

Characterizing Family Forest Owners who are Eligible to Participate in Preferential Forest Property Tax Programs (PFPTPs) across the U.S.

by

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Abstract

This research is one of the first to empirically assess the relationship between family forest landowner, parcel, and tax program characteristics and participation in state preferential forest property tax programs (PFPTPs) across the U.S. using data from the National Woodland Owner Survey (NWOS). Results of a binary logistic regression model demonstrate that PFFTP participation for family forest owners who responded to the NWOS between 2011 and 2013, were at least slightly familiar with their PFFTP, owned a single wooded parcel, and met the minimum/maximum acreage requirements for PFFTP enrollment is influenced by five primary categories comprised of landowner characteristics, PFFTP characteristics, and land use characteristics. These categories are defined as the financial benefit of participation, the financial cost of participation, personal characteristics of the woodland owner, PFFTP enrollment criteria/restrictions, and land characteristics. Interestingly, practically no woodland management objectives or concerns that were hypothesized to control costs of woodland ownership were found to have any effect on participation. For owners enrolled in PFPTPs, these programs may help align their management actions with society’s goals for private forests. It’s not clear, however, that enrolled woodland owners would not have responded similarly to other, less expensive and less bureaucratic forms of messaging on forest management. Marginal increases in PFFTP participation across the U.S. may be gained through deemphasizing timber production and government oversight.

Chapter 1: Introduction

Family forest landowners control a greater proportion of U.S. forestland than any other single ownership group (Butler et al., 2012). This group manages the production of goods and services provided by the nation's private forests such as clean air, clean water, carbon sequestration, and biodiversity. As public goods, landowners may not be adequately compensated for their production. For instance, biodiversity or clean air produced by private forests is not directly bought and sold in capital markets. Attempting to correct this market failure, government has promoted an interest in perpetuating the production of forest based ecosystem goods and services through a variety of public policy tools, including property tax incentives (Kilgore et al., 2017). Administered in every state, preferential forest property tax programs (PFFTP) offer favorable forest property tax treatment as an incentive to promote forest based ecosystem goods and services. Family forest landowners play a key role in determining the success of these programs across the U.S.

This analysis is motivated by an interest to better understand the characteristics of family forest landowners who were eligible to participate in PFFTPs during the period of 2011-2013. This information, in turn, may aid policymakers and tax program administrators in more effectively designing programs that will advance society's interest in private forest management and structuring programs in such a way that may result in substantial gains in program participation.

The objectives of this analysis were to:

- Characterize family forest owner participants of state PFFTPs in the U.S.
- Describe and contrast important similarities and differences among family forest owners who participate in state PFFTPs and those who do not.
- Identify and quantify the relationship between family forest owner, parcel, and tax program characteristics and participation in state PFFTPs.

These objectives were accomplished by:

- Reviewing literature on family forest owner policy tools, including tax policy.
- Obtaining a diverse data set using multiple sources of data.
- Screening family forest owner data to conform to specific analysis criteria.
- Analyzing the data consistent with stated objectives by using multiple methods.
- Drawing summary conclusions based on the analysis of the data.

1.1. Report Organization

A presentation of this analysis follows in which chapters 2-4 are presented as stand-alone analyses. Chapter 2, titled, *A Characterization of the Family Forest Landowners Who Participate in State PFFTPs across the U.S.*, segmented our population of U.S. family forest owners across several different characterizations of PFFTP. Chapter 3, titled, *A Comparison of the Family Forest Landowners Who Participate and Those Who Do Not Participate in State PFFTPs across the U.S.*, compared and contrasted similarities and differences of U.S. family forest landowners who were enrolled and those who were not enrolled in the nation's PFFTPs; estimated of the strength of association between landowner characteristics and participation in state PFFTPs are presented. Chapter 4, titled, *A Quantification of the Relationship between Family Forest Landowner, Parcel, and Tax Program Characteristics and*

Participation in State PFPTPs across the U.S., used binomial logistic regression to model the PFFTP enrollment decision. Insights regarding factors that were significant predictors of PFFTP participation and those that were not are identified and discussed.

All statistical tests performed in this data analysis were generated using SAS software version 9.4 (SAS Institute Inc., 2013). Copyright © 2002-2012 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

The presentation of this three part analysis (Chapters 2-4) is followed by a comprehensive synthesis chapter. This chapter aims to summarize the key findings from the analyses. It also suggests ways in which a better understanding of family forest owners and their participation in the nation's PFFTP may help policymakers design programs that will advance society's interest in private forest management. The synthesis is followed by a conclusion and closing remarks in Chapter 6.

Chapter 2: A Characterization of the Family Forest Owners Who Participate in State PFPTPs across the U.S.

2.1. Introduction

Collectively, the land base of the United States consists of 766 million acres of forestland and is owned by both public and private entities (Oswalt et al., 2014). Forty two percent of forest land in the United States is controlled by federal, state, and local governments, while the majority of forest land is privately owned (58%) by a diversity of individuals, families, Native American tribes, partnerships, corporations, nongovernment organizations, and other private groups (Oswalt et al., 2014). The private ownership component in the U.S. amounts to an estimated 11 million owners. Of these, 92% (10 million) are “family forest” owners, defined as families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals that own forestland (Butler, 2008). Collectively, they control 264 million acres or 35% of America’s forestland (Butler et al., 2012) and provide forest-based public goods to society for which they are not always compensated. For example, these public goods include lower soil erosion, increased carbon sequestration, water regulation, and aesthetics (Wolde et al., 2016); raw materials like sawtimber and pulpwood; non-wood forest products such as mushrooms and berries; and other services such as aesthetics, wildlife habitat, and recreational opportunities (Oswalt et al., 2014).

As public goods, services provided by the nations privately owned forests are subject to underproduction. Over the past 100 years, a broad suite of policy tools have been suggested and used to address market failures by incentivizing private forestland management (e.g., Greene et al. 2005), reduce forest fragmentation and parcelization, and encourage landowners to make long-term investments in their forest land (e.g., Cushing, 2006; D’Amato et al., 2010). These tools include technical assistance, information, educational programs, financial incentives, regulations, and tax policy (Butler et al., 2012; Kilgore and Blinn, 2004; Greene et al., 2005). Of particular prominence and importance in the U.S. are financial incentives concerning tax policy (Greene et al., 2005).

Numerous tax policies have been developed to motivate sustainable forest management and production of forest-based goods and services that are social, environmental, and economic (e.g., recreational opportunities, wildlife habitat, clean water, and timber production) (Kilgore et al., 2008). A review of the forest property tax literature by Kilgore (2014) found that major areas of investigation have focused on state forest property tax program design, use, and administration (e.g., Hibbard et al., 2003; Fortney and Arano, 2010); property tax impacts on forest land investment and management decisions (e.g., Klemperer 1982; Amacher et al., 1991; Cushing, 2006); property tax policy influence on landowner land tenure decisions (e.g., Poudyal and Hodges, 2009; Butler et al., 2012); and factors influencing enrollment in and the effectiveness of preferential forest property tax programs (e.g., Kilgore et al., 2008; Fortney et al., 2011; Bagdon and Kilgore, 2013). With regard to this latter area, a significant portion of forest tax policy development has focused on the group of forest landowners collectively referred to as family forest landowners. Specifically, past research has focused on the factors influencing their enrollment in and the effectiveness of preferential forest property tax programs (PFPTP) (i.e., those tax programs that are preferentially available and tailored to forestland ownerships under private management).

Preferential forest property tax programs are administered by state or local governments and have traditionally offered favorable property tax treatment to incentivize the sustainable production of forest-based ecosystem services (Kilgore et al., 2017). Tax policies focusing on family forest landowners exist in every U.S. state (Hibbard et al., 2003; Kilgore et al., 2017). They differ structurally based on their fundamental basis for taxation, specific program criteria regarding enrollment and land use restrictions, tax benefit, and ecosystem services promoted (Kilgore et al., 2017). For instance, Hibbard et al. (2003) conducted a study on state forest property tax program design, use, and administration and identified five major types of forest property tax programs regarding their fundamental basis for taxation: 1) ad valorem laws taxing forestland according to its fair market value; 2) current use programs which determine the

land's taxable value according to its use in a forested condition; 3) flat tax programs which levy a fixed annual tax per acre; 4) exemption programs which excuse forestland from property taxation altogether; and 5) hybrids where current use and ad valorem values are used to derive a taxable value for forested property.

Regarding programmatic criteria and restrictions, tax benefits and participation, and ecosystem services promoted, Kilgore et al. (2017) found that certain enrollment criteria are common in PFPTPs across the U.S. These include a specified program commitment length accompanied by penalties for early withdrawal, specified productive forest conditions, application requirements, land use restrictions regarding implementation of a forest management plan (FMP), and land use restrictions regarding commercial or agricultural development. In 2015, average annual tax benefits for landowners enrolled in state PFPTPs ranged from \$15.14 per acre in the Northern United States to \$2.89 per acre on the U.S. Pacific Coast. State PFPTPs promote a diversity of ecosystem services on private forest land including open space and scenic resources, conservation of soils and wetlands, production of timber and fiber products, and recreational uses and resource preservation (Kilgore et al., 2017).

At the state level, PFPTP are designed to provide compensation for the production of ecosystem goods and services that benefit society, encourage private forest landowners to invest in activities that result in increased timber supply, and provide a more equitable basis for investment in their forest land due to their long-term nature (USDA-Forest Service, 1990). The success PFPTPs enjoy in accomplishing their goals is exceedingly important. Of the vast acreage of forestland in the United States family forest owners control 36% (Butler et al., 2016). The public resources used to fund total state expenditure on any one program designed to motivate tax program enrollment and provision of environmental, social, and economic benefits can be large. For instance, the average state-level preferential forest property tax program in the United States provides tax benefits in excess of 34 million dollars per year. Total expenditure incentivizing program enrollment across all programs in the continental United States exceeds 1.6 billion dollars per year, an average of \$7.68 per acre (Kilgore et al., 2017).

PFPTP success can be tied to a variety of characteristics that relate to one of their largest target audience: family forest landowners. Characteristics of family forest owners and their wooded land vary across the United States. These woodland owners have diverse land management objectives, past land management history and future land use plans. Specific characteristics of the surrounding landscape offer certain opportunity costs based on the development potential and alternative uses of forest land in their particular location. The United States Department of Agriculture (USDA) Forest Service's Forest Inventory and Analysis (FIA) program conducts the National Woodland Owner Survey (NWOS) as a social complement to its plot-based inventory program. Both are designed to meet its legislative requirement to maintain a comprehensive inventory and analysis of the present and prospective conditions of the forests and rangelands of the United States (Humphrey, 1974). The NWOS is charged with quantifying the number of people who own forest land, why they own it, how they have used it in the past, and how they intend to use it in the future (Oswalt et al., 2014). Based on an analysis of the 2013 NWOS, the most recent and comprehensive survey of the nation's family forest owners, Butler et al. (2016) reported that the most common reasons for owning wooded land cited by family forest owners include the beauty, wildlife habitat, and nature protection the woodlands provide. Financial objectives such as land investment and timber production are rated much lower overall than amenity-oriented objectives. The most common activity undertaken by family forest owners is harvesting timber for personal use (i.e., firewood), while commercial harvesting and traditional forest management is much less common. Common future land management activities cited by family forest landowners include improving wildlife habitat and harvesting trees for personal use (Butler et al., 2016).

A variety of factors influence decisions about management behaviors by family forest owners. However, increasing property taxes on forestlands with high value alternative land uses, such as those surrounding growing cities, provides a disincentive to holding land for the purpose of growing trees and managing forests (Cushing, 2006). Similarly, landowners may be forced to cope with the additional land holding expense in various ways that negatively affect sustainable forest management. For instance, they may be forced to sell (or subdivide) a portion of their property to generate additional revenue or harvest at an inopportune time, based on timber markets or timber stand maturity (Cushing, 2006).

Motivated by an interest to align landowner behavior with social or public welfare (Fortney et al., 2011), scientists have endeavored to quantify landowner characteristics and model their effect on the family forest landowner PFFTP enrollment decision. The focus of most empirical studies regarding family forest owner enrollment in PFFTPs has been to investigate relationships at the state, specific tax program, or regional level. For instance, Kilgore et al. (2008) estimated the probability of enrollment in Minnesota's Sustainable Forest Incentives Act. Compensation amount, intention to obtain a forest management plan, opposition to the program's land covenant, prior awareness of the program, and total acres of forestland owned were significant predictors of a landowner's interest in program enrollment. Fortney et al. (2011) examined the factors that influence a forest landowner's decision to participate in West Virginia's Managed Timberland Program. Factors found to be significant drivers of enrollment were age, income, place of residence, county location of the enrolled property, and perceived benefits of the program. Additional examples of previous empirical literature on state and regional enrollment in PFFTP include Kilgore et al. (2008), Stevens et al. (2002), and Dennis and Sendak (1992). Enrollment in incentive programs for forestland management beyond the scope of preferential tax programs (e.g., cost share and technical assistance) are also numerous. For instance, Wolde et al. (2016) conducted a survey of 1,800 forestland owners in Virginia and Texas. They found that forestland owners who are less likely to enroll in a forestland incentive programs have relatively smaller forestland acreage, a lower level of education, and shorter landownership tenure, while forestland owners with past experience with public incentive programs for forestry attach higher importance to potential programs.

Comparatively few empirical studies have assessed the relationship between landowner characteristics and involvement in preferential forest property tax programs at a national scale. In one such example, Butler et al. (2012) surveyed PFFTP administrators and conducted interviews with family forest owners and forestry/conservation professionals. Their analysis reported that lack of awareness, confusion, misinformation about these programs, and often complicated and/or restrictive requirements prevented preferential forest property tax programs from reaching their full potential across the U.S. Considering involvement in forest conservation programs in general, Ma et al. (2012) examined the factors associated with landowner involvement in forest conservation programs (e.g., cost share, forest certification, and conservation easements) in the U.S. They found family forest owners with larger land holdings and those who had obtained forest management information or advice were more likely to have participated in various incentive programs.

To our knowledge, no empirical studies have attempted to describe, analyze, and model U.S. forest property tax enrollees at a national scale. Specifically, there are no published studies that have examined and quantified the relationship between landowner, property, and tax program characteristics and program enrollment across the spectrum of forest property tax programs in the U.S. Addressing this information gap will form a baseline to inform family forest tax policy analysis and revision at local, regional, and national scales. This will be especially relevant as land uses, industry requirements, and forestland management objectives of America's family forest landowners continue to change. Providing a national characterization of this forest ownership segment will allow for more accurate targeting of this group for development of PFFTPs and other forest incentive programs. Furthermore, empirically established

correlations between landowner/land characteristics, enrollment status, and specific tax program characteristics will aid policy makers in tax program design when considering intended programmatic goals and outcomes. For instance, a characterization of the relationship between PFFTP characteristics and urban sprawl surrounding enrolled parcels may provide insight concerning the ability of PFFTPs to curb forestland fragmentation in areas where increasing land values and associated land taxes result in increased financial burdens and/or opportunity costs for forestland owners. Furthermore, positive relationships between program enrollment status nationally and landowner/land characteristics associated with sustainable forest management may help to provide further validity for the benefits of the nation’s preferential forest property tax programs.

2.2. Study Objective

The study objective associated with this chapter is to characterize the participants of state PFFTPs in the U.S.

2.3. Data and Methods

The analysis used the 2013 NWOS data set, the most recent iteration of complete NWOS data that was collected between 2011 and 2013. The data set contained information provided by 10,109 U.S. family forest owners such as socio-economic/demographic characteristics, ownership purposes, attitudes, and current and future land management activities (Table 1). The 2013 NWOS data set was screened to include only family forest ownerships, defined in Butler et al. (2016) as a legal entity composed of one or more individuals. Family forest owners were defined as not being corporate or business partnership ownerships. The data contained 66 landowners owning fewer than 10 acres and four landowners owning greater than 10,000 acres. As such, no minimum or maximum acreage constraints were imposed (i.e., those 76 landowners who either owned less than 10 acres or more than 10,000 acres were not excluded from the analysis). Additionally, no data on Alaska or Hawaii landowners were included, as the NWOS data set only contained data on landowners in the contiguous United States.

Table 1. Description of variables from the National Woodland Owner Survey (NWOS) data set and additional ancillary land variables from the Family Forest Research Center (FFRC) used in the analysis.

Category/Variable	Original Variable	Description	Data Set
Owner Social/Economic/Demographic			
Age	own1_age	Owner age in years	NWOS
Income ¹	income	Owner income category	NWOS
Education ²	own1_edu	Owner education category	NWOS
Income from woods	inc_wood	Percentage of annul income derived from wooded land	NWOS
Owner Attitudes/Concerns			
Taxes concern ³	cnc_tax	Concern for taxes	NWOS
Development concern ³	cnc_dev	Concern for development	NWOS
Succession concern ³	cnc_heir	Concern for keeping land intact for future	NWOS

		generations	
Tax help ⁴	help_tax	Helpfulness of more favorable tax policies	NWOS
Timber markets help ⁴	help_tim	Helpfulness of stronger timber markets	NWOS
Cost share help ⁴	help_cost	Helpfulness of cost sharing for woodland management	NWOS
Owner Reasons for Owning Wooded Property			
Objective aesthetics ⁵	obj_bea	Ownership beauty objective	NWOS
Objective wildlife ⁵	obj_wil	Ownership objective wildlife	NWOS
Objective investment ⁵	obj_inv	Ownership investment objective	NWOS
Objective children ⁵	obj_child	Ownership passing land to heirs objective	NWOS
Objective timber ⁵	obj_tim	Ownership timber objective	NWOS
Objective recreation ⁵	obj_rec	Ownership recreation objective	NWOS
Objective hunting ⁵	obj_hunt	Ownership hunting objective	NWOS
Objective residence ⁵	obj_hom	Ownership home objective	NWOS
Owner Participation in Forestry Assistance Programs			
Cost share familiarity ⁶	cost_know	Familiarity with cost share programs	NWOS
PFFTP familiarity ⁶	tax_know	Familiarity with the state preferential forest tax program (PFFTP)	NWOS
Cost share	cost	Past participation in a cost share program (1=yes, 0=no)	NWOS
Advice	advice	Received advice on care, management, or protection for their wooded land in past five years (1=yes, 0=no)	NWOS
Tax	tax	Enrolled in state PFFTP (1=yes, 0=no)	NWOS
Past Land Management Activities, Practices, Assistance, and Land Uses			
Transfer ⁷	tran	Number of times transferred land	NWOS
Purchased	acq_type_purch	Wooded land was purchased (1=yes, 0=no)	NWOS
Inherited	acq_type_inherit	Wooded land was inherited (1=yes, 0=no)	NWOS
Management plan	man_plan	Has a forest management plan (1=yes, 0=no)	NWOS
Harvest 5 years	act_cut_sale	Harvested trees for sale in the past five years (1=yes, 0=no)	NWOS
Invasive 5 years	act_inva	Treated invasive plants in the last five years (1=yes, 0=no)	NWOS
Harvest	cut_log_sale	Harvested trees for sale since owning the property (1=yes, 0=no)	NWOS

Forester	cut_forester	Use of forester during harvest (1=yes, 0=no)	NWOS
Logger	cut_logger	Use of certified or master logger during harvest (1=yes, 0=no)	NWOS

Planned Future Activities and Uses

Future harvest ⁸	fut_cut_sale	Likelihood of future harvesting	NWOS
Future transfer ⁸	tran_fut	Likelihood of transferring property in the future	NWOS
Sell ⁹	att_sell	Agreement with selling land in future for right price	NWOS
Wooded ⁹	att_wooded	Agreement with wanting to keep their wooded land wooded	NWOS

Forest Land Characteristics

Tenure	years_owned	Ownership tenure in years	NWOS
Residence	home	Home or primary residence on or within one mile of wooded land (1=yes, 0=no)	NWOS
Farm	farm	Owens a farm or ranch in state (1=yes, 0=no)	NWOS
Cabin	cabin	Cabin on or within one mile of wooded land (1=yes, 0=no)	NWOS
Acres woods	ac_wood	Acres of woods on parcel	NWOS

Proximate Land Use and Development Activity/Potential

Population	pop_10_sqmi	Number of people per square kilometer within the Census block group where land is located	FFRC
Urban distance	urb_dist	Straight-line distance (meters) to Urban Area as defined in 2010 census (>2,500 residents)	FFRC
Forest	prop_for	Proportion of land that is forested within a 1 km radius of respondent's wooded land (2011 National Land Cover Database)	FFRC
Agriculture	prop_ag	Proportion of land that is agricultural crop or pasture land within a 1 km radius of respondent's wooded land (2011 National Land Cover Database)	FFRC
Development	prop_dev	Proportion of land that is developed (impervious surface) within a 1 km radius of respondent's wooded land (2011 National Land Cover Database)	FFRC
Road density	rd_1km	Sum of 30m road pixels within 1km of wooded land	FFRC

¹2013 NWOS respondent annual income categories include: 20 = Less than \$25,000; 25 = \$25,000 to \$49,999; 50 = \$50,000 to \$99,999; 100 = \$100,000 to \$199,999; and 200 = \$200,000 or more.

²2013 NWOS categories for highest level of education obtained by the respondent include: 1 = Less than 12th grade; 2 = High school/GED; 3 = Some college; 4 = Associate degree; 5 = Bachelor's degree; 6 = Advanced degree.

³The 2013 NWOS survey respondents were asked to rank their concern for various topics relating to their wooded lands on a 1-5 Likert scale where 1 = No concern; 2 = Of little concern; 3 = Moderate concern; 4 = Concern; 5 = Great concern.

⁴The 2013 NWOS survey respondents were asked to rank the helpfulness of a variety of services, improvements to policies, and markets on a 1-5 Likert scale where 1 = Of no help; 2 = Of little help; 3 = Moderately helpful; 4 = Helpful; 5 = Very Helpful.

⁵The 2013 NWOS survey respondents were asked to rank the importance of the reasons for owning their wooded lands on a 1-5 Likert scale where 1 = Not important; 2 = Of little importance; 3 = Moderately important; 4 = Important; 5 = Very important.

⁶The 2013 NWOS survey respondents were asked to rank their familiarity on a 1-5 Likert scale where 1 = Not at all familiar; 2 = Slightly familiar; 3 = Somewhat familiar; 4 = Moderately familiar; 5 = Extremely familiar.

⁷2013 NWOS categories for number of times respondent had sold or given away any of their wooded land: 0 = Never; 1 = Once (1 time); 2 = 2 to 5 times; 3 = 6 or more times.

⁸The 2013 NWOS survey respondents were asked to rank the likelihood of activity occurrence on any of their wooded land in the next five years on a 1-5 Likert scale where 1 = Extremely unlikely; 2 = Unlikely; 3 = Undecided; 4 = Likely; 5 = Extremely likely.

⁹The 2013 NWOS survey respondents were asked to rank their level of agreement on a 1-5 Likert scale where 1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree.

Thirty percent of the NWOS respondents in the data set owned multiple parcels, and the NWOS questionnaire is not parcel specific in that landowners are asked to answer each question for all the wooded land they own in the state. Kilgore et al. (2015) reported that multiple parcel owners are different than single parcel owners in many respects regarding the NWOS data set. However, landowner responses to NWOS questions are not parcel-specific, so there is no way of attributing a specific action (e.g., conducted a timber harvest) to a specific parcel owned by the respondent. Therefore, landowners owning more than one parcel in the state for which they answered the NWOS questionnaire were removed from the data set. Past studies using the NWOS data set (Kilgore et al. 2015; Butler et al. 2016) have screened the respondents to include only those landowners who owned an acreage of forest land that is representative of the typical family forest landowner. For example, Kilgore et al. (2015) excluded landowners owning less than 10 acres and more than 10,000 acres of forestland in their analysis.

Two data sets were appended to the 2013 NWOS data set: 1) georeferenced land use and socio/economic characteristics of the area surrounding the wooded parcel owned by each NWOS respondent (Table 1) compiled by the Family Forest Research Center at University of Massachusetts Amherst; and 2) state-level data from Kilgore et al. (2017) on each state’s preferential forest property tax program (PFPTP) regarding the fundamental tax program type (i.e., flat tax, modified use assessment, exemption tax, or combination of tax program types), program eligibility requirements and enrollment process, land use restrictions, land stewardship requirements, enrollment commitments and penalties, and program benefits and participation (Table 2). Land use and socio/economic characteristics provided by the Family Forest Research Center included, for example, population and distance to urban areas from the 2010 US census and percentage of surrounding land use in agriculture, forestry, or developed use from the 2011 National Land Cover Database. Regarding the specific PFPTP data from Kilgore et al. (2017), variables were created for use in this analysis using two methods: 1) data contained within tables in the published report; and 2) reasonable inference of program descriptions. A description of property tax program attributes is contained in Table 2.

Table 2. Description of variables from preferential forest property tax program characteristic variables obtained from Kilgore et al. (2017) used in the analysis.

