taxes property based on a specially assessed forestland use value (Elwood et al., 2006). The Small Tract Forestland (STF) Program is available to landowners who own between 10 and 5000 acres and taxes property on 20 % of the specially assessed forestland value (Elwood et al., 2006). Both programs have existed in Oregon since 2004, though they were largely adapted from programs that had been in place for decades. Currently, there are about 626,000 acres of land enrolled in the STF Program (Oregon Department of Revenue Research Section, 2020). The STF Program includes a severance tax, assessed at \$6.33/MBF in western Oregon for 2021, levied on harvested timber on enrolled lands and is additional to property tax and harvest tax (required of all who harvest timber above 25 MBF/year). The severance tax is designed to recover the 80 % reduction from the Forestland Program. The use of a severance tax in lieu of a higher property tax may benefit landowners who delay, reduce, or forego harvesting on their land. The STF Program option recognizes the infrequent cash flows from harvests on small acreage and is a better match for revenue to expenses. The design and structure of tax programs are a recurring subject of legislative debate in Oregon and proposals have been made to eliminate both programs and replace them with programs favoring longer rotations and conservation objectives.

3.2. Survey of NIPF landowners

We surveyed NIPF landowners in Oregon to gather information about their enrollment in the Forestland and STF Programs. Our mail survey followed a modified Dillman et al. (2014) tailored design. We sent our survey to Oregon Small Woodland Association (OSWA) members. OSWA represents Oregon woodland owners with 10 to 5000 acres of forested land. OSWA provides members with resources on forest management, representation to state agencies and the legislature, opportunities to gather with other similar-minded landowners, and opportunities to collectively participate in carbon markets, prescribed burning, and other forest management practices. Presently, there are 16 active Oregon chapters with approximately 3200 members who together own more than 500,000 acres. This represents just under five percent of all NIPF landowners in Oregon, and approximately 15 % of total NIPF land in the state. OSWA members are likely to be more familiar with forest management activities, more knowledgeable about forestry-related education opportunities, and more engaged in political advocacy. Although this potentially introduced some bias into our sample, the OSWA subpopulation of Oregon landowners in many ways is an ideal representation of private forest owners for this study, because they are motivated, well-versed in forest management practices and are more likely to answer questions about forest management activities (e.g., Matta et al., 2009; Potter-Witter, 2005; Rickenbach et al., 2006; Sun et al., 2009; Snyder et al. 2020).

We sent our mail survey to forestland owners with significant forestland in western Oregon counties containing an OSWA chapter. These included Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Polk, Tillamook, Washington, and Yamhill Counties. We obtained a current OSWA membership list in fall of 2020 that included landowner contact information, acres owned, and chapter affiliation. We screened this list to remove landowners who owned fewer than 10 and more than 5000 acres, resulting in a survey sample of 1190 unique OSWA members. The survey asked respondents about their forest ownership history, property characteristics, and ownership objectives, as well as their concerns and attitudes concerning forest property ownership, management, and taxation. The questions informing the present analysis pertained to respondents' forest ownership objectives, past and planned future management, and enrollment status in Oregon's preferential tax programs.

3.3. Factor analysis and logit regression analysis

Following previous analyses of nonindustrial forest landowner behavior (e.g., Kline et al. 2000, among others), we conducted factor and cluster analysis on respondents' rankings of a list of reasons for owning forest land. Factor analysis is used to identify unobservable, hypothetical variables (factors) that contribute to the variance of observable variables. A series of survey questions asked respondents to rank on a 4-point scale, from "very important" to "not at all important", the importance of potential reasons for owning forest land. The list of reasons ranged from financial reasons, such as harvesting timber products, to nonfinancial reasons, such as enjoying scenery. We conducted factor and cluster analysis on the responses to these ranking questions to categorize survey respondents into different groups according to their prevailing forest landownership objectives (e.g., Fischer et al. 2013; Kline et al., 2000). Factor analysis employs latent variables to explain variation among a larger set of data. Following Tabachnick et al. (2007), we conducted *k*-means cluster analysis of identified factors to assign survey respondents to groups based on the mean importance for owning land that loaded together in the latent factors. This enabled us to create a set of dummy variables describing landowners of like ownership objectives that were used as independent variables in a regression model of tax program enrollment.

We used these and other variables describing characteristics of respondents' and their forest land in a logistic regression to examine the potential influence of characteristics on enrollment in the Oregon preferential tax programs. A key survey question asked respondents to indicate whether they were enrolled in either of Oregon's preferential tax programs. This question provided data for logit analysis, with our dependent variable taking on the value of "1" for respondents who were enrolled in a program, and the value of "0" for respondents not enrolled.

