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Determinants of Nonindustrial Private Forest Owners' Willingness to Harvest Timber in Norway

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Abstract: In Norway, 84% of the productive forest is privately owned, and these forests dominate the supply of timber to industries. However, during last 80 years, annual forest growth has seen a substantial upsurge while annual timber harvest has been rather stable, generating an increasing potential for timber supply. In this study, we provide new insights to better understand Norwegian non-industrial private forest owners' timber harvesting decisions. This was achieved by comparing the outcomes of two different statistical approaches (i.e., a combination of probit-linear models with a tobit model). These approaches are commonly applied in timber supply studies, but to the best of our knowledge have never been compared on the same dataset. The survey utilized for this study constitutes a population of Active and Inactive forest owners, based on whether the owner had harvested timber for sale during the last fifteen years. Two gross samples of 1500 and 1650 were drawn, with response rates of 56% and 49% for the Active and Inactive owner samples, respectively. The study results reveal that the average holding size varied from 25.2 ha for Inactive to 49.5 ha for both samples and 73.8 ha for Active owners. The probit model analysis indicated that knowledge of forest fund and financial objectives had the most significant impact on the willingness to harvest, with marginal effects of 11% and 12%, respectively. In the linear regression, being a male owner increased the historical timber supply by 1.48 m^3 ha^{-1} $year^{-1}$ compared to female ownership. In the second regression pathway (tobit model), the two variables male forest owner and owning forests for financial objectives triggered the supply of timber by 1.85 m^3 ha^{-1} $year^{-1}$ and 1.25 m^3 ha^{-1} $year^{-1}$, respectively. Timber prices were significant in the linear model (elasticity 1.18) and tobit model (elasticity 0.66), whereas they were non-significant in the probit model. Our study concludes that Active owners had a better understanding of acknowledging forests for economic security. Policy-makers and extension services should recognize that the Inactive forest owner group may require different actions than Active owners.

Keywords: NIPF; timber supply; questionnaire; active; inactive; regression; tobit; two-step model

1. Introduction

Globally, forest ownership structure varies significantly between countries, with about 14% of the global forest controlled by individuals or communities referred to as non-industrial private forest (NIPF) owners [1,2]. These owners account for 40% of the total forests available for wood supply in the area covered by an assessment of temperate and boreal forest resources in 55 countries [3]. In many countries like Portugal (79%), Norway (79%), Finland (62%), and the US (62%), a significant share of total forest is managed by NIPF owners, mainly for wood supply [4–7].

In Norway, about 26% of the land area is covered by productive forest, of which 84% of is privately owned and divided on about 127,000 properties [8,9]. Privately owned forest dominates the supply of timber to industries, with 89% of harvest volumes [8,9]. The forest and the related sector has historically been an important employer in many rural areas of Norway; its contribution to GDP declined from 2.5% in 1950 to 0.2% in 2017 [10,11]. The significant decline in share of GDP is due to a strong reduction in timber prices over the last 70 years. Over the same time period, the forest growing stock has accumulated substantially and increment more than doubled [9,11]. Harvest levels have increased over the last few years, while the share of owners refraining from harvest is increasing, with about half of owners not harvesting timber for sale over the last 20 years [9,12]. Many of these properties are small, but together they constitute more than 20% of the productive forest area [9]. On average, small properties have higher productivity and larger growing stock and thus possess higher possibilities for increased harvest than larger properties [9,12,13].

The management strategies adopted by owners are based on their values and reasons for owning forest. These strategies ultimately determine the forest sustainability and functionality in catering to society's demands of goods and services [14]. To achieve the objectives of reduced greenhouse gas emissions, economic activity, and employment, the EU and Norway have asserted on policies of increased wood supply [12,15,16]. Better knowledge of factors influencing NIPF owners' forest management decisions (including harvest) and reasons for owning forest is important for designing policies [14,17–19]. Studies of timber supply have been carried out in Norway [12,20–23], but in contrast to other countries with sizeable private ownership base, a lack of knowledge of the attitudes and objectives of ownership among Norwegian forest owners restricts effective policy-making. In particular, more insight on owners that do not harvest is warranted because relatively little attention has been paid to this growing owner group. We will fill parts of both these voids by combining national-level harvest, income, and tax panel data with survey data of attitudes and objectives of ownership sampled on owners who harvest and those who do not. Several of the revealed-preferences studies use the tobit modelling approach [20,21,24,25], while others use a two-step logit/probit and linear modeling approach [23,26]. The stated-preferences framework constitutes another branch of timber supply studies that we are not incorporating in this study [12,27,28].

In the two-step procedure, forest owners are first assumed to decide to harvest or not modelled by the probit model. If a positive decision is made, then the harvest volume is decided (linear model). In tobit modelling, both the decision to harvest and the volume are assumed to be determined together. Both modelling approaches can reflect reality well. It may be realistic that owners may first take the decision to harvest given prices and other factors and thereafter decide how much to harvest. For instance, total volume may be determined only when the harvest is complete, as more information about available timber volumes and forest conditions may be unveiled during the harvest operations. However, if they are using a management plan with periodic harvest volumes, forest owners may decide the timing of the prescribed harvest volumes; in this way, the decision to harvest and harvest volumes are taken together.

Although both the tobit and two-step approaches are well documented in the literature, we have not come across studies that compare the two. As the outcomes of modelling approaches cannot be directly compared between studies using different datasets, it is not clear how the choice between these two main econometric pathways steer the results. We fill part of that void by constructing models using the same dataset to compare the outcomes of the approaches directly. Another contribution of our study is the enhanced modelling used in conjunction with an extensive panel data set [29].

With this study, we provide key insights to help better understand Norwegian NIPF owner characteristics and timber harvesting decisions. Our specific objectives were to (1) evaluate the differences in the socio-economic profiles, objectives, and attitudes between owners who do and do not harvest timber for sale in Norway; (2) analyze and compare the impact of different factors on timber harvesting behavior (decision-making modes) of NIPF owners using tobit and two-step probit and linear modelling.

The rest of this paper proceeds as follows. In Section 2, we draw the hypotheses based on the literature review. Section 3 provides an overview of the theoretical background and econometric modelling techniques used to analyze the timber harvest behavior of NIPF owners. The results are presented in Section 4, while the implications of the results are discussed in Section 5 and conclusions are drawn in Section 6.

2. Literature Review and Hypotheses

The decision of forest owners to harvest/not harvest timber is guided by many factors [12,30–32]. Among many variables, timber price, forest size, distance to property, ownership objectives, policy awareness, membership in a forest organization, and socio-economic factors such as age, gender, education, income, and net wealth have been emphasized in the following studies [22,31,33–35]. However, their reported magnitude and statistical significance on timber harvesting intentions and intensities are not consistent across studies [30,36]. For instance, timber price was found to affect NIPF owners' harvesting behavior significantly in several studies [18,19,21,22], while other studies found no or ambiguous response of NIPF owners to timber prices [27,37].

Forest property size has been stressed as an essential factor influencing NIPF owners' harvesting choices in many studies, although the direction and impact may vary based on the forest conditions [12,17,33]. A positive association between the size of the forest land and NIPF owners' intention to harvest timber was reported by [34] and [21] in the USA and Norway, respectively.

Increasing age restricts the interest of forest owners in timber harvesting because of their reduced requirement for income and the intention to sell or transfer the forest property in the near future [17,23,30,38–40]. Conversely, a study conducted in Mississippi, USA found that older NIPF owners were more likely to supply woody biomass compared to younger landowners [41]. Concerning gender, [42] in Finland observed that female owners harvested 30% less timber than male owners, but harvested larger quantities when they did. The distance to forest property from the owner's residence is inversely related to timber harvest due to weaker motivations for ownership [39,43].