Category/Variable	Original Variable	Description
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Eligibility Requirements and Enrollment Process

Minimum acreage	ptp_acmin_bin	Minimum acres required for enrollment
Natural resource agency application review	ptp_app_rev	Required natural resource agency review of enrollment application (1=yes, 0=no)
Land Use Restrictions		
Building on enrolled lands	ptp_ownbuilding	Residence/ buildings on property restricted (1=yes, 0=no)
Commercial operations on enrolled lands	ptp_owncommer	Restrictions of some commercial use (e.g., ag, mining, or commercial development) (1=yes, 0=no)
Stewardship Requirements		
Forest management plan (FMP)	ptp_fmp	Forest management plan required (1=yes, 0=no)
Manage for commercial timber production	ptp_owntimber	Timber growth and use for commercial timber production reasonably inferred from state property tax summary table (1=yes, 0=no)
FMP implementation	ptp_planimp	Plan implementation required (1=yes, 0=no)
Harvest plan	ptp_harvestplan	Harvest plan (provisions in wording for forest management plan requirements) (1=yes, 0=no)
Harvest notice	ptp_harvnotice	Notice of timber harvest required (1=yes, 0=no)
Professional FMP preparation	ptp_planprep	Qualified preparer or approver required (1=yes, 0=no)
Enrollment Commitment and Penalties		
Minimum commitment period	ptp_yrscommit_bin	Commit years summary (1=yes, 0=no) (blank = no limit, indefinite, or not mentioned)
Withdrawal penalty	ptp_wdrawpen	Retroactive monetary penalty for withdrawal (1=yes, 0=no)
Program Benefits		
Per acre tax benefit	ptp_benefit	Average annual tax benefit (savings) per acre (Tables 8-11 in Kilgore et al., 2017)
Percent change taxes per acre	ptp_mag	Benefit magnitude. Percent change in taxes if enrolled in program
Total program tax benefit expenditure	ptp_totbenefit	Total annual program tax benefit (savings) (Tables 8-11 in Kilgore et al., 2017)
Program Participation		
Enrollment	ptp_acperenroll	Percent of private forest acres enrolled (total acres enrolled/total private forest acres) (Tables 8-11 in Kilgore et al., 2017)
Acres enrolled	ptp_acres	Total acres enrolled (Tables 8-11 in Kilgore et al., 2017)
Participants	ptp_partic	Number of participants (Tables 8-11 in Kilgore et al., 2017)

Fundamental tax program type refers to the basis by which the forest land is taxed. The major types of fundamental tax program types identified in Kilgore et al. (2017) are: 1) flat tax (forest land is assessed a fixed amount per acre regardless of parcel-specific features); 2) modified use tax (forest land taxation is

based on alternative land uses (e.g., forestry) rather than the land's highest and best use); and 3) exemption tax (exempts certain types of land or land uses from property taxes) (Hibbard et al., 2001). Five states' PFPTPs are composed of multiple major tax program types; for the purpose of this analysis, we combined these states into a tax program category Combination tax class that may include any combination of flat, modified use, and/or exemption tax). The states of Maine, Massachusetts, Michigan, Minnesota, Ohio, Oregon, and Washington administer two separate PFPTPs. For those states, the PFFTP with the greatest enrollment, based on program participants identified in Kilgore et al. (2017), was selected to represent the PFFTP characteristics offered in that state

Preferential forest property tax programs require certain criteria to establish landowner eligibility for enrollment. As it was assumed that this analysis would be conducted using only forest landowners that are eligible for the specific PFFTP offered in their state, the most relevant PFFTP eligibility criteria was a minimum enrollment acreage requirement. Therefore, we removed from the data set landowners that did not own enough acreage of wooded land to qualify for PFFTP enrollment, as defined in Kilgore et al. (2017). After combining data sets, applying the parcel and minimum acreage criteria decreased the NWOS to 3,863 enrolled and not-enrolled respondents or about 38% of all the contiguous U.S. family forest landowners who responded to the 2013 NWOS. We consider this data set representative of U.S. family forest owners who own one forest parcel that meets the eligibility requirements of its state's PFFTP. Last, the data set was screened to include only family forest landowners enrolled in their state's PFFTP. The final data set used in this analysis contained 1,090 respondents.

Multiple characterizations of landowners who are enrolled in PFPTPs were developed and used to compare characteristics of landowners and their land and, secondly, specific PFFTP characteristics. As every state offers a PFFTP, all contiguous states are represented in this data set except Arkansas. Arkansas was excluded because none of the respondents from that state met the criteria for inclusion in the first portion of this analysis (e.g., owned a single parcel, owned a minimal eligible acreage for program enrollment, and was enrolled). The data set used for this study objective contains 1,090 respondents, all of which are enrolled in a state PFFTP. Characterizations of PFFTP enrollees were made according to the: 1) fundamental tax program type defined as either flat tax, modified use assessment, or a combination of flat tax, modified use assessment, or exemption tax; 2) PFFTP ecosystem services provided, defined as either timber emphasis programs or programs that emphasize or promote open space and a variety of non-timber ecosystem services such as protection and supply of water and recreational uses and resource preservation obtained from Appendix Tables 2-5 in Kilgore et al. (2017); and 3) level of program participation defined as low (less than or equal to the national average of 22% of private forest land enrolled in the state PFFTP), medium (greater than the national average of 22% and less than or equal to the national third quartile of 54% of private forest land enrolled), and high (greater than 54% of private forest land enrolled). Level of program participation was established using PFFTP enrollment acreage figures in Tables 8-11 in Kilgore et al. (2017) and total state private forest acreage from Resource Table 54 in Oswalt, S.N., W.B. Smith, P.D. Miles, and S.A. Pugh (2014).

Multinomial logistic regression was used to compare characteristics of enrolled landowners and their wooded parcels, obtained from the 2013 NWOS and ancillary data from the Family Forest Research Center (FFRC), with fundamental tax program type and with level of program participation; the results of which are reported in Tables 3 and 5, respectively. All statistical tests performed in this data analysis were generated using SAS 9.4 software. Copyright © 2002-2012 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

Tests for statistically significant differences were conducted using the Wald Chi-square statistic at $\alpha = 0.05$ (Dalgard, 2008). Binary logistic regression was used to compare ecosystem services provided by the PFFTP with landowner and land characteristics of enrolled landowners. The results of these analyses are reported in Table 4, with statistically significant differences ($\alpha \leq 0.05$) identified. The characteristics of enrolled landowners and their wooded parcels were organized into the eight categories according to the following characteristics of the owner; attitudes and concerns regarding their wooded land; reasons owners own their wooded land; owner participation in forestry assistance programs; past land management activities, practices, assistance, and uses; planned future activities; forest land characteristics; and land use and development activity or potential. These eight categories were derived from a review of the literature, PFFTP objectives, and available NWOS and ancillary socio-economic and parcel data and are thought to represent broad, distinguishing categories relevant to the PFFTP enrollment decision. Since only one preferential forest property tax program is referenced by the NWOS for a given state, this analysis represents landowners' choices to enroll in a program based on the specific program characteristics offered, not their preference of multiple program offerings.

Descriptive statistics associated with the comparison of PFFTP characteristics with fundamental tax program type, program ecosystem emphasis, and enrollment level using state-specific PFFTP eligibility criteria obtained from Kilgore et al. (2017) are reported in Tables 6, 7, and 8. Characteristics of PFFTPs were organized into six categories according to their eligibility requirements and enrollment process, land use restrictions, stewardship requirements, enrolment commitment and penalties, program benefits, and program participation. Such characteristics were identified based on a review of the literature, common PFFTP objectives and characteristics, and the availability of PFFTP data. These categories helped to organize a broad suite of PFFTP characteristics into relevant categories for comparison.

2.4. Results

Enrollment by Tax Program Type

Preferential forest property tax programs were categorized according to the basis by which the forest land is taxed as reported in Kilgore et al. (2017). Table 3 describes how selected characteristics of enrollees and their forest land vary by the three types of forest property tax programs. Figure 1 displays the locations of the three types of forest property tax programs by state.

When examining the enrollees and their forest land by the forest property tax program type, program enrollees (and their forest land) are not found to be statistically different with respect to their socio-economic or demographic status (Table 3). They are also very similar with respect to their attitudes and concerns regarding forest land ownership. For example, landowner concern regarding development pressure on their forest land, interest in passing their forest land on to their heirs, and likelihood of selling their forest land are not statistically different by tax program type. Similarly, the level of development surrounding these lands (as measured by population density, road density, and proportion of developed land) is not statistically different by tax program type.

Of the three types of forest property tax programs, participants and the forest land enrolled in combination forest property tax programs are the most distinct (Table 3). In general, these owners are least likely to be active managers of their forest land. For example, they are least likely to have a forest management plan, conducted a commercial timber harvest, or plan to harvest timber in the future. However, they are most likely to have taken advantage of cost share programs designed to provide money to landowners to help them establish or otherwise manage their wooded land. Additionally, they have the smallest acreage of

forest land parcels enrolled, and are least familiar with their state's PFFTP. The forest land that is enrolled in combination tax programs is most likely to be part of a farming operation and located in areas where agriculture is the dominant land use. Enrollees of flax tax programs are the most familiar with their states' PFFTP, but they are least likely to own their forest land for investment purposes, least likely to manage it for timber production, and derive the smallest percentage of their annual income from their wooded land. Their forest land is also least likely to be located close to an urban area and be part of a farm. The only uniquely-distinct and statistically significant attributes of the enrollees of modified use tax programs is their knowledge of their state's PFFTP, which is less than the flat tax participants but greater than the combination forestry tax participants, and that their forest land is second most likely to be owned by a farmer.

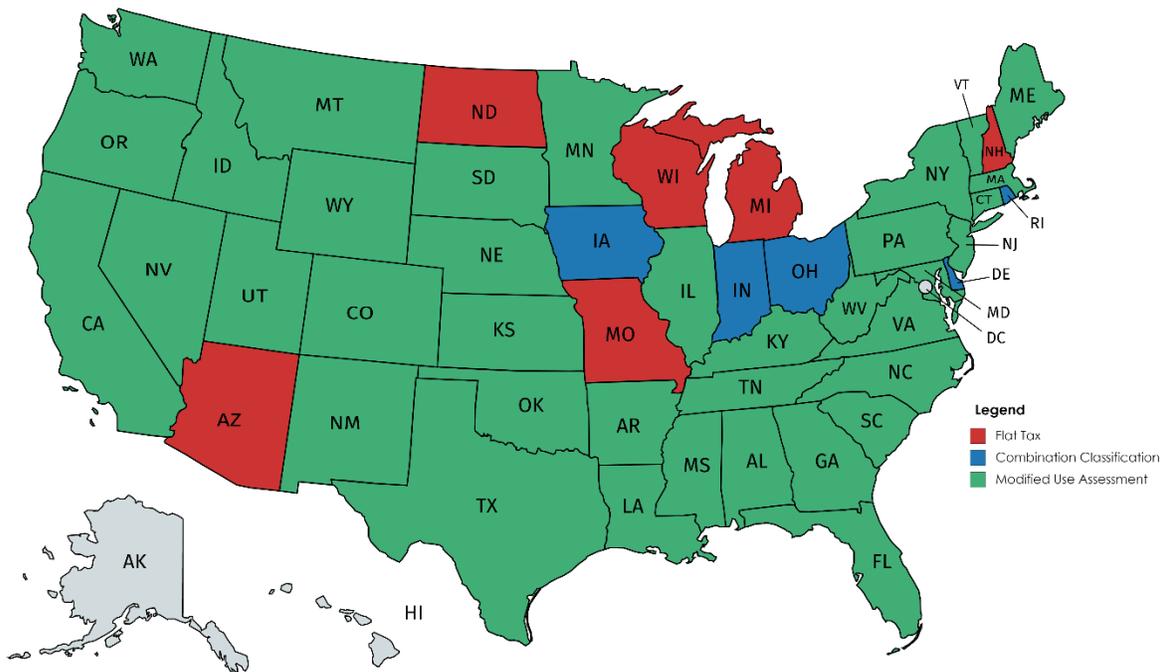


Figure 1. Preferential forest property tax program types by state according to their taxation basis.

Table 3. Characteristics of landowners and forest land enrolled in preferential forest property tax programs by tax program type.^{1 & 2} Mean values (5 point Likert Scale, nominal) are reported unless otherwise noted.

Category/Variable	Flat Tax	Modified Use	Combination Tax	N
Owner				
Social/Economic/Demographic				
Age (years) ³	63 ^a	64 ^a	64 ^a	921
Income ^{3&4}	\$74,995 ^a	\$74,995 ^a	\$74,995 ^a	823
Education ³	5 ^a	5 ^a	5 ^a	927
Income from woods	1.27 ^a	3.81 ^b	3.31 ^b	866

Owner Attitudes/Concerns				
Taxes concern	4.17 ^{ab}	4.30 ^a	3.91 ^b	1,052
Development concern	3.50 ^a	3.27 ^{ab}	3.12 ^b	1,019
Succession concern	4.31 ^a	4.21 ^a	4.21 ^a	1,055
Tax help	3.92 ^a	4.12 ^a	3.87 ^a	838
Timber markets help	3.48 ^a	3.69 ^a	3.53 ^a	868
Owner Reasons for Owning Wooded Property				
Objective aesthetics	4.50 ^b	4.33 ^a	4.39 ^{ab}	1,052
Objective investment	2.90 ^a	3.39 ^b	3.40 ^b	1,009
Objective children	3.84 ^a	4.08 ^b	4.16 ^{ab}	948
Objective timber	2.90 ^a	3.30 ^b	3.34 ^b	973
Objective recreation	3.83 ^a	3.52 ^b	3.53 ^{ab}	971
Objective hunting	3.19 ^a	3.15 ^a	3.48 ^a	976
Objective residence	4.18 ^a	4.33 ^a	4.07 ^a	696
Owner Participation in Forestry Assistance Programs				
Cost share familiarity	2.19 ^{ab}	2.15 ^a	2.53 ^b	1,086
PFPTP familiarity	4.32 ^a	4.16 ^b	3.94 ^c	1,088
Cost share	0.22 ^a	0.25 ^a	0.36 ^b	1,030
Advice	0.54 ^a	0.60 ^a	0.66 ^a	1,079
Past Land Management Activities, Practices, Assistance, and Land Uses				
Transfer ³	0.00 ^a	0.00 ^a	0.00 ^a	1,039
Purchased ⁵	0.81 ^a	0.72 ^b	0.76 ^{ab}	1,066
Inherited ⁵	0.22 ^a	0.35 ^b	0.33 ^{ab}	1,066
Management plan	0.63 ^a	0.60 ^a	0.45 ^b	1,058
Harvest 5 years	0.40 ^a	0.37 ^a	0.25 ^b	1,063
Invasive 5 years	0.26 ^a	0.30 ^a	0.45 ^b	1,063
Harvest	0.66 ^a	0.61 ^a	0.56 ^a	909
Planned Future Activities and Uses				
Future harvest	2.92 ^a	3.00 ^a	2.45 ^b	1,030
Future transfer	2.06 ^a	2.03 ^a	1.84 ^a	1,081
Sell	2.28 ^a	2.46 ^a	2.24 ^a	1,056
Wooded	4.58 ^a	4.55 ^a	4.83 ^b	1,076
Forest Land Characteristics				
Tenure ³	22 ^a	24 ^a	21 ^a	1,023
Residence	0.55 ^a	0.60 ^a	0.60 ^a	1,086
Farm	0.17 ^a	0.34 ^b	0.49 ^c	1,080
Acres woods ³	100 ^a	102 ^a	80 ^b	1,090
Proximate Land Use and Development Activity/Potential				
Population ³	35.50 ^a	39.55 ^a	37.10 ^a	1,090
Urban distance ³	10,997 ^a	8,661 ^b	9,708 ^b	1,090
Forest ³	0.82 ^a	0.80 ^a	0.50 ^b	1,090

Agriculture ³	0.07 ^a	0.07 ^a	0.33 ^b	1,090
Development ³	0.04 ^a	0.04 ^a	0.04 ^a	1,090
Road density ³	161 ^a	185 ^a	153 ^a	1,060

¹Tax Type levels with the same letter are not significantly different at $\alpha \leq 0.05$.

² See Tables 1 and 2 for a description of categories/variables.

³Median value.

⁴Midpoint of 2013 NWOS respondent annual income category is reported.

⁵Variable is not mutually exclusive.

2.4.2 Enrollment by Tax Program Emphasis

Preferential forest property tax programs were divided into two categories based on their stated emphasis or importance of ecosystem services commonly promoted by PFPTPs (Kilgore et al., 2017): 1) timber; and 2) open space/other ecosystem services (Figure 2). Timber programs were designated based on their being a program that emphasizes the production of timber and fiber products as an ecosystem service, although they may also promote other non-timber ecosystem services (Kilgore et al., 2017). Open space/other ecosystem services programs were designated if they emphasize or promote other ecosystem services, such as conservation of soils and wetlands or recreational uses and resource preservation (Kilgore et al., 2017). Such programs may also promote timber production along with these other ecosystem services.

These two areas of emphasis are often the stated goals of taxing authorities and/or private forest landowners. As such, they provide one method for examining the way in which landowner/land characteristics match up with tax program emphasis. When analyzing the enrollees and their forest land by PFFTP emphasis, enrollees of both emphasis types are largely very similar (Table 4). No statistically significant differences between the two program emphases were observed based on owner socio-economic characteristics, owner attitudes, or planned future activities. For instance, landowner desire for stronger timber markets for enrollees in programs that emphasized timber was not different from those enrolled in a tax program that emphasizes the protection of open space and production of non-timber ecosystem services.

Statistically significant differences among landowners and their forest land according to tax program emphasis are associated with past land management activities, owner participation in forestry assistance programs, forest land characteristics, and land use and development activity in the immediate area. Notably, landowners enrolled in PFPTPs with a timber emphasis are less likely to have a forest management plan (FMP), which is unexpected since FMPs are commonly associated with commercial timber management (Kilgore et al., 2015). Landowners enrolled in timber-emphasized tax programs are, however, more familiar with cost-share programs than those enrolled in programs whose primary objective is preserving open space and/or promoting non-timber goods and services. Forest land enrolled in timber-focused tax programs are more likely to be located in areas with higher intensity of agricultural use. That is, land enrolled in timber-emphasized property tax programs, on average, is located in areas with a higher density of agricultural land use and a lower density of forested land use relative to land enrolled in PFPTPs that emphasize open space and other ecosystem services.

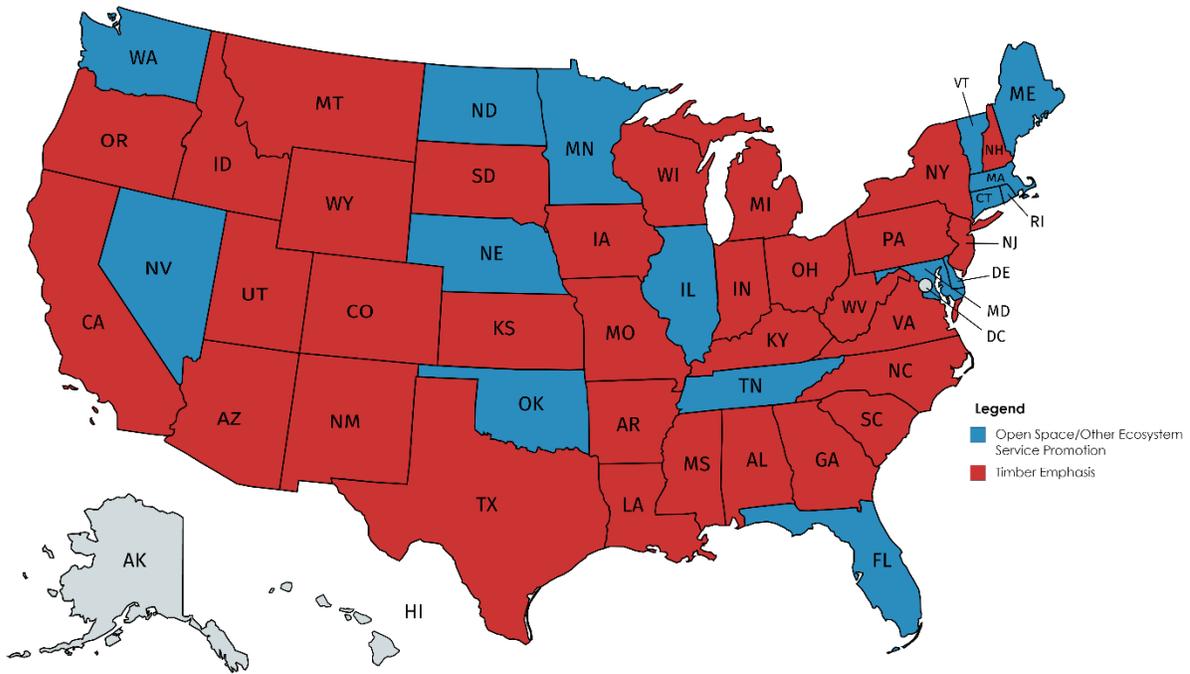


Figure 2. Preferential forest property tax programs by state emphasizing timber and open space/other ecosystem services in the United States.

Table 4. Characteristics of landowners and forest land enrolled in preferential forest property tax programs by tax program ecosystem emphasis.¹ Mean values (5 point Likert Scale, nominal) are reported unless otherwise noted.

Category/Variable	Timber ²	Open space ³	N
Owner			
Social/Economic/Demographic			
Age ⁴	64	64	921
Income ^{4&5}	\$74,995	\$74,995	823
Education ⁴	5	5	927
Income from woods	3.36	3.42	866
Owner Attitudes/Concerns			
Taxes concern	4.26	4.24	1052
Development concern	3.31	3.28	1019
Succession concern	4.28	4.17	1055
Tax help	4.08	4.07	838
Timber markets help	3.73	3.57	868
Owner Reasons for Owning Wooded Property			
Objective aesthetics	4.33	4.39	1052
Objective investment	3.39	3.27	1009

Objective children	4.11	4.00	948
Objective timber	3.31	3.19	973
Objective recreation	3.61	3.51	971
Objective hunting	3.40*	2.95*	976
Objective residence	4.17*	4.41*	696
Owner Participation in Forestry Assistance Programs			
Cost share familiarity	2.27*	2.10*	1086
PFPTP familiarity	4.17	4.15	1088
Cost share	0.27	0.24	1030
Advice	0.57	0.62	1079
Past Land Management Activities, Practices, Assistance, and Land Uses			
Transfer ⁴	0.00	0.00	1039
Purchased ⁶	0.72	0.75	1066
Inherited ⁶	0.34	0.31	1066
Management plan	0.49*	0.69*	1058
Harvest 5 years	0.39	0.34	1063
Invasive 5 years	0.32	0.29	1063
Harvest	0.61	0.62	909
Planned Future Activities and Uses			
Future harvest	2.90	3.01	1030
Future transfer	2.03	2.01	1081
Sell	2.40	2.44	1056
Wooded	4.59	4.56	1076
Forest Land Characteristics			
Tenure ⁴	22	24	1023
Residence	0.53*	0.65*	1086
Farm	0.34	0.32	1080
Acres woods ⁴	100	100	1090
Proximate Land Use and Development Activity/Potential			
Population ⁴	36.15	41.20	1090
Urban distance ⁴	9610	8234	1090
Forest ⁴	0.76*	0.82*	1090
Agriculture ⁴	0.10*	0.07*	1090
Development ⁴	0.04	0.04	1090
Road density ⁴	167	190	1060

¹See Tables 1 and 2 for a description of categories/variables.

²PFPTP emphasizes timber production and may emphasize or promote other ecosystem services.

³PFPTP emphasizes Open space and/or other ecosystem services but does not emphasize timber production. PFPTP may promote timber production and other ecosystem services.

⁴Median value.

⁵Midpoint of 2013 NWOS respondent annual income category is reported.

⁶Variable is not mutually exclusive.

*Ecosystem emphases are significantly different at $\alpha = 0.05$.

2.4.3. Participation in PFPTPs

PFPTPs were categorized according to their level of enrollment, as determined in this analysis by the percentage of the respective state's private forest land acreage enrolled in its PFFTP using data from Kilgore et al., (2017) and Oswald et al., (2014). The three enrollment categories are low (less than or equal to 22%), medium (greater than 22% and less than or equal to 54%), and high (greater than 54%). Table 5 indicates how selected characteristics of enrollees and their forestland vary by level of enrollment. Figure 3 indicates the enrollment-level designation for each state's program. Landowners in these three categories are practically indistinguishable from each other based on their attitudes and concerns and landownership objectives, with few statistically significant differences found among the three categories. For instance, landowners enrolled in programs with high enrollment are no more concerned about property taxes than are those enrolled in programs with low enrollment. Similarly, landowners enrolled in programs with low or medium enrollment rank owning their land as part of their home site/primary residence no differently than those enrolled in programs with high enrollment.

Considering the three enrollment categories, PFPTPs with low enrollment and those with high enrollment are the most dissimilar, and PFPTPs with medium enrollment are most similar to PFPTPs with low enrollment. The major statistically significant distinction between PFPTPs with low and high enrollment is associated with the educational background of their landowners, their history of land management activity, and the characteristics of their forest land and the surrounding land use. Landowners in tax programs with high enrollment are most likely to be college educated, received advice about the management of their wooded land, commercially harvested timber, plan to commercially harvest timber in the next five years, and are most familiar with their state's PFFTP. Landowners in programs with high enrollment are least likely to own a farming operation, and most likely to own land located in areas where the land use is dominated by forestry. They are also least likely to be located in areas with a high level of development. Landowners in tax programs with low enrollment are least likely to have received advice about the management of their wood land. Additionally, their land is most likely to be located close to urban centers, in areas with high road density and where agriculture is the dominant land use. Landowners in medium enrollment programs were unique in only three cases: surrounding agriculture land use, surrounding forest land use, and receipt of land management advice. In all three cases, these unique characteristics were determined to be at a level that was between that of landowners in high and low enrollment tax programs (i.e., landowners in programs with medium enrollment had received management advice less often than those in programs with high enrollment but more often than landowners in programs with low enrollment).