4. Results

We mailed out 1190 questionnaires in November 2020. We received 421 returned surveys and two undeliverable surveys. Of the returned surveys, three were blank, nine were from landowners indicating they did not own land in western Oregon, and seven were from landowners who indicated they owned less than 10 forested acres. Taking disqualified surveys into account, 403 of the returned surveys were adequately completed and usable. Using the Dillman et al. (2014) formula for response rate,

$$\text{Response rate} = \frac{\# \text{Returned}}{\# \text{in sample} - (\text{noneligible} + \text{nonreachable})} \times 100$$

We computed our usable response rate for the survey at 34 %. This is comparable to previous NIPF landowner studies, which range from 16 % to 58 % (Brockett and Gebhard, 1999; Fortney et al., 2011; Jacobson, 2001; Joshi and Arano, 2009; Kline et al., 2000; Khanal et al., 2017; Langpap, 2004). As the response rate is in the mid-range among comparable surveys and given the variety of responses we received within our narrow population of interest, we did not attempt to address non-response bias.

4.1. Description of respondents and their land

Our forest landowner sample averaged 70 years in age, 79 % were male, and 60 % were retired. Just over 70 % of respondents had received at least a bachelor's degree and 36 % had received an advanced degree. Forty-five percent reported household incomes of over \$100,000 in 2019. The average acres owned in western Oregon was 240 acres (median = 90), with an average percentage of land reported forested of 82 % (median = 90 %), for an average 189 forested acres (median = 72). Land tenure averaged 35 years and 75 % of respondents purchased their parcels, while 22 % inherited their properties (Table 2). Comparing our sample data to the National Woodland Owners Survey data for Oregon

Table 2

Land characteristics of survey respondents enrolled in the Forestland and STF Programs.

Land Characteristics	Forestland Program		STF Program		Don't Know	
	<i>n</i> = 166		<i>n</i> = 163		<i>n</i> = 58	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Acres	323.3**	589.2	198.6	445.5	122.0	194.0
Forested acres	247.4	436.6	178.5	434.4	62.3	78.9
Number of parcels	3.2	3.9	2.8	3.4	1.5	0.9
Tenure	34.5	23.6	36.4	23.4	31.0	24.2
Reside on or within a mile of forestland	61 %**	0.5	65 %	0.5	67 %	0.5
Purchased land	76 %	0.43	72 %	0.45	79 %	0.41
Inherited land	19 %	0.4	26 %	0.44	17 %	0.38

Note: *, **, and *** show statistically significant differences between STF and Forestland Programs at 10, 5, and 1 % respectively. *N* = 387.

(Butler et al., 2021), respondents were older, more educated and own a larger average acreage (240 vs. 94 in NWOS).

Most forest land owned by respondents was Douglas-fir dominated mixed conifer (94 %), consistent with forest lands in western Oregon. Respondents reported multi-aged stands, with 28 % of forested acres comprised of trees 1–20 years old, 34 % in the 20–40-year age class, 16 % in 40–60-year age class, 11 % in the 60–80-year age class, and 5 % in the above 80-year class. Harvesting timber products was noted as the most important reason for owning forestland, followed by enjoying beauty/scenery, and passing land on to children or other family. This differs from NWOS data which indicates that enjoyment of beauty and scenery, nature protection, and privacy are most important, with timber production less important among family forest owners nationally (Butler et al., 2021). The difference is not surprising given that our survey sample are OSWA members, many of whom likely have an above average focus on timber production.

Half of respondents reported clearcutting in the past ten years, 46 % reported commercial thinning, suggesting fairly robust engagement in active forest management. Additionally, most respondents engaged in a variety of activities—67 % removing unhealthy trees, 63 % planting native seedlings, 61 % removing invasive species, and 62 % improving wildlife habitat by leaving snags and planting riparian areas among other actions. Fifty-five percent of respondents indicated they had received educational assistance, 46 % had claimed income tax deductions for forest management, and 39 % received cost-share assistance for stewardship or management activities.

4.2. Oregon tax program participation

Respondents were roughly split between having land enrolled in the Forestland versus the STF Programs, with 41 % reporting land enrolled in the Forestland Program and 40 % reporting land enrolled in the STF Program. Fifteen percent were unsure which program their land was enrolled in. Concerning the benefits of STF Program enrollment, 78 % indicated that tax savings were very important, followed by retaining ownership (76 %) and keeping land in forest (74 %). In contrast, only 33 % of respondents indicated that preserving open space was important to them, with 18 % indicating that preserving open space was not important. On average, Forestland Program respondents owned more total acres (*P* < 0.05) on more parcels in western Oregon than did STF Program participants, and STF Program participants tended to reside closer than Forestland Program participants to their forest land parcels.