The higher level of income provides an opportunity for acquiring more forests and advanced equipment to improve harvesting efficiency, resulting in higher financial gains, and income may be positively related to intentions to make income from the forest. Therefore, a higher income may increase the probabilities of engaging in timber harvesting [17,37,44]. On the other hand, other sources of income reduce the importance of timber. Hence, owners tend to prioritize conservation or recreation values in comparison to harvest [20,42,45]. The above statements signify an ambiguous income–harvest relationship for forest owners [12].

In a study conducted by [17], education level had a significant impact on the willingness to harvest, with a marginal effect of 28%. This signifies that education enhances knowledge and understanding of forests as resources among forest owners. Studies by [23] and [46] in Norway and Sweden, respectively, found that owners with higher education harvested more. Conversely, [47] in Canada and [48] in Finland observed that forest owners with higher education attached greater importance to aesthetic and conservation values than to harvesting.

Public policies like forestry assistance and incentive programs are often designed to motivate owners to actively manage forest land [49,50]. The main policy instrument in Norway is the "Forest Fund". Forest owners have to set to aside a self-selected share between 4% and 40% of the forestry gross income for this fund. No tax is levied on the amount deposited in the fund, but if the forest owner decides to invest this amount in forestry activity, only 15% will be taxed [51]. The tax waiver assistance results in higher after-tax income and incentivizes maintaining or establishing new stands [12]. Therefore, we hypothesized that NIPF owners with greater knowledge of the Forest Fund would be more positive towards timber harvesting.

The reasons and objectives for owning forest property contribute significantly to the decision making of forest owners towards managing forests [52]. Forest owners' higher preference for non-timber benefits compared to timber harvesting is highlighted in many studies [17,26,53]. Similarly, authors

in [54] also reported that owners' forest management objective was to prioritize conservation or environment protection over the production of wood.

Based on the literature, we hypothesized that the factors specified in Table 1 impact timber supply.

Table 1. Description of variables (dependent and independent; type of variable) and expected relationship used in the empirical models examining non-industrial private forest owners' decision to harvest timber in Norway.

Variable (Type)	Description	Type of Variable	Expected Relationship (Y_{it})/(Y'_{it})/(T_{it})
	Dependent variables		
Harvest (Y_{it}) *	Dependent variable (binary) for probit model indicate that if timber harvested for sale = 1; Not harvested = 0	Dichotomous	
Harvest_m^3 ha^{-1} year^{-1} (Y'_{it})	Dependent variable (continuous) for linear model. Linear model includes only the forest owners' harvested timber for sale (natural logarithm (LN) transformed).	Rational number	
Harvest_ m^3 ha^{-1} year^{-1} (T_{it})	Dependent variable (censored) for tobit model, includes all forest owners, where 0 values imply forest owners did not harvest any timber in a given year (LN transformed).	Rational number	
	Independent variables		
Age	Age of forest owner (years) (2003–2012)	Natural number	-/-/-
Gender	male = 1, female = 2	Dichotomous	+/+/+
General education	Primary and secondary = 0, higher (bachelor, master, doctorate) 1	Dichotomous	+/+/+
Size of forest property	Size of property in decares (1 ha = 10 dec) (LN transformed)	Rational number	+/-/+
Distance from the property	Distance between forest land and the residence (km) (LN transformed)	Rational number	-/-/-
Gross income$_{it}$	Annual gross income before tax (sum of salaries, pensions, income from self-employment and capital) from 2003–2012 (from Statistics Norway) in millions (Norwegian krone) NOK (adjusted for inflation)	Rational number	?/?/?
Taxable net wealth$_{it}$	Taxable net wealth 2003–2012 (from Statistics Norway) in millions NOK (adjusted for inflation)	Rational number	?/?/?
Real timber prices$_{it}$	NOK per m^3 from year 2003–2012 (adjusted for inflation)	Rational number	+/+/+
Knowledge of the forest fund	1 if answered "Yes some or very much knowledge of "forest fund", 0 if answered "No knowledge"	Dichotomous	+/+/+
Visits to forest land for activity	1 if owner visited land "more than once over the last 12 months", 0 for "No visits"	Dichotomous	+/+/+
Interest in buying more forests	1 if answered "Very or slightly interested to the question about buying more forests, otherwise 0 for "Not interested"	Dichotomous	+/+/+
Plan to sell/transfer	1 if answered "Yes" on the question on planning to transfer to family/sell the property within ten years and 0 for "No specific plans"	Dichotomous	+/+/+
Nature	How important reason for owning forest is "The forest provides me the opportunity of nature experiences"	** Ordinal 4-point: Not important at all (1); slightly important (2); of relatively great importance (3); of decisive importance (4)	
Protection	How important reason for owning forest is "The forest provides me the opportunity to protect and preserve nature's diversity"?		
Conservation	How important reason for owning forest is "The forest is first and foremost a nature conservation object for me"		
Income	How important reason for owning forest is "My forest provides me income"?		
Economic security	How important reason for owning forest is "My forest provides me economic security"		
Investment	How important reason for owning forest is "My forest is an investment object for me"?		
Environmental	How important reason for owning forest is "The forest is part of the environment where I live or spend my leisure time"?		
Hunting	How important reason for owning forest is "The forest provides me the opportunity to hunt"?		
Intrinsic	How important reason for owning forest is "My forest has an intrinsic value for me (e.g., as part of a family farm or that I am a forest owner)"?		
Inheritance	How important reason for owning forest is "My forest will be inherited by close family"?		
Relax	How important reason for owning forest is "In my forest I can relax, find silence and contemplate"?		
Native	How important reason for owning forest is "I keep contact with my native area through my forest"?		
Social objectives	Intrinsic + Inheritance	Ordinal (2 to 8)	???
Financial objectives	Income + Economic security + Investment	Ordinal (3 to 12)	+/+/+
Conservation objectives	Protection + Conservation	Ordinal (2 to 8)	-/-/-
Recreation objectives	Environment + Hunting + Nature + Relax	Ordinal (4 to 16)	-/-/-

* *i* and *t* represent individual (forest owner) and time period (year), respectively. ** The broader categories—i.e., Social, Financial, Conservation, and Recreation variables—were constructed by grouping ordinal 4-point variables, due to the high correlation between the original variables. The groupings led to the change of scale represented in the table. In the analyses, the new variables were treated as continuous, as is commonly done in this kind of survey analysis [12].

3. Methods

3.1. Survey Database

In this survey, we created two populations of private individual forest owners: *Active owners* and *Inactive owners*. Private forest owners having more than 2.49 hectares of forest property were included in this study [12]. This is because Statistics Norway categorizes only private forest owners with more than 2.49 hectares of forest property into different size classes. Active owners were defined as those having harvested more than 5 m^3 of timber for sale, whereas Inactive owners were those that harvested less than 5 m^3 timber in total from 1998 to 2012 (technical assumption for timber harvest set by Statistics Norway). Three strata dimensions were used to create the samples—activity (Active/Inactive), county (18), and size class (8). The county Finnmark was not included in the study because most of forest land is publicly owned.

Out of the populations of 55,965 Active and 72,147 Inactive owners, two gross samples of 1500 and 1650, respectively, were collected by Statistics Norway, the national body for surveys and statistics [12]. All records of forest owners in Norway are maintained by this agency. The questionnaire for Active forest owners was first developed and thereafter altered to accommodate Inactive forest owners in collaboration with Statistics Norway [12]. The Total Design Method [55] framework was employed in the administration of the survey. The respondents were also asked questions about ownership objectives and attitudes alongside demographic information. A panel data set for the years 2003–2012 of forest area, harvest, and income figures from the nationwide property and tax registers was appended with data from the questionnaires. For more details on the sampling, see [12].