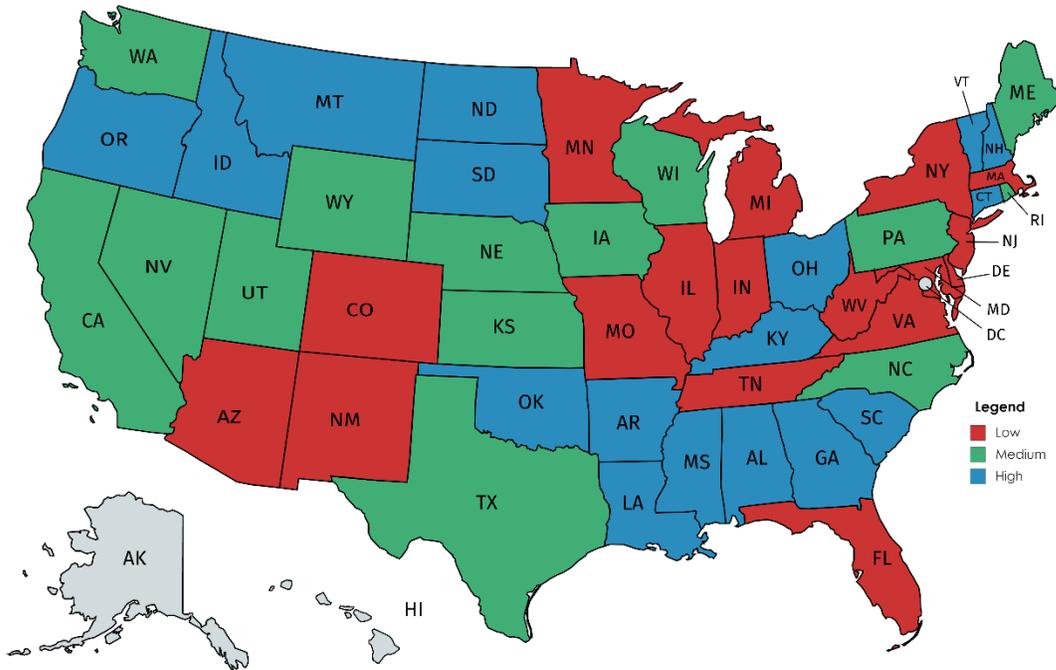


Figure 3. Preferential forest property tax programs by state designated as having high, medium, or low enrollment, based on the percent of private forest land acres enrolled.

Table 5. Characteristics of landowners and forest land enrolled in preferential forest property tax programs by intensity of state-level participation (enrollment)¹ Mean values (5 point Likert Scale, nominal) are reported unless otherwise noted.

Category/Variable	Low Enrollment ²	Medium Enrollment ³	High Enrollment ⁴	N
Owner Social/Economic/Demographic				
Age ⁶	64 ^a	63 ^a	64 ^a	921
Income ^{6&7}	\$74,995 ^{ab}	\$74,995 ^a	\$74,995 ^b	823
Education ⁶	4 ^a	5 ^a	5 ^b	927
Income from woods	3.21 ^a	3.30 ^a	3.73 ^a	866
Owner Attitudes/Concerns				
Taxes concern	4.27 ^a	4.25 ^a	4.25 ^a	1052
Development concern	4.26 ^a	3.25 ^a	3.35 ^a	1019
Succession concern	4.21 ^a	4.23 ^a	4.23 ^a	1055
Tax help	4.11 ^a	3.98 ^a	4.14 ^a	838
Timber markets help	3.65 ^a	3.53 ^a	3.75 ^a	868
Owner Reasons for Owning Wooded Property				
Objective aesthetics	4.40 ^a	4.34 ^a	4.34 ^a	1052
Objective investment	3.41 ^a	3.36 ^a	3.23 ^a	1009

Objective children	4.08 ^a	4.04 ^a	4.05 ^a	948
Objective timber	3.24 ^{ab}	3.07 ^a	3.41 ^b	973
Objective recreation	3.59 ^a	3.53 ^a	3.55 ^a	971
Objective hunting	3.41 ^a	3.21 ^a	2.94 ^b	976
Objective residence	4.35 ^a	4.16 ^a	4.35 ^a	696
Owner Participation in Forestry Assistance Programs				
Cost share familiarity	2.20 ^a	2.16 ^a	2.18 ^a	1086
PFPTP familiarity	4.12 ^a	4.11 ^a	4.24 ^b	1088
Cost share	0.26 ^a	0.26 ^a	0.25 ^a	1030
Advice	0.59 ^a	0.50 ^b	0.68 ^c	1079
Past Land Management Activities, Practices, Assistance, and Land Uses				
Transfer ⁶	0.00 ^a	0.00 ^a	0.00 ^a	1039
Purchased ⁸	0.74 ^a	0.73 ^a	0.72 ^a	1066
Inherited ⁸	0.34 ^a	0.32 ^a	0.33 ^a	1066
Management plan	0.59 ^{ab}	0.53 ^a	0.64 ^b	1058
Harvest 5 years	0.32 ^a	0.32 ^a	0.45 ^b	1063
Invasive 5 years	0.33 ^a	0.30 ^a	0.28 ^a	1063
Harvest	0.56 ^a	0.58 ^a	0.69 ^b	909
Planned Future Activities and Uses				
Future harvest	2.84 ^a	2.64 ^a	3.33 ^b	1030
Future transfer	2.04 ^a	2.10 ^a	1.93 ^a	1081
Sell	2.50 ^a	2.37 ^a	2.39 ^a	1056
Wooded	4.57 ^a	4.57 ^a	4.59 ^a	1076
Forest Land Characteristics				
Tenure ⁶	23 ^a	22 ^a	26 ^a	1023
Residence	0.61 ^a	0.56 ^a	0.60 ^a	1086
Farm	0.40 ^a	0.36 ^a	0.24 ^b	1080
Acres woods ⁶	90 ^a	90 ^a	126 ^a	1090
Proximate Land Use and Development Activity/Potential				
Population ⁶	50.45 ^a	32.00 ^a	35.5 ^b	1090
Urban distance ⁶	7,293 ^a	9,818 ^b	9,819 ^b	1090
Forest ⁶	0.72 ^a	0.76 ^b	0.86 ^c	1090
Agriculture ⁶	0.15 ^a	0.07 ^b	0.06 ^c	1090
Development ⁶	0.05 ^a	0.04 ^a	0.03 ^b	1090
Road density ⁶	192 ^a	178 ^{ab}	169 ^b	1060

¹Levels of program participation with the same letter are not significantly different at $\alpha = 0.05$.

²See Tables 1 and 2 for a description of categories/variables.

³Less than or equal to 22% of all state private forest land enrolled in the PFPTP.

⁴Greater than 22% and less than or equal to 54% of state private forest land enrolled in the PFPTP.

⁵Greater than 54% of state private forest land enrolled in the state PFPTP.

⁶Median value.

⁷Midpoint of 2013 NWOS respondent annual income category is reported.

⁸Variable is not mutually exclusive.

2.4.4. Tax Program Characteristics and Benefits by Tax Program Type

The characteristics (e.g., enrollment requirements) and benefits (e.g., annual tax reduction) of PFPTPs were contrasted with tax program type (Table 6). This portion of the analysis is not supported by statistical tests. Alaska is an exemption tax state, and, thus, is not included in this portion of the analysis. Noticeable differences were observed in every category of PFFTP characteristics from eligibility requirements and enrollment process to program participation. PFPTPs of the modified use assessment tax category stand out from the rest regarding their unique combination of limited requirements in the categories of eligibility and enrollment, land use restrictions, stewardship, and enrollment commitments and penalties, a small magnitude of tax savings, and relatively high enrollment. In contrast, both flat tax and combination tax type PFPTPs administer programs containing more stringent eligibility requirements and enrollment processes, land use restrictions, stewardship requirements, and enrollment commitments and penalties, offer a large magnitude of tax savings, but garner relatively low program enrollment. Thus, these programs are categorized as strict, in those respects.

The PFPTPs that comprise the flat tax type programs are characterized by relatively strict program enrollment processes and stewardship requirements, and thus, were categorized as strict programs. Thematically, requirements focus on the timber production process. For instance, 83% of programs require a forest management plan prepared by a professional, 67% of programs require that the FMP is implemented (defined implementation timelines were not available), and 83% of programs contain wording indicative of managing forests for commercial timber production. These programs compensate enrolled landowners by providing a median 93% per acre reduction in taxes, but garner a median enrollment of just 23% of the total state private forest acreage.

The PFPTPs that comprise the modified use assessment tax type programs are characterized by minimal requirements, restrictions, and penalties, offering a low magnitude of tax savings, and garnering relatively high enrollment. Thus, these programs are categorized as lenient. Thirty-two percent require agency (e.g., a state natural resource agency) review of the enrollment application, and 26% restrict commercial operations other than forestry (e.g., mining, agriculture, etc.) on enrolled lands. Thirty-seven percent of these programs require an FMP, and 32% require its implementation. The compensatory magnitude of tax savings offered is 55%, and median enrollment includes 42% of the state private forest acreage and a median 37,938 participants enrolled per state.

The PFPTPs that make up the combination tax type programs are characterized by relatively strict program requirements, restrictions, and penalties. Thus, similar to flat tax programs, these programs are categorized as strict PFFTP. Their requirements, restrictions, and penalties are centered on maintaining the integrity of the enrolled wooded land, as all of these programs require a minimum acreage for enrollment, 60% restrict building on enrolled lands, 80% restrict various other commercial operations other than forest management on enrolled lands, and all institute a retroactive monetary penalty for early withdrawal. The median compensation offered for enrollment results in a 82% annual tax savings per acre, but enrollment in these programs is relatively low (median of 27% of private forest acres owned and 13,000 enrolled landowners per state). Notwithstanding a low level of statewide program participation, these PFPTPs expend a large amount in tax reduction to its participants. Median expenditure per program is \$11.1 million annually, providing an 82% reduction in taxes in these states with an associated property tax benefit that averages \$17.61/acre.

Table 6. Preferential forest property tax program characteristics and benefits by tax program type. Mean values are reported unless otherwise noted.^{1, 2, 3, &4}

Category/Variable	Flat Tax (N=6)⁵	Modified Use Tax (N=38)⁶	Combination Tax (N=5)⁷
Eligibility Requirements and Enrollment Process			
Minimum acreage	0.83	0.71	1.00
Natural resource agency application review	0.67	0.32	0.80
Land Use Restrictions			
Building on enrolled lands	0.33	0.37	0.60
Commercial operations on enrolled lands	0.67	0.26	0.80
Stewardship Requirements			
Forest management plan (FMP) required ⁸	0.83	0.37	0.80
Manage for commercial timber production	0.83	0.87	0.60
FMP implementation	0.67	0.32	0.60
Harvest plan	0.50	0.26	0.40
Harvest notice	0.67	0.16	0.60
Professional FMP preparation ⁸	0.83	0.40	0.60
Enrollment Commitment and Penalties			
Minimum commitment period	0.50	0.13	0.20
Withdrawal penalty	0.67	0.66	1.00
Program Benefits			
Per acre tax benefit ⁹	\$6.55	\$4.44	\$17.61
Percent change taxes per acre ⁹	93%	55%	82%
Total program tax benefit expenditure ⁹	\$3,831,250	\$9,307,000	\$11,125,980
Program Participation			
Enrollment ⁹	23%	42%	27%
Acres enrolled ⁹	1,527,500	2,150,550	599,700
Participants ⁹	17,760	37,938	13,000

¹Tests for statistical differences were not performed.

²Alaska is not included in this table because it is an exemption tax state.

³See Table 2 for a description of categories/variables.

⁴The average of binary variables is reported and, thus, represents a proportion of PFFTP. When multiplied by 100, this proportion represents the percent of PFFTP with the variable. For instance a value of 0.83 indicates that 83% of programs have the variable.

⁵Less than or equal to 22% of all state private forest land enrolled in the PFFTP.

⁶Greater than 22% and less than or equal to 54% of state private forest land enrolled in the PFFTP.

⁷Greater than 54% of state private forest land enrolled in the state PFFTP.

⁸States may require alternative FMP criteria such as Vermont (Conservation plan may suffice in place of FMP), North Carolina (FMP is optional at the discretion of the tax assessor), and New Hampshire (FMP not required for *Standard Assessment Provisions*).

⁹Median value.

2.4.5. Tax Program Characteristics and Benefits by Program Ecosystem Service Emphasis and Promotion

The characteristics and benefits of PFPTPs (requirements, tax benefits to enrollees) were contrasted with two types of program ecosystem services: emphasis of timber production or emphasis/promotion of open space/other ecosystem services (Table 7). This portion of the analysis is not supported by statistical tests, and all state PFPTPs are included in this portion of the analysis. These two types of programs are similar regarding their land use restrictions, enrollment commitments and penalties, and program benefits.

Inclusion of land management and enrollment commitments regarding restrictions of commercial operations other than forestry on enrolled lands and retroactive monetary penalties for early withdrawal, as well as the magnitude of tax savings, are similarly represented in both programs types. Differences between these two groups pertain to their eligibility requirements and enrollment process, stewardship requirements, and level of participation within the state.

Of the PFFTP categorized as timber-emphasized programs, common criteria associated with the enrollment process include a minimum acreage (71% of the programs). A less common enrollment criteria is a state agency review of the enrollment application (32%). Ninety-one percent of timber emphasis programs contain wording indicative of managing forests for commercial timber production, and 41% require an FMP prepared by a professional (44%). Sixty-eight percent contain a retroactive monetary penalty for early withdrawal. The magnitude of the tax break for the enrollees of these programs is 66%, and these programs are popular, with 45% of private forest land acreage enrolled with a median 48,365 participants and 2.45 million enrolled acres per program per state.

Of the programs designated as emphasizing or promoting open space/other ecosystem services, 81% include a minimum acreage requirement, and inclusion of wording indicative of managing enrolled forests for commercial timber production is represented by 63% of programs. A forest management plan, a characteristic pragmatically associated with timber production (Kilgore et al., 2015) but not necessarily other ecosystem services, is required by 56% of these PFPTPs, and 50% require its preparation by a professional. The magnitude of the tax break for these programs is 55% and enrollment is relatively low, at a median 27% of state private forest acres, equating to 15,650 participants and 503,500 enrolled acres per program.

Table 7. Preferential forest property tax program characteristics and benefits by program ecosystem service emphasis and promotion. Mean values are reported unless otherwise noted.^{1, 2, 3, & 4}

Category/Variable	Timber (N=34)⁵	Open space/other (N=16)⁶
Eligibility Requirements and Enrollment Process		
Minimum acreage	0.71	0.81
Natural resource agency application review	0.32	0.56
Land Use Restrictions		
Building on enrolled lands	0.35	0.44
Commercial operations on enrolled lands	0.35	0.38
Stewardship Requirements		
Forest management plan (FMP) required ⁷	0.41	0.56
Manage for commercial timber production	0.91	0.63
FMP implementation	0.35	0.44

Harvest plan	0.29	0.31
Harvest notice	0.27	0.25
Professional FMP preparation ⁷	0.44	0.50
Enrollment Commitment and Penalties		
Minimum commitment period	0.18	0.19
Withdrawal penalty	0.68	0.69
Program Benefits		
Per acre tax benefit ⁸	\$5.32	\$4.49
Percent change taxes per acre ⁸	66%	55%
Total program tax benefit expenditure ⁸	\$12,123,048	\$2,666,620
Program Participation		
Enrollment ⁸	45%	27%
Acres enrolled ⁸	2,453,683	503,500
Participants ⁸	48,365	15,650

¹ Tests for statistical differences were not performed.

² All 50 state PFPTPs are included in this table.

³ See Table 2 for a description of categories/variables.

⁴ The average of binary variables is reported and, thus, represents a proportion of PFFTP. When multiplied by 100, this proportion represents the percent of PFFTP with the variable. For instance a value of 0.71 indicates that 71% of programs have the variable.

⁵ PFFTP emphasizes timber production and may emphasize or promote other ecosystem services.

⁶ PFFTP emphasizes Open space and/or other ecosystem services but does not emphasize timber production. PFFTP may promote timber production and other ecosystem services.

⁷ States may require alternative FMP criteria such as Vermont (Conservation plan may suffice in place of FMP), North Carolina (FMP is optional at the discretion of the tax assessor), and New Hampshire (FMP not required for *Standard Assessment Provisions*).

⁸ Median value.

2.4.6. Tax Program Characteristics and Benefits by Intensity of State-Level Participation (Enrollment)

The characteristics and benefits of PFPTPs (requirements, tax benefits to enrollees) were contrasted with three program enrollment levels: high, medium, and low (Table 8). This portion of the analysis is not supported by statistical tests, and all state PFPTPs are included in this portion of the analysis. Programs across all three enrollment levels place similar emphasis on managing forests for commercial timber production. They also provide extremely similar per acre tax savings (average of 63%, 65%, and 67% for programs in the low, medium, and high enrollment categories, respectively). Differences between PFPTPs in each of the enrollment categories exist with respect to eligibility requirements and enrollment process and stewardship requirements. Low enrollment programs are characterized as having strict eligibility requirements and stewardship requirements, whereas high enrollment programs in general have lenient eligibility requirements and stewardship requirements.

Of the PFPTPs experiencing low enrollment, 65% require natural resource agency review of the enrollment application, and 88% require a minimum acreage for enrollment. Seventy-one percent require an FMP developed by a professional, and its implementation is required in 65% of programs. A retroactive monetary penalty for early withdrawal is included in 77%. The PFPTPs designated as programs with high enrollment typically contain minimal enrollment process criteria; 65% require a

minimum enrollment acreage, while 18% require natural resource agency review of the enrollment application. Land use restrictions, stewardship requirements, and enrollment commitments and penalties are, similarly, minimal for the high enrollment programs. Commercial operations other than forestry are restricted on enrolled lands in 18% of the high enrollment programs, 29% require an FMP prepared by a professional, 18% require implementation of an FMP, and 47% impose a penalty for early withdrawal.

Table 8. Preferential forest property tax program characteristics and benefits by enrollment level. Mean values are reported unless otherwise noted.^{1, 2, 3, & 4}

Category/Variable	Low Enrollment (N=17)⁵	Medium Enrollment (N=16)⁶	High Enrollment (N=17)⁷
Eligibility Requirements and Enrollment Process			
Minimum acreage	0.88	0.69	0.65
Natural resource agency application review	0.65	0.38	0.18
Land Use Restrictions			
Building on enrolled lands	0.47	0.38	0.29
Commercial operations on enrolled lands	0.53	0.38	0.18
Stewardship Requirements			
Forest management plan (FMP) required ⁸	0.71	0.38	0.29
Manage for commercial timber production	0.77	0.88	0.82
FMP implementation	0.65	0.31	0.18
Harvest plan	0.41	0.38	0.12
Harvest notice	0.29	0.25	0.24
Professional FMP preparation ⁸	0.71	0.38	0.29
Enrollment Commitment and Penalties			
Minimum commitment period	0.24	0.19	0.12
Withdrawal penalty	0.77	0.81	0.47
Program Benefits			
Per acre tax benefit ⁹	\$6.61	\$5.61	\$3.47
Percent change taxes per acre ⁹	63%	66%	65%
Total program tax benefit expenditure ⁹	\$3,831,250	\$6,844,492	\$15,580,447
Program Participation			
Enrollment ⁹	13%	40%	75%
Acres enrolled ⁹	700,000	961,750	7,615,000
Participants ⁹	9,310	50,420	125,000

¹ Tests for statistical differences were not performed.

²All 50 state PFPTPs are included in this table.

³See Table 2 for a description of categories/variables.

⁴The average of binary variables is reported and, thus, represents a proportion of PFFTP. When multiplied by 100, this proportion represents the percent of PFFTP with the variable. For instance a value of 0.88 indicates that 88% of programs have the variable.

⁵Less than or equal to 22% of all state private forest land enrolled in the PFFTP.

⁶Greater than 22% and less than or equal to 54% of state private forest land enrolled in the PFFTP.

⁷Greater than 54% of state private forest land enrolled in the state PFFTP.

⁸States may require alternative FMP criteria such as Vermont (Conservation plan may suffice in place of FMP), North Carolina (FMP is optional at the discretion of the tax assessor), and New Hampshire (FMP not required for *Standard Assessment Provisions*).

⁹Median value

2.5. Discussion

Enrollment by Tax Program Type

Analysis of the participants of PFFTPs according to the fundamental basis of taxation lead to the following observations: 1) the majority of tax program types are modified use (current use) type programs, but all program types administer a tax break that is directly related to the ad valorem tax rate (this may indicate why no taxation type appears to be more prevalent in states that are experiencing greater development (urban) pressure); 2) participants of combination type programs are commonly located in agrarian regions; 3) lack of interest in timber management for flat tax program participants is at odds with the timber focus of flat tax programs; 4) participants of modified use (current use) programs have woodland management objectives that are well aligned with modified use programs.

The lack of a connection between landowner concern for development of nearby lands, actual development of nearby lands, and the fundamental type of taxation method imposed suggests that no single taxation method is associated with use in states experiencing greater development pressure, based on the characteristics of the land use surrounding the owners woodland. This may be true since, regardless of the fundamental basis for taxation utilized, a larger tax benefit is awarded to wooded parcels with higher ad valorem tax rates. Flat, modified use (current use), and combination tax programs reduce the per acre tax liability of enrolled lands relative to unenrolled lands by taxing the enrolled lands at a lower rate. Flat tax programs institute a single tax that applies to all enrolled parcels across the state. Modified use programs often use more complicated formulas to assess wooded land at some lower percentage of its highest and best use value. The tax benefit (savings per acre) of both types of programs is, thus, directly associated with the alternative, ad-valorem tax rate and/or land value (e.g., as land values and ad valorem tax rates rise, these fundamental taxation methods provide a larger tax break).

Participants of Combination Tax Programs

An important characteristic of combination tax type programs and their participants is agricultural development. Landowners enrolled in PFFTPs that utilize a combination of fundamental taxation methods can be characterized as less active timber managers (timber sale history), less familiar with their PFFTP, and more likely to have their lands located in agrarian areas. The specific PFFTPs they are enrolled in are, on average, 'strict' programs that focus on maintaining the integrity of the wooded land. These programs offer a high per acre tax benefit but garner little enrollment success across all private forest ownerships. Considering the prevalence of land in agricultural use, high PFFTP tax benefits may be tied to high opportunity costs of land use in these regions.

Participants of Flat Tax Programs

Woodland management objectives of the flat tax program participants seem to be at odds with the flat tax program requirements and restrictions associated with participation. Landowners enrolled in PFPTPs that administer a flat tax on enrolled woodlands are the least likely to have investment or timber management objectives, but the most familiar with their state PFFTP. Ironically, flat tax programs demonstrate an observable focus on commercial timber production. Thus, the PFPTPs may have to offer a large tax break to incentivize landowner participation because, often, landowners must harvest timber once enrolled.

The combination of PFFTP focus on timber production and a high tax benefit of participation may have generated more program familiarity by the participants. For instance, having to keep up with programmatic requirements and the prevalence of interactions with resource professionals during harvesting operations may result in greater program awareness.

Participants of Modified Use Tax Programs

Woodland management objectives of the modified use program participants may also be playing a large role in determining their interest in their PFFTP. These landowners are characterized as active timber managers (based on history of timber harvesting), even though timber production is not a central focus of their PFFTP. These PFPTPs are relatively lenient regarding stated PFFTP requirements of forest stewardship and withdrawal penalties. Considering the interaction of these characteristics, these PFPTPs have been able to garner relatively high enrollment in return for relatively little financial incentive for the landowner.

Enrollment by Tax Program Emphasis

The results of this analysis indicate that woodland owners of both timber emphasis and other ecosystem service emphasis PFFTP differ only slightly in their woodland management approach, attitudes and concerns, and objectives. Lack of difference between these groups suggests that PFFTP ecosystem emphasis has little influence on altering the woodland management approach for enrolled woodland owners or that these owners are just quite similar, based on characteristics we were able to assess. For example, land management history and woodland owner objectives and concerns vary little between these two groups of woodland owners.

At least one caveat to this argument exists. Woodland owners of PFPTPs that do not emphasize timber production are statistically significantly more likely to have an FMP than woodland owners enrolled in PFFTP that emphasize timber production. This may be because PFPTPs that do not emphasize timber production as an ecosystem service tend to require FMPs and stewardship requirements, relative to timber emphasis programs (no statistical significance was determined for this claim). Thus, FMPs and PFFTP stewardship requirements could be influencing the harvesting decisions, management objectives, and woodland concerns of enrolled owners in this group.

Enrollment by Intensity of State-Level Participation (Enrollment)

This analysis reveals that family forest owners of high enrollment PFFTP may be woodland owners who are well suited for PFFTP enrollment, relative to woodland owners of low enrollment PFFTP. Additionally, echoing the results of segmenting this population of family forest owners by PFFTP ecosystem emphasis, PFPTPs in and of themselves may demonstrate little power to affect the woodland management approach of enrolled family forest landowners. For instance, PFFTP enrollment success is positively correlated with regions that are dominated by forest with little urban and agricultural

development and with family forest owners who are active timber managers and least likely to be farmers. The reverse is true for PFFTP with poor enrollment success. These correlations were found to be statistically significant. Regionally, the areas of high enrollment success are prevalent in the southeastern and northwestern U.S. Thus family forest owners of high enrollment PFFTP appear to be woodland owners who are well suited for PFFTP enrollment in that they are active forest managers and are faced with potentially lower opportunity costs of woodland preservation based on the characteristics of the land use surrounding enrolled parcels.

However, based on data from Kilgore et al. (2017), many PFFTP emphasize and promote timber production. Thus, timber management activity might be hypothesized to be a function of PFFTP timber production/stewardship requirements, restrictions, and emphasis. As we also suggested in section 2.5.2, this may not be true, as PFFTP with the highest enrollment success were also observed as having relatively lenient stewardship requirements and enrollment commitments/penalties when compared to low enrollment PFFTP, although no statistical tests for comparison were performed. Therefore, family forest owners enrolled in these programs are engaging in active timber management, even though their PFFTPs rarely require it.