4.3. Comparison of forest management practices and assistance

Regarding past forest management, Forestland Program and STF Program respondents were nearly identical in their past timber

management and stewardship actions. Just over half of respondents in both programs had clearcut and replanted some forestland in the past ten years. Similarly, 47 % of Forestland Program and 50 % of STF Program participants have thinned for a sale. Respondents' reported past management actions were fairly similar across program enrollment, with exception of the removal of invasive species—68 % of STF Program participants removed invasive species in the past ten years whereas fewer (58 %) of the Forestland Program participants removed invasive species ($P < 0.05$). STF Program participants received more educational and financial assistance than Forestland Program participants. Sixty-five percent of respondents in the STF Program option received educational assistance compared to 55 % of Forestland Program participants. While 38 % of FP participants received cost-sharing assistance, 48 % of STF Program participants did so. STF Program participants also used income tax deductions for forest management expenses more often than Forestland Program respondents (56 % and 46 % respectively).

4.4. Factor analysis

Our factor analysis of respondents' forest landownership objectives identified three factors that together explain 54 % of the variation in the importance rankings (Table 3). Based on the "reasons for owning forestland" groupings, we identified the factors as "stewardship," "aesthetic," and "financial."

4.5. Cluster analysis

Our cluster analysis of factor scores identified three respondent groups based on commonalities in their ownership objectives. These three groups included *financially-motivated* owners, *multiobjective* owners, and *environmental* owners (Table 4). Financially motivated owners made up 42 % of the sample, and generally had positive scores for the financial factor and negative scores for stewardship and aesthetic factors. Multiobjective owners made up 32 % of the sample and generally had positive scores for all three factors. Environmental owners made up 25 % of the sample and generally had positive scores for stewardship and aesthetic factors and a negative score for the financial factor. These owners appear to be motivated by their ability as landowners to provide

Table 3

Exploratory factor analysis loading coefficients for reasons for owning forest land.

Reasons for owning forestland	Factor 1: "Stewardship"	Factor 2: "Aesthetic"	Factor 3: "Financial"
To store carbon for climate benefits	0.559	0.136	−0.087
To protect water resources	0.770	0.192	0.022
To protect or improve wildlife habitat	0.710	0.378	−0.155
To enjoy beauty or scenery	0.434	0.615	−0.140
For privacy	0.144	0.720	0.012
To harvest timber products, including logs or pulpwood	−0.236	−0.278	0.447
For hunting	−0.037	0.090	0.456
For land investment	−0.130	0.080	0.337
To pass land on to my children or other family	0.171	0.009	0.607
To raise my family in nature	0.315	0.426	0.437
To harvest nontimber products, including berries or mushrooms	0.240	0.229	0.172
For firewood	0.140	0.368	0.275
For recreation, other than hunting	0.367	0.444	0.221
Eigen value	1.78	1.41	1.05
Proportion variance	.272	.170	.096

Note: Sample includes 370 observations. The three factors explain 54 % of the variation in variables.

Table 4

Landowner clusters based on factor scores.

Owner objective group	n	Mean factor scores		
		Stewardship	Aesthetic	Financial
<i>Financially motivated owners</i>	157	−0.824	−0.841	0.164
<i>Multiobjective managers</i>	120	0.483	0.441	0.645
<i>Environmental owners</i>	93	0.247	0.341	−1.301

wildlife habitat, store carbon, provide privacy for their family and connect to nature as opposed to invest in productive timberland. These factors and clusters are roughly similar to those found by Kline et al. (2000) and we used them to create dummy variables describing different types of forest landowners that we included in regression analysis of tax program enrollment.

