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Factors Affecting Enlargement of Family Forest Holdings

Ilona Suuriniemi, Jukka Matero, Harri Hänninen and Jussi Uusivuori

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This study contributes to the research of enlargement – a counterforce of parcelization – of forest holdings. To help planning policy measures aiming at increased average size of forest holdings, we study the characteristics of family forest owners who acquired additional forestland area during the years 2004–2008. Increases of forestland area due to purchases on the open market, purchases from parents or other relatives, inheritance or gift are studied. Survey data, containing information of 6318 forest owners, are analyzed with logistic regression analysis in order to establish a relationship between the probability of increasing the forestland area and the characteristics of landowners. The results indicate that young male owners, who appreciate economic values of the ownership and are active users of their forest estates, most often expand their forest property. This can be considered as an encouraging result from the point of view of the political objective to boost forest management activity through enlarging family forest holdings.

Keywords economies of scale, structural change, forest ownership, non-industrial private forest owners, land policy, parcelization, consolidation
Addresses *Suuriniemi* and *Matero*, University of Eastern Finland, School of Forest Sciences, P.O. Box 111, FI-80101 Joensuu, Finland; *Hänninen* and *Uusivuori*, Finnish Forest Research Institute, Vantaa Unit, P.O. Box 18, FI-01301 Vantaa, Finland **E-mail** jukka.matero@uef.fi
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1 Introduction

The Finnish forest sector is highly dependent on family forests, which cover some 60% of the forest area and provide around 80% of the domestic roundwood used by export oriented forest industries (Finnish Statistical… 2010). At the end of 2009 there were nearly 345 000 privately owned forest holdings exceeding the size of two hectares. These holdings were owned by some 730 000 individuals indicating that the estates often have more than one owner, e.g. married couples or members of jointly owned holdings like private partnerships and legal or testamentary heirs (Hänninen and Sevola 2010).

During the recent three decades Finnish family forest ownership has faced a strong structural change. Firstly, the characteristics of forest owners have changed and diversified substantially: a dramatic decline in the number of farmers as forest owners, an increase in the number of absentee and urban owners, and the ageing of the forest owners that has made pensioners as the largest private forest owner group (Reunala 1974, Karppinen et al. 2002, Karppinen and Hänninen 2006, Leppänen 2010). Secondly, forest ownership objectives have been diversified (Karppinen and Hänninen 2006, Leppänen 2010). Thirdly, the number of forest holdings has increased but the development has been bipolar: both the number of the smallest and the largest holdings have been increased (Ripatti and Reunala 1989, Leppänen 2008, Hänninen and Sevola 2010).

The described development is not unique to Finland but well-known in many European countries (Hirsch et al. 2007, Schmithüsen and Hirsch 2009, Schwarzbauer et al. 2010), as well as in the U.S. (Butler and Leatherberry 2004, Butler 2008). About 60% of the European forests (EU 27) are privately owned, the average size of forest holdings being around 10 hectares. The large majority of forest owners are non-industrial private forest owners, i.e. family forest owners (Schwarzbauer et al. 2010, 32–36). In the U.S., family forest owners constitute about 40% of the total forest area, the average size of holdings is also around 10 hectares (Butler and Leatherberry 2004, Butler 2008) and parcelization and consolidation coexist similarly as in Finland (Zhang et al. 2005, Mundell et al. 2010). In terms of numbers of forest owners as well as size-class distributions, small scale forest holdings dominate in both continents, and their number is increasing.

As the number of landowners increase, the average size of forest property decreases when larger lots are divided into separate ownerships. The phenomenon is known as parcelization (Mehmood and Zhang 2001). Parcelization has several consequences in forestry. The smaller the property, the less relevance it has for the owner in terms of forest management. Not surprisingly, small-scale forest owners often have different objectives for owning forestland from those of large-scale forest owners, who put more value on timber production (e.g., Karppinen 1998, Ingemarson et al. 2006, Butler 2008). Several studies have shown that small parcel size means higher production costs per unit in harvesting operation, plantation, and management (see Zhang et al. 2005). Parcelization may also increase forest fragmentation (Mehmood and Zhang 2001, Minnesota Forest Resources Council 2006), which has negative effects on biodiversity, watersheds, ecosystems, and landscape (Debinski and Holt 2000, Haines et al. 2011).