Taken together, this analysis suggests that the woodland management approach taken by family forest owners who participate in PFFTPs may be indicative of cultural and economic characteristics of woodland and surrounding land uses, as opposed to what their PFFTPs specifically require. As an example, if a hypothetical woodland owner from Minnesota moved to Georgia, bought a woodland and enrolled in Georgia's Conservation Use Valuation Program (CUVA), they would not necessarily manage their woodlands as the predominating Georgian woodland management culture dictates and vice versa. The policy implication of this insight is that the power a tax program has to influence family forest owners' management may be restricted by the cultural and economic norms in the area. Thus, PFFTP must be designed, and seemingly have been designed, with this in mind.

2.6. Conclusions

This research used a statistically rigorous approach to characterizing family forest owners who participate in PFFTPs across the U.S. To be eligible for this analysis, landowners who responded to the NWOS during the period of 2011-2013 had to be currently enrolled in a PFFTP, own just a single parcel of wooded land, and meet the minimum/maximum wooded acreage requirements for PFFTP enrollment. Thus, the selection criterion limits direct application of our results to just this narrow segment of U.S. family forest owners.

In order to characterize this population of family forest owners who were participating in PFFTPs at the time of survey response, a segmentation approach based on PFFTP characteristics was taken. Three completely separate segmentation analyses were subsequently performed. These included first segmenting our sample population by the fundamental type of taxation method employed by the PFFTP being either a flat tax, modified use tax (current use), or a combination of taxation methods. The second analysis segmented owners according to their PFFTP's ecosystem emphasis, identified as either: 1) emphasis on timber production or 2) emphasis on open space/other ecosystem service (e.g., clean air and water) and did not emphasize timber production. The final analysis segmented landowners according to the enrollment success of their PFFTP, defined as the percentage of all state private forest land enrolled in the PFFTP (i.e., not just family forest ownerships). As similar analyses had never been completed, these segmentations were based on insights from our literature review, personal experience, and logic.

The analysis yielded several important observations of family forest owners according to each segmentation. First, participants were very similar in their ranking of concern for succession, disagreement with selling their land for the right price, and agreement with wanting to keep their wooded land wooded across segmentations. This suggests an interest in maintaining the integrity of their wooded land and may be a key characteristic that defines these family forest owners.

When this population of family forest owners was segmented according to their PFFTP's fundamental basis for taxation, the following observations were made: 1) the majority of tax program types are modified use (current use) type programs, but all program types administer a tax break that is directly related to the ad valorem tax rate (this may indicate why no taxation type appears to be more prevalent in states that are experiencing greater development (urban) pressure); 2) participants of combination type programs are commonly located in agrarian regions; 3) lack of interest in timber management for flat tax program participants is at odds with the timber focus of flat tax programs; and 4) participants of modified use (current use) programs have woodland management objectives that are well aligned with modified use programs.

When the segmentation basis was PFFTP ecosystem emphasis, woodland owners of both timber emphasis and other ecosystem service emphasis PFFTPs differed only slightly in their woodland management approach, attitudes and concerns, and objectives. Lack of difference between these groups suggests that their woodland management approach is similar, regardless of which ecosystem service are emphasized by their PFFTP. When the segmentation approach was by PFFTP enrollment success, the analysis yielded slightly different results that more closely mirror the results from segmenting by fundamental tax type. Notably, family forest owners of high enrollment PFFTP may be woodland owners who are well suited for PFFTP enrollment, based on their propensity for timber harvesting and the characteristics of the surrounding land use, relative to woodland owners of low enrollment PFFTP. The policy implication of this insight is that the power a tax program has to influence family forest owners' management may be limited by the cultural and economic land use norms in the area.

Results of these segmentations call into question the ability of PFFTPs to actually influence the management of family forest owners. Instead, cultural and economic land use characteristics may limit PFFTP potential to influence family forest owner management activity and sentiment. Thus, policies that align well with the cultural and economic land use norms of the state could gain more traction with family forest owners. Policies that promote woodland management that are adverse to cultural or economic land use norms of woodland owners may have little success.

Chapter 3: A Comparison of the Family Forest Owners Who Participate and Those Who Do Not Participate in State PFPTPs across the U.S.

3.1. Study Objective

The objective associated with this chapter is to describe and contrast important similarities and differences among family forest landowners who participate in state PFFTP and those who do not.

3.2. Data and Methods

For this analysis, NWOS records and ancillary data were first combined and filtered exactly as described in Chapter 2.3. As in Chapter 2, this data set was limited to single parcel woodland owners who met the minimum and/or maximum wooded acreage requirements of their state's PFFTP. However, this analysis includes landowners who were participating (enrolled), as well as, those who were not participating in their PFFTP when they answered the NWOS between 2011 and 2013. After these steps, this data set was comprised of 3,863 records (participating and nonparticipating woodland owners) or about 38% of the contiguous U.S. family forest owner respondents of the 2013 NWOS. This data set consists of family forest owner in the U.S. who own one forested parcel and meet the eligibility requirements of its state's PFFTP.

NWOS respondents were asked to rank their familiarity with their state PFFTP (TAX_KNOW) from 1 to 5, where a value of 1 indicated not at all familiar with the state PFFTP and a value of 5 indicated they were extremely familiar. Eligibility for landowner inclusion in this portion of the analysis was further restricted to landowners who were at least slightly familiar with their state PFFTP ($TAX_KNOW \geq 2$). A binary variable was created then in which respondents who were at least slightly familiar with the state PFFTP were coded as 1 and those who were not at all familiar with the PFFTP as 0. This final restriction to the data set was imposed based on the logic that a landowner could not know they were enrolled and simultaneously be completely unaware of their state PFFTP (less than 1% of landowners included in this modeling dataset disproved this logic).

Tax program familiarity criteria was applied to family forest owners who participate and those who do not participate, because it was thought that characterizing family forest owners who participate or don't participate but also know the program exists would be of interest to policy makers and resource managers. Thus, in this regard, family forest owners who were not at all familiar with their PFFTP were thought to be a fundamentally different population of family forest owners, which would necessitate a separate analysis. After screening records to remove landowners not aware of their state's PFFTP, the final data set used consisted of 1,752 landowners who were familiar with their state PFFTP and were eligible to participate, comprised of 672 landowners (38%) who did not participate and 1,080 landowners (62%) who did participate in a state PFFTP.

Descriptive statistics for landowners enrolled versus those who are not enrolled in a state Preferential Forest Property Tax Program (PFFTP) using original data set variables are reported in Table 9. However, multiple variables were created from the data set for use in this analysis. These are discussed now and reported in Table 10. All statistical tests performed in this data analysis were generated using SAS 9.4 software (SAS Institute Inc., 2013).

Six questions from the 2013 NWOS data set used in this analysis asked respondents to select their response from a Likert rating scale ranking the importance, likelihood, familiarity, helpfulness, or level of

concern regarding various topics (e.g., importance of reasons for owning wooded land and concern about various topics relating to the landowner's wooded land). The Likert rating scale response options ranged from 1 to 5 (e.g., 1 = not important, 2 = of little importance, 3 = moderately important, 4 = important, and 5 = very important). In order to conduct a relative probability analysis (Allison, 2003), we converted the categorical Likert scale responses to binary response measures of importance (Kilgore et al., 2015), where importance was determined when the respondent selected a Likert scale response of ≥ 4 and no importance when a Likert scale response of < 4 was selected (Butler et al., 2016). These variables are included in Table 10.

The variables for landowner annual income, education level, and number of times they have sold or given away of their wooded land request the landowner to select their response from a list of income ranges, education levels, and ranges categorizing the number of times the landowner has transferred any part of their wooded land to another owner, respectively. These three variables were converted to binary response measures for the purpose of conducting the relative probability analysis. Annual income ranges in the 2013 NWOS include $< \$25,000$, $\$25,000$ to $49,999$, $\$50,000$ to $99,999$, $\$100,000$ to $199,999$, and $\geq \$200,000$. The median income level across all landowners in the data set for this portion of the analysis was $\$50,000$ - $\$99,999$, and was used to create a binary variable to represent annual income where annual income $> \$99,999 = 1$ and annual income $\leq \$99,999 = 0$. Education levels in the 2013 NWOS include less than 12th grade, high school/GED, some college, associate degree, bachelor's degree, and advanced degree. A binary measure of education level was determined by setting all landowners who had received a college degree = 1 (i.e., education level \geq associate degree) and all landowners who had not received a college degree = 0 (i.e., education level $<$ associate degree). The 2013 NWOS response categories regarding the number of times a landowner has transferred to a different owner their land are never, once, 2 to 5 times, and 6 or more times. The median response across all landowners in the data set for this portion of the analysis was never transferred wooded land, and this value was used to create a binary response measure for land transfer where 1 = transferred wooded land > 0 times and 0 = never transferred wooded land.

Several 2013 NWOS and additional parcel characteristics variables used in this analysis are continuous, including landowner age, income from wooded land, acres woods, tenure, and several ancillary parcel characteristics. These variables were converted into binary response measures by defining the binary response = 1 if landowner response $>$ median response, and 0 if landowner response \leq median response. These variables are included in Table 10.

Family forest owners who were familiar with, eligible, and enrolled in their state's PFPTP were compared to those family forest owners who were not enrolled in their state's PFPTP, but were eligible to enroll in and familiar with the program. Landowner and parcel characteristics were placed in one of eight categories which were hypothesized to distinguish landowners who participate from those who do not participate in state PFPTPs. The categories were based on the socio-economic and demographic characteristics of the owner; attitudes and concerns regarding their wooded land; reasons owners own their wooded land; owner participation in forestry assistance programs; past land management activities, practices, assistance, and uses; planned future activities; forest land characteristics; and land use and development activity or potential. These eight categories were derived from a review of the family forest landowner literature, PFPTP objectives as specified in state laws and administrative rules, and available NWOS and ancillary socio-economic and parcel data and are thought to represent broad, distinguishing categories of characteristics relevant to the PFPTP enrollment decision. To illuminate the average occurrence of landowner and parcel characteristics in both populations, descriptive statistics for

landowners who participate and landowners who do not participate in state PFPTPs are reported in Table 9. Statistics reported in Table 9 are based on original variables from the NWOS and other data sets. Subsequently, a comparison of the proportion of landowner and parcel characteristics in the categories of participation and non-participation in state PFPTPs was conducted using two sample t-tests (Dalgard 2008) and Chi-square tests of significance for differences of proportions in two way frequency tables (Dalgard, 2008). Statistically-significant differences were identified at $\alpha \leq 0.05$.

Relative probabilities (also known as “probability ratio” and “relative risk”) were used to identify differences between eligible landowners who participate and those who do not participate in state PFPTPs (Allison, 2003) (Table 10). The relative probabilities were reported based on the simplicity of their interpretation regarding the strength of association between landowner and parcel characteristics and PFFTP participation. Relative probability is the ratio of the probability of two events, and is calculated by dividing the probability of one outcome by the probability of a second outcome (see Siström and Garvan (2004) for a discussion of relative probabilities). In the context of this study objective, relative probabilities indicate the probability that a landowner enrolled in a state PFFTP has undertaken (would undertake for certain analyses) an activity, or that the landowner or their wooded land exhibits a certain characteristic compared with the probability that a landowner not participating in a state PFFTP has/would undertake the same activity or that the non-participating landowner or their land exhibits the characteristic. Relative probabilities greater than 1 indicate a higher likelihood of occurrence than a relative probability of less than 1. For instance, a relative probability of 2.0 pertaining to participation in cost share programs indicates that a landowner who participates in state PFPTPs are twice as likely to have utilized a cost share program relative to landowners who do not participate in state PFPTPs, and a relative probability of 0.5 means landowners who participate in state PFPTPs are half as likely to have utilized a cost share program, compared to those who do not participate in state PFPTPs. Chi-Square tests for differences of proportions and relative probabilities were conducted using SAS 9.4.

3.3. Results

3.3.1 Owner Social/ Economic/ Demographic

Landowners enrolled in a state PFFTP are 1.22 times as likely to have an annual income that exceeds \$99,999 and are 1.18 times as likely to have obtained a college level degree relative to landowners not enrolled in a state PFFTP (Table 10). For instance, 36% of landowners enrolled in a state PFFTP have annual income greater than \$99,999 compared to 29% of landowners who are not enrolled in a state PFFTP. Enrolled landowners are also 1.25 times as likely to derive some portion of their annual income from their wooded land relative to landowners who are not enrolled in a state PFFTP.

3.3.2. Owner Attitudes/ Concerns

Landowner concern for high property taxes, development of surrounding land, and keeping land intact for future generations is not correlated with enrollment in a state PFFTP, as the analysis found that landowners enrolled in state PFPTPs are no different than landowners who are not enrolled in state PFFTP, with respect to these concerns (Table 10). However, landowners enrolled in a state PFFTP are 1.18 times as likely to desire more favorable tax policies regarding their wooded land relative to landowners who are not enrolled in a state PFFTP.

3.3.3. Owner Reasons for Owning Wooded Property

With respect to ownership objectives, landowners who participate in a state PFFTP are 1.05 times as likely to have aesthetics as an ownership objective and 1.23 times as likely to own their land for timber production relative to landowners who do not participate in a state PFFTP (Table 10). For example, 46% of enrolled landowners own their land for timber production while 37% of landowner who are not enrolled in a PFFTP own their land for timber production. Landowners who are not enrolled in a state PFFTP are 1.14 times as likely to own their land for hunting relative to landowners enrolled in a state PFFTP. Landowner enrolled in a state PFFTP are no different from landowners not enrolled in a state PFFTP with respect to holding their wooded land as an investment or as a home site or primary residence.

3.3.4. Owner Participation in Forestry Assistance Programs

Landowners who participate in a state PFFTP are extremely familiar with their state's PFFTP relative to landowners who do not participate in their state's PFFTP. For instance, enrolled landowners are 3.49 times as likely to be familiar with the state PFFTP relative to unenrolled landowners, as 80% of enrolled landowners are familiar with the PFFTP, while 23% of landowners who are not enrolled are familiar with the state PFFTP (Table 4). Enrolled landowners are 1.74 times as likely to have received advice about the care or management of their wooded land and almost twice as likely (relative risk of 1.90) to have used a cost share program to help manage their wooded land relative to landowners not enrolled in a PFFTP (Table 10). Yet, no difference in familiarity with cost share programs for forest management exists between landowners enrolled in a state PFFTP and those not enrolled in a state PFFTP.

3.3.5. Past and Future Land Management Activities, Practices, Assistance, and Land Uses

Regarding past land management activities and planned future activities, landowners enrolled in a state PFFTP are 2.92 times as likely to have a forest management plan, 1.41 times as likely to have harvested timber in the past five years, and 1.24 times as likely to have harvested timber since owning their wooded land relative to landowners who are not enrolled (Table 10). Although, it is important to consider that these activities are often requirements of state PFFTPs (Kilgore et al., 2017). Of the landowners who had harvested timber since owning their wooded land, those landowners who participate in a state PFFTP are 1.73 times as likely to have used a forester during the harvesting process and 1.31 times as likely to have used a certified or master logger relative to those landowners who do not participate in a state PFFTP. Intentions to harvest timber in the next five years is 1.64 times as likely for landowners who participate in a state PFFTP relative to those that do not participate, as 42% and 25%, respectively, report having future harvest plans. Landowners enrolled in a state PFFTP are 1.07 times as likely to have purchased their wooded land relative to landowners not enrolled in a state PFFTP. Landowners enrolled and those not enrolled in a state PFFTP are equally as likely to have transferred some portion of their wooded land, as approximately 1 in 5 landowners from each group has transferred or given away some portion of their land in the past. Similarly, no difference exists with regard to future intentions to sell their wooded land or agreement with selling their wooded land if offered the right price. However, landowners enrolled in a state PFFTP are 1.04 times as likely to want their wooded land to stay wooded relative to landowners who are not enrolled in a state PFFTP.

3.3.6. Forestland Characteristics and Development Potential/Activity

Ownership tenure and having a home on the wooded land does not appear to be correlated with enrollment in a state PFFTP. The analysis found that enrolled and non-enrolled landowners are not statistically different regarding their ownership tenure, assessed as being greater than the median 23 years,

and having a home on or within one mile of their wooded land (Table 10). Landowners not enrolled in a state PFFTP are 1.17 times as likely to own a farm or ranch in the state relative to landowners enrolled in a state PFFTP, while landowners enrolled in a state PFFTP exhibit a 35% increase in the likelihood of owning a wooded parcel that contains more than the median 88 acres of woods relative to landowners not enrolled in a state PFFTP (Table 10). The surrounding population density is more likely higher and distance to urban areas more likely shorter for landowners enrolled in a state PFFTP relative to those not enrolled. Additionally, the dominant land use surrounding a landowner's wooded property is more likely to be forested and less likely to be agriculture for landowners enrolled in a state PFFTP relative to those not enrolled. For example, enrolled landowners are 1.28 times as likely to be in geographic locations where the surrounding land use is dominated by more than 76% forest relative to landowners not enrolled in a state PFFTP, while landowners not enrolled in a state PFFTP are 1.18 times as likely to be in a geographic location where the surrounding land use is characterized by greater than 10% agriculture relative to enrolled landowners. The proportion of surrounding land use classified as urban does not differ between landowners enrolled in state PFFTPs and those not enrolled.

Table 9. Descriptive statistics for landowners enrolled versus those who are not enrolled in a state Preferential Forest Property Tax Program (PFFTP). Mean values (5 point Likert Scale, nominal) are reported unless otherwise noted.¹

Category/Variable	Enrolled (N=1,080)	Not Enrolled (N=672)	All Landowners (N=1,752)
Owner Social/Economic/ Demographic			
Age ²	64	63	63
Income ^{2,3*}	\$75,000	\$75,000	\$75,000
Education ^{2*}	5	4	5
Income from woods	3.38	3.12	3.28
Owner Attitudes/ Concerns			
Taxes concern	4.26	4.21	4.24
Development concern	3.29	3.23	3.27
Succession concern*	4.22	4.07	4.16
Tax help*	4.07	3.70	3.92
Timber markets help*	3.65	3.12	3.45
Cost share help*	3.47	2.88	3.24
Owner Reasons for Owning Wooded Property			
Objective aesthetics*	4.36	4.23	4.31
Objective wildlife	4.24	4.11	4.19
Objective investment	3.33	3.29	3.32
Objective children	4.05	3.92	4.00
Objective timber*	3.25	2.93	3.13
Objective recreation	3.56	3.49	3.53
Objective hunting*	3.18	3.42	3.27
Objective residence	4.30	4.25	4.28
Owner Participation in Forestry Assistance Programs			
Cost share familiarity*	2.18	2.45	2.28

PFPTP familiarity ^{4*}	4.18	2.86	3.68
Cost share*	0.25	0.13	0.21
Advice*	0.59	0.34	0.49
Past Land Management Activities, Practices, Assistance, and Land Uses			
Transfer ²	0	0	0
Purchased ^{5*}	0.73	0.78	0.75
Inherited ⁵	0.33	0.28	0.31
Management plan*	0.59	0.20	0.44
Harvest 5 years*	0.37	0.26	0.33
Invasive 5 years	0.30	0.30	0.30
Harvest*	0.62	0.50	0.57
Forester*	0.58	0.34	0.48
Logger*	0.48	0.37	0.43
Planned Future Activities and Uses			
Future harvest*	2.96	2.52	2.79
Future transfer	2.02	2.04	2.03
Sell	2.42	2.35	2.39
Wooded*	4.58	4.43	4.52
Forest Land Characteristics			
Tenure ²	23	23	23
Residence	0.59	0.63	0.61
Farm*	0.33	0.40	0.36
Cabin*	0.25	0.20	0.23
Acres woods ²	100	65	88
Proximate Land Use and Development Activity/Potential			
Population ^{2,6*}	38.10	28.75	34.25
Urban distance ^{2,6*}	9,129	12,184	10,157
Forest ^{2,6*}	0.79	0.72	0.76
Agriculture ^{2,6*}	0.08	0.13	0.10
Development ^{2,6}	0.04	0.04	0.04
Road density ^{2,6}	178	170	176

*Statistically significantly different distributions established at $\alpha \leq 0.05$ level.

¹See Table 1 in Chapter 2 for variable descriptions.

²Median value.

³Midpoint of 2013 NWOS respondent annual income category is reported.

⁴Respondents who reported that they are not at all familiar with the state PFPTP were excluded from this analysis.

⁵Variable is not mutually exclusive.

⁶Family Forest Research Center (FFRC) variable.

Table 10. Percent frequencies for assessed variables and relative risk (relative probability) of landowners enrolled versus those who are not enrolled in a state Preferential Forest Property Tax Program (PFPTP).¹

Category/ Variable	Description	Enrolled (N=1,080)	Not Enrolled	Relative Risk	p-value
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		(N=672)	(Tax=1)		
Owner Social/ Economic/ Demographic					
Age ²	Owner age in years > 63	51.15	47.31	1.08	0.141
Income ³	Owner income category > \$99,999	35.50	29.14	1.22*	0.014
Education ⁴	Owner education category ≥ Associate degree	62.93	53.13	1.18*	0.0001
Income from woods ²	Percentage of annul income derived from wooded land > 0	33.22	26.64	1.25*	0.008
Owner Attitudes/ Concerns					
Taxes concern ⁵	Concern for taxes	79.67	78.51	1.07	0.564
Development concern ⁵	Concern for development	47.38	48.31	0.98	0.713
Succession concern ⁵	Concern for passing land down to heirs	79.54	76.44	1.04	0.131
Tax help ⁶	Helpfulness of more favorable tax policies	77.28	65.36	1.18*	0.0001
Timber markets help ⁶	Helpfulness of stronger timber markets	62.46	46.29	1.35*	0.0001
Cost share help ⁶	Helpfulness of cost sharing for woodland management (Likert scale)	56.68	38.25	1.48*	0.0001
Owner Reasons for Owning Wooded Property					
Objective aesthetics ⁷	Ownership beauty objective	85.32	81.27	1.05*	0.028
Objective wildlife ⁷	Ownership wildlife objective	80.08	76.50	1.05	0.085
Objective investment ⁷	Ownership investment objective	47.95	46.15	1.04	0.481
Objective children ⁷	Ownership passing land to heirs objective	72.95	68.68	1.06	0.071
Objective timber ⁷	Ownership timber objective	45.79	37.35	1.23*	0.001
Objective	Ownership recreation objective	57.07	53.26	1.07	0.140

recreation ⁷					
Objective hunting ⁷	Ownership hunting objective	47.00	54.86	0.86*	0.002
Objective residence ⁷	Ownership home objective	82.63	81.62	1.01	0.659
Owner Participation in Forestry Assistance Programs					
Cost share familiarity ⁸	Familiarity with cost share programs	22.47	23.69	0.95	0.556
Cost share	Past participation in a cost share program (1 = yes, 0 = no)	25.17	13.26	1.90*	0.0001
Advice	Received advice on care, management, or protection for their wooded land in past five years (1 = yes, 0 = no)	59.49	34.24	1.74*	0.0001
Past Land Management Activities, Practices, Assistance, and Land Uses					
Transfer ⁹	Number of times transferred land > 0	22.16	20.85	1.06	0.528
Purchased ¹⁰	Wooded land was purchased (1 = yes, 0 = no)	73.11	78.35	0.93*	0.014
Inherited ¹⁰	Wooded land was inherited (1 = yes, 0 = no)	32.67	28.27	1.16	0.055
Management plan	Has a forest management plan (1 = yes, 0 = no)	59.06	20.24	2.92*	0.0001
Harvest 5 years	Harvested trees for sale in the past five years (1 = yes, 0 = no)	37.04	26.19	1.41*	0.0001
Invasive 5 years	Treated invasive plant species in the last five years (1 = yes, 0 = no)	30.48	29.71	1.03	0.735
Harvest	Harvested trees for sale since owning the property (1 = yes, 0 = no)	61.64	49.73	1.24*	0.0001
Forester	Use of forester during harvest	58.14	33.53	1.73*	0.0001
Logger	Use of certified or master logger	48.01	36.61	1.31*	0.0002

during harvest

Planned Future Activities and Uses					
Future harvest ¹¹	Likelihood of future harvesting	41.72	25.46	1.64*	0.0001
Future transfer ¹¹	Likelihood of transferring property in the future	14.38	14.61	0.98	0.900
Sell ¹²	Agreement with selling land in future for right price	19.87	18.65	1.07	0.539
Wooded ¹²	Agreement with wanting to keep their wooded land wooded	90.71	86.86	1.04*	0.012
Forest Land Characteristics					
Tenure ²	Ownership tenure in years > 23	49.85	49.69	1.00	0.949
Residence	Home or primary residence on or within one mile of wooded land (1 = yes, 0 = no)	59.11	63.19	0.94	0.089
Farm	Owens a farm or ranch in state (1 = yes, 0 = no)	33.18	40.00	0.83*	0.004
Cabin	Cabin on or within one mile of wooded land (1 = yes, 0 = no)	24.60	20.39	1.21*	0.042
Acres woods ²	Acres of woods on parcel > 88 acres	55.46	41.07	1.35*	0.0001
Proximate Land Use and Development Activity/Potential					
Population ^{2,13}	Number of people per square kilometer within the Census block group where land is located > 34.3	53.98	43.30	1.25*	0.0001
Urban distance ^{2,13}	Straight-line distance (meters) to Urban Area as defined in 2010 census > 10,154	45.65	56.99	0.80*	0.0001
Forest ^{2,13}	Proportion of land that is forested within a 1 km radius of respondent's wooded land (2011 National Land Cover Database) > 0.76	55.65	43.45	1.28*	0.0001
Agriculture ^{2,13}	Proportion of land that is agricultural crop or pasture land within a 1 km radius of respondent's wooded land	45.93	56.25	0.82*	0.0001

(2011 National Land Cover Database) > 0.10					
Development ^{2,13}	Proportion of land that is developed within a 1 km radius of respondent's wooded land (2011 National Land Cover Database) > 0.04	51.30	50.15	1.02	0.640
Road density ^{2,13}	Sum of 30m road pixels within 1km of wooded land > 176	49.54	45.68	1.08	0.117

*Statistical significance at $\alpha \leq 0.05$ level based on the Wald Chi-Square statistic

¹Percent frequency reported (proportions). See Table 1 in Chapter 2 for descriptions of original data set variables used to create analysis variables used in this table.