4.6. Regression analysis of enrollment factors

Our estimated logit model described STF Program enrollment (ENROLL) as a function of explanatory variables describing respondents and their forest land. The equation estimated was:

$$\begin{aligned} \text{ENROLL}_j = & \beta_0 + \beta_1 \ln(\text{FORACRES}_j) + \beta_2 \text{PARCEL}_j \ln(\text{FORACRES}_j) \\ & + \beta_3 \text{MULTIOBJECTIVE}_j + \beta_4 \text{DEVELOP CONCERN}_j \\ & + \beta_5 \text{TAX CONCERN}_j + \beta_6 \text{INHERIT}_j + \beta_7 \text{EDUC ASSIST}_j \\ & + \beta_8 \text{INCOME ASSIST}_j + \beta_9 \text{INCOME}_j + \beta_{10} \text{COLLEGE}_j \\ & + \beta_{11} \text{AGE}_j + \varepsilon_j \end{aligned}$$

where ENROLL_j represents a binary variable indicating whether jth forest owner enrolls in the STF program, β_i are the estimated model coefficients and ε is the error term, and the independent variables are described in Table 5.

We found that forested acreage (lnFORACRES) had a statistically significant negative correlation with STF Program enrollment, with a marginal effect of −0.10 (Table 6). With logit models, an explanatory variable's marginal effect shows the change in predicted likelihood given an increase in the value of an explanatory variable by one unit. We found the interaction variable PARCEL*lnFORACRES to have a statistically significant positive correlation with STF Program enrollment (marginal effect=0.04), suggesting that holding total forest acreage constant, respondents owning multiple forest parcels are more likely to enroll in the STF Program. Together, these two results would seem to suggest that owners who possess larger forest parcels are less inclined to enroll, possibly because they are more likely to harvest, both because larger parcels offer more opportunities to harvest and may offer greater net revenues because fixed costs of management and harvest can be spread across greater acreage. A respondent owning 100 acres as a single parcel, would be less likely to enroll in the STF Program than a respondent owning 100 acres that is divided between two separate parcels.

The coefficient for MULTIOBJECTIVE is negative and statistically significant ($P < 0.10$), with a marginal effect of −0.13. This suggests that, holding other variables constant, *multiobjective* owners are less likely to enroll in the STF Program than *environmental owners* and *financially-motivated owners*. Greater interest in multiple forest uses and ownership reasons relative to just *environmental* or just *financial* reasons appears to correspond with lower likelihood of STF Program enrollment. The *multiobjective owner* cluster represents a diverse group of landowners who place high importance on all aspects of forest ownership, including environmental, *stewardship*, and *financial*. Past research has found inconsistent results regarding landowner management objectives and preferential forest property tax programs (PFPTP) enrollment, with some studies finding a positive relationship between enrollment and specifically timber objectives (Wolde et al., 2016) and other studies finding no relationship between enrollment and forest ownership

Table 5

Description of the variables used in the empirical model that examines factors affecting landowners' decision to enroll in the Small Tract Forestland Program, western Oregon counties, Oregon, 2021.

Variables	Definition and description	Mean value	Std. Dev.	Min	Max
<i>Forestland characteristics (L)</i>					
ln(FORACRES)	Natural log of the total number of forested acres owned in western Oregon.	4.44	1.23	2.29	8.44
PARCEL*ln (FORACRES)	Interaction term between dummy variable representing multiple parcel ownership where 1=owns at least two parcels, and 0=otherwise and ln (FORACRES)	2.78	2.61	0	8.44
<i>Ownership characteristics (O)</i>					
MULTIOBJECTIVE	Respondent is in the multi-objective cluster as opposed to the environmental or financially-motivated clusters. 1= multi-objective owner, 0= otherwise.	0.32	0.47	0	1
DEVELOP CONCERN	Level of concern regarding development of nearby forest and agricultural lands (e.g., real estate development). 1= at least 'of little concern', 0=no concern.	0.94	0.25	0	1
TAX CONCERN	Level of concern regarding high property taxes. 1= at least 'of little concern', 0=no concern.	0.98	0.27	0	1
INHERIT	Respondent inherited a majority of the forestland they own in Western Oregon as opposed to acquiring land by purchasing or receiving it as a gift. 1= inherited majority of forestland, 0 = otherwise.	0.20	0.40	0	1
<i>Management characteristics (M)</i>					
EDUC ASSIST	Respondent has received educational assistance (tours, workshops, conferences, publications) regarding their forest management. 1= received assistance, 0 = otherwise.	0.61	0.49	0	1
INCOME ASSIST	Respondent has deducted forest management expenses from income taxes. 1= deducted costs from income taxes, 0 = otherwise.	0.52	0.50	0	1
<i>Social and demographic characteristics (D)</i>					
INCOME	Binary variable representing annual household income of the respondents in US dollars. 1=\$50,000 or above, 0=otherwise.	0.88	0.32	0	1
COLLEGE	Highest level of education achieved by respondents. 1=bachelor or advanced degree, 0=associate degree or less.	0.75	0.43	0	1
AGE	Age of the respondent. Continuous variable.	68.90	10.78	32	90

Table 6

Estimated coefficients of the STF Program enrollment logit model describing respondents' likelihood of participating in the Small Tract Forestland property tax program.