3.2. Theoretical and Statistical Modelling Framework

NIPF landowners are described as maximizing utility rather than profit [17,36]. This study modelled NIPF owners' decisions as utility-maximizing choices explained by a set of observable owner-specific factors [17,33,56]. The set of observable factors determining timber harvesting were assumed to be a set of four vectors: forest owner characteristics, ownership characteristics, management characteristics, and timber prices. Hence, in our study the forest owner utility model for timber harvesting possesses a deterministic component and a random error term and can be expressed as [18,57]:

$$U_{it} = f(O, P, M, T) + e_{it}, \quad (1)$$

where U_i is owner i's utility in period t of harvesting or not and O, P, M, and T are vectors of factors influencing the decision to harvest or not: of forest owner characteristics (O), property characteristics (P), management characteristics (M), and timber price (T), and e is a random error term.

Two statistical pathways were carried out: first, a two-stage regression analysis with a binary probit and linear regression, and then a tobit (censored) regression analysis, where the dependent variable is censored (with zero values) and continuous. Tobit models predict the simultaneous decision of whether to harvest and how much to harvest [40,58,59]. The tobit model has more information associated with it compared to the probit model [22,25,60].

Binary probit regression examines the relationships between categorical data versus a binary response. The variable Y, a binary choice denoting differences in utility between being willing to harvest timber (U_{1i}) and not (U_{0i}), is unobserved but related to the observed dependent variables. In our binary probit regression model the dependent variable takes the value of "1" if the respondent harvested timber in a given year and "0" if the respondent did not. The probit model can be stated as

$$P(Y_{it} = 1) = \Phi(X_{it}\beta + \varepsilon_{it}), \quad (2)$$

where X_{it} and β represent vectors of independent variables and coefficients, respectively, Φ denotes the cumulative normal distribution, and ε_{it} is the error term [12].

Thereafter, we developed a linear regression model for the part of the panel where $Y_{it} = 1$ in the probit model to estimate the impact of variables on timber harvest volume.

$$Y'_{it} = X_{it}\gamma + \varepsilon_{it}, \quad (3)$$

where Y'_{it} is the dependent variable harvest (m^3 ha^{-1} $year^{-1}$) supplied by owner i in period t, X_{it} is a vector of explanatory variables, and ε_{it} is the error varying over i and t.

In our sample, nearly 85% of the observations on harvest were zero. Hence, the dependent variable was regarded as censored, and the limited dependent variables tobit model was applied [61]. The tobit model is defined as follows [62]:

$$T_{it} = T^*_{it} = \beta' x_{it} + \varepsilon_{it} \quad if\ the\ right-hand\ side\ is\ positive, T_{it} = 0\ otherwise, \quad (4)$$

where T_{it}* is the latent potential timber supply, T_{it} is the observed timber supply (non-negative) of owner i in year t. x_{it} and β are corresponding vectors of independent variables and coefficients, respectively. The error term ε_{it} is normally and independently distributed with a mean zero and a common variance [22,25].

3.3. Data Check

The independent variables were checked for correlation and collinearity. Some variables were excluded or grouped from the analysis at the preliminary stage due to a high correlation coefficient (>0.4) (i.e., out of the three variables information on tax deductions, member of forest organization, and knowledge of forest fund, only the latter was included in the models). Later, the variance inflation factor (VIF) was calculated for the independent variables to test for possible multicollinearity [63], but none of the independent variables (after elimination or grouping) had VIF values >2, suggesting low multicollinearity.

Data variability was reduced to achieve symmetry in the central distribution, employing logarithmic transformation [64,65]. Therefore, dependent variables Y'_{it} and T_{it} (m^3 ha^{-1} $year^{-1}$) and the independent variables (size of forest property, distance from the property, and real timber prices) were log transformed and included in all regression models (Table 1). The distribution was assessed by histograms and scatter plots in R. The assumption of homoscedasticity of errors in the linear and tobit model was rejected, implying the presence of heteroscedasticity (the condition when error term varies across the values of an independent variable). A possible consequence of heteroscedasticity is biased standard errors [66]. Therefore, we employed the heteroscedasticity covariance matrix procedure [66] using the R function vcovHC() to obtain robust standard errors to correct this bias.

In this study, many of the respondents in our sample of Active and Inactive owners did not answer all questions. The issue of receiving incomplete surveys leads to a database with missing information. The missing values in our survey database varied from 5% to 10% across all the variables. The two usual procedures to deal with missing information in datasets are list-wise deletion and multiple imputations. In list-wise deletion the entire respondent with incomplete information is removed from the dataset. The elimination of data will lead to loss of information and may cause biased results [67].

Therefore, we employed a multiple imputation procedure to fill the missing values in our dataset [68,69]. In the imputation method, the value for missing observation is calculated based on the estimates of observed values [67,69]. We created multiple datasets using the R package *mice* and combined the results of imputed datasets [70]. Furthermore, imputed datasets were used to perform regression analysis in probit, linear, and tobit models. In the following, all results refer to the imputed datasets. All statistical analyses were performed using R software [71].

4. Results

4.1. Descriptive and Survey Statistics

Out of the 1500 and 1650 questionnaires sent to Active and Inactive forest owners, 842 and 795 questionnaires were returned, respectively. The adjusted response rates after accounting for non-deliverables and non-responses were 56% and 49% for the Active and Inactive owner samples, respectively. Mean values and standard deviations were calculated for all variables (Table 2). The mean age was 53 years for all NIPF owners, compared to 51.7 years for Active and 55.7 years for Inactive owners. The majority of questionnaires came from male owners (75–77%) for all three classes of Inactive owners, Active owners, and all owners combined. In terms of general education level, no significant difference were observed across activity classes of NIPF owners. Almost 60% of respondents had primary education and 40% of respondents had a bachelor degree or higher. The average holding size varied between 25.2 ha for Inactive to 49.5 ha for both samples and 73.8 ha for Active owners. On average, Inactive NIPF owners had more than twice (78.9 km) the distance between residence and forest property in comparison to Active forest owners (34.4 km). Income and net wealth varied between the owner groups, with means of the individual annual gross income and net wealth averaged over the years 2003–2012 being slightly higher for Active owners (0.48 and 1.08 M (Norwegian krone(NOK); 1 NOK ≈ 0.10 euro) than Inactive owners (0.44 M NOK and 0.82 M NOK). Furthermore, according to the data, 74% of the Active respondents reported knowledge of the Forest Fund, in contrast to 30% of Inactive owners. Overall, the share of owners who had visited the forest property at least once over the last 12 months ranged from 45% in the Inactive group to 59% among all owners and 73% of the Active group. Among Active owners, 42% planned to sell or transfer the property within the next ten years, compared to 28% of Inactive owners. Additionally, 37% of the Active forest owners reported interest in buying more forests, in contrast to 23% of the Inactive owners.

Table 2. Descriptive statistics (mean values and standard deviations) of the independent variables tested to affect NIPF owners' decision to harvest timber (owners grouped as Active and Inactive based on harvesting activity from the last 15 years). Weighted numbers. SD = standard deviation. See Table 1 for variable definition.