²Binary response measure created where landowner response > median value=1 and landowner response < median value=0.

³Binary response measure based on median income category. Midpoint of 2013 NWOS respondent annual income category is reported.

⁴Binary response measure created based on landowner education level \geq Associate degree = 1 and landowner education level < Associate degree = 0.

⁵The 2013 NWOS survey respondents were asked to rank their concern in regards to their wooded lands on a 1-5 Likert scale; 5 being great concern and 1 being no concern. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

⁶The 2013 NWOS survey respondents were asked to rank the helpfulness on a 1-5 Likert scale; 5 very helpful and 1 being of no help. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

⁷The 2013 NWOS survey respondents were asked to rank the importance of the reasons for owning their wooded land on a 1-5 Likert scale; 5 being very helpful and 1 being of no help. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

⁸The 2013 NWOS survey respondents were asked to rank their familiarity on a 1-5 Likert scale; 5 being extremely familiar and 1 being not at all familiar. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

⁹Categorical variable; binary response measure created where landowner response > median value = 1 and landowner response < median value = 0.

¹⁰Variable is not mutually exclusive.

¹¹The 2013 NWOS survey respondents were asked to rank the likelihood in regards to their wooded land on a 1-5 Likert scale; 5 being extremely likely and 1 being extremely unlikely. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

¹²The 2013 NWOS survey respondents were asked to rank their agreement in regards to their wooded land on a 1-5 Likert scale; 5 being strongly agree and 1 being strongly disagree. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

¹³Family Forest Research Center (FFRC) variable.

3.4. Discussion

This relative risk analysis reveals that family forest owners included in this analysis who participate in their PFPTP are more likely to be active timber managers, have opinions on forest tax policy and use subsidy programs for forest management, and own large wooded parcels in forested areas close to urban centers relative to those who do not participate. Commonly described family forest owner characteristics were found to be shared by both participating and nonparticipating woodland owners, such as concern for keeping their wooded land intact for future generations. However, it is family forest owners who do not participate in PFPTPs that appear to have lower relative risk estimates for many variables in this data set,

relative to family forest owners who do participate in PFPTPs. For instance, nonparticipating woodland owners are more likely to have higher levels of just three tested variables, relative to owners who participate in PFPTPs. These are hunting objectives for their wooded land, owning their wooded land as part of a farm or ranch, and owning their wooded land in an area that is surrounded by greater than 10% adjacent, agricultural land use. These characteristics may reveal cultural and livelihood obstacles regarding family forest owner participation in PFPTPs for the specific group of family forest owners assessed (i.e., single parcel owners who are at least somewhat familiar with their PFFTP and who meet the minimum/maximum acreage requirements for PFFTP enrollment).

First, for family forest owners who do participate in PFPTPs, relevant policy implications are evident from this analysis. These include, for instance, that participating owners are more likely to have received forest management advice, use a forester or master or certified logger during timber harvesting, be active timber managers, and continue to be active timber managers in the future. However, while many PFFTP require or emphasize timber production as a condition of PFFTP participation (Kilgore et al., 2017), participating owners are more likely to actually have a timber management objective relative to nonparticipating owners. Thus, one caveat for policy makers to consider is that it is not evident from this analysis that PFPTPs actually cause woodland owners to be more active timber managers or if these woodland owners would be active timber managers even if they were not enrolled. If the latter is true, then the case for using PFPTPs as a policy tool to incentivize commercial timber production on family forestland is less obvious.

The family forest owners who do not participate in PFPTPs are less likely to have assessed characteristics or participate in assessed activities, relative to owners who do participate. The implication for the nation's family forests, according to our analysis, is that timber harvesting is less common on woodlands that are not enrolled, especially in agrarian regions. It is not evident from this analysis that woodlands owned by nonparticipating family forest owners are less productive in producing other forest based public goods (e.g., clean air and water, carbon sequestration, or biodiversity).

The characteristics of family forest who do not participate in PFPTPs may reveal underlying themes that are preventing their participation. These themes reflect cultural tendencies and characteristics of the woodland owner's primary livelihood. For instance, hunting on one's land is a cultural experience that is often accompanied by deep rooted traditions and stories that have been passed down through generations. For instance, regarding hunting in Texas, Adams et al. (2004) suggest that recruitment of new hunters and sustained participation throughout a hunter's lifetime has always been in the context of hunting tradition with family and friends. When the land on which the hunting takes place is one of the underlying connections that makes this tradition possible, changes to its management may result in visceral, negative feedbacks from woodland owners. For instance, a woodland owner may determine that timber harvesting could have deleterious effects on hunting habitat which would decrease their traditional hunting experience. Since many PFPTPs emphasize timer production, family forest owners who have traditional ties to hunting on their wooded land may be deterred from participating in these PFPTPs. If commercial timber production is a goal of forest tax policy, then resource managers and policy makers could expound on the positive connections between timber management and wildlife habitat productivity in order to engage nonparticipants.

Family forest owners who do not participate in PFPTPs are more likely to own their wooded land as part of a farm or ranch and own wooded land that is surrounded by a landscape in which greater than 10% is developed for agriculture. Focusing on farmers and ranchers, these owners may be less likely to be enrolled in a PFFTP as a result of their wooded land being more closely tied to their livelihood (i.e., their

farm or ranch). This sentiment may manifest in two ways. First, any reduction in management autonomy or flexibility of lands associated with their income producing land operation may supersede the benefits of PFFTP participation. Many studies have found similar results regarding farmer participation in land retirement systems like the Conservation Reserve Program (CRP) (Isik and Wang, 2004) and in conservation practice adaptation cost share programs such as the Environmental Quality Incentives Program (EQIP) (Claassen, Cattaneo, and Johansson, 2008). Second, agricultural land may qualify for current use land valuation, similar to that employed by many PFFTPs (Polyakov and Zhang, 2008). Perhaps, as a result, woodland owners who do not participate in PFFTPs view more favorable tax policies regarding their woodland as less helpful. Therefore, preferential property tax treatment of competing land uses may be contributing to the more limited PFFTP participation rate in agrarian regions.

Last, certain characteristics of the woodland owner and the surrounding land uses demonstrated no statistically significant difference in association with participating woodland owners relative to nonparticipating woodland owners. Level of owner concern for land taxes, development of nearby lands, keeping forest land intact for future generations, investment objective and cost share familiarity did not result in a significant difference in the probability of participation between these two groups. Not surprisingly, keeping land intact for future generations ranked high, on average, for all family forest landowners in this and past empirical analyses (e.g., Butler et al., 2016). This insight may present an opportunity to align society's interest in sustainable forest management with landowner sentiment through PFFTP policy.

3.5. Conclusions

This relative risk analysis focused on characterizing the similarities and differences between a group of family forest owners who participate and a group of family forest owners who do not participate in preferential forest property tax programs (PFFTPs). Characterization of these landowners was based on their responses to the National Woodland Owners Survey administered from 2011-2013. Survey respondents who were eligible for this analysis were at least slightly familiar with their PFFTP, owned a single wooded parcel, and met the minimum/maximum acreage requirements for PFFTP participation.

Two primary limitations of this analysis exist. First, estimates of relative risk do not provide evidence of causation (Allison, 2003). Thus, these estimates simply identify the strength of association of certain characteristics with family forest owners who participate relative to those who do not participate in PFFTPs. Second, family forest owner respondents to the NWOS who were not at all familiar with their PFFTP were excluded from this analysis. Understanding the characteristics that define participating and nonparticipating owners who also know the PFFTP exists is interesting and relevant to forest tax policy. However, these results may have been different had we included woodland owners who were not at all familiar with their PFFTP.

Family forest owners who participated in PFFTP were found to have many strong associations with assessed forest management characteristics, relative to nonparticipating owners. For instance, participating family forest owners were more likely to have received forest management advice, use a forester or master or certified logger during timber harvesting, be active timber managers, and will continue to be active timber managers in the future. One policy implication from these insights is that foresters and master or certified loggers were more often used during timber harvests for this group. A caveat of this analysis is that it is not evident from this data set that PFFTPs actually caused these family forest owners to conduct timber harvests and associated activity (i.e., contacting a forester) or if they would have conducted them anyway.

A strong association with hunting objectives and owning wooded land as part of a farm or ranch may reveal underlying themes that are preventing PFFTP participation for these family forest owners. These themes reflect cultural tendencies and characteristics of the woodland owner's primary livelihood. Woodland owners may fail to see positive associations with timber harvesting that is associated with many PFFTPs and wildlife habitat development. Instead, they may conclude that timber harvesting could have negative effects on wildlife habitat which would lead to reductions in their culturally important, traditional hunting experience. Some farmers and ranchers may be less likely to participate in PFFTPs because their wooded land is closely associated with their ability to produce income for their livelihood. Additionally, competing preferential tax treatment for agricultural land use may detract from the financial benefit of PFFTP participation. In these regards, expounding on the benefits of timber harvesting for wildlife management or through eliminating other types of preferential tax treatment for woodlands, could lead to increases in PFFTP participation.

Chapter 4: A Quantification of the Relationship between Family Forest Owner, Parcel, and Tax Program Characteristics and Participation in State PFFTPs across the U.S.

4.1. Introduction

This research is one of the first to empirically assess the relationship between family forest landowner, parcel, and tax program characteristics and participation in preferential forest property tax programs (PFPTPs) across the U.S. Administered in every state, PFPTPs offer favorable forest property tax treatment as an incentive to family forest owners to provide forest based ecosystem goods and services for the public. In this analysis, a binomial logistic regression model is used to estimate the probability of landowner participation in a PFFTP.

4.2. Objective Statement

The study objective associated with this chapter is to identify and quantify the relationship between landowner, parcel, and tax program characteristics and participation in state PFPTPs by the nation's family forest owners.

4.3. Data and Methods

4.3.1. Dataset

For this analysis, NWOS records and ancillary data were first combined and filtered as described in Chapter 2.3. As in Chapter 2, this data set was limited to single parcel woodland owners who met the minimum and/or maximum wooded acreage requirements of their state's PFFTP. However, this analysis includes landowners who were participating (enrolled), as well as, those who were not participating in their PFFTP when they answered the NWOS between 2011 and 2013. After these steps, this data set was comprised of 3,863 records (participating and nonparticipating woodland owners) or about 38% of the contiguous U.S. family forest owner respondents of the 2013 NWOS. This data set consists of family forest owner in the U.S. who own one forested parcel and meet the eligibility requirements of its state's PFFTP.

NWOS respondents were asked to rank their familiarity with their state PFFTP (TAX_KNOW) from 1 to 5, where a value of 1 indicated not at all familiar with the state PFFTP and a value of 5 indicated they were extremely familiar. Eligibility for landowner inclusion in this portion of the analysis was further restricted to landowners who were at least slightly familiar with their state PFFTP (TAX_KNOW \geq 2). A binary variable was created then in which respondents who were at least slightly familiar with the state PFFTP (i.e., respondent answered 2, 3, 4, or 5) were coded as 1 and those who were not at all familiar with the PFFTP (i.e., respondent answered 1) as 0. This final restriction to the data set was imposed based on the logic that a landowner could not know they were enrolled and simultaneously be completely unaware of their state PFFTP (less than 1% of landowners included in this modeling dataset disproved this logic).

Tax program familiarity criteria was applied to family forest owners who participate and those who do not participate because it was thought that characterizing family forest owners who participate or don't participate but also know the program exists would be of interest to policy makers and resource managers. Thus, in this regard, family forest owners who were not at all familiar with their PFFTP were thought to be a fundamentally different population of family forest owners, which would necessitate a separate analysis. The implication of this decision is that insights from this model cannot be applied to landowners who were not at all familiar with their state PFFTP (See *Endogeneity and Tax Program Knowledge Analysis*, below, for further discussion). After screening records to remove landowners who were not aware of their state's PFFTP, the final data set used consisted of 1,752 landowners who were familiar

with their state PFFTP and were eligible to participate, comprised of 672 landowners (38%) who did not participate and 1,080 landowners (62%) who did participate in a state PFFTP.

4.3.2. Binary Logistic Regression Model

Binary logistic regression using maximum likelihood estimation (MLE) procedures was used to identify statistically significant factors that influence a landowner's decision to participate in a PFFTP using SAS 9.4 (SAS Institute Inc., 2013). Significance was identified at $\alpha = 0.05$ level. Binary logistic regression assigns probabilities to each of the two possible outcomes. For a binary response variable Y and a vector of explanatory variables X , these probabilities are:

$$P(Y_i = 1) = P_i = \frac{e^{\beta X_i}}{1 + e^{\beta X_i}}$$

$$P(Y_i = 0) = 1 - P_i = 1 - \frac{e^{\beta X_i}}{1 + e^{\beta X_i}} = \frac{1}{1 + e^{\beta X_i}}$$

where P_i represents the probability of a landowner from the set of eligible landowners, i , having participated in a PFFTP, β_i is a vector of regression coefficients, and βX_i is a standard notation representing the right hand side of a regression model, and e is the exponential function. Unlike ordinary least squares (OLS) regression, the logistic procedure involves estimating the regression parameters by maximizing a likelihood function, and the coefficient estimates in a logistic regression do not carry the implication of per unit impact of individual explanatory variables as in the OLS case (Mehmood and Zhang, 2005). To aid in meaningful interpretation of model results, marginal effects were calculated to examine the change in predicted probability associated with unitary changes in the explanatory variables (Green, 2000). Marginal effects were calculated at the means.

The odds ratio for each of the explanatory variables were used to provide information on how each variable influenced the odds of landowner enrollment in a PFFTP when the remaining variables are held constant (Snyder et al., 2008). The marginal effects, when multiplied by 100, provide the percentage change in the probability of landowner participation in a PFFTP given a 1-unit change in a continuous variable or a change from 0 to 1 for a binary variable when all other variables are evaluated at their means (Snyder et al., 2008). An eligible landowner was defined as a family forest landowner who owned a single parcel of wooded land in the state for which they answered the NWOS, met the minimum and/or maximum acreage requirements set forth for enrollment by their specific state PFFTP, and who had some knowledge of the state specific PFFTP ($TAX_KNOW \geq 2$). All statistical tests performed in this data analysis were generated using SAS 9.4 software (SAS Institute Inc., 2013).

To test for possible multicollinearity between potential explanatory variables, Spearman Correlation Coefficients were calculated prior to final independent variable selection (Dalgard, 2008). PENALTY_YEARS (the maximum number of years that could be used to assess a penalty for early program withdrawal) and PTP_APP_REV (natural resource agency review of the landowner's enrollment application) had a Spearman Correlation Coefficient of .451 which was the highest correlation coefficient of any two independent variables used in the final model. Additionally, Variance Inflation Factor (VIF) was calculated for independent variables. VIF is a multicollinearity diagnostic statistic produced by linear regression analysis and values above 2.5 may be a cause for concern in logistic regression (Allison, 2003). As none of the independent variables had a VIF value above 2.5, none were excluded based on multicollinearity of independent variables.

Previous empirical studies have used binomial logistic regression to model the family forest owner PFFTP participation decision (Kilgore et al., 2008; Kauneckis and York, 2009; Fortney et al., 2011) and, more broadly, their decision to enroll in natural resource incentive programs (Ma et al., 2012; Wolde et al., 2016). Much of the past empirical research has, additionally, focused on family forest owner participation in both PFFTP (Kilgore et al., 2008; Fortney et al., 2011) and other natural resource incentive programs (Majumdar et al., 2008; Wolde et al., 2016) at finer scales than this analysis. For instance, prior analyses limited the binary logistic regression participation model to state or regional scales, as opposed to nationally.

4.3.3. Study Variables and Research Hypotheses

For the family forest owners included in the data set used for this model, we hypothesized that the participation decision for eligible landowners is a function of five major factors. These include the financial benefit of PFFTP participation, financial cost of PFFTP participation, personal characteristics of the landowner, PFFTP enrollment criteria/restrictions, and characteristics of the wooded land and the surrounding land use. Additionally, being at least slightly familiar with the tax program was thought to be a necessary precursor to participation and that ex ante level of familiarity would positively influence enrollment. However, due to endogeneity of tax program knowledge and our inability to separate ex ante program knowledge (prior to enrollment) and ex post program knowledge, level of landowner familiarity with the tax program was not directly included in this model (see *Endogeneity*, below, for further discussion). Table 11 contains definitions of these potential explanatory variables and their hypothesized effect on PFFTP participation.

$$\text{Participation} = f(\text{financial benefit, financial cost, personal characteristics of landowner, PFFTP enrollment criteria/restrictions, land characteristics})$$

The dependent variable, landowner enrollment in their state PFFTP, is a binary variable from the NWOS named TAX, where 1=enrolled and 0=not enrolled in a state PFFTP. Each of the five major factors that were hypothesized to be potential explanatory variables are described below.

Table 11. Description and hypothesized influence of the potential explanatory variables on a landowner’s decision to participate in their state’s preferential forest property tax program.

Category/Variable	Dataset Variable	Description	Hypothesized Effect on Participation
Financial Benefit			
Log(population*tax benefit)	LN_SPECIFIC_BENEFIT	Continuous: log of PFFTP tax benefit*square mile population density in 2010 census block	Positive
Financial Cost			
Penalty	PENALTY_YEARS	Continuous: maximum	Negative

number of years a retroactive monetary penalty could be assessed for early program withdrawal

Personal Characteristics

Education ¹	OWN1-EDU2	Categorical: Associates Degree or greater = 1, no college degree=0	Positive
Development Concern ²	CNC_DEV2	Binary: Great concern/concern=1, moderate concern or lower=0	Positive
Taxes Concern ²	CNC_TAX2	Binary: Great concern/concern=1, moderate concern or lower=0	Positive
Investment Objective ³	OBJ_INV2	Binary: Very important/important=1, moderate importance or lower=0	Positive
Timber Objective ³	OBJ_TIM2	Binary: Very important/important=1, moderate importance or lower=0	Positive
Wildlife Objective ³	OBJ_WIL2	Binary: Very important/important=1, moderate importance or lower=0	Positive

PFFTP Enrollment Criteria/Restrictions

Application Review	PTP_APP_REV	Binary: Natural resource agency review enrollment application (1=yes, 0=no)	Negative
No Building	PTP_OWNBUILDING	Binary: Residence/buildings on property restricted (1=yes, 0=no)	Negative
Program Emphasis	ECO	Binary: PFFTP major ecosystem emphasis is timber production (1=yes, 0=no)	Negative

Land Characteristics

Purchased	ACQ_TYPE_PURCH	Binary: Wooded land was purchased (1=yes, 0=no)	Positive
Log(wooded acres)	LNACRES	Continuous: log of parcel wooded acres	Positive
Home	HOME	Binary: home or primary	Negative/Positive

Ag	PROP_AG	residence on or within one mile of wooded land (1=yes, 0=no) Continuous: proportion of land that is agricultural crop or pasture land within a 1 km radius of respondent's wooded land	Negative
Development	PROP_DEV	Continuous: proportion of land that is developed (impervious surface) within a 1 km radius of respondent's wooded land	Negative

¹ Binary response measure created based on landowner education level \geq Associate degree = 1 and landowner education level $<$ Associate degree = 0.

² The 2013 NWOS survey respondents were asked to rank their concern in regards to their wooded lands on a 1-5 Likert scale; 5 being great concern and 1 being no concern. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

³ The 2013 NWOS survey respondents were asked to rank the importance of the reasons for owning their wooded land on a 1-5 Likert scale; 5 being very helpful and 1 being of no help. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

Financial Benefit

A financial benefit is incorporated into the design of almost all state PFPTPs in the form of a per acre tax reduction for conveyance of certain landowner obligations (Kilgore et al., 2017). Kilgore et al. (2008) identified a positive relationship between financial benefit, in the form of compensation amount, and enrollment in Minnesota's Sustainable Forestry Incentives Act (SFIA). However, also in Minnesota, Kilgore and Bagdon (2013) found that financial compensation for program enrollment was secondary to deed restrictions, all else equal, when comparing the probability of enrollment in Minnesota's SFIA and the Minnesota 2c managed Forest Lands (2c) PFPTPs. Stevens et al. (2002) identified a positive relationship between value of the compensatory financial benefit offered and enrollment in private forest management programs in Massachusetts.

The log of the product of property tax benefit (PFFTP savings per acre) and a scaling factor (census block 1 square mile population density) obtained from the 2010 Census (LN_SPECIFIC_BENEFIT) was used to represent the financial benefit associated with enrollment (Table 11). Increasing the financial incentive of enrollment was thought to provide relief from the costs of landownership and increase the likelihood of enrollment. We thought this would be an accurate representation of the financial benefit offered to a landowner by their PFFTP, given that there is a fixed supply of land and demand for land resulting from increased population growth increases land values, and thus the total property tax revenue (Heimlich and Anderson, 2001). Additionally, every PFFTP provides a larger tax break to higher taxed woodland ownerships, based on their fundamental methods of taxation modified use (current use), flat tax, or a combination. The range of the variable LN_SPECIFIC_BENEFIT (i.e., the product of the PFFTP tax benefit and the census block population) was 12,710 units and right-skewed with the vast majority of data points occurring at the low end of the data's range. Therefore, the log approximation of this relationship is

used in our model. Given that the supply of land is fixed, increased demand for land due to growth increases land values, and thus the total property tax revenue.

Financial Cost

Researchers have treated the costs associated with PFFTP enrollment as implicit opportunity costs associated with lost revenue from other land uses (e.g., agriculture or development) (Polyakov and Zhang, 2008; Kauneckis and York, 2009). Additionally, studies have considered financial costs associated with PFFTP enrollment as a factor that explicitly affects the willingness to accept payment for deed restrictions (Kilgore et al., 2008).

Within the context of this analysis, financial cost is defined as the implied maximum size of the penalty for early withdrawal from the PFFTP. First, our definition of financial cost abstracts (i.e., considers separately) from economic opportunity costs, which we maintain are controlled for by including characteristics of the surrounding land uses in our model (see *Characteristics of the Land*, below). Second, our definition of financial costs abstracts from other direct financial costs associated with PFFTP enrollment, such as application fees or fees associated with forest management plan (FMP) development. For the latter, we simply did not have the requisite data.

We calculated the implied maximum size of the penalty for early withdrawal from the PFFTP as the maximum number of years that could be used to assess a penalty for early program withdrawal (PENALTY_YEARS) (Table 11). The majority of PFFTPs assess their early program withdrawal penalty as the back taxes over the number of years of enrollment up to some arbitrary amount plus interest and/or other miscellaneous fees (Kilgore et al., 2017). Thus, our proxy for financial cost represents the implied maximum penalty for early withdrawal from the PFFTP. Increasing the value of this variable implies that the penalty, abstracting from financial discounting, grows linearly with time because every year adds just one additional year of back taxes onto the withdrawal penalty. Using the maximum number of years a penalty for early withdrawal could be assessed for was thought to represent a realistic tradeoff considered by the landowner during the enrollment process (i.e., when considering the financial benefits now versus the risk associated with financial penalties for early withdrawal in the future). Since a higher value of this variable essentially reduces asset liquidity, this variable is expected to have a negative impact on the probability of PFFTP enrollment.

Personal Characteristics of the Landowner

A wide variety of landowner characteristics have been empirically shown to influence a family forest landowner's decision to enroll in PFFTPs and other conservation incentive programs. These include socioeconomic characteristics of the landowner(s), property levels objectives, resource concerns, and absentee status characteristics (e.g., Dennis and Sendak, 1992; Koontz, 2001; Kilgore et al., 2008; Kauneckis and York (2009). For example, as Kauneckis and York (2009) identify in their review of the literature, income, education, age, urbanite status, and land ownership tenure (length of ownership) have been shown to be significant determinants of conservation program participation (Royer, 1987; Wilson, 1996; Soule et al., 2000; Erickson et al., 2002). Landowners have been consistently found to express a preference for aesthetic and amenity benefits over strictly economic incentives such as timber production (Koontz, 2001; Ryan et al., 2003).

Our model includes six personal characteristics obtained from the NWOS hypothesized to be integral to the landowner PFFTP enrollment decision (Table 11). These characteristics include owner educational attainment, concern for development, concern for property taxes, woodland investment objectives, timber management objectives, and wildlife objectives. Education of the primary owner (OWN1_EDU2) was used as a measure of socio-economic status. Education has also been associated with greater understanding and knowledge of environmental issues. Education level was found to have a positive influence on enrollment in Vermont's Use Value Appraisal property tax program (Dennis and Sendak, 1992). Education was also found to positively influence estimated family forest owners' participation in cost-share, forest certification, and conservation easement programs (Ma et al., 2012). Wolde et al. (2016) found that landowners with lower educational attainment were less likely to participate in public incentive programs for forest management. In our model, landowners are categorized as having less than or equal to a high school education/GED or as having an associate's degree or higher level of college experience (i.e., a binary variable).

Landowner concern for development of nearby lands (CNC_DEV2) and landowner concern for property taxes (CNC_TAX2) were used to represent a diversity of landowner concerns that could be drivers of PFFTP enrollment (Table 11). Both of these variables were converted to binary form from their original Likert scale. For the new variables, a value of 1 represented concern or great concern and a value of zero represented moderate concern or lower. Landowner concerns were hypothesized to reduce to two main categories: 1) ecological integrity of the parcel; and 2) financial value of the parcel. Concern for development of nearby lands suggests a familiarity with environmental impacts associated with commercial development. We expect this variable to have a positive influence on the likelihood of enrollment. Similarly, doing what is perceived as right and demonstrating a strong ethic of conservation were found to be primary motivating sentiments regarding forestry incentive programs and sustainable forest management for a small study group of woodland owners from Minnesota, Oregon, Pennsylvania, and South Carolina (Daniels et al., 2010). Environmental protection was a strong motivator for protecting and retaining woodlots for woodland owners (Erickson et al., 2002). Interest in forest preservation was found to be a significant positive predictor of participation in West Virginia's Managed Timberland program (Fortney et al., 2011).