Variable	Estimated coefficient	Std. Err.	t- Ratio	Marginal effects	Odds Ratio
ln(FORACRES)	−0.41 **	0.17	−2.36	−0.10	0.66
PARCEL*ln (FORACRES)	0.17 **	0.08	2.20	0.04	1.19
MULTIOBJECTIVE	−0.54 *	0.31	−1.72	−0.13	0.59
DEVELOP CONCERN	−0.65	0.61	−1.07	−0.16	0.52
TAX CONCERN	−0.23	1.08	−0.21	−0.06	0.80
EDUC ASSIST	0.86 ***	0.31	2.80	0.21	2.37
INCOME ASSIST	0.73 **	0.30	2.43	0.18	2.08
INHERIT	0.64 *	0.37	1.73	0.16	1.90
INCOME	−0.75 *	0.45	−1.65	−0.18	0.47
COLLEGE	0.08	0.33	0.23	0.02	1.08
AGE	0.01	0.01	0.74	0.00	1.01
Constant	1.13	1.69	0.67		

Note: *, **, and *** show significance at 10, 5, and 1 %, $N = 231$. Pseudo $R^2 = 0.17$.

objectives and enrollment (Brockett and Gebhard, 1999; Fortney et al., 2011).

We found that EDUC ASSISTANCE (e.g., tours, workshops, publications) and INCOME ASSIST were statistically significant and positively correlated with STF Program enrollment, with marginal effects of 0.21 and 0.18, respectively, suggesting that respondents who take advantage of forestry incentives are more likely to enroll. The positive sign of INCOME ASSIST also suggests that in addition to educational assistance, being familiar with and utilizing other vehicles of forest-based tax strategies is associated with forest property tax program participation. Together these variables further highlight the importance of landowner education and engagement in order to maximize the reach and effect of targeted programs in Oregon.

The coefficient for INHERIT is positive and statistically significant ($P < 0.10$), with a marginal effect of 0.16. Holding all else equal, landowners who inherited a majority of their forestland are more likely to enroll in the STF Program than those who purchased their forestland or received it as a gift. This is consistent with past findings that consistently found landowners who purchased their forestland were less likely to enroll in PFPTPs (Fortney et al., 2011; Stevens et al., 2002; Wolde et al., 2016). Additionally, this could be explained by the fact that the new owner also “inherited” the STF Program tax program; new owners may face penalties if they chose to remove their property from the STF Program.

The coefficient for INCOME was negative and statistically significant ($P < 0.1$), with a marginal effect of −0.18. Holding other variables constant, landowners with annual household incomes over \$50,000 were less likely to be enrolled in the STF Program than those with incomes under \$50,000. Coefficients for concerns over taxes (TAX CONCERN) and development (DEVELOP CONCERN) were not statistically significant at 10 %. A vast majority of respondents indicated high levels of concern over both development of nearby forestlands and high property tax rates – so while the result suggests STF Program participants are no more concerned than non-participants, it does not indicate they are not concerned at all. Estimated coefficients for age (AGE) and education (COLLEGE) were also statistically insignificant in the model.

Taken together, landowners who have forestland split between multiple parcels (PARCEL*ln(FORACRES)), received educational assistance (EDUCASSIST), utilized income tax deductions for forest management costs (INCOMEASSIST), and inherited a majority of their forestland (INHERIT) are more likely to participate in the STF Program. Landowners with more total forested acres (ln(FORACRES)), who are characterized as multi-objective owners (MULTIOBJECTIVE), and earned an annual household income over \$50,000 (INCOME) are less

likely to enroll in the STF Program.