Parcelization and changes in ownership structure have raised concern over decreasing or irregular supply of roundwood, as forest owners become less dependent on forestry income. In order to reduce unfavorable impacts of forest ownership structures in Europe, various efforts have been proposed, such as improving organization of forest owners, enhancing co-operation between forest owners, and consolidating land management units (Schmithüsen and Hirsch 2009, Schwarzbauer et al. 2010). In Finland, the national forest policy aims to put a stop on parcelization and to enhance enlargement of forest properties (Finland's national… 2011).

Research on forestland use has largely focused on identifying underlying causes of forestland parcelization, and on the consequences of parcelization (Dennis 1992, Ripatti 1996, DeCoster 1998, Mehmood and Zhang 2001, Zhang et al. 2005, 2009, Haines et al. 2011). In contrast, hardly any studies investigate the enlargement of forest holdings – the counterforce for parcelization. In order to carry out efficient land policy, it is useful to recognize also the opposite phenomenon of parcelization, the enlargement of forest hold-

ings. Mundell et al. (2010), for example, found that more than 50% of the sales on larger acreage parcels in a Minnesota county were actually consolidations whereby the adjacent landowner was the buyer of these tracts.

Zhang et al. (2009) outlined generally that optimal landholding size for a family forest owner is the holding size for which marginal value is equal to marginal cost (market price of forestland plus holding costs, including taxes, management costs and risk). They further hypothesized that when the primary ownership objective is timber production, the optimal holding size is likely based on the efficiency of timber production (e.g. management skill and scale). But for a family forest owner whose primary objectives are not related to timber production, (marginal) amenity values are dependent on the owner's income. However, the ultimate choice of size of forest holdings is constrained by capital and land availability (which in turn are affected by several potential tax and land use policies). Zhang et al. (2005) emphasized the role of transaction costs and argued that higher transaction costs of non-timber amenities from forests, along with increasing demand for these services, increases the number of people who own smaller forest holdings. In contrast, production-oriented owners were explained to increase their holding size because of the economies of scale for timber production. The role of transaction costs may, however, be quite different under the Finnish right of free access to the land (Everyman's right… 2007) when non-timber amenity valuations are not dependent on the land ownership. Tahvonen and Salo (1999), for example, showed that the value of forest land is dependent on the property rights related to nontimber values of forests.

The aim of this study is to identify the characteristics and objectives of family forest owners who enlarged their forest properties during the years 2004–2008 through purchases on the open market, purchases from parents or other relatives, or by receiving a gift or an inheritance. Firstly, variables describing the objectives of forest owners are constructed. Secondly, the probability of enlarging the forest property is explained by owner and ownership related factors using a logistic regression analysis. Our analysis is exploratory as we feel that existing theoretical frameworks outlined for example by Zhang et al. (2005, 2009) do not provide clear, testable hypotheses about the links between changes in holding size and the characteristics of the forest owners in our specific context.

2 Material and Methods

The data used in this study are from The Forest Owner 2010 survey conducted by the Finnish Forest Research Institute in 2009. The survey considered solely-owned, family-owned and jointly-owned non-industrial forest holdings in Finland, with the minimum of 5 hectares. The sample of 13 000 forest holdings was picked out from the estate register of the National Board of Taxes. At the first stage, the forest holdings were arranged according to their size in growing order from the smallest to the largest in each Forestry Center (there are 13 regional administrative units), and at the second stage, every 24th holding was picked out in each Forestry Center. Since updating the tax records, some forest owners had died or sold their holdings, so the final sample size was 12 848 forest holdings (Hänninen et al. 2011).

The survey included three mailings. The response rate was 49.2%, with 6318 acceptable mail questionnaires returned. The analysis of non-response, based on the data of National Board of Taxes and interviews of 201 non-responded owners, indicated that the share of farmers was slightly bigger in non-respondents than respondents (Hänninen et al. 2011). The focus of this study was on the established forest owners, so the new forest owners who had acquired the holding or major part of it during 2004–08 (857 respondents), were removed. In addition, observations with incomplete or inconsistent information were removed. Finally, 2310 forest owners with complete information in all variables were retained for the logistic regression analysis.

Independent variables that were expected to have an effect on the enlargement of forest holding were chosen. The variables were forest owner´s gender, age, professional education, occupation, social status, district of residence, wage and total income, type of ownership, the mode by which the forest owner had received the main forest holding

Table 1. Objectives of forest ownership: factor analysis. Rotated factor matrix (loadings below 0.250 are not shown).