Variable	Inactive Owners		Active Owners		All Owners	
	Mean	SD	Mean	SD	Mean	SD
Age	55.74	14.07	51.72	13.71	53.73	13.89
Gender	1.26	0.43	1.24	0.43	1.25	0.43
General education	0.38	0.48	0.42	0.50	0.40	0.49
Size of forest property ha, (LN_ha)	25.26 (2.48)	61.69 (1.05)	73.88 (3.46)	244.45 (1.38)	49.57 (2.97)	153.07 (1.22)
Distance from the property, km (LN_KM)	78.97 (1.73)	370.12 (2.06)	34.47 (1.25)	235.25 (1.76)	56.72 (1.49)	302.74 (1.91)
Gross Income (M NOK)	0.44	0.70	0.48	0.62	0.46	0.66
Taxable net wealth (M NOK)	0.82	3.46	1.08	6.07	0.95	4.77
Real timber prices NOK per m^3 (LN_NOK per m^3)	285.18 (5.62)	66.59 (0.24)	294.00 (5.66)	65.53 (0.24)	289.64 (5.64)	66.06 (0.24)
Knowledge of the forest fund	0.30	0.45	0.74	0.53	0.52	0.49
Visits to forest land for activity	0.45	0.49	0.73	0.49	0.59	0.49
Interest in buying more forests	0.23	0.42	0.37	0.48	0.30	0.45
Plan to sell/transfer	0.28	0.45	0.42	0.49	0.35	0.47
Social values	3.75	1.39	3.85	1.45	3.80	1.42
Financial values	5.44	2.01	6.88	2.47	6.16	2.24
Conservation values	4.39	1.67	4.33	1.53	4.36	1.60
Recreation values	10.55	3.47	11.30	3.34	10.93	3.41

The objectives of owning forests varied between the owner groups (Figure 1). The largest differences were found in financial objectives. Overall, 60% of Inactive owners did not see their forest property as an important entity for financial gains, compared to 33% of Active owners. More Inactive than Active owners (15% compared to 6%) categorized intrinsic and heritage (social) objectives as a factor of no importance for owning forest. However, for all owners, recreational and social objectives were the most important of all objectives.

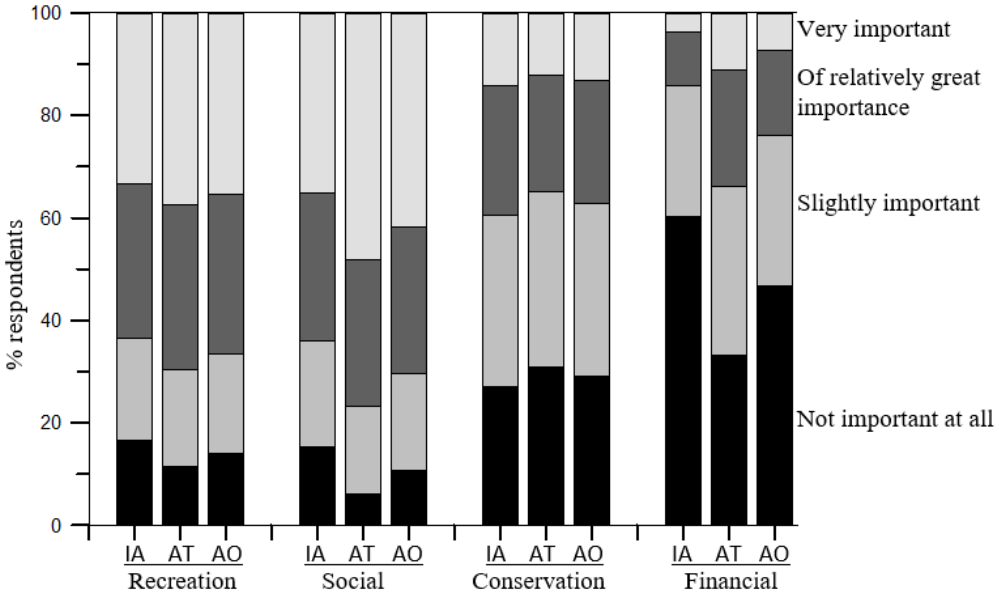

Figure 1. Objectives for owning non-industrial private forest (NIPF) among Active (AT), Inactive (IA), and All owners (AO).

4.2. Willingness to Harvest Timber: Regression Analyses

First the two-step probit and linear regression approach was carried out, followed by tobit modeling. Out of the included variables in the probit model, age, income, wealth, and timber price were non-significant (p-value > 0.05) (Table 3). Forest owners with higher education and with interest in buying more forest property were more responsive to harvesting. In addition, the forest owners possessing thorough knowledge of Forest Fund were more willing to harvest timber compared to others with no knowledge. Forest owners owning forests for financial gains/economic security and social consideration (inheritance) were statistically significant factors leading forest owners to harvest. Whereas, owners that designated forests for conservation and recreation objectives were restrictive to timber harvest. Distance to travel from home to forest had a significant negative impact on the observed willingness to harvest.

Table 3. Parameter estimates and marginal effects of the probit model in the period 2003–2012 (N = 16,370 over 10 years).

Factor	Estimate	Std. Error	p-Value	Marginal Effects
Age	−0.002	0.001	0.074	−0.0002
Gender	0.108 **	0.034	0.001	0.0136
General education	0.071 *	0.028	0.011	0.0091
Size of forest property	0.266 ***	0.010	$<2 \times 10^{-16}$	0.0343
Distance from the property	−0.040 ***	0.008	4.43×10^{-14}	−0.0052
Gross income	0.017	0.015	0.238	−0.0024
Taxable net wealth	−0.001	0.001	0.373	−0.0100
Real timber prices	0.024	0.060	0.687	0.0035
Knowledge of the forest fund	0.830 ***	0.042	$<2 \times 10^{-16}$	0.1149
Visits to forest land for activity	0.341 ***	0.038	$<2 \times 10^{-16}$	0.0455
Interest in buying more forests	0.100 **	0.030	0.040	0.0127
Plan to sell/transfer	0.143 ***	0.028	4.13×10^{-7}	0.0187
Social objectives	0.040 ***	0.011	0.0004	0.0050
Financial objectives	0.099 ***	0.007	$<2 \times 10^{-16}$	0.1243
Conservation objectives	−0.062 ***	0.011	3.40×10^{-8}	−0.0076
Recreation objectives	−0.020 ***	0.005	4.09×10^{-10}	−0.0023
Constant	−3.539 ***	0.352	$<2 \times 10^{-16}$	
Pseudo R^2	0.45			

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level.

We calculated the marginal effects to show the change in the probability of harvest given a 1% change in the explanatory variable, with all other variables held constant [37,72]. The variables with the largest impacts on the willingness to harvest were knowledge of Forest Fund and financial objectives, with marginal effects of 11% and 12%, respectively. In addition, an increase of 2.718 times the size of productive forest area increased the probability to harvest by 3%.

The second-stage linear model assessed how much timber forest owners harvested, given that they decided to harvest in the first-stage probit model. The model accounted for all forest owners who harvested timber at a given year within the time period 2003–2012, hence excluding owners who did not harvest that year. Contrary to the first part of the analyses, after owners decided to harvest, age and timber price seemed to have an impact on the harvest levels (Table 4). Age inversely influenced the timber harvest, whereas higher timber prices elevated the quantity of harvest. Results from the coefficient size in the linear model imply that the gender factor tended to remain significant in determining harvest volumes even after the owner had decided to harvest according to the probit model. Being a male owner increased the timber supply by 1.48 m^3 ha^{-1} compared to female ownership. Higher education and objective of owning forest for financial gains significantly inclined NIPF owners to harvest. Owners with financial objectives harvested 1.1 m^3 ha^{-1} $year^{-1}$ more timber than others. Interest in buying more forest as well as social and conservation objectives were statistically insignificant variables. However, recreation objectives and forest property area significantly influenced the harvest volumes, in the inverse direction. Timber harvest was reduced by 7% with a 10% increase in productive forest area. The variables taxable net wealth and income significantly and positively influenced timber supply. Timber harvest rose in the range of 1.02 to 1.25 m^3 ha^{-1} with an increase of 1% in net wealth and income. The elasticities for wealth and income were observed as 0.02 and 0.10, respectively. Finally, timber price was significant with an elasticity of 1.18, indicating that 1% increase in timber price elevated timber harvest by 1.18%.