4.7. Sensitivity analysis of explanatory variable influence on program enrollment

Although marginal effects help to illustrate the magnitude of impact of each explanatory variable on the predicted likelihood of STF Program enrollment, the nonlinear nature of logit models somewhat obscures the relative variation in impact magnitude over the full range of each individual variable value. Following Olsen et al. (2017: Table 7), we conducted a sensitivity analysis to examine the ranges of predicted likelihood values of STF Program enrollment across the full range of each individual explanatory variable—from each variable's minimum to maximum value—while holding all other explanatory variables at their mean values (Table 7). Our sensitivity analysis indicates that the variable $\ln(\text{FORACRES})$ has the greatest magnitude of impact across its full value range in our survey sample, with predicted likelihood values ranging from 0.68 to 0.15. The interaction variable $\text{PARCEL} * \ln(\text{FORACRES})$ is second in terms of impact magnitude, with predicted values ranging from 0.36 to 0.70. Taken together, these results suggest that STF Program enrollment is highly sensitive to the number of forested acres owned by our sample of western Oregon survey respondents across the full range of values reported. The magnitudes of impact on predicted likelihood of STF Program enrollment also are fairly sensitive to EDUCASSIST and INCOMEASSIST . Our sensitivity analysis indicates that the influence of MULTIOBJECTIVE forest ownership objectives ranges from a program enrollment likelihood of 0.52 among forest owners without multiple objectives to 0.38 among forest owners who do hold multiple forest ownership objectives (Table 7).

5. Discussion

Our results suggest that Oregon's preferential tax programs do seem to influence forest landowner behavior among Oregon's most active forest landowners—those OSWA members making up our survey sample. Results also suggest that forest management among OSWA members enrolled in either the STF or Forestland Programs are fairly similar, regardless of in which program they are enrolled. An equal proportion of landowners in each program had conducted clearcutting, commercially thinned, or pre-commercially thinned within the past ten years. Although, the survey results suggest that STF Program participants own significantly fewer total acres ($P < 0.05$), collectively they own a similar forested acre total. Past literature has found that NIPF landowners

owning greater forested acres are more likely to produce timber given economies of scale (Amacher et al., 2003; Beach et al., 2005; Row, 1978).

However, with sampled STF Program participants owning smaller forested parcels and potentially harvesting at equal rates to Forestland Program participants, perhaps it is the STF Program design that allows for viable harvest of these smaller parcels. This is supported by the finding that STF Program participants on average earn lower income levels and may participate in the STF Program to reduce the annual tax bill and then are able to pay the severance tax at time of harvest when there is revenue available to pay the tax. The severance tax does seem to deter some potential participants. About 30 % of Forestland Program landowners reported that they do not have land enrolled in the STF Program, to avoid paying the severance tax at time of harvest. This enables them to garner higher net revenues from harvesting and avoid penalties incurred when unenrolling from the STF Program to avoid the severance tax. Our survey did not ask STF Program participants about their opinions and attitudes toward the severance tax. Additional research could investigate the extent to which the STF severance tax factors into landowner timber harvesting decisions.

In terms of potential ecological benefits from Oregon's preferential tax programs, both STF and Forestland Program participants indicated similar rates of unhealthy tree removal, native seedling plantings, wildlife habitat improvement, and prescribed burns. STF Program participants reported higher rates of invasive species removal ($P < 0.05$), and more STF Program participants have written forest management plans ($P < 0.01$). The STF Program does not specifically mention invasive species removal. This finding is in line with Drescher et al. (2019) which found that landowners in an Ontario conservation incentive program, had higher rates of invasive species removal not because the program specifically asked landowners to do so, but in part because the program required a management plan. They posit that the process of writing a management plan increases landowners' familiarity with and concern about invasive species and thus inspires more participants to address invasive species. We suspect that the same could be true of STF Program participants, but the STF Program currently does not require a management plan for enrollment. A higher proportion of STF Program participants are retired and reside on or within a mile of their forestland. These factors, not STF Program characteristics, may help explain why STF Program participants were more actively removing invasive species than their Forestland Program counterparts.

Regardless of program, sampled landowners were generally familiar with the tax program options available to them. Just 14 % of respondents did not know the program under which their lands were assessed. As expected, OSWA members are highly knowledgeable about forest management options and programs given their regular exposure to educational resources and expressed interest in landowner education and engagement. However, even within this highly engaged subset of landowners, 40 % of the survey respondents without land enrolled in STF Program indicated they were not enrolled because they did not know about the program. Although this may seem high among members of an organization like OSWA, it is significantly lower than results from other surveys, which found much higher rates of program unawareness (Fortney et al., 2011; Williams et al., 2004). Results suggest that those who do not know what program they are in may not know because they are distinctly different from landowners that indicated either STF or Forestland Program. They own less land and fewer parcels, have lower annual income and levels of education, and fewer have undertaken forest management actions.

Consistent with past studies on NIPF program enrollment, our STF Program enrollment model indicated that educational assistance such as tours, workshops, conferences, and publications were positively correlated with STF Program enrollment. While 32 % of respondents learned of Oregon's tax programs through a landowner association like OSWA, 17 % learned through an extension specialist and 17 % learned through a tax assessor. If a policy goal is to recruit additional participants to STF

Table 7

Sensitivity analysis showing predicted likelihood STF Program enrollment^a when setting each explanatory variable at its minimum, mean, and maximum value while holding all other variable values at their mean values.