Variables	Factors			
	1	2	3	4
Security against exceptional situations	0.800			0.259
Security for old age	0.772			0.336
Security against inflation	0.708			
Credibility	0.592			0.334
Investment	0.546			0.270
Inheritance	0.530			
Residential environment		0.718	0.252	
Outdoor recreation		0.715	0.297	
Berry and mushroom picking		0.673		
Solitude and meditation		0.577	0.435	
Forest work		0.554		
Household timber		0.552		
Connection to native locality		0.371	0.322	
Inherent value	0.335	0.356	0.294	
Nature conservation			0.705	
Biodiversity		0.381	0.696	
Aesthetic value		0.420	0.683	
Regular sales income for consumption	0.345			0.706
Funding of big investment	0.445			0.637
Labor income and employment	0.270			0.627
Eigenvalue	3.384	3.241	2.144	1.806
Variance explained (%)	16.9	16.2	10.7	9.0
n=5110				

Interpretation of the factors: 1: Economic security, 2: Recreation and household timber, 3: Conservation and landscape, 4: Income and self-employment.

in his/her possession, forestland area, time spent in the forest estate within a year, satisfaction with the current forest management methods, existence of forest plan, volume of timber sold during 2004–08, timber price expectations until 2020, and objectives of forest ownership (see Appendix 1). The timber price expectation is the only variable that can be considered to be a market level variable, the other variables being related to the characteristics of the owner or the forest property. Information on income and forestland area were obtained from the National Board of Taxes based on the year 2007. However, the respondents were given a possibility to update and correct the information on forestland area. All other variables were directly based on the questionnaire.

Forest ownership objectives were surveyed using 20 objective statements with Likert scale from 1 to 5 (see Appendix 2). The statements (variables) were condensed into four dimensions by explanatory factor analysis with maximum likelihood extraction and orthogonal varimax rotation (Tabachnick and Fidell 2001). The factor scores were calculated for 5110 forest owners who had responded at minimum to 18 objective statements. The remaining missing values were imputed with the value 3. The four interpretable factors were named as *economic security*, *recreation and household timber*, *conservation and landscape* and *income and self-employment*, based on the loadings of the objective statements (Table 1). Kaiser-Meyer-Olkin (KMO) measure was 0.921 and Bartlett's test of sphericity highly significant ($p<0.001$) indicating that analysis was appropriate. The four factors explained 52.8% of the total variance.

In the next phase, these factor scores were used as grouping variables in K-means cluster analysis

Table 2. Forest owner groups based on ownership objectives (means of factor scores). K-means cluster analysis.

Factors	Owner groups						
	1	2	3	4	5	F	p-value
1 Economic security	–0.346	0.634	–1.059	–0.118	0.512	1150.94	<0.001
2 Recreation and household timber	0.244	0.330	0.383	–1.526	0.255	1884.46	<0.001
3 Conservation and landscape	–1.116	0.376	0.604	–0.406	0.188	1094.65	<0.001
4 Income and self-employment	–0.136	–0.641	–0.379	–0.173	0.956	1441.87	<0.001
n	820	1097	965	842	1386		
%	16	21	19	16	27		

Interpretation of the groups: 1: Opponents of conservation, 2: Economic security owners, 3: Conservationists and recreationists, 4: Indifferent owners, 5: Economical multiobjective owners.

used to classify forest owners into groups based on stated objectives (Tabachnick and Fidell 2001; see Kuuluvainen et al. 1996 for the application of the method). Forest owners could be classified into five groups (Table 2). The groups were named as *opponents of conservation*, *economic security owners*, *conservationists and recreationists*, *indifferent owners* and *economical multiobjective own*ers.

Opponents of conservation represent owners for whom nature conservation and aesthetic values were not important at all, but who visited their forest sometimes, for example to cut household timber or for berry picking. They did not search for economic benefits. *Economic security owners* considered their forest property as a source of economic security, but also appreciated recreation and conservation. Interestingly, they did not have regular income expectations. *Conservationists and recreationists* emphasized forest conservation and landscape, and enjoyed recreation but did not consider forest as an economic investment. *Indifferent owners* did not have any specific objectives for the forest ownership. Low mean score at the factor 2 (recreation and household timber) indicate that these owners hardly ever visited their forests. Although *economical multiobjective owners* valued both monetary and amenity benefits of their forests, they appreciated economic aspects notably over the other objectives.