Table 4. Parameter estimates of the linear model in the period 2003–2012 (N = 2682) (Dependent variable: m^3 ha^{-1}).

Factor	Estimate	Std. Error	*p*-Value
Age	−0.007 **	0.002	0.001
Gender	0.392 ***	0.064	1.110×10^{-9}
General education	0.255 ***	0.566	7.009×10^{-6}
Size of forest property	−0.739 ***	0.022	$<2 \times 10^{-16}$
Distance from the property	0.062 ***	0.017	0.0003
Gross income	0.224 ***	0.065	0.0006
Taxable net wealth	0.020 ***	0.003	1.622×10^{-10}
Real timber prices	1.176 ***	0.128	$<2 \times 10^{-16}$
Knowledge of the forest fund	0.133	0.130	0.305
Visits to forest land for activity	0.065	0.099	0.507
Interest in buying more forests	−0.079	0.067	0.240
Plan to sell/transfer	0.151 **	0.054	0.006
Social objectives	−0.029	0.019	0.132
Financial objectives	0.104 ***	0.015	1.972×10^{-11}
Conservation objectives	−0.023	0.022	0.306
Recreation objectives	0.016	0.011	0.152
R^2	0.38		

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level.

In the tobit model, 7 out of the 16 explanatory variables significantly influenced the timber harvesting behavior of NIPF owners (Table 5). Similar to the probit but contrary to the linear model, knowledge of the Forest Fund and frequent visits to forest inclined forest owners more towards timber harvest. Gender and owning forest for financial gains significantly influenced harvesting behavior across all three statistical models. In the tobit model being a male forest owner and owning forests

for financial objectives elevated the supply of timber by 1.85 m^3 ha^{-1} and 1.25 m^3 ha^{-1}, respectively. Whereas owners valuing the forests for conservation objectives restricted timber harvesting to 1.23 m^3 ha^{-1} less than other owners. Additionally, NIPF owners visiting more than once over the last 12 months harvested more timber (2.23 m^3 ha^{-1}) compared to owners with no visits. Higher timber prices and income attributes inclined owners to harvest, like in the linear model. With a 1% increase in forest owner income, the supply of timber could be raised by 1.35 m^3 ha^{-1}. A timber price increase of 1% resulted in an increase in the harvest level of 0.66%. Lastly, in the tobit model, contrary to the probit and linear model, forest area, distance to forest property, and education were not significant in determining harvesting behavior of forest owners.

Table 5. Parameter estimates of the tobit model in the period 2003–2012 (N = 16,370 over 10 years).

Variable	Estimate	Std. Error	*p*-Value
Age	−0.009	0.005	0.060
Gender	0.618 **	0.196	0.001
General education	0.153	0.147	0.299
Size of forest property	0.106	0.089	0.238
Distance from the property	−0.071	0.043	0.098
Gross income	0.288 ***	0.069	3.209×10^{-5}
Taxable net wealth	−0.197	0.709	0.781
Real timber prices	0.658 ***	0.199	0.0009
Knowledge of the forest fund	2.512 ***	0.258	$<2 \times 10^{-16}$
Visits to forest land for activity	0.804 ***	0.222	0.0003
Interest in buying more forests	0.192	0.198	0.331
Plan to sell/transfer	0.212	0.139	0.1291
Social objectives	0.110	0.062	0.077
Financial objectives	0.229 ***	0.042	4.822×10^{-8}
Conservation objectives	−0.179 ***	0.046	0.0001
Recreation objectives	−0.040	0.031	0.163
Constant	−12.098 ***	2.986	5.134×10^{-5}
Pseudo R^2	0.09		
Log-likelihood	−6999.85		

** Significant at 5% level, *** Significant at 1% level.

5. Discussion

NIPF owners possess a vast proportion of productive forest and play a paramount role in the sustainability of forests and the forest sector in Norway [73]. However, a total of about 22% of the productive forest area had no timber harvest for sale during the last twenty years [8,9]. In-depth analyses of factors influencing NIPF owners' forest management decisions are warranted to formulate efficient policies that encourage sustainable supply of timber and non-timber services [17]. Our study used a statistical approach to encompass the observed behavior of forest owners at different stages in the timber harvesting decision-making in Norway.

Forest area was significant in the probit and linear models, but with different sign and inversely related to timber harvest intensity in the linear model. The forest area was inversely related to timber supply because of the higher productivity and larger growing stock recorded on the smaller properties [9,12,13]. The finding that forest property size affects harvesting decisions is consistent with earlier findings [21,27,74]. We found that gender was a significant factor influencing timber harvesting across all models. In European and many other countries, significant gender differences are observed among private forest owners [73,75,76]. Female forest owners place more emphasis on conservation values than their male counterparts, and hence are less inclined towards harvesting [45]. Compared to male owners, female forest owners have been found to be older across Europe with less competence in forestry [76] and low engagement in practical forestry [75].

The results support our hypothesis that information on the Forest Fund has a strong significance in motivating NIPF owners towards timber harvesting in Norway. These type of forestry incentives

are positively influencing timber harvesting activities [77,78]. Hence, it should be noted that 40% of the forest owners possess a low level of awareness about and participation in these programmes. Sjølie et al. [12] found that forest owner organizations were the main source of information for Active owners. Only a small share of Inactive forest owners (17%) were members of the forest organizations in comparison to Active owners (72%). The direction of effects remains to be elucidated, but higher participation in forest organization might raise awareness and encourage activity on forestland. Forest owners with a previous record of harvesting possess a sense of familiarity with forest policies, and hence have fewer reservations about starting a new activity [79–81]. In contrast, forest owners with limited knowledge about the Forest Fund erroneously estimate taxes after timber harvest and the cost of stand establishment after harvesting [12,41,82].

The statements that determined ownership objectives in our study are financial security from the timber harvesting. The financial attribute was the strongest separating factor between Active and Inactive NIPF owners. The results support our hypothesis that Active forest owners with economic objectives for managing their forests were positively inclined towards timber harvesting. Our study results are consistent with [18,32,52,83], indicating that forest property is considered as an asset by forest owners to attain a sense of financial security and well-being. On the contrary, a number of studies recorded that NIPF owners do not recognize forests for financial security but more for recreation or other non-timber amenities [47,84]. A total of 50% of Inactive forest owners did not visit their forest property during the last 12 months. The reason could be that a significant number of Inactive owners (21%) in the study were above 70 years of age and many lived far away from their property, which is consistent with findings from other countries [26,40,85,86].

The European Union adopted an updated version of its renewable energy directive in 2018 [87], committing to cover at least 32% of its energy from renewable sources by 2030. Norway is also covered by this directive, as it is part of the European Economic Area. Forest biomass is expected to contribute significantly to Europe's renewable energy mix towards 2030. Currently, 8% of the total energy and about two-thirds of the bioenergy supplied in the EU stems from biomass; the total bioenergy supply from forests is projected to grow by 2030 [88,89]. In this regard, the present study contributes to our understanding of the driving forces of timber supply, which may aid authorities in formulating policies that encourage more forest owners towards timber harvesting.

A larger harvest will also contribute to higher economic activities in rural areas and promote viable and sustainable rural communities. This will help to fulfil a core objective of Norway's political agenda—to develop rural areas with proper population settlement patterns distributed over the country [82]. The same concept is also adopted by the EU through the rural development policy of diversification of economic activity in rural areas [90].