Variable	Explanatory variable held at:		
	Minimum	Mean	Maximum
$\ln(\text{FORACRES})$	0.68	0.47	0.15
$\text{PARCEL} * \ln(\text{FORACRES})$	0.36	0.47	0.70
MULTIOBJECTIVE	0.52	0.47	0.38
DEVELOP CONCERN	0.62	0.47	0.46
TAX CONCERN	0.53	0.47	0.47
EDUC ASSIST	0.35	0.47	0.56
INCOME ASSIST	0.38	0.47	0.56
INHERIT	0.44	0.47	0.60
INCOME	0.64	0.47	0.45
COLLEGE	0.46	0.47	0.48
AGE	0.38	0.47	0.53
Global predicted value ^b	0.63	0.47	0.47

^a Likelihood values predicted using estimated coefficients from Table 6 combined with explanatory variable minimum, mean, and maximum values reported in Table 5.

^b Predicted values computed while holding all explanatory variables at their minimum, mean, and maximum values.

Program or a similar landowner program, additional resources and educational materials disseminated via extension, landowner associations, and other similar modes could be critical to increased enrollment.

Our landowner enrollment model suggests that landowners with more forested acres were less likely to enroll in the STF Program. Landowners holding more forest land acreage have consistently been shown in other studies to be more interested in pursuing voluntary incentive-based programs than smaller acreage owners (Nagubadi et al., 1996; Ma et al., 2012; Song et al., 2014). On the other hand, landowners with more acreage can be more likely to oppose mandatory compliance programs due to property-rights concerns associated with losing forest-based income than owners with smaller acreage (Johnson et al., 1997; Poudyal and Hodges, 2009). In the context of Oregon's preferential tax programs, the STF Program is indeed an incentive-based program, but comes with property use restrictions and impacts forest-based income via severance tax. Our results are therefore consistent with the literature suggesting landowners with more total acreage are less likely to enroll in a program with mandatory compliance elements.

Our model results also indicate that landowners with smaller forest parcels were less likely to enroll in the program. One potential explanation is that parcel size generally increases with increasing distance away from urban and suburban areas. With this in mind, smaller parcels may be subject to more development pressure and be located in more densely populated counties with higher tax rates. These two factors might induce contrasting effects as discussed throughout the literature on preferential property tax programs (Frey et al., 2019). While preferential tax programs offer landowners greater tax savings in areas with higher tax rates, those higher savings come at a higher opportunity cost due to forgone development opportunities. However, with Oregon's Land Use Planning Program greatly reducing the opportunities for parceling and developing forestland, the effect of tax savings may outweigh development opportunity costs for the average landowner.

Our STF Program enrollment model results suggest that few landowner characteristics were associated with likelihood of enrollment. Landowners with higher education, age, and concerns about development and high property taxes were no more or less likely to enroll. *Multiobjective owners* had high mean scores for *financial*, *stewardship*, and *aesthetic* factors suggesting they actively manage for a suite of forestland characteristics. While *environmental owner* and *financially-motivated owner* scores indicated they own their land for a narrower set of reasons, the *multiobjective owners* placed high importance on timber management and forestland aesthetics. This more diverse set of objectives likely aligns more closely with the Forestland Program compared to the STF Program, which has greater withdrawal penalties.

The negative relationship between income and STF Program enrollment is at odds with other regionally-specific studies (Fortney et al., 2011). One possible anecdotal explanation supported by several comments on returned survey instruments is that some landowners may feel a responsibility to provide full property tax payments to their counties given that the revenue from forest property taxes helps pay for local schools and other public services. Additionally, higher income individuals are more likely to be employed than retired, which is in line with the finding that STF Program participants are significantly more likely to be retired than Forestland Program participants and have lower average income. Past research has shown that income is generally negatively related to timber harvesting (Amacher et al., 2003; Beach et al., 2005), and if those higher income individuals were to enroll in STF Program and not make up the deferred property tax via severance taxes, then the hypothetically deferred property tax payment is never recovered. A similar sentiment was expressed by numerous respondents that they felt their tax payments were already low enough in the Forestland Program.