Concern for taxes was generally used to gauge the financial impetus for enrollment. Greater concern for taxes may mean either high land taxes or that land taxes are accountable for a more significant portion of a landowner's budget. In both cases, greater concern for taxes might be expected to increase the probability of enrollment, as landowners would seek avenues to control land holding costs.

Three variables were used to capture land ownership objectives (Table 11). These variables are woodland investment objectives, timber management objectives, and wildlife objectives. Two of these, investment objective (OBJ_INV2) and timber objective (OBJ_TIM2), were chosen to represent an interest in controlling the financial costs of land ownership. Landowners with these landownership objectives are thought to be more likely to enroll in PFFTPs, considering the associated tax reductions and resultant financial savings associated with enrollment. Additionally, timber production requirements are emphasized in the majority of PFFTPs. Plans to harvest timber in the future were found to have no effect on enrollment in West Virginia's Managed Timberland program (Fortney et al., 2011). Ma et al. (2012) found that having completed a timber harvest and having future plans to complete a timber harvest positively influenced estimated family forest owners' participation in cost-share, forest certification, and conservation easement programs. Song et al. (2014) found that having a timber objective negatively influenced family forest owner participation in cost-share programs in the U.S. Northern region. Both cost controlling objectives were included in the model because it was thought that having one objective does not necessarily imply the other; in other words, that they might not be highly correlated.

Wildlife ownership objective (OBJ_WIL2) was used to represent landowner sentiment for land preservation and general stewardship that is implicit in PFPTPs, therefore increasing the likelihood of enrollment. Daniels et al. (2010) found that doing what is “right” and demonstrating a strong ethic of conservation were found to be primary motivating sentiments regarding forestry incentive programs and sustainable forest management. Aesthetics (including wildlife) and environmental protection were found to be strong motivators for retaining woodlots for one group of Michigan woodland owners (Erickson et al., 2002). All three variables for ownership objectives were converted to binary from their original Likert scale. For the new variables, a value of 1 now indicated important or very important and a value of zero indicated moderately important or lower.

PFFTP Enrollment Criteria and Restrictions

In general, restrictions on management autonomy and hurdles to program enrollment negatively impact enrollment in PFFTP (Kilgore, 2008; Fortney et al., 2011; Butler, 2012). Ma et al. (2014) demonstrate that more restrictive stewardship and land management PFFTP criteria, such as requiring forest management plans and specifying an enrollment period and/or withdrawal penalty, do not necessarily lead to increased retention of private forestland acreage or decreased parcel fragmentation. Additionally, a general aversion to government control and management authority may play a role in reducing program enrollment. For example Fortney et al. (2011) found that aspects of West Virginia’s Managed Timberland tax incentive program most strongly opposed by participants was the tax assessors’ overriding authority in determining their forestland’s valuation. Anti-bureaucratic viewpoints and anti-government sentiment were demonstrated by family forest owner focus group participants interviewed by Daniels et al., 2010, regarding forestry incentive programs and sustainable forest management.

PFFTP enrollment criteria and restrictions were included in the model (Table 11). These variables are represented by natural resource agency review of the landowner’s enrollment application (PTP_APP_REV), restrictions on buildings and other construction on enrolled lands (PTP_OWNBUILDING), and stewardship restrictions represented by an emphasis on timber production (ECO). All three variables were hypothesized to negatively impact the probability of program enrollment. Additional natural resource agency review of the enrollment application was thought to be viewed as an extra bureaucratic hurdle to entry. Restricting building on enrolled lands was thought to represent the stringency of preservation associated with the program and was highly correlated with other variables that limited management autonomy which were not included in the model (e.g., restrictions on commercial operations associated with enrolled lands). Since landowners tend to express a preference for aesthetic and amenity benefits over strictly economic incentives such as timber production (Koontz, 2001; Ryan et al., 2003), PFFTP focus on timber production was thought to poorly align with the woodland management objectives of many family forest owners.

Land Characteristics

In this study, land characteristics consist of two subcategories that are hypothesized to influence the enrollment decision: 1) parcel characteristics; and 2) characteristics of the surrounding land use. Individual parcel characteristics are often included in empirical studies and measure a range of characteristics from parcel size to percentage of land cover (Kauneckis and York 2009). Method of land acquisition (e.g., purchased or inherited), has been shown to impact the PFFTP enrollment decision (Stevens et al., 2002). Distance to cities or urban centers have been explored as an indicator of land

development pressure (Kilgore and Bagdon, 2013). Specific characteristics of the surrounding land are included as a metric for assessing opportunity costs of conservation. For instance Kilgore and Bagdon (2013) include parcel proximity to a lake, river, and/or road and a minimum distance to an incorporated city as predictors of enrollment in one of two Minnesota-based PFFTP. Polyakov and Zhang (2008) highlight the differences between major land use categories in Louisiana (agriculture, forestry, Conservation Reserve Program (CRP), developed, and other) and their interaction with tax incentives for influencing land use change. Considering enrollment in natural resource preservation programs generally, Kaueckis and York (2009) distinguish parcel use characteristics as being forest and/or some combination of agriculture or residential.

Characteristics specific to the individual parcel and characteristics of the surrounding land use were used in the model (Table 11). Characteristics specific to the wooded parcel included the method of acquisition being purchase or other (ACQ_TYPE_PURCH), whether the landowner owned a home on or within one mile of the property (HOME), and the log of the size of the wooded acreage on the property (LNACRES). Landowner parcel acquisition through purchase was hypothesized to increase the likelihood of PFFTP enrollment, as it was thought, based on personal experience, that the landowner would be likely in this situation to seek out management advice. This would increase the likelihood of their contact with a professional or other individual with PFFTP knowledge. However, previous empirical work demonstrates the opposite effect of this land ownership characteristic. For instance, having purchased the property negatively influenced participation in West Virginia's Managed Timberland program (Fortney et al., 2011). Wolde et al. (2016) found that owners who purchased their woodland were less likely to participate in public incentive programs for forest management.

Fortney et al. (2011) found that living within the same county had a negative effect on enrollment in West Virginia's Managed Timberland program. However, we hypothesize that the probable effect of residential/non-residential use of a wooded parcel is uncertain. First, absentee ownership may negatively influence enrollment via increased difficulty accessing program information and advice. Conversely, according to this variable, no distinction is made between landowners who actually live on or just within one mile of their parcel. Living on the parcel may negatively influence enrollment because landowners may be less willing to convey management autonomy (e.g., mandatory timber harvests or restrictions on construction) around their home site. Because this variable does not differentiate between landowners who explicitly live on their wooded land and those that just live within one mile of their wooded land, the hypothesized effect of this variable is ambiguous.

The number of wooded acres associated with the parcel is hypothesized to positively influence the probability of enrollment in a PFFTP as greater acreage has been found to be associated with a variety of forest land management behaviors (Butler et al. 2016). To adequately capture the relationship between the size of the landowner's wooded acreage and PFFTP enrollment, the log of the wooded acres was taken (Table 11). Taking the log of this variable for use in empirical models is common as distribution of woodland ownership size is often highly positively skewed (e.g., Fortney et al., 2011; Ma et al., 2012). Therefore, the log approximation of this relationship is used in our model (LNACRES). Consistent with past empirical studies (Kilgore et al., 2008; Ma et al., 2012; Wolde et al., 2016), the size of the wooded acreage was expected to lead to increased owner engagement in conservation program participation.

Land uses that characterize the land base surrounding eligible forested parcels was hypothesized to influence the PFFTP enrollment decision (Table 11). These metrics are thought to simultaneously reflect a measure of opportunity costs associated with alternative land development and act as a metric for

historical land uses of the adjacent land base (e.g., agrarian). Due to the economic and cultural importance of agriculture in the U.S. and its subsequent demand for land use, the proportion of the surrounding land base (1 km radius) developed for agricultural use (PROP_AG), as determined by the 2011 National Land Cover Database (Homer, 2015), was used in our model. An increase in this variable was hypothesized to decrease the likelihood of program enrollment.

Second, the proportion of the surrounding land base (1 km radius) classified as developed by the 2011 NLCD (Dewitz, 2011) based on the presence of impervious surfaces (PROP_DEV), was included in the model as a unique measure of urban development pressure. This landscape characteristic represented a competing land use that would not necessarily be observed by other metrics for development, such as population density. For instance, high demand may exist for housing and infrastructure in seasonal tourist destinations but may not be accompanied by high numbers of permanent residents (e.g., seasonal cabin or recreational destinations). Proportion of surrounding land designated as developed (impervious surface) was hypothesized to negatively influence the likelihood of tax program enrollment. For instance other studies have used various metrics of urban development to have a negative effect on predicting participation in Vermont's Use Value Appraisal property tax program (Dennis and Sendak, 1992) and in predicting participation in voluntary forest conservation programs for Indiana woodland owners (Kauneckis and York, 2009).

4.3.4. Endogeneity

An endogenous explanatory variable in a regression equation is defined as any in which an explanatory variable may be correlated with the error term (Wooldridge, 2012). Correlation of an explanatory variable with the error term can stem from simultaneous determination, which arises when changes in the dependent variable change the value of a covariate (i.e., an explanatory variable is jointly determined with the dependent variable) (Wooldridge, 2012). Therefore, the hypothesis that level of tax program knowledge (TAX_KNOW) is a key predictor of tax program enrollment is problematic, as tax program knowledge most likely increases with enrollment in a tax program.

Several approaches exist for addressing model bias when considering simultaneity. The primary method includes using simple simultaneous equation models or SEMs (Wooldridge, 2012). The leading method for SEM estimation is to use an instrumental variable, which has applications for modeling binary outcomes. An instrumental variable is correlated with the endogenous variable but is uncorrelated with the error term of the regression model. The method of two stage least squares (2SLS) is one that can be used to estimate a linear probability model where the dependent variable is binary (Wooldridge, 2012). Second, a probit model can be estimated using maximum likelihood estimation with instrumental variables (Wooldridge, 2012).

Several attempts were made at identifying an instrumental variable for use in our model, but it was not possible to identify any reliable variables, or combination of variables, that met the requirements for use as an instrumental variable and for which we had data. Therefore, our model excludes program knowledge as a predictor variable and also does not contain an instrumental variable to control for program knowledge. Excluding a relevant predictor variable, or underspecifying the model, will lead to inconsistent and biased estimates (Wooldridge, 2012). However, by the nature of our assumption that a landowner must have some familiarity of the tax program to enroll, we have controlled for some of the variation in program knowledge by constraining the data set to only landowners who knew about the program. We believe this was a defensible decision because of the landowners who reported having zero

knowledge of the tax program, less than one percent are enrolled in the program and including the variable TAX_KNOW directly would result in endogeneity.

Not including level of tax program knowledge directly in this model has implications for its interpretation. Specifically, including just landowners who knew the program existed limits application of this model to just landowners with that characteristic. We maintain that identifying predictors of PFFTP enrollment for landowners who knew the program existed is relevant to forest tax policy. Asking why landowners who knew their PFFTP existed and did not enroll is a fundamentally different policy question than asking why landowners did not know the program existed.

4.4. Results

4.4.1. Tax Program Familiarity Analyses

Fifty-four percent of family forest owners who were otherwise eligible for inclusion in our binary logistic regression model predicting PFFTP participation were not included in the model because they were not at all familiar with their state's PFFTP. As noted earlier, the implications of our decision to include only landowners who were at least somewhat familiar with their PFFTP is that the population of landowners eligible for our model is now more limited and extrapolation of conclusions from our model is only applicable to landowners who knew their PFFTP existed. However, the group of landowners who did not know their PFFTP existed is equally important, and our model likely may have performed differently had this group of landowners been included.

In an attempt to shed light on differences between family forest owners who were familiar with their PFFTP ($TAX_KNOW \geq 2$) and those who were not ($TAX_KNOW = 1$), we performed two analyses comparing these two groups. The first analysis compares landowners according to the variables used in our binary logistic regression model, and the second analysis compares landowners according to a broader suite of NWOS characteristics and ancillary land data. To complete these analyses, we used SAS 9.4 (SAS Institute Inc., 2013) to conduct two sample t-tests to test for statistical differences in means and Chi-square tests to test for significant differences in distributions between the two groups (Dalgard, 2008). Statistical significance was established at $\alpha = 0.05$ level.

First, we compared measures of central tendency between these two groups for the predictor variables included in our binary logistic model. Thus, we hypothesized that characteristics relevant to the PFFTP enrollment decision might vary significantly between these two groups. Differences between landowners who were at least slightly familiar with their tax program and those who were not at all familiar with their tax program were found in every category hypothesized to drive PFFTP participation. These differences suggest that the results of our binary logistic regression model would likely have varied if family forest owners had not been screened based on their level of tax program familiarity. For instance, the financial benefit of PFFTP participation, based on the $\log(\text{population} * \text{tax benefit})$ (LN_SPECIFIC_BENEFIT), was significantly higher for landowners that were at least slightly familiar with the program compared to those that were not. The financial cost, as measured by the maximum number of years a retroactive monetary penalty for early withdrawal could be assessed (PENALTY_YEARS), was higher for the population of landowners who were at least slightly familiar with their PFFTP compared to those that were not. Table 12 contains measures of central tendency for model variables and indications of statistically significant differences between woodland owners who were at least slightly familiar and those who were not at all familiar with their PFFTP.

Table 12. Descriptive statistics for landowners who are familiar versus those who are not familiar with their state’s Preferential Forest Property Tax Program (PFPTP) for variables hypothesized to be important predictors of PFPTP participation. Mean values are reported unless otherwise noted.

Category/Variable	Dataset Variable	Description	Familiar (N=1,752)	Not Familiar (N=2,098)
Financial Benefit				
Log(population*tax benefit)*	LN_SPECIFIC_BENEFIT	Continuous: log of PFPTP tax benefit*square mile population density in 2010 census block	5.20	4.95
Financial Cost				
Penalty ^{1*}	PENALTY_YEARS	Continuous: maximum number of years a retroactive monetary penalty could be assessed for early program withdrawal	13.16	9.60
Personal Characteristics				
Education ²	OWN1-EDU2	Categorical: Associates Degree or greater = 1, no college degree=0	.59	0.44
Development Concern ^{3*}	CNC_DEV2	Binary: Great concern/concern=1, moderate concern or lower=0	0.48	0.43
Taxes Concern ³	CNC_TAX2	Binary: Great concern/concern=1, moderate concern or lower=0	0.79	0.77
Investment Objective ^{4*}	OBJ_INV2	Binary: Very important/important=1, moderate importance or lower=0	0.47	0.51
Timber Objective ^{4*}	OBJ_TIM2	Binary: Very important/important=1, moderate importance or lower=0	0.43	0.31
Wildlife Objective ⁴	OBJ_WIL2	Binary: Very important/important=1, moderate importance or lower=0	0.79	0.78
PFPTP Enrollment Criteria/Restrictions				
Application Review*	PTP_APP_REV	Binary: Natural resource	0.53	0.45

No Building*	PTP_OWNBUILDING	agency review enrollment application (1=yes, 0=no) Binary: Residence/buildings on property restricted (1=yes, 0=no)	0.49	0.43
Program Emphasis*	ECO	Binary: PFPTP major ecosystem emphasis is timber production (1=yes, 0=no)	0.56	0.69

Land Characteristics

Purchased*	ACQ_TYPE_PURCH	Binary: Wooded land was purchased (1=yes, 0=no)	0.75	0.72
Log(wooded acres)*	LNACRES	Continuous: log of parcel wooded acres	4.52	4.16
Home	HOME	Binary: home or primary residence on or within one mile of wooded land (1=yes, 0=no)	0.61	0.58
Ag ¹ *	PROP_AG	Continuous: proportion of land that is agricultural crop or pasture land within a 1 km radius of respondent's wooded land	0.10	0.16
Development ¹	PROP_DEV	Continuous: proportion of land that is developed (impervious surface) within a 1 km radius of respondent's wooded land	0.04	0.04

*Statistically significantly different distributions established at $\alpha \leq 0.05$ level.

¹ Binary response measure created based on landowner education level \geq Associate degree = 1 and landowner education level $<$ Associate degree = 0.

² The 2013 NWOS survey respondents were asked to rank their concern in regards to their wooded lands on a 1-5 Likert scale; 5 being great concern and 1 being no concern. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

³ The 2013 NWOS survey respondents were asked to rank the importance of the reasons for owning their wooded land on a 1-5 Likert scale; 5 being very important and 1 being of not important. Likert scale ranked values were converted to a binary variable with a value of 1 assigned if respondents answered 4 or 5 and 0 if respondents answered 1, 2, or 3.

Landowners who were at least slightly familiar with their PFPTP were more concerned for the development of the surrounding land (CNC_DEV), and more ranked timber production as a woodland management objective (OBJ_TIM) as important or very important than owners who were not at all familiar. For instance, 43% of owners who were at least slightly familiar and 31% of owners who were not at all familiar with their PFPTP ranked timber management as important or very important. Conversely, owners who were not at all familiar with their PFPTP ranked investment objectives (OBJ_INV) for their wooded property higher than those who were at least slightly familiar. Owner education level (OWN1_EDU2), concern for taxes (CNC_TAX), and wildlife management objective (OBJ_WIL) did not vary significantly between these two groups of landowners.

Statistically significant differences in PFFTP enrollment criteria/restrictions were found between the population of landowners who were at least slightly familiar and those that were not at all familiar with their PFFTP. For instance, a higher percentage of owners who were at least slightly familiar with their PFFTP were otherwise eligible to enroll in a PFFTP that mandated natural resource agency review of the enrollment application (PTP_APP_REV) and restricted building on enrolled woodlands (PTP_OWNBUILDING) compared to owners who were not at all familiar with their PFFTP. However, 56% of owners who were at least slightly familiar with their PFFTP were otherwise eligible to enroll in a PFFTP that emphasized timber production (ECO) compared to 69% of owners who were not at all familiar with their PFFTP.

Characteristics of the land differed significantly between owners who were at least slightly familiar and those who were not at all familiar with their PFFTP. For instance, a larger proportion of landowners who were at least slightly familiar with their PFFTP had purchased their wooded land (ACQ_TYPE_PURCH). The log of wooded acres (LNACRES) was larger for landowners who were familiar with their PFFTP. However, a greater percentage of the surrounding landscape was developed for agricultural use (PROP_AG) for landowners who were not at all familiar with their PFFTP (16%) compared to landowners who were at least slightly familiar with their PFFTP (10%). Having a home or site of primary residence on or within one mile of the wooded property (HOME) and the proportion of the surrounding landscape that was developed (impervious surface) (PROP_DEV) did not vary significantly between these two groups of landowners.

Table 13 contains a broader suite of information describing how selected landowner and land characteristics vary across landowners who were eligible for our binary logistic regression model but differed according to their level of tax program knowledge (i.e., those that were at least slightly familiar with their PFFTP and those that were not at all familiar). Measures of central tendency for important variables and results of tests for significant differences between these two groups are reported in Table 13. Landowner and land characteristics in this table are organized into eight categories which were hypothesized to distinguish family forest owners from one another (these are the same variable categories used in Chapters 2 and 3). See Table 1 for a description of the variables comprising these categories.

Table 13. Descriptive statistics for landowners who are familiar versus those who are not familiar with their state’s Preferential Forest Property Tax Program (PFFTP). Mean values (5 point Likert Scale, nominal) are reported unless otherwise noted.

Category/Variable	Original Variable	Familiar (N=1,752)	Not Familiar (N=2,098)
Owner Social/Economic/ Demographic			
Gender ^{4*}	OWN1_GENDER	0.83	0.80
Age ^{1*}	OWN1_AGE	63	64
Income ^{1,2*}	INCOME	\$75,000	\$75,000
Education ^{1*}	OWN1_EDU	5	3
Income from woods	INC_WOOD	3.27	2.64

Owner Attitudes/ Concerns				
Taxes concern*	CNC_TAX	4.24	4.15	
Development concern*	CNC_DEV	3.27	3.10	
Succession concern	CNC_HEIR	4.16	4.13	
Tax help	HELP_TAX	3.92	3.88	
Timber markets help	HELP_TIM	3.45	2.97	
Cost share help*	HELP_COST	3.24	3.05	
Owner Reasons for Owning Wooded Property				
Objective aesthetics*	OBJ_BEA	4.31	4.23	
Objective wildlife	OBJ_WIL	4.19	4.18	
Objective investment	OBJ_INV	3.32	3.36	
Objective children	OBJ_CHILD	4.00	4.05	
Objective timber*	OBJ_TIM	3.13	2.65	
Objective recreation*	OBJ_REC	3.53	3.40	
Objective hunting*	OBJ_HUNT	3.27	3.44	
Objective residence	OBJ_HOM	4.28	4.22	
Owner Participation in Forestry Assistance Programs				
Cost share familiarity*	COST_KNOW	2.28	1.63	
PFPTP familiarity*	TAX_KNOW	3.68	1.00	
Tax*	TAX	0.62	0.00	
Cost share*	COST	0.21	0.09	
Advice*	ADVICE	0.50	0.16	
Past Land Management Activities, Practices, Assistance, and Land Uses				
Transfer ¹	TRAN	0	0	
Purchased ^{3*}	ACQ_TYPE_PURCHASED	0.75	0.72	
Inherited ³	ACQ_TYPE_INHERITED	0.31	0.32	
Management plan*	MAN_PLAN	0.44	0.10	

Harvest 5 years*	ACT_CUT_SALE	0.33	0.18
Invasive 5 years*	ACT_INVA	0.30	0.25
Harvest*	CUT_LOG_SALE	0.57	0.38
Forester*	CUT_FORESTER	0.48	0.25
Logger*	CUT_LOGGER	0.43	0.26

Planned Future Activities and Uses

Future harvest*	CUT_FUT_SALE	2.79	2.12
Future transfer	TRAN_FUT	2.03	2.04
Sell	ATT_SELL	2.39	2.41
Wooded*	ATT_WOODED	4.52	4.43

Wooded Land Characteristics

Tenure ^{1*}	YEARS_OWNED	23	21
Residence	HOME	0.61	0.58
Farm	FARM	0.36	0.38
Cabin*	CABIN	0.23	0.19
Acres woods ¹	AC_WOOD	88	58

Proximate Land Use and Development Activity/Potential

Population ^{1,5}	POP_10_SQMI	34	26
Urban distance ^{1,5*}	URB_DIST	10,157	11,553
Forest ^{1*}	PROP_FOR	0.76	0.66
Agriculture ^{1,5*}	PROP_AG	0.10	0.16
Development ^{1,5}	PROP_DEV	0.04	0.04
Road density ^{1,5}	RD_1KM	176	166

See Table 1 for variable descriptions.

*Statistically significantly different distributions established at $\alpha \leq 0.05$ level.

¹Median value.

²Midpoint of 2013 NWOS respondent annual income category is reported.

³Variable is not mutually exclusive.

⁴Binary; male=1, female=0

⁵Family Forest Research Center (FFRC) variable.

Sixty-two percent of landowners who were at least slightly familiar with their PFPTP were enrolled, while less than one percent of landowners who were not at all familiar with their PFPTP were enrolled. Statistically significant differences between these two populations were found in all eight categories of landowner/land characteristics (Table 13). Regarding the social and economic characteristics of the two groups, landowners who were at least slightly familiar with their PFPTP had obtained, on average, a bachelor's degree. Landowners who were not familiar with their state PFPTP had had educational attainment amounting to some college experience but no college level degree (e.g., Associates or bachelor's degree). Landowners who were not at all familiar with their PFPTP were less concerned about taxes and the development of nearby lands and ranked timber management as an ownership objective as less important than landowners who were at least slightly familiar with their PFPTP.

Landowners who were not at all familiar with their state PFPTP were less familiar with available cost share programs for forest management, and only 9% of the owners who were not at all familiar with their PFPTP had used a cost share program for forest management, as compared to 21% of the landowners who were at least slightly familiar with their PFPTP. Just 16% of landowners who were not at all familiar with their state PFPTP had received woodland management advice in the past five years, compared to 50% of the landowners who were at least slightly familiar with their state PFPTP (Table 13).

Landowners who were not at all familiar with their PFPTP had been less active timber managers. For example, fewer landowners that were not at all familiar with their PFPTP had a forest management plan (FMP), harvested timber in the past five years, harvested timber since owning the wooded land, or treated invasive plant species in the past five years. Regarding future intentions, landowners not at all familiar with their state PFPTP were less likely to have plans for future timber harvesting. Landowners were no different regarding their plans for future transfer or sale of their wooded property, but landowners who were not at all familiar with their state PFPTP were less likely to agree with wanting their wooded land to stay wooded.

Landowners who were at least slightly familiar and those that were not at all familiar with their PFPTP did not differ regarding their use of their wooded land as part of a primary residence or as part of a farm. However, landowners who were not at all familiar with their state PFPTP had owned their wooded land for slightly shorter durations. Regarding characteristics of the surrounding landscape, these landscapes were no different in the population density or proportion of developed use surrounding the wooded parcel. However, the wooded parcels of landowners who were not at all familiar with their PFPTP were, on average, further from urban areas and surrounded by higher proportions of land that is developed for agricultural use. For instance, 15% of the land base surrounding wooded parcels of owners who were not at all familiar with their PFPTP was, on average, developed for agricultural use, as compared to 8% of the land base surrounding wooded parcel of landowners who were at least slightly familiar with their PFPTP.