In this study, we followed a statistical modelling approach of probit-linear and tobit regression to determine the significance of various variables in different settings of forest owner timber harvesting decision-making. Comparing the modelling approaches, we believe that both the one-step and two-step approaches could realistically reflect forest owner decision-making. These two statistical pathways give two sets of results that vary in their assumptions. The probit/linear model result outcomes are more useful to be employed when harvesting timber is decided as two separate decisions—firstly harvest or not harvest, and secondly the quantity of timber to harvest. Whereas, when both decisions come at once, then results from the tobit model will have more relevance. Therefore, both models have significant contributions based on the situation of the forest owner. Furthermore, it needs to be validated which approach may reflect forest owners' actual decision-making in different settings. This may vary according to the specific situation or forest owner and property characteristics. Better understanding of forest owner decision-making processes is a topic for future studies.

However, the given elasticity of supply with regard to price was very high in the linear model and insignificant in the probit model. In the tobit model, this elasticity was 0.66, about at the expected value consistent with the elasticities reported by previous studies [22,26]. The higher elasticity in the

linear model may be due to the fact that only positive harvest volumes were included in the model; and thus this elasticity applies to owners who had already made the decision to harvest.

6. Conclusions

Our study found that forest owners with economic objectives were more inclined to harvest, and that male owners harvested more than female owners. Across all three statistical models applied for the analysis, the two variables gender and economic objectives were observed to be significant in influencing timber harvest, whereas other variables like age, distance to property, timber price, knowledge of the forest fund, and property size also had an impact on harvesting in some models. Both modelling approaches (i.e., probit/linear and tobit) reflect forest owner decision-making. The suitability of the approaches in specific contexts could be further explored, as this study only compared and presented the outcomes of both statistical pathways.

Our study provides detailed insights about the factors influencing the timber harvesting behavior of NIPF owners in Norway. This study also identified the owner groups that may require special attention from forest policymakers and extension services, such as female owners and owners with limited knowledge on forest policy instruments. Policies and information campaigns may be more effective when directed to particular groups of forest owners. Policy-makers should consider these factors for designing effective and efficient forest policy instruments.

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References

1. FAO. The State of the World's Forests 2018—Forest Pathways to Sustainable Development. Available online: http://www.fao.org/3/ca0188en/ca0188en.pdf (accessed on 27 July 2019).
2. Zhang, Y.; Zhang, D.; Schelhas, J. Small-scale non-industrial private forest ownership in the United States: Rationale and implications for forest management. *Silva Fenn.* **2005**, *39*, 378. [CrossRef]
3. UN-ECE/FAO. *Forest Resources of Europe, CIS, North America, Australia, Japan, and New Zealand (Industrialized Temperate/Boreal Countries): UN-ECE/FAO Contribution to the Global Forest Resources Assessment 2000, Geneva Timber and Forest Study Papers*; United Nations: New York, NY, USA, 2000.
4. Halder, P.; Paladinić, E.; Stevanov, M.; Orlović, S.; Hokkanen, T.J.; Pelkonen, P. Energy wood production from private forests—Nonindustrial private forest owner' perceptions and attitudes in Croatia and Serbia. *Renew. Sustain. Energ. Rev.* **2014**, *35*, 515–526. [CrossRef]
5. Lindstad, B.H. *A Comparative Study of Forestry in Finland, Norway, Sweden, and the United States, with Special Emphasis on Policy Measures for Nonindustrial Private Forests in Norway and the United States (No. PNW-GTR-538)*; U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: Portland, OR, USA, 2002.
6. Valente, S.; Coelho, C.; Ribeiroe, C.; Soares, J. Forest Intervention Areas (ZIF): A New Approach for Non-Industrial Private Forest Management in Portugal. *Silva Lusit.* **2003**, *21*, 137–161.
7. Živojinović, I.; Weiss, G.; Lidestav, G.; Feliciano, D.; Hujala, T.; Dobšinská, Z.; Lawrence, A.; Nybakk, E.; Quiroga, S.; Schram, U. *Forest Land Ownership Change in Europe. COST Action FP1201 FACESMAP Country Reports, 2015, Joint Volume EFICEEC-EFISEE Research Report*; University of Natural Resources and Life Sciences: Vienna (BOKU), Austria, 2015.

8. Rognstad, O.; Steinset, T.A. Landbruket i Norge 2011. Available online: https://www.ssb.no/jord-skog-jakt-og-fiskeri/artikler-og-publikasjoner/_attachment/91107?_ts=13c5d8b68f8 (accessed on 5 March 2019).
9. Statistics Norway. Færre høgg Tømmer for sal—Samla Hogst Aukar Fewer Harvest Timber for Sale—Total Harvest Increases. 2017. Available online: https://www.ssb.no/jord-skog-jakt-og-fiskeri/artikler-og-publikasjoner/faerre-hogg-tommer-for-sal-samla-hogst-aukar (accessed on 27 May 2019).
10. Johansen, U.; Werner, A.; Nørstebø, V.S. Optimizing the wood value chain in northern Norway taking into account national and regional economic trade-offs. *Forests* **2017**, *8*, 172. [CrossRef]
11. Statistics Norway. This is Norway. 2018. Available online: https://www.ssb.no/en/befolkning/artikler-og-publikasjoner/_attachment/364602?_ts=1664418b978 (accessed on 27 May 2019).
12. Sjølie, H.K.; Wangen, K.R.; Solberg, B.; Lindstad, B.H. The importance of timber prices and other factors for harvest increase among nonindustrial private forest owners. *Can. J. For. Res.* **2019**, *49*, 543–552. [CrossRef]
13. Hobbelstad, K.; Ørnelund Nilsen, J.E. Forest Resources in Norway 2 Skogressursene i Norge. In *Forest Resources in Norway 2006 Skogressursene i Norge 2006*; Vennesland, B., Hobbelstad, K., Bolkesjø, T., Baardsen, S., Lileng, J., Rolstad, J., Eds.; Norwegian Forest and Landscape Institute: Ås Municipality, Norway, 2006; p. 94.
14. Tian, N.; Poudyal, N.C.; Hodges, D.G.; Young, T.M.; Hoyt, K.P. Understanding the factors influencing nonindustrial private forest landowner interest in supplying ecosystem services in Cumberland Plateau, Tennessee. *Forests* **2015**, *6*, 3985–4000. [CrossRef]
15. European Commission. Strategy for Innovating for Sustainable Growth: A bioeconomy for Europe, Brussels, 2012. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Available online: https://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf (accessed on 14 January 2019).
16. Norwegian Ministry of Food and Agriculture. *The Agricultural and Food Policy Landbruks-og Matpolitikken*; Norwegian Ministry of Food and Agriculture: Oslo, Norway, 2011.
17. Joshi, S.; Arano, K.G. Determinants of private forest management decisions: A study on West Virginia NIPF landowners. *For. Policy Econ.* **2009**, *11*, 118–125. [CrossRef]
18. Aguilar, F.X.; Cai, Z.; D'Amato, A.W. Non-industrial private forest owner's willingness-to-harvest: How higher timber prices influence woody biomass supply. *Biomass Bioenergy* **2014**, *71*, 202–215. [CrossRef]
19. Pattanayak, S.; Murray, B.; Abt, R. How joint is joint forest production? An econometric analysis of timber supply conditional on endogenous amenity values. *For. Sci.* **2002**, *47*, 479–491.
20. Bolkesjø, T.F.; Solberg, B.; Wangen, K.R. Heterogeneity in nonindustrial private roundwood supply: Lessons from a large panel of forest owners. *J. For. Econ.* **2007**, *13*, 7–28. [CrossRef]
21. Bolkesjø, T.F.; Baardsen, S. Roundwood supply in Norway: Micro-level analysis of self-employed forest owners. *For. Policy Econ.* **2002**, *4*, 55–64. [CrossRef]
22. Bolkesjø, T.F.; Solberg, B. A panel data analysis of nonindustrial private roundwood supply with emphasis on the price elasticity. *For. Sci.* **2003**, *49*, 530–538.
23. Størdal, S.; Lien, G.; Baardsen, S. Analyzing determinants of forest owners' decision-making using a sample selection framework. *J. For. Econ.* **2008**, *14*, 159–176. [CrossRef]
24. Bolkesjø, T.F.; Buongiorno, J.; Solberg, B. Joint production and substitution in timber supply: A panel data analysis. *Appl. Econ.* **2010**, *42*, 671–680. [CrossRef]
25. Favada, I.M.; Karppinen, H.; Kuuluvainen, J.; Mikkola, J.; Stavness, C. Effects of timber prices, ownership objectives, and owner characteristics on timber supply. *For. Sci.* **2009**, *55*, 512–523.
26. Kuuluvainen, J.; Karppinen, H.; Ovaskainen, V. Landowner objectives and nonindustrial private timber supply. *For. Sci.* **1996**, *42*, 10.
27. Conway, M.C.; Amacher, G.S.; Sullivan, J.; Wear, D. Decisions nonindustrial forest landowners make: An empirical examination. *J. For. Econ.* **2003**, *9*, 181–203. [CrossRef]
28. Vokoun, M.; Amacher, G.S.; Wear, D.N. Scale of harvesting by non-industrial private forest landowners. *J. For. Econ.* **2006**, *11*, 223–244. [CrossRef]
29. Baltagi, B.H. Editor's introduction: Panel data. *J. Econom.* **1995**, *68*, 1–4. [CrossRef]
30. Beach, R.H.; Pattanayak, S.K.; Yang, J.-C.; Murray, B.C.; Abt, R.C. Econometric studies of non-industrial private forest management: A review and synthesis. *For. Policy Econ.* **2005**, *7*, 261–281. [CrossRef]
31. Cooper, N.A.; Kainer, K.A. To log or not to log: Local perceptions of timber management and its implications for well-being within a sustainable-use protected area. *Ecol. Soc.* **2018**, *23*, 4. [CrossRef]