The dependent variable was based on a question where the forest owners were asked to state whether the forestland area of the holding had changed during the last five years (2004–08) and for which reason. The variable consisted of two categories: 0, meaning no change and 1, meaning increase due to purchases from the market or relatives, or due to inheritance or gift (8.3% of the respondents in the category 1). Of the forest owners with changed land area, 69% had purchased the forest parcel on open market, while 20% had purchased the land from parents or other relatives. Finally 16% had received the additional forestland as a gift or an inheritance from their parents or some other persons. The sum of proportions exceeds 100% as some owners had increased the forest area by several modes.

Because the dependent variable was dichotomous, logistic regression analysis was performed. In the logistic regression analysis the response variable, $\hat{Y}$, given the independent variables X_j, is of the form (Tabachnick and Fidell 2001):

$$\hat{Y} = \frac{e^{A+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_k X_k}}{1+e^{A+\beta_1 X_1+\beta_2 x_2+\ldots+\beta_k x_k}} \quad (1)$$

where $\hat{Y}$ is the estimated probability for the response variable taking value 1, A is the constant term, β_j are the coefficients and X_j are the independent variables ($j=1, 2, \ldots, k$). It is assumed that in the logistic regression there is a linear connection between the independent variables and the logit transformation of the response variable:

$$\ln\left(\frac{\hat{Y}}{1-\hat{Y}}\right) = A + \sum \beta_j x_j \quad (2)$$

The unknown parameters, β_j, were estimated with the maximum likelihood method. The effects of the predictors on the dependent variable were

easiest to interpret through the odd ratios, OR that in the case of a binary predictor is given by:

$$\mathrm{OR} = \frac{\hat{Y}(1)/\left[1-\hat{Y}(1)\right]}{\hat{Y}(0)/\left[1-\hat{Y}(0)\right]} \quad (3)$$

where 0 and 1 denote the coding of two categories of a binary predictor (e.g. existence of the forest plan). The odds ratio can be obtained from the estimated logistic coefficient, because they have the following relationship:

$$\mathrm{OR} = e^{\beta_1} \quad (4)$$

The odds ratio provided a description of the net impact of a given predictor on the odds controlling for all other effects in the model (Demaris 1993). Demaris (1993) points out that the interpretation of odds ratio is strictly in terms of odds and not probabilities. However, if the model is developed as a predictive tool for identifying categories of individuals at risk of certain event, specific probabilities for substantially interesting cases may be calculated to support the interpretation (Demaris 1993). Those probabilities were calculated by Eq. 1.

Traditionally the most parsimonious model that still explains the data is preferred (Hosmer and Lemeshow 2000). In this study, independent variables were selected by forward stepwise method. Variables were entered into the multivariate model one at a time, beginning from the one that improved most the model's explanatory power measured by the likelihood ratio test. The process was continued until the additional variables did not further improve the model. Finally, the statistical significance of the model was tested using the likelihood ratio test and Hosmer & Lemeshow goodness-of-fit test. Also Wald test was used to verify the importance of each variable included in the final model.

The test of multicollinearity between the variables did not indicate problems except in the case of income variables. Although wage income and total income correlated, they were both included in the analysis, because they represented rather different information. Multicollinearity after all should not be a great problem in the case of forward stepwise method of binary logit (Metsämuuronen 2006).

3 Results

3.1 Variables Affecting the Increase of Forestland

With forward stepwise method 10 variables out of 17 were selected into the final model: age (AGE), district of residence (DIST), number of visits in the forest estate within a year (TIME), gender (SEX), forestland area (FOR), existence of forestry plan (PLAN), total income (TINC), occupation (OCCUP), objectives of forest ownership (OBJ) and the way by which forest owner had received the main forest holding in his/her possession (POSSES).

The final model was compared to the model containing only a constant term. Likelihood ratio (LR) test statistic indicated that the model was statistically significant (Table 3). Also the Hosmer & Lemeshow goodness-of-fit statistic indicated a good fit. Cox & Snell's R^2 and Nagelkerke's R^2 indicated, however, that the proportion of variance explained by the model was not very high (Table 4).

The classification accuracy of the model was measured by the area under the receiver operating characteristic (ROC) curve. This forms a cutoff point -independent measure, able to deal with unequal class distributions and misclassification error costs (Fielding 2007). The area under the ROC curve was 0.796, which was considered acceptable (Hosmer and Lemeshow 2000).