Landowners who inherited their forestland were significantly more likely to enroll in the STF Program. One explanation for this result is that those who inherit the land may be more knowledgeable about available

tax programs given the time and resources devoted to estate and asset evaluation in the wake of a family death. Additionally, heirs may split the estate and parcelate the inherited forestland, resulting in smaller, fragmented parcels which was also significantly positively related to STF Program enrollment. Connection to the land is often passed from one generation to the next (Brandenburg and Carroll, 1995). Perhaps their inherited connection to place motivated them to ensure their forestland was more challenging to develop or sell to a non-NIPF buyer due to STF Program penalties on withdrawing from the program.

Overwhelmingly, landowners felt Oregon's forest property tax programs were necessary to achieve long-term forest ownership and management, pursue forest stewardship, and harvest when desired. A vast majority of STF Program participants indicated tax savings, forestland retention, and ownership retention were equally important benefits of the STF Program. In their comments on the survey, many landowners expressed profound connection to their forestlands and supported current tax rates. As illustrated by the results of this study, and consistent with the literature, non-industrial private landowners appear to provide a suite of public benefits for which they otherwise would generally not be compensated. Reduced forest property tax rates are one form of compensation, and survey results suggest that they indeed encourage the public benefits that Oregonians enjoy from nonindustrial private forest lands in their state.

6. Conclusions

Previous studies suggest that while enrollees in preferential tax programs do vary in their individual characteristics, the forest management behaviors of enrollees generally do not vary from those of non-enrollees. Our results suggest there are few differences between STF Program-enrolled and Forestland Program-enrolled OSWA members and their management practices. However, landowners who received educational assistance, deducted management costs from income taxes, inherited their forestland, and own smaller parcels were significantly more likely to enroll in the program. Consistent with past studies, it is clear that forest management education is directly linked to higher rates of STF Program enrollment, and additional funding for outreach programs may result in higher rates of familiarity with and enrollment in the program. Our findings also suggest that estate planning may play a key role in the future of NIPF landowners as they relate to enrollment in the STF Program; further research on heirs to forestland and their management objectives and plans is critical to ensuring the STF Program will effectively retain participation.

Given these results, we do acknowledge several potential caveats that attend any use of survey data to examine family forest owner behavior. First, there is the aforementioned possible sampling bias potentially induced by our reliance on a sample of OSWA members. Such family forest owners may be more engaged active forest management than an average forest owner, and so relatively active forest owners may be overrepresented in our sample. Also, we conducted our survey via mail, which could bias our sample toward forest owners who are more likely to respond to mail surveys than other survey protocols. However, in the absence of specific information pertaining to survey response tendencies associated with particular forest owner characteristics, we are unable to even hypothesize what these particular biases might be. Lastly, it is sometimes suggested that survey respondents may sometimes provide responses to survey questions based on what they feel might be considered socially desirable in a given circumstance or provide responses strategically with an intent to influence survey outcomes, such as tax policy in this case. But again, without specific information or evidence of such behaviors among the sample of forest owners we surveyed, we are unable to speculate on the presence and magnitude of these potential sources of bias in the survey data we examined.

Still, with those caveats in mind, we feel our results offer implications for policy and management of private forest lands in Oregon. It has been suggested that NIPF landowners' objectives should play a central

role in the development of incentive-based management programs that are intended to induce changes in landowner behavior which may actually align with existing landowner objectives (e.g., Daniels et al., 2010). With respect to forest property tax structure in Oregon, it is clear that NIPF landowners manage their forest lands differently than do industrial forest landowners, yet many are taxed under the same property tax programs. Our analysis suggests that a single program may be met with varying levels of interest, depending on the specific objectives and characteristics of individual forestland owners. It also has been suggested that a wider social contract acknowledging the importance of small private forestlands to all of society is critical to the long-term stewardship of family forestlands (e.g., Bliss, 2003). Oregon's NIPF owners are known for providing a suite of ecological, aesthetic, and recreational benefits to all Oregonians, and they receive fairly limited compensation for doing so, if at all. Although Oregon's existing preferential tax programs, specifically the STF Program, acknowledge the importance of non-industrial private forestlands, future policy proposals could continue to do so by taxing industrial and non-industrial forests differently. Many survey respondents indicated the tax programs enable long term forest ownership, extended rotation ages, and investment in stewardship activities. However, additional research could consider the extent to which these results are consistent with non-OSWA members throughout both western and eastern Oregon.

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CRediT authorship contribution statement

Benjamin Rushakoff: Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tamara L. Cushing:** Writing – review & editing, Writing – original draft, Resources, Methodology, Conceptualization. **Jeffrey D. Kline:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis. **Olli-Pekka Kuusela:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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