4.4.2 Tax Program Familiarity Analysis Summary

Based on this analysis, a variety of differences exist between family forest owners who are at least slightly familiar with their PFPTP and those that are not at all familiar with their PFPTP. Family forest owners who are not at all familiar with their PFPTP may be further uninterested in the incentive structure employed by PFPTPs which includes managing timber and receiving a tax deduction. For instance, this group of woodland owners is less concerned about taxes and less interested in managing their woodland for timber production. Similarly, many of the management activity characteristics available for comparison related to timber production, and family forest owners who are not at all familiar with their

PFFTP had been far less engaged with those activities (e.g., past harvesting). Last, these ownerships are commonly associated with areas where the surrounding landscape is more developed for agricultural use. These analyses reveal that woodland owners who are not at all familiar with their PFFTP are less engaged with forest management (based on characteristics we were able to assess), less motivated by PFFTP structure, and own land in areas that may be less culturally and economically focused on woodlands.

4.4.3. Results of Binary Logistic Regression Model

Table 14 contains descriptive statistics for explanatory variables used in our binary logistic regression model, and Table 15 contains model results. Nine of the 15 explanatory variables included in the model are significant, with at least one explanatory variable from each of the five categories hypothesized to influence family forest landowner enrollment (Table 15). Overall, the model estimates that 62% of eligible family forest owners (e.g., those that met the minimum and maximum wooded acreage requirements and were at least slightly familiar with their PFFTP) in the dataset are more likely than not to be enrolled in a PFFTP.

Table 14. Descriptive statistics of explanatory variables used in the binary logistic regression model.

Variable	Mean	Minimum	Maximum
Financial Benefit			
LN_SPECIFIC_BENEFIT	5.20	-1.01	9.45
Financial Cost			
PENALTY_YEARS	13.16	0	30
Personal Characteristics			
OWN1_EDU2	0.59	0	1
CNC_DEV2	0.48	0	1
CNC_TAX2	0.79	0	1
OBJ_INV2	0.47	0	1
OBJ_TIM2	0.43	0	1
OBJ_WIL2	0.79	0	1
PFFTP Enrollment Criteria/Restrictions			
PTP_APP_REV	0.53	0	1
PTP_OWNBUILDING	0.49	0	1
ECO	0.56	0	1
Land characteristics			
ACQ_TYPE_PURCH	0.75	0	1
LNACRES	4.52	0.69	9.74
HOME	0.61	0	1
PROP_AG	0.17	0	0.95
PROP_DEV	0.06	0	0.67

Table 15. Binary logistic regression results (dependent variable is state PFFTP enrollment status).

Variable	Coefficient	Standard error	Odds ratio	Marginal effect
Financial Benefit				
LN_SPECIFIC_BENEFIT	0.2195**	0.0462	1.2455	0.051851
Financial Cost				
PENALTY_YEARS	0.0288**	0.00742	1.0292	0.006803
Personal Characteristics				
OWN1_EDU2	0.2748*	0.1353	1.3163	0.0649
CNC_DEV2	-0.279*	0.135	0.7565	-0.0659
CNC_TAX2	0.0109	0.1695	1.0110	0.0026
OBJ_INV2	0.1747	0.1384	1.1909	0.0413
OBJ_TIM2	0.0437	0.1459	1.0447	0.0103
OBJ_WIL2	0.4146**	0.1605	1.5138	0.0979
PFPTP Enrollment Criteria/Restrictions				
PTP_APP_REV	-0.9692**	0.1546	0.3794	-0.2290
PTP_OWNBUILDING	-0.1847	0.1432	0.8314	-0.0436
ECO	-0.9091**	0.1511	0.4029	-0.2148
Land characteristics				
ACQ_TYPE_PURCH	-0.1701	0.1633	0.8436	-0.0402
LNACRES	0.2384**	0.0568	1.2692	0.05632
HOME	-0.2474	0.1419	0.7808	-0.0584
PROP_AG	-0.7663*	0.365	0.4647	-0.1810
PROP_DEV	3.1403*	1.3375	23.1108	0.7418
Constant	-1.2402*			
N	1,141			
-2 Log likelihood	1,538.685			
Prediction Success				
% Concordant	71.1			
% Discordant	28.9			

* $P \leq 0.05$

** $P \leq 0.01$

Financial Benefit

Increasing the size of the per acre tax program benefit variable LN_SPECIFIC_BENEFIT (log(PFPTP per acre tax benefit (\$) * census block population)) increases the estimated probability of enrollment. Specifically, increasing the log of the product of tax program benefit (savings) in dollars per acre and the census block one square mile population density where the wooded parcel is located by one unit from the mean increases the estimated probability of enrollment by 5.2% (Table 15).

Financial Cost

The financial cost of program enrollment was defined in our study as the financial value of the penalty for early withdrawal from the PFFTP. Contrary to our hypothesis, we found that increasing the maximum number of years a monetary penalty for early withdrawal from the tax program could be assessed by one year, often equal to the back taxes plus interest, increases the probability of enrollment by 0.7%.

Personal Characteristics of the Landowner

Three of the six personal landowner characteristics are statistically significant drivers of PFFTP enrollment (education level, concern for development, and having a wildlife-oriented woodland ownership objective). For example, if a landowner has education at an associate degree or higher level, the probability of enrollment increases an estimated 6.5%. Landowners with a wildlife-focused ownership objective were more likely to enroll. Specifically, having a wildlife-focused ownership objective increases the estimated probability of enrollment by 9.8%.

Landowners who were concerned about development of nearby lands were less likely to enroll, decreasing the estimated probability of enrollment by 6.6%.

PFFTP Enrollment Criteria and Restrictions

Specific characteristics and enrollment criteria of the PFFTP are significant drivers of program enrollment. Specifically, mandating state natural resource agency review (e.g., Wisconsin Department of Natural Resources) of the landowner's enrollment application decreases the estimated probability of enrollment by 22.9%. PFFTP ecosystem emphasis on timber production, as opposed to more specifically emphasizing and promoting other ecosystem services such as open space and water quality, reduces the estimated probability of enrollment by 21.5%. Restricting building on enrolled woodlands is not a significant predictor of the estimated probability of PFFTP participation.

Land Characteristics

Consistent with our hypothesis, characteristics of the landowner's wooded parcel as well as characteristics of the surrounding land base are significant predictors of PFFTP enrollment. Two variables, woodland acquisition type and having a home on or within a mile of the wooded property, were not found to be statistically significant predictors of the estimated probability of PFFTP participation. Regarding the landowner's specific wooded parcel, owners of larger wooded acreages are more likely to enroll in PFFTPs. A one unit increase from the mean log acres of woods owned (i.e. an increase in lnacres from 4.51 to 5.51) increases the estimated probability of enrollment by 5.6%.

Increasing the proportion of agricultural land use within one square kilometer surrounding the wooded ownership from the mean by 0.01 (one unit) decreases the probability of enrollment by about 1/10th of one percent. Moreover, a landowner who owned land with no surrounding agricultural land use relative to a landowner with 100% of the surrounding land use developed for agriculture demonstrates a 18 percentage point increase in the estimated probability of enrollment (i.e., this is the marginal (discrete) effect reported in Table 15).

Increasing the proportion of developed land use within one square kilometer surrounding the wooded ownership from the mean by 0.01 (one unit) increases the estimated probability of enrollment by about

7/10th of one percent. Increasing the proportion of land surrounding the landowner's wooded parcel that is developed as impervious surface from 0% to 100% developed results in a 74 percentage point increase in the estimated probability of enrollment (i.e., this is the marginal (discrete) effect reported in Table 15).

4.5. Discussion

These analyses shed light on several important facets of PFFTP participation tendencies of family forest owners across the U.S. analyzed in our model (i.e., those who met PFPPT acreage requirements, owned a single wooded parcel, and were at least slightly familiar with their PFFTP). These results are especially relevant when interpreted within the context of previous empirical research conducted at the state and regional levels. First, a multi-faceted set of landowner characteristics within five broad categories play a role in determining landowner enrollment in PFFTP across the U.S. This research identifies these important categories to be financial benefits of PFPPT participation, financial costs of participation, personal characteristics of the landowner, PFFTP enrollment criteria and restrictions, and characteristics of the wooded land and the surrounding land use. Taken together, this insight confirms the results of other finer scale (e.g., state and regional) empirical analyses that have addressed family forest owner PFFTP participation and expands on them by synthesizing the five major factors hypothesized to influence participation. These include PFFTP financial benefit, PFFTP financial cost, personal characteristics of the woodland owner, PFFTP enrollment criteria/restrictions, and land characteristics.

A limitation of our model is that it applies to a very specific group of family forest owners that met the acreage requirements for their PFFTP, owned a single parcel of land, and were at least slightly familiar with their PFFTP. Considering just our sample population of landowners who were otherwise eligible for their PFFTP, screening on landowners being at least somewhat familiar with their PFFTP eliminated over half of eligible landowners. Screening on single parcel ownerships eliminated 38% of otherwise eligible landowners (2,353 NWOS respondents). While no additional analysis comparing single to multi-parcel landowners was completed for this study, results of the analysis comparing landowners who were at least slightly familiar and those who were not at all familiar with their PFFTP shows that these groups of landowners are statistically significantly different from one another. As no modeling exercise was completed on the latter group of landowners, we cannot say definitively that these two groups behave identically when considering PFFTP participation. More likely, they actually behave differently, and thus, the results of this study need to be interpreted cautiously.

An attempt to validate the results of our model can be made by comparing and contrasting the results to general findings from past empirical research. This analysis shows that when landowner, land, and PFFTP characteristics are assessed across the U.S., specific drivers of PFFTP participation quite accurately reflect drivers of PFFTP participation identified in previous forest tax policy empirical literature. For instance, our model shows that education level, amenity objectives associated with woodland management, size of woodland holding, and the annual financial benefit of enrollment are significant, positive predictors of program participation. The remainder of this discussion will focus on the five categories of characteristics hypothesized to influence PFFTP participation by U.S. family forest owners who were eligible for this analysis.

Financial Benefit

This study identifies that increasing the tax benefit (LN_SPECIFIC_BENEFIT) of PFFTP participation leads to increases in the probability of PFFTP participation, all else equal. Our dataset did not provide

actual data on an individual landowner's financial benefit of PFFTP participation (i.e., we only knew the average statewide, per acre tax benefit of participation). In order to model the effect of the PFFTP's tax benefit on participation, we used the 2010 census block population where the wooded ownership was located as a scaling factor to approximate the specific level of financial benefit provided to a woodland ownership (on a per acre basis). One drawback of this approach, is that it may undervalue the tax benefit awarded to highly valued lands in low population areas. One potential example of a misvaluation is in agrarian regions, where farmable land values may be high but populations may be low.

While this variable has the expected effect on participation, it is evaluated for average characteristics of woodland ownerships and PFFTPs (e.g., at the means of predictor variables). Thus, we are unable to say which specific PFFTP characteristics might drive required increases in financial benefit for increased participation or increased production of specific goods (e.g., timber), which would be useful for using this variable to inform forest tax policy. To do so, policy makers will need to be further equipped with more detailed analyses that identify the economic tradeoffs of forest tax policy design. These may be in terms of value added output from timber industries; identification of PFFTP criteria that truly work to increase the production of public goods from private forests by keeping forests as forests; and, ultimately, economically relevant payments for ecosystem services such as clean water, purified air, or aesthetics. Relevant payments for ecosystem services would enable policy makers to bridge connections between public spending on forest resources and potential economic and environmental benefits.

Financial Cost

The proxy we used for financial costs of PFFTP participation is the maximum number of years a penalty for early withdrawal can be assessed. The coefficient for this variable is positive and statistically significant, according to our model predicting PFFTP participation for landowners eligible for our model (see Figure 4). This effect is counterintuitive because increasing the maximum number of years a penalty for early program withdrawal can be assessed essentially decreases asset liquidity and thus, limits landowner management flexibility. One explanation for the seemingly opposite effect of this variable is that it inaccurately captures landowner sentiment regarding the financial costs of PFFTP participation. This could be true if landowners are generally unaware of implied program commitment periods (i.e., if they withdrawal early, there will be financial penalties up to a certain number of years). Thus, ambiguity regarding interpretation of this variable minimizes its usefulness for informing forest tax policy, and further discussion should be interpreted tenuously.

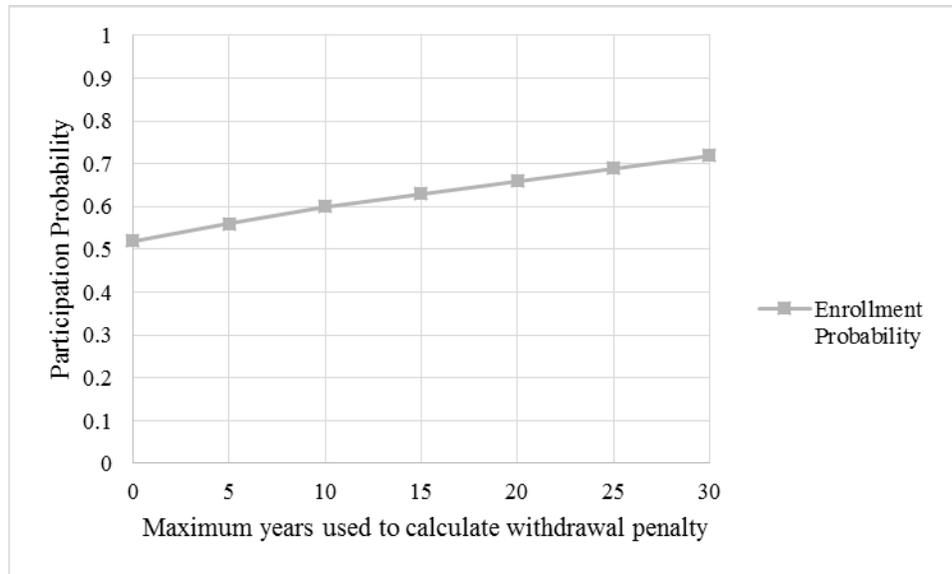


Figure 4. Estimated probability of family forest owner participation at various levels of years used to calculate the maximum penalty for early program withdrawal (the model proxy variable for financial costs of PFFTP participation). Remaining explanatory variables are evaluated at their means.

As defined in this study, the financial costs of enrollment will only be realized if a landowner chooses to voluntarily withdraw their wooded property from the tax program earlier than is acceptable under the program’s land covenant. The effect of this variable can be positive only if there is a legitimate reason for landowners to desire that their wooded land stay enrolled in the PFFTP for a longer period, enforced by a continually increasing penalty for withdrawal. Using the landowner’s attitude toward selling their woodland if offered the right price and their agreement with wanting to keep their wooded land wooded provides insight, in this regard. Accordingly, 20% of participating woodland owners disagreed or strongly disagreed with selling their woodland if offered the right price, and 91% of enrolled landowners agreed with wanting their wooded land to stay wooded. Thus, the majority of enrolled landowners may be interpreting greater financial restrictions on early program withdrawal as positive because they perceive this as a reliable avenue to preserving the integrity of their woodland into the future.

Results that suggest landowners react positively to financial costs of PFFTP participation (e.g., the effects of program withdrawal penalties and commitment periods) are rare in the forest tax law literature. One example is Fortney et al. (2011), which identified that West Virginia forest owners who took part in their analysis identified a longer commitment period as a favorable change to the states Managed Timberland program. Nonetheless, an important takeaway from this analysis may be that family forest owners (specifically those used in our model) care deeply for maintaining the integrity of their woodland. They may even be willing to sacrifice future financial gains to better ensure its maintenance and preservation into the future. Additional research that focuses on commitment periods and the associated financial costs of the withdrawal penalty for PFFTPs is needed to better understand this relationship.

Personal Characteristics of the Landowner

Concern for development of nearby lands (CNC_DEV) is significant in the model, but the sign on this variable is inconsistent with logical landowner reactions in that they react negatively (regarding PFFTP

participation) to concerns for development pressure. That is, those landowners who are more concerned about development of nearby land are estimated to be less likely to participate in PFPTPs. There are several plausible explanations for this finding. First, perhaps landowners inconsistently interpret the “nearby” portion of this question when responding to the NWOS. As nearby is undefined, the landowner could plausibly interpret “nearby” in a variety of ways. These range from immediately adjacent to the individual’s forestland to a broader geographic region (e.g., north or south part of the county). Second, depending on the philosophical underpinnings of family forest owners, concern for development may not translate into a motive for conserving one’s own land, or the larger forest resource base. Last, the correlation between concern for development and our two available measures of urban development pressure (PROP_DEV and LN_SPECIFIC_BENEFIT) do not demonstrate statistical significance ($\alpha = 0.05$ level) for landowners eligible for our model. Therefore, the variable CNC_DEV is unexplained within the context of this model and may not be accurately capturing woodland owner sentiment.

Several variables hypothesized to be important predictor variables of PFFTP participation are not significant predictors of the probability of participation in this analysis. These variables include concerns and objectives of the landowner that are related to controlling costs of woodland ownership. For example, level of concern for land taxes (CNC_TAX), land investment objective (INV_OBJ), and timber management objective (OBJ_TIM) are not significant predictors of PFFTP participation for landowners eligible for inclusion in our model. Of these, concern for taxes is perhaps the most surprising. One explanation may be that landowner concern for taxes may be socially and politically complicated or motivated. A landowner may respond to this question in a way that reflects the social and political ideals of the political party they identify with. For instance, if the political party the landowner identifies with promotes a specific platform on the topic of taxation, the landowner may be likely to align their answer to a tax-related question with that party’s platform. This may bias the effect towards zero, but we have no way to control for this in our model. Alternatively, this study demonstrates that woodland owners infrequently sell their wooded land (approximately once every 20 years). Thus, they may view taxes as something they cannot change in the short run and are a policy they just have to “take”, resulting in apathy. Last, concern for taxes could be related to their share of the owner’s household budget. If their share of the budget is relatively small (e.g., perhaps for wealthy individuals) this could result in less concern for taxes and vice versa for woodland taxes that represent a larger shares of an individual’s budget.

If, however, concern for taxes truly has zero effect on PFFTP participation, then a reduction in taxes as an incentive to participate in a PFFTP may not be appropriate. An alternative for policy makers to consider may be offering a direct financial payment for participation. A second alternative may be to offer free or cost shared services aimed at addressing objectives of the landowner that *are* statistically significant predictors of PFFTP participation in our model, such as wildlife objectives.

Regarding forest owner land investment objectives, these family forest owners are less divided on viewing their lands as an investment than expected. All else equal, we would expect a positive effect from owner woodland investment objectives on the probability of PFFTP participation. Since PFPTPs reduce land holding costs by lowering land taxes, participation can be used as a cost controlling measure for a woodland investment. However, at least as many landowners who do not view their woodland as an investment participate in PFPTPs. On one hand, this may validate the appropriateness of the current PFFTP participation incentive structure to solicit participation from a wide segment of woodland owners. Alternatively, some investor woodland owners may view PFFTP restrictions as counteracting investment flexibility. If family forest owners with an investment objective are more likely to sell their wooded land

in the future, this could increase the chance of development for non-woodland purposes (i.e., reduce PFFTP effectiveness at keeping forests as forests). Of the landowners included in our model without an investment objective, 14% stated they agreed with selling their wooded land if offered the right price, while 27% of landowners with an investment objective stated they would sell their land if offered the right price. This difference is statistically significant ($\alpha=0.05$).

The non-significance of having a timber management objective of woodland ownership implies that timber management objectives are not a driving factor of PFFTP participation for family forest owners eligible for our model. This is unexpected because one of the defining characteristics of many PFFTPs is that they emphasize timber production (See Chapter 2). Thus, we hypothesized that woodland owners with a timber objective may see participation as a win-win scenario where they receive a financial bonus for managing their woodland similarly to how they would have if they were not enrolled in the program (i.e., from a commercial timber production standpoint).

Since timber objectives have no appreciable effect on the estimated probability of participation, commercial timber management objectives of these woodland owners may be superseded by PFFTP restrictions on timber production itself. These include requiring harvest plans, harvest notice, and forest management plans (FMPs), for example. These restrictions are likely required to ensure quality forest stewardship, sustainable harvesting, and dependable timber production on enrolled woodlands. States may be remiss in seeking to eliminate these requirements, but they could be relaxed. For instance, if PFFTPs require strict adherence to harvest scheduling developed in the woodland owner's forest management plan, the woodland owner may be restricted in their ability to efficiently time timber markets to maximize harvest profits. Additionally, harvest notice and harvest plan approval (e.g., when required by a natural resource agency) may be viewed as burdensome by woodland owners. This type of burden could be reduced by replacing harvest oversight with random auditing of enrolled lands for adherence to forest management plans and strict penalties for noncompliance. This type of policy could have the effect of incentivizing woodland owners to follow their FMPs and harvest sustainably, while allowing autonomy and flexibility.

PFFTP Enrollment Criteria and Restrictions

Additional government oversight, as well as reduced management autonomy associated with PFFTPs that focus on timber production, both result in reductions in the estimated probability of PFFTP participation for the average family forest owner. For example, natural resource agency review of the landowner's application for enrollment (PTP_APP_REV) reduces the estimated probability of PFFTP participation.

Based on data from Kilgore et al. (2017), natural resource agency review of the enrollment application (PTP_APP_REV) is highly correlated with PFFTPs that require additional government oversight such as minimum commitment periods, forest management plans, harvesting notices, and harvesting plans (e.g., harvest plan submitted to the New York Department of Lands and Forestry). Similar to suggestions from the previous section, this finding may reflect that PFFTPs may be difficult to navigate and/or that family forest owners eligible for this study view reductions in management autonomy negatively. Neither would be surprising. States face a difficult decision, in this regard, when developing PFFTPs. Additional oversight, such as enrollment applications, should be associated with greater adherence to programmatic restrictions and internal validation of adherence to enrollment criteria (e.g. assurance that landowners meet requirements that make them eligible for a tax reduction). However, the potential gains from higher levels of control over private forest resource management may be limited by lower levels of program

participation. Additional research needs to be conducted to identify these tradeoffs in order for states to use insights from this analysis appropriately. As an example, Ma et al. (2014) conducted a national study in which they assessed preferential forest property tax program attributes that were conventionally considered to be important regarding their effectiveness in retaining forest land and fostering management. By measuring PFFTP effectiveness as change in private forest land cover, change in average size of private forest holdings, and the extent to which private forest land is being actively managed, they found that PFFTP attributes previously thought to be important did not always correlate with program effectiveness.

Many of the nation's PFFTPs were developed as a tool to incentivize timber production. Of the landowners eligible for this analysis, 79% had a wildlife objective ($OBJ_WIL \geq 4$) while 43% had a timber objective ($OBJ_TIM \geq 4$). According to this analysis, the estimated probability of PFFTP enrollment across the U.S. is substantively less for landowners whose state PFFTP emphasizes timber production as the primary ecosystem service versus those that do not. The popularity of amenity based management objectives among family forest landowners (Butler et al., 2015), is one factor that makes PFFTPs appear potentially less marketable. Furthermore, the financial incentives required to incentivize conveyance of landowner rights and management autonomy associated with PFFTPs and other conservation programs can be large (Stevens et al., 2002; Kilgore et al., 2008;). This analysis demonstrated in Chapter 2 that, on average, a positive correlation exists between commercial timber production by family forest owners and participation in PFFTPs. Therefore, states developing PFFTPs will need to consider that emphasizing timber production may not lead to increases in program participation, but that appropriately incentivizing family forest owners to participate is correlated with greater likelihood of timber production, relative to family forest owners who do not participate, for landowners eligible for this study.

Building restrictions on enrolled lands had no effect on the estimated probability of PFFTP participation for landowners eligible for our model. This is perhaps due to the ability of landowners to exclude portions of their woodland for building during the PFFTP application process. This effect would bias the effect of this variable towards zero.

Land Characteristics

Regardless of the ecosystem service emphasized by the nation's individual PFFTPs, maintaining forests as forests is a central theme (Kilgore et al., 2017). Our analysis suggests that the estimated probability of PFFTP participation in this regard depends largely on the characteristics of competing land uses. Not surprisingly, increases in the proportion of agricultural use surrounding the owner's wooded parcel ($PROP_AG$) decreases that parcel's estimated probability of enrollment (Figure 5). This may be due, in part, to high opportunity costs of land use in agrarian regions or competing preferential land taxation incentives. For example, owning wooded land as part of or connected to an agricultural operation may already be assessed and taxed at a lower rate under its own current use program (Polyakov and Zhang, 2008). This type of arrangement results in reduced taxes and no assumed opportunity cost associated with tying up potentially productive land. Examples like this illustrate that preferential treatment of certain competing land uses, such as agriculture, may be making PFFTPs in these areas less competitive.

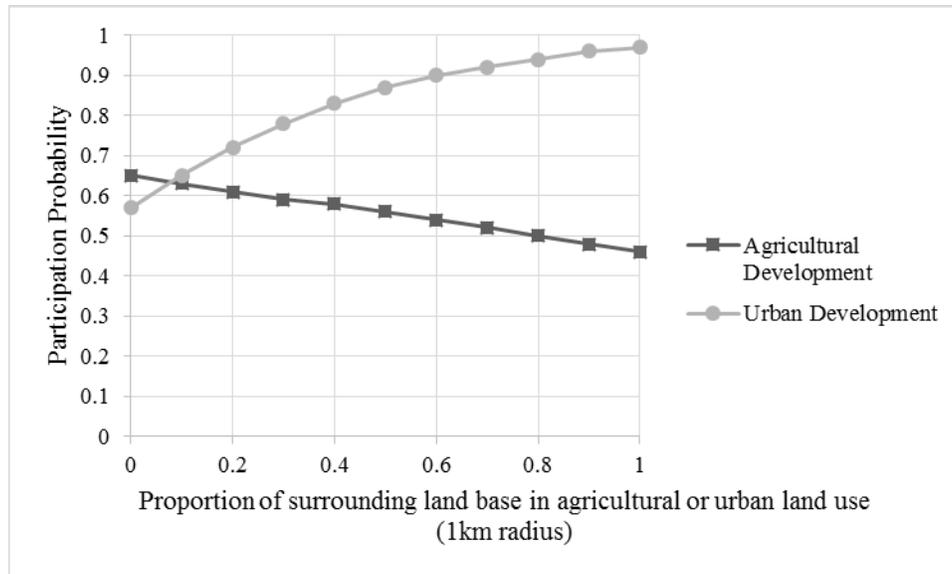


Figure 5. Estimated probability of family forest owner participation in PFPTPs varying the proportion of surrounding agricultural and urban land use development. Remaining explanatory variables are evaluated at their means.