32. Petuccoa, C.; Abildtrupa, J.; Stengera, A. Influences of nonindustrial private forest landowners' management priorities on the timber harvest decision—A case study in France. *J. For. Econ.* **2015**, *21*, 52–166. [CrossRef]
33. Cai, Z.; Narine, L.L.; D'Amato, A.W.; Aguilar, F.X. Attitudinal and revenue effects on non-industrial private forest owners' willingness-to-harvest timber and woody biomass. *For. Policy Econ.* **2016**, *63*, 52–61. [CrossRef]
34. Joshi, O.; Mehmood, S.R. Factors affecting nonindustrial private forest landowners' willingness to supply woody biomass for bioenergy. *Biomass Bioenergy* **2011**, *35*, 186–192. [CrossRef]
35. Joshi, O.; Grebnera, D.L.; Munn, I.A.; Grala, R.K. Issues concerning landowner management plan adoption decisions: A recursive bivariate probit approach. *Int. J. For. Res.* **2015**, *2015*, 926303. [CrossRef]
36. Amacher, G.S.; Conway, C.M.; Sullivan, J. Econometric analyses of nonindustrial forest landowners: Is there anything left to study? *J. For. Econ.* **2003**, *9*, 137–164.
37. Dennis, D.F. An economic analysis of harvest behavior: Integrating forest and ownership characteristics. *For. Sci.* **1989**, *35*, 1088–1104.
38. Karppinen, H. New forest owners and owners-to-be: Apples and oranges? *Small-Scale For.* **2012**, *11*, 15–26. [CrossRef]
39. Butler, B.J.; Leatherberry, E.C. America's Family Forest Owners. *J. For.* **2004**, *102*, 4–14.
40. Kuuluvainen, J.; Salo, J. Timber supply and life cycle harvest of nonindustrial private forest owners: An empirical analysis of the Finnish case. *For. Sci.* **1991**, *37*, 1011–1029.
41. Joshi, O.; Grebnera, D.L.; Hussainb, A.; Gradoa, S.C. Landowner knowledge and willingness to supply woody biomass for wood-based bioenergy: Sample selection approach. *J. For. Econ.* **2013**, *19*, 97–109. [CrossRef]
42. Kuuluvainen, J.; Karppinen, H.; Hänninen, H.; Uusivuori, J. Effects of gender and length of land tenure on timber supply in Finland. *J. For. Econ.* **2014**, *20*, 363–379. [CrossRef]
43. Rickenbach, M.B.; Kittredge, D.B. Time and distance: Comparing motivations among forest landowners in New England, USA. *Small-Scale For.* **2009**, *8*, 95–108. [CrossRef]
44. Romm, J.; Tuazon, R.; Washburn, C. Relating forestry investment to the characteristics of nonindustrial private forestland owners in Northern California. *For. Sci.* **1987**, *33*, 197–209.
45. Nordlund, A.; Westin, K. Forest Values and Forest Management Attitudes among Private Forest Owners in Sweden. *Forests* **2011**, *2*, 30–50. [CrossRef]
46. Wästerlund, D.S.; Kronholm, T. Market analysis of harvesting services engaged by private forest owners in Sweden. In *Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics*; Roos, A., Lönnstedt, L., Nord, T., Gong, P., Stendahl, M., Eds.; Scandinavian Society of Forest Economics: Uppsala, Sweden, 2014; Volume 45, pp. 111–119.
47. Côté, M.-A.; Gilbert, D.J.; Solange, N. Characterizing the profiles, motivations and behaviour of Quebec's forest owners. *For. Policy Econ.* **2015**, *59*, 83–90. [CrossRef]
48. Häyrinen, L.; Mattila, O.; Berghäll, S.; Toppinen, A. Forest owners' socio-demographic characteristics as predictors of customer value: Evidence from Finland. *Small-Scale For.* **2015**, *14*, 19–37. [CrossRef]
49. Andrejczyk, K.; Butler, B.J.; Dickinson, B.J.; Hewes, J.H.; Lindsay, M.M.; David, B.; Kittredge, D.B.; Kilgore, M.A.; Snyder, S.A.; Catanzaro, P.F. Family forest owners' perceptions of landowner assistance programs in the USA: A qualitative exploration of program impacts on behaviour. *Small-Scale For.* **2016**, *15*, 17–28. [CrossRef]
50. Butler, B.J.; Lindsay, M.M.; Snyder, S.A.; Catanzaro, P.F.; Kittredge, D.B.; Andrejczyk, K.; Dickinson, B.J.; Eryilmaz, D.; Hewes, B.J.; Randler, P.; et al. Effectiveness of landowner assistance activities: An examination of the USDA Forest Service's Forest Stewardship Program. *J. For.* **2014**, *112*, 187–197.
51. Norwegian Ministry of Food and Agriculture. *Director of Agriculture (Landbruksdirektoratet), Forestry, Forest Trust Fund*; Norwegian Ministry of Food and Agriculture: Oslo, Norway, 2019; Available online: https://www.landbruksdirektoratet.no/en/forestry/forest-trust-fund (accessed on 22 March 2019).
52. Dhubháin, Á.N.; Cobanova, R.; Karppinen, H.; Mizaraite, D.; Ritter, E.; Slee, B.; Wall, S. The values and objectives of private forest owners and their influence on forestry behaviour: The Implications for entrepreneurship. *Small-Scale For.* **2007**, *6*, 347–357. [CrossRef]
53. Kline, J.D.; Alig, R.J.; Johnson, R.L. Fostering the production of non-timber services among forest owners with heterogeneous objectives. *For. Sci.* **2000**, *46*, 302–311.
54. Cordell, H.K.; Tarrant, M.A. Southern Forest Resource Assessment highlights: Changing Demographics, Values, and Attitudes. *J. For.* **2002**, *100*, 28–33.