A second land use change that threatens the integrity of the nation’s family forests is urban expansion (Nowak and Walton, 2005). For instance, our results indicate that increasing the proportion of developed land use (based on proportion of impervious surface) (PROP_DEV) surrounding the owner’s wooded parcel increases that parcel’s estimated probability of being enrolled in a PFFTP (Figure 5). Additionally, our model indicates a positive relationship between PFFTP participation probability and the logged product of the per acre PFFTP tax benefit and the census block population (a scaling factor). As discussed earlier, the latter variable is used in our model to represent the financial benefit of PFFTP participation. However, since the variable itself is a function of the population surrounding the wooded land, it has relevant implications for the effect of that population on PFFTP participation.

Taken together, these two land characteristic drivers of participation account for two fundamental forms of urban expansion: 1) development within woodland regions not explicitly experiencing population growth; and 2) development of woodland regions actually experiencing population growth associated with urban sprawl (Heimlich and Anderson, 2001). An example of the former might resemble development pressure associated with seasonal home or cabin building in woodland regions. An example of the latter is rural, wooded areas located peripherally to urban centers that are expanding.

In both cases, we would expect demand for wooded land to be high, driving up market prices and ad valorem property tax rates. Potential displacement of woodland owners may be prevalent in both situations, as opportunity costs begin to outweigh woodland ownership benefits. Thus, with respect to urban sprawl and population growth in forested regions, the positive coefficients for both PROP_DEV and LN_SPECIFIC_BENEFIT may be inconsistent with conventional wisdom and should be interpreted tenuously.

Nonetheless, we suggest instead that landowners may be acting on an impulse to keep their wooded land wooded within a transforming landscape. They, may also be utilizing the increased tax break to partially

offset the potential financial gains associated with the next best opportunity (e.g., divestiture of their wooded land for profit). In situations where policy makers are seeking to curb urban-type development pressure, and for family forest owners represented by the landowners used in our model, continuing to develop PFPTPs that are marketable to landowners experiencing this type of development pressure has merit. Our results suggest that one way to do this is by increasing the financial incentive of participation proportionately to the population (e.g., of the census block).

Neither having purchased the property (versus inherited/other means) (ACQ_TYPE_PURCH) or having a home (primary residence) on or within a mile of the wooded land (HOME) affects the estimated probability of PFPTP participation. Overall, seventy five percent of landowners eligible for our model indicated that they had purchased their property (Table 12), 73% of participating landowners and 78% of nonparticipating landowners (Table 9, Chapter 2). Therefore, an opportunity may exist for information transfer during the land purchasing process. This could be accomplished through strategic partnerships within government (e.g., university extension and/or county auditors/assessors) or with integral entities of the private sector (e.g., realtor services).

While HOME is not a significant predictor of PFPTP participation for landowners eligible for use in our model, this may be due to the wording of the specific NWOS questionnaire. The variable is defined as having a home on or within a mile of the wooded property. In this regard, one hypothesis is that landowners who actually live on their wooded property and those that live close (within a mile) but not on their wooded property make different land management decisions. Since this variable does not control for this nuance, it may be simply capturing the average relationship for these two types of ownerships (i.e., instead of just capturing the effect for landowners who live on their parcel or the effect for landowners who live near their wooded parcel). Thus, the effect of HOME may be biased toward zero. Unfortunately, this was the most accurate representation of this relationship available for use in this model. Controlling for this important relationship could be made possible by rewording this question in future National Woodland Owner Surveys.

4.6. Conclusion

This research is one of the first to empirically assess the relationship between family forest landowner, parcel, and tax program characteristics and participation in state PFPTPs across the U.S. In this analysis, a binomial logistic regression model was used to estimate the probability of PFPTP participation. The analysis' strength is derived from its econometric approach to modeling PFPTP participation and its use of multiple, detailed data sets. These data sets included woodland owner characteristics from the 2013 NWOS, detailed characteristics of every state's PFPTP, and characteristics of the surrounding land use.

To be eligible for inclusion in our model, 2013 NWOS respondent family forest owners had to own wooded land that met the minimum and maximum PFPTP acreage requirements for enrollment, own a single parcel of wooded land in their state for which they completed the NWOS, and be at least slightly familiar with their PFPTP. The analysis demonstrated that five primary categories comprised of landowner characteristics, PFPTP characteristics, and land use characteristics drive participation in PFPTPs for landowners included in this analysis. These five primary categories are the financial benefit of participation, the financial cost of participation, personal characteristics of the woodland owner, PFPTP enrollment criteria/restrictions, and land characteristics. As expected, the financial benefit of participation positively affected the estimated probability of participation. Conversely, the financial cost of participation, defined in analysis as the maximum number of years a penalty for early withdrawal could

be assessed, also positively affected the estimated probability of participation. Although perhaps contrary to conventional wisdom, we suggest that this latter result is plausible and can be attributed to family forest owners' deep desire to keep their wooded land wooded.

We found that the owner's education level and wildlife management objective were significant positive predictors and concern for development of nearby lands a significant negative predictor of the probability of PFFTP participation for family forest owners eligible for this analysis. As the negative coefficient for concern for development of nearby lands makes little sense in the context of PFFTP participation, this regression result may be spurious and should be interpreted cautiously.

Several variables hypothesized to be important predictors of PFFTP participation that were related to controlling costs of woodland ownership were not shown to be significant by our model. These included concern for taxes, investment objectives of the woodland owner, and timber management objectives of the woodland owner. While our model was specified to the best of our ability using all available data, attenuation bias resulting from model misspecification is possible for the estimated effect of concern for taxes and timber management objective. For instance, we suggest that zero effect of concern for taxes on the estimated probability of PFFTP participation may result from a woodland owner's propensity to respond to questions of taxation along political party lines. We also argue that conventional wisdom dictates that owners with a timber management objective would be more likely to participate in PFFTPs. If this characteristic truly has no effect on estimating the probability of participation, it may be because some landowners with a timber objective view PFFTP restrictions on the timber harvesting process unfavorably. Finally, since investment objectives of the landowner have no effect on the estimated probability of PFFTP participation, we suggest that it may be beneficial for forest tax policy to target landowners who do have an investment objective. This approach may have merit because these landowners are more likely to agree with selling their property in the future if offered the right price, according to our model data set.

Additional government oversight, as well as reduced management autonomy associated with PFFTP that focus on timber production, both result in reductions in the estimated probability of PFFTP participation for the average family forest owner. More research is needed to address the specific tradeoffs associated with the degree of PFFTP regulatory structure and its effect on the private forest resource. States that emphasize timber production should understand that it may be a serious deterrent of enrollment.

Many characteristics of the surrounding land use were found to be important predictors of the estimated probability of PFFTP participation by our model. Not surprisingly, the proportion of surrounding land developed as agriculture decreased the estimated probability of participation, but perhaps most interesting was that our results indicate that forest tax policy that targets areas experiencing urban-type development pressure shows promise. We suggest that one way to do this is by increasing the financial incentive of participation proportionately to the population of the census block where the ownership is located, for instance.

Degree of ex ante familiarity with the tax program was thought to positively influence the probability of PFFTP participation. Despite specifying our model as appropriately as possible using available data, we were not able to find a perfect solution to control for level of tax program familiarity. Instead, we screened eligible landowners who were not at all familiar with their tax program. The implications of this decision are practically important. First, the model only estimates the probability of PFFTP participation for landowners who knew the program existed (and met all other study criteria). These results should still

be relevant to policy makers and professionals seeking to better understand why family forest owners who know about forest property tax programs do/do not participate in them. However, our approach left out the large percentage of the family forest owner population represented in our data who were not at all familiar with their PFPTP (greater than 50% of landowners who were otherwise eligible for our model).

The results of a comparative analysis showed that the group of family forest owners who were at least slightly familiar with the PFPTP and the group that was not at all familiar with their PFPTP were statistically different from each other based. Differences in characteristics between these two groups included characteristics from the eight categories developed in Chapter 2 and Chapter 3 (i.e., the categories hypothesized to distinguish family forest owners from one another) and the specific characteristics used to estimate the probability of PFPTP participation using our model. While most of these differences appear to be practically small, landowners who were not at all familiar with their PFPTP confessed less agreement with wanting their wooded land to stay wooded, for instance. They were also less likely to have harvested timber commercially, have a forest management plan, use a forester during timber harvesting, or use a certified or Master Logger during timber harvesting. This specific group of landowners is not well represented in past empirical literature. Future research is needed to address this knowledge gap and should focus on relevant means of communication with this group and the drivers of their woodland management decisions.

Chapter 5: Synthesis

5.1. Summary and Synthesis

From the variety of data used in the three analyses performed, the results of this research allow for a synthesis that takes into account spatial characteristics of the landscape, past and future woodland management approaches, and characteristics of forest tax policy designed to provide public goods. Thus, based on the examination of these data, it may be possible to suggest why family forest owners participate in PFPTPs and if these programs in and of themselves are having a profound effect on improving the sustainability of woodlands owned by U.S. family forest owners. To the extent that the NWOS is representative of family forest owners, it does provide useful insights into the questions asked in this analysis. However, as noted in each chapter, all three analyses included in this research used a narrow population of the family forest owner group, and thus, results are only directly interpretable for those particular segments of that population.

As family forest owners relate to PFPTPs, it appears they are willing to use them to help offset opportunity and holding costs associated with urban development. Other factors that reduce the utility of PFPTPs in agrarian regions may be preventing farmers and landowners in these regions from using PFPTPs. PFPTPs appear to have a relatively small influence on the past management, intentions, and management objectives/woodland concerns of current enrollees. Instead, influential themes appear to be related to cultural (e.g., hunting) characteristics and economic characteristics of woodland use and the surround land uses. Programs with the highest enrollment (i.e., percentage of total state private forestland enrolled in the PFFTP) are comprised of family forest owners who appear to have timber management and other goals that are well aligned with common PFFTP objectives anyway (e.g., timber harvesting, woodland integrity, etc). Thus, evidence from this analysis seems to support the theory that a large portion of resources are spent on incentivizing participation for groups of woodland owners who would be managing their woodland regardless of participation in a state PFFTP.

States might improve the cost effectiveness of public spending on PFPTPs. Improvements could be accomplished by focusing resources on areas where land use characteristics are normally associated with high opportunity costs to woodland ownership. For instance, PFFTP resources could be directed at areas experiencing urban development pressure and agrarian regions. Theoretically, these regions represent an opportunity to close the gap between private interests and society's interests regarding private woodland use and sustainability. Of course, pending unlimited funding, this may require eliminating these programs in areas where woodland owners are more likely to manage their woodland anyway. Unfortunately, this would almost certainly be met with stiff opposition from woodland owners who currently benefit from PFFTP tax reductions.

A strong woodland stewardship ethic and openness to government messaging may present an opportunity to improve conservation program policy by substituting educational type programs for complex and highly regulated PFPTPs. The data sets used in this analysis were rich with information regarding the timber harvesting characteristics of woodland owners and the emphasis placed on timber harvesting by their respective PFPTPs. Regarding both past activities and future plans, woodland owners enrolled in PFPTPs were more likely to be active timber managers. However, our binary logistic model did not estimate that timber production objectives had any effect on PFFTP participation. Thus, we suggest that participating woodland owners were open to influence by their PFFTP because they may have always intended on managing their wooded land according to what they perceived was best for it. In the case of

timber harvesting, state sponsored emphasis and promotion of this activity (and sometimes requiring it) may have helped enrolled woodland owners land on this conclusion.

However, it's not clear that woodland owners who participate in PFPTPs would not have acted in the best interest of their woods to begin with. For woodland owners who participate in PFPTPs, acting in the best interest of their woods by harvesting timber reflects one of society's goals for private forest management. Thus, it might be that other forms of public and/or private engagement could influence woodland owners to align their management with society's interests. For instance, it could be that simply having a face-to-face interaction with a public/private forester would have worked just as well to align the woodland management activities of family forest owners with the woodland management goals of society. Positive PFFTP messaging could be accomplished by educating realtors, auditors, and assessors or through including PFFTP information in property tax statements. This type of approach may be less expensive. It could also eliminate unpopular government oversight that was shown by this analysis to detract from PFFTP participation by family forest owners.

Last, focusing on increasing PFFTP participation at the margin would help improve the relevance of these programs as policy tools. Based on evidence provided regarding timber harvesting and government oversight, PFPTPs that deemphasize these concepts might experience higher beneficial gains in marginal participation by family forest owners. Two policies include simply not requiring timber harvesting and reducing government oversight of the enrollment process. The effect might be to stoke interest in PFPTPs by current nonparticipants

These conclusions are based on a synthesis of the three analyses performed on family forest owners in this research. A summation of this research, and thus, supporting evidence for this synthesis, is provided below.

5.2. Research insights from individual analyses

Insights from The Characterization of the Family Forest Owners Who Participate in state PFFTP across the U.S.

To be eligible for this analysis family forest owners who responded to the NWOS between 2011 and 2013 had to be enrolled in a PFFTP, own a single parcel of wooded land, and meet the minimum and maximum wooded acreage requirements for PFFTP enrollment. The analysis yielded several important observations of family forest owners according to each segmentation. Segmentation categories were based on the following PFFTP characteristics: 1) PFFTP fundamental basis of taxation (e.g., flat tax, modified use tax (current use), and a combination of taxation methods); 2) PFFTP ecosystem emphasis as either Timber or Open Space/All; and 3) Enrollment success based on the percentage of all private forestland enrolled in the state's PFFTP and defined as high, medium, and low.

The analysis yielded several important observations of family forest owners according to each segmentation. First, participants were very similar in their ranking of concern for succession (i.e., passing land onto the next generation), disagreement with selling their land for the right price, and agreement with wanting to keep their wooded land wooded across the three segmentation categories. This suggests an interest in maintaining the integrity of their wooded land and may be a key characteristic that defines these family forest owners.

When this population of family forest owners was segmented according to their PFFTP's fundamental basis for taxation (i.e., flat tax, modified use assessment, and combination tax), the following observations were made: 1) the majority of tax program types are modified use (current use) type programs, but all program types administer a tax break that is directly related to the ad valorem tax rate. This may indicate why no taxation type appears to be more prevalent in states that are experiencing greater development (urban) pressure (based on the proportion of the landscape surrounding wooded ownerships developed as urban); 2) participants of combination type programs are commonly located in agrarian regions; 3) lack of interest in timber management for flat tax program participants is at odds with the timber focus of flat tax programs; and 4) participants of modified use (current use) programs have woodland management objectives that are well aligned with modified use programs.

When the segmentation basis was PFFTP ecosystem emphasis, woodland owners of both timber emphasis and other ecosystem service emphasis PFFTP differed only slightly in their woodland management approach, attitudes and concerns, and objectives. Lack of difference between these groups suggests that regardless of PFFTP emphasis, these two ownership groups are very similar. When the segmentation approach was by PFFTP enrollment success, the analysis yielded results similar to those reported when participants were segmented according to the program's fundamental tax type. Notably, family forest owners of high enrollment PFFTP may be woodland owners who are well suited for PFFTP enrollment, relative to woodland owners of low enrollment PFFTP, and PFFTPs in and of themselves may demonstrate little power to affect the woodland management approach of enrolled family forest landowners. Instead, cultural and economic characteristics of woodland and surrounding land use, such as for agriculture, amenities, or timber may play a larger role.

Results of these segmentations call into question the ability of PFFTPs to actually influence the management of family forest owners. Instead, cultural and economic land use characteristics may limit PFFTP potential to influence family forest owner management activity and sentiment. Thus, policies that align well with the cultural and economic land use norms of the state could gain more traction with family forest owners. Policies that promote woodland management that are adverse to cultural or economic land use norms of woodland owners may have little success.

Insights from The Comparison of the Family Forest Owners Who Participate and Those Who Do Not Participate in State PFFTP across the U.S.

To be eligible for this analysis family forest owners who responded to the NWOS between 2011 and 2013 had to be at least slightly familiar with their PFFTP, own a single parcel of wooded land, and meet the minimum and maximum wooded acreage requirements for PFFTP enrollment. Family forest owners who participated in a PFFTP were found to have many strong relationships with assessed forest management characteristics, relative to nonparticipating owners. These relationships were assessed based on estimates of relative risk. For instance, participating family forest owners were more likely than nonparticipants to have received forest management advice, use a forester or master or certified logger during timber harvesting, be active timber managers, continue to be active timber managers in the future, and agree with wanting their wooded land to stay wooded. One policy implication from these insights is that foresters and master or certified loggers were more often used during timber harvests for this group. A caveat of this analysis is that it is not evident from this data set that PFFTPs actually caused these family forest owners to conduct timber harvests or if they would have conducted them anyway.

A strong association with hunting objectives and owning wooded land as part of a farm or ranch may reveal underlying themes that are preventing PFFTP participation for these family forest owners. These themes reflect cultural tendencies and characteristics of the woodland owner's primary livelihood. Woodland owners may fail to see positive relationships between timber harvesting associated with many PFFTPs and wildlife habitat development. Instead, they may conclude that timber harvesting could have negative effects on wildlife habitat which would lead to reductions in their culturally important, traditional hunting experience. Farmers and ranchers may be less likely to participate in PFFTPs because their wooded land is closely associated with their ability to produce income for their livelihood. Additionally, competing preferential tax treatment for agricultural land use may detract from the financial benefit of PFFTP participation. In these regards, improvements in forest tax policy may be generated through expounding on the benefits of timber harvesting for wildlife management or through eliminating other types of preferential tax treatment for woodlands, such as those associated with agricultural operations.

Insights from the Quantification of the Relationship between Family Forest Owner, Parcel, and Tax Program Characteristics and Participation in State PFFTP across the U.S.

To be eligible for use in our model, family forest owners who responded to the NWOS between 2011 and 2013 had to own wooded land that met the minimum and maximum PFFTP acreage requirements for enrollment, own a single parcel of wooded land in their state for which they completed the NWOS, and be at least slightly familiar with their state's PFFTP. The analysis demonstrated that five primary categories comprised of landowner characteristics, PFFTP characteristics, and land use characteristics drive participation in PFFTPs for landowners included in this analysis. These are the financial benefit of participation, the financial cost of participation, personal characteristics of the woodland owner, PFFTP enrollment criteria/restrictions, and land characteristics. Of the variables that comprised these categories, the following were found to be significant predictors of program participation: our proxy for financial benefit of participation, our proxy for financial cost of participation, owner education, owner concern for development of nearby lands, wildlife objectives of the owner, review of the PFFTP application by the state natural resource agency, PFFTP ecosystem emphasis, the log of the number of wooded acres owned, proportion of agricultural land use surrounding the wooded ownership, and the proportion of urban development surrounding the wooded ownership.

Several variables hypothesized to be important predictors of PFFTP participation that were related to controlling costs of woodland ownership were not shown to be significant by our model. These included concern for taxes, investment objectives of the woodland owner, and timber management objectives of the woodland owner. We suggest that zero effect of concern for taxes on the estimated probability of PFFTP participation may result from a woodland owner's propensity to respond to questions of taxation along political party lines. If a timber management objective truly has no effect on estimating the probability of participation, it may be because some landowners with a timber objective view PFFTP restrictions on the timber harvesting process unfavorably. Finally, investment objectives of the landowner have no effect on the estimated probability of PFFTP participation. We suggest that it may still be beneficial for forest tax policies to target landowners who do have an investment objective, as these landowners are more likely to agree with selling their property in the future if offered the right price, according to our analysis.

The financial cost of participation, defined in this analysis as the maximum number of years a penalty for early withdrawal could be assessed, positively affected the estimated probability of participation.

Although perhaps contrary to conventional wisdom, we suggest that this latter result is plausible and can be attributed to family forest owners' deep desire to keep their wooded land wooded. Additional government oversight (PTP_APP_REV), as well as reduced management autonomy associated with PFFTP that focus on timber production (ECO), both resulted in reductions in the estimated probability of PFFTP participation for the average family forest owner.

The proportion of surrounding land developed as agriculture decreased the estimated probability of participation, but perhaps most interesting was that our results indicate that forest tax policy that targets areas experiencing urban-type development pressure shows promise. We suggest that one way to do this is by increasing the financial incentive of participation proportionately to the population (e.g., of the census block where the woodland is located).

The implications of our decision to screen our model data set of all woodland owners who were not at all familiar with their PFFTP has practical importance. As a result, our model estimated the probability of PFFTP participation for landowners who knew their program existed (and met all other study criteria). This screening reduced the population of otherwise eligible woodland owners by greater than 50%. Thus, this model would almost certainly perform differently if woodland owners who were not at all familiar with their PFFTP were included. As family forest owners who were not at all familiar with their PFFTP constituted a large portion of our potential modeling data set and there is little past empirical research on this specific segment of family forest owners, they warrant attention from future empirical analyses.

Chapter 6: Conclusion

This research is one of the first to empirically assess the relationship between family forest landowner, parcel, and tax program characteristics and participation in state PFPTPs across the U.S. This research is important because family forest landowners control a greater proportion of U.S. forestland than any other single ownership group (Butler et al., 2012). This group provides goods and services from the nation's private forests such as clean air, clean water, carbon sequestration, and biodiversity to everyone. Administered in every state, preferential forest property tax programs (PFPTPs) offer favorable forest property tax treatment as an incentive to promote forest based ecosystem goods and services to society. Family forest landowners play a key role in determining the success of these programs across the U.S.

Our results demonstrated that PFFTP participation for family forest owners who responded to the NWOS between 2011 and 2013, were at least slightly familiar with their PFFTP, owned a single wooded parcel, and met the minimum/maximum acreage requirements for PFFTP enrollment was influenced by five primary categories. These primary categories are comprised of landowner characteristics, PFFTP characteristics, and land use characteristics. These are the financial benefit of participation, the financial cost of participation, personal characteristics of the woodland owner, PFFTP enrollment criteria/restrictions, and land characteristics.

Proxy variables were used for the financial benefit and the financial cost of PFFTP participation and both were shown to positively influence participation. The latter result is contrary to conventional wisdom. However, we argued that because our proxy for financial cost represents the maximum number of years a penalty for early withdrawal from the tax program could be assessed, this represented a deep desire to keep their wooded land wooded by family forest owners in our data set. Similarly, the proportion of the surrounding landscape developed as urban had a positive influence on PFFTP participation. Again, it's plausible to argue that the average family forest owner is deeply interested in keeping their wooded land wooded. Thus, PFFTP participation may allow them to offset associated opportunity costs and control land holding costs associated with increased urban development (e.g., divesting land holdings for profit and increases in property taxes, respectively).

Additional government oversight in the form of natural resource agency review of the enrollment application and program emphasis on timber production, as well as the proportion of the surrounding landscape developed as agriculture reduced the estimated probability of participation. All were hypothesized to have this effect.

Although some of the characteristics we thought would influence PFFTP participation for family forest owners in our model data set were significant, many were not. These included concern for taxes, investment objectives of the woodland owner, and timber management objectives of the woodland owner. We suggest that zero effect of concern for taxes on the estimated probability of PFFTP participation may have resulted from a woodland owner's propensity to respond to questions of taxation along political party lines. Timber production objectives may have zero effect because some landowners with a timber objective view PFFTP restrictions on the timber harvesting process unfavorably. Investment objectives may have zero effect because average PFFTP restrictions counteract the benefits for investor owners. The effect of investment objectives may be practically important, as woodland owners in our modeling data set with an investment objective state they were more likely to sell their wooded land if offered the right price.

Degree of ex ante familiarity with the tax program was thought to positively influence the probability of PFFTP participation. However, despite specifying our model as appropriately as possible using available data, we were not able to find a perfect solution to control for level of tax program familiarity. As a result of screening our model of all woodland owners who were not at all familiar with their PFFTP, our model estimated the probability of PFFTP participation for landowners who knew their program existed (and met all other study criteria). Further comparison of these two groups of woodland owners demonstrated statistically significant differences between them. Thus, this model may have performed differently had owners who were not at all familiar with their PFFTP been included. Future empirical research on this specific group of family forest owners may provide insight on a group that has lacked attention from empirical research.

The results of our model helped to shed light on the driving factors of PFFTP participation by family forest owners. These, along with characterizations of family forest owners who participate, as well as differences between family forest owners who do and do not participate suggest that resources are sometimes spent unnecessarily on incentivizing participation for groups of woodland owners who would be managing the same regardless of their participation in their state PFFTP. This could be because PFFTPs simply align well with woodland owners who want to do what is right for their wooded land and are open to messaging from the state government. For instance, enrolled owners have had an active history of timber harvesting and demonstrate a deep desire to maintain the integrity of their wooded land. These insights lead to two potential improvements to forest tax policy. First, marginal gains in participation may be gained through focusing public funding for PFFTPs on forested areas that are under pressure from alternative land uses, as opposed to being spread evenly across a state, and by deemphasizing timber production. Second, woodland owners who enroll in PFFTPs are already open to doing what is best for their woods, based on a deep connection with perpetuating its integrity. This insight could be exploited to more cost effectively align their management actions with society's interests. For instance, longer commitment periods may be palatable, or public funding could be directed toward education and outreach in the form of public/private foresters and other professionals that work with forestland, such as assessors and realtors.

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