55. Dillman, D.A. *Mail and Telephone Surveys: The Total Design Method*; Wiley: Hoboken, NJ, USA, 1978.
56. Nagubandi, V.; McNamara, K.T.; Hoover, W.L.; Mills, W.T., Jr. Program participation behavior of nonindustrial forest landowners: A probit analysis. *J. Agric. Appl. Econ.* **1996**, *28*, 323–336. [CrossRef]
57. Manski, C.F. The structure of random utility models. *Theory Decis.* **1977**, *8*, 229. [CrossRef]
58. Wear, D.N.; Parks, P.J. The economics of timber supply: An analytical synthesis of modelling approaches. *Nat. Resour. Model.* **1994**, *8*, 199–223. [CrossRef]
59. Favada, I.M.; Kuuluvainen, J.; Uusivuori, J. Consistent estimation of long-run non-industrial private forest owner timber supply using micro data. *Can. J. For. Res.* **2007**, *37*, 1485–1494. [CrossRef]
60. Roodman, D. Fitting fully observed recursive mixed-process models with cmp. *Stata J.* **2011**, *11*, 159–206. [CrossRef]
61. Tobin, J. Liquidity preference as a behaviour toward risk. *Rev. Econ. Stud.* **1958**, *25*, 65–86. [CrossRef]
62. Maddala, G.S. A perspective on the use of limited-dependent and qualitative variables models in accounting research. *Account. Rev.* **1991**, *66*, 788–807.
63. Allison, P. *Multiple Regression: A Primer*; Pine Forge Press: Thousand Oaks, CA, USA, 1999.
64. Cohen, J. *Statistical Power Analysis for the Behavioural Sciences*; Academic Press: New York, NY, USA, 1969.
65. Pek, J.; Wong, O.; Wong, A.C.M. How to address non-normality: A taxonomy of approaches, reviewed, and illustrated. *Front. Psychol.* **2018**, *9*, 2104. [CrossRef]
66. White, H. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* **1980**, *48*, 817–838. [CrossRef]
67. Håbesland, D.E.; Kilgore, M.A.; Becker, D.R.; Snyder, S.A.; Solberg, B.; Sjølie, H.K.; Lindstad, B.H. Norwegian family forest owners' willingness to participate in carbon offset programs. *For. Policy Econ.* **2016**, *70*, 30–38. [CrossRef]
68. King, G.; Honaker, J.; Joseph, A.; Scheve, K. Analyzing incomplete political science data: An alternative algorithm for multiple imputation. *Am. Political Sci. Assoc.* **2001**, *95*, 49–69. [CrossRef]
69. Schafer, J.L.; Graham, J.W. Missing data: Our view of the state of the art. *Psychol. Methods* **2002**, *7*, 147–177. [CrossRef]
70. Buuren, S.; Oudshoorn, K.G. Mice: Multivariate Imputation by Chained Equations in R. *J. Stat. Softw.* **2011**, *45*, 3. [CrossRef]
71. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2018; Available online: http://www.R-project.org/ (accessed on 15 November 2018).
72. Greene, W.H. *Econometric Analysis*, 7th ed.; Upper Saddle River: Pearson Prentice Hall, NJ, USA, 2012.
73. Lidestav, M.; Ekstrom, M. Introducing gender in studies on management behaviour among non-industrial private forest owners. Scand. *J. For. Res.* **2000**, *15*, 378–386.
74. Messmer, M.; Percy, M.; Phillips, W.E.; Boylen, D. *An Economic Analysis of Wood Supply from Private Land in Alberta: Joint Publication of Forestry Canada*; Minister of Supply and Services Canada: Edmonton, AB, Canada, 1990.
75. Eriksson, L. Explaining gender differences in private forest risk management. *Scand. J. For. Res.* **2018**, *33*, 716–723. [CrossRef]
76. Follo, G.; Lidestav, G.; Ludvig, A.; Vilkriste, L.; Hujala, T.; Karppinen, H.; Didolot, F.; Mizaraite, D. Gender in European forest ownership and management: Reflections on women as New forest owners. *Scand. J. For. Res.* **2017**, *32*, 174–184. [CrossRef]
77. Sun, X.; Sun, C.; Munn, I.A.; Hussain, A. Knowledge of three regeneration programs and application behavior among Mississippi nonindustrial private forest landowners: A two-step sample selection approach. *J. For. Econ.* **2009**, *15*, 187–204. [CrossRef]
78. Bell, C.D.; Roberts, R.K.; English, B.C.; Park, W.M. A logit analysis of participation in Tennessee'S forest stewardship program. *J Agric. Appl. Econ.* **1994**, *26*, 463–472. [CrossRef]
79. Van Putten, I.; Jennings, S. Modeling forest owner harvesting behaviour and future Intentions in Tasmania. *Small-Scale For.* **2010**, *9*, 175–193. [CrossRef]
80. Gramann, J.H.; Marty, T.; Kurtz, W.B. A logistic analysis of the effects of beliefs and past experience on management plans for non-industrial private forests. *J. Environ. Manag.* **1985**, *20*, 347–356.
81. Young, R.A.; Reichenbach, M. Factors influencing the timber harvest intentions of nonindustrial private forest owners. *For. Sci.* **1987**, *33*, 381–393.

82. Follo, G. Factors influencing Norwegian small-scale private forest owners' ability to meet the political goals. *Scand. J. For. Res.* **2011**, *26*, 385–393. [CrossRef]
83. Karppinen, H. Objectives of non-industrial private forest owners: Differences and future trends in southern and northern Finland. *J. For. Econ.* **1998**, *4*, 147–174.
84. Zhao, M.; Kittredge, D.B. How Family Forest Owners Consider Timber Harvesting, Land Sale, and Conservation Easement Decisions: Insights from Massachusetts, USA. *Int. J. For. Res.* **2011**, *2011*, 290353.
85. Loeyland, K.; Ringstad, V.; Oey, H. Determinants of forest activities—A study of private nonindustrial forestry in Norway. *J. For. Econ.* **1995**, *1*, 219–237.
86. Zhang, D.; Flick, W.A. Sticks, carrots, and reforestation investment. *Land Econ.* **2001**, *77*, 443–456. [CrossRef]
87. European Commission. *United in Delivering the Energy Union and Climate Action—Setting the Foundations for a Successful Clean Energy Transition, Communication from the Commission to the European Parliament, the Council*; The European Economic and Social Committee and the Committee of the Regions: Brussels, Belgium, 2019; pp. 1–26.
88. Bogaert, S.; Pelkmans, L.; van den Heuvel, E.; Devriendt, N.; Regel, S.D.; Hoefnagels, R.; Junginger, M.; Resch, G.; Liebmann, L.; Mantau, U.; et al. *Sustainable and Optimal Use of Biomass for Energy in the EU Beyond 2020*; European Commission: Amsterdam, The Netherlands, 2017; pp. 1–198.
89. De Schutter, L.; Giljum, S. *A Calculation of the EU Bioenergy Land Footprint Discussion Paper on Land Use Related to EU Bioenergy Targets for 2020 and an Outlook for 2030 Institute for the Environment and Regional Development*; Vienna University of Economics and Business (WU): Vienna, Austria, 2014; pp. 1–39.
90. European Commission. *The EU Rural Development Policy: Facing the Challenges. European Commission*; Directorate-General for Agriculture and Rural Development: Brussels, Belgium, 2008; pp. 1–21.