Table 3. Goodness-of-fit by the likelihood ratio test and Hosmer & Lemeshow test.

likelihood ratio (LR) test statistic			Hosmer & Lemeshow		
χ^2	df	p-value	χ^2	df	p-value
256.250	20	<0.001	9.549	8	0.298

Table 4. Goodness-of-fit by the Cox & Snell's R^2 and Nagelkerke's R^2.

–2 LL	Cox & Snell R^2	Nagelkerke
1132.664	0.105	0.232

3.2 Estimated Coefficients

The results of fitting the final binary logistic regression model are shown in Table 5, in which the following information is presented: the estimated coefficients, the estimated standard errors, Wald-test statistics, p-values of the Wald test, the estimated odds ratios, confidence interval for the odds ratios and inverse values of the odds ratios.

The odds ratios of the way by which forest owner had received the main forest holding in his/her possession (POSSES) remained below zero. Therefore, to ease the interpretation, inverse values (OR^{-1}) were taken. The odds of increase of forestland were almost 4.5 times higher for owners who had originally bought the main estate on the open market, compared to those who had received it through inheritance or gift, and 3.1 times higher compared to those who had bought it from their parents or other relatives. The odds ratio of increase of forestland with respect to owner age (AGE) was 4.0 for 15–39 year old and 1.9 for 40–56 year old owners compared to owners over 60 years old. The contribution of

Table 5. Logistic regression model: increase of forestland area through purchases on the open market and between relatives and through inheritance or gift. Reference classes as well as p-values and odds ratios of statistically significant classes are in bold. Sample size: 2310.

Variable name	Class	β	S.E.	Wald	p-value	Odds ratio	CI 95 % of OR		OR^{-1}
							lower	upper	
	Constant	–1.851	0.491	14.212	<0.001	0.157			
AGE	15–39	1.383	0.289	22.896	**<0.001**	**3.988**	2.263	7.027	
	40–59	0.628	0.175	12.819	**<0.001**	**1.874**	1.329	2.644	
	60–								
DIST	Living in countryside	0.890	0.261	11.619	**0.001**	**2.434**	1.460	4.060	
	In town, less than 20 000 inhabitants	0.391	0.300	1.691	0.194	1.478	0.820	2.663	
	In town, more than 20 000 inhabitants								
TIME	0–10 days per year	–0.341	0.272	1.576	0.209	0.711	0.417	1.211	
	11–50 days per year	–0.194	0.256	0.574	0.449	0.824	0.498	1.361	
	51–364 days per year	0.720	0.273	6.963	**0.008**	**2.054**	1.203	3.505	
	Living in the estate								
SEX	Male	0.692	0.263	6.916	**0.009**	**1.997**	1.193	3.344	
	Female								
FOR	Continuous (in 100 hectares)	0.187	0.064	8.484	**0.004**	**1.206**	1.063	1.368	
PLAN	No	–0.481	0.202	5.680	**0.017**	**0.618**	0.416	0.918	1.617
	Yes								
TINC	–18 000 €	–1.304	0.312	17.483	**<0.001**	**0.271**	0.147	0.500	3.684
	18 001–34 000 €	–0.915	0.243	14.163	**<0.001**	**0.401**	0.249	0.645	2.497
	34 001–56 000 €	–0.379	0.189	4.027	**0.045**	**0.685**	0.473	0.991	1.461
	56 001– €								
OCCUP	Not working in the forest sector	–0.637	0.207	9.503	**0.002**	**0.529**	0.353	0.793	1.891
	Working in the forest sector								
OBJ	Opponents of conservation	–0.151	0.236	0.409	0.522	0.860	0.541	1.366	
	Economic security owners	0.261	0.216	1.462	0.227	1.298	0.851	1.980	
	Conservationists and recreationists	–0.969	0.315	9.468	**0.002**	**0.380**	0.205	0.704	2.635
	Indifferent owners	–0.186	0.278	0.448	0.503	0.830	0.481	1.432	
	Economical multiobjective owners								
POSSES	Inheritance or gift	–1.486	0.242	37.653	**<0.001**	**0.226**	0.141	0.364	4.419
	Purchase from parent or other relatives	–1.150	0.202	32.538	**<0.001**	**0.317**	0.213	0.470	3.158
	Purchase on the open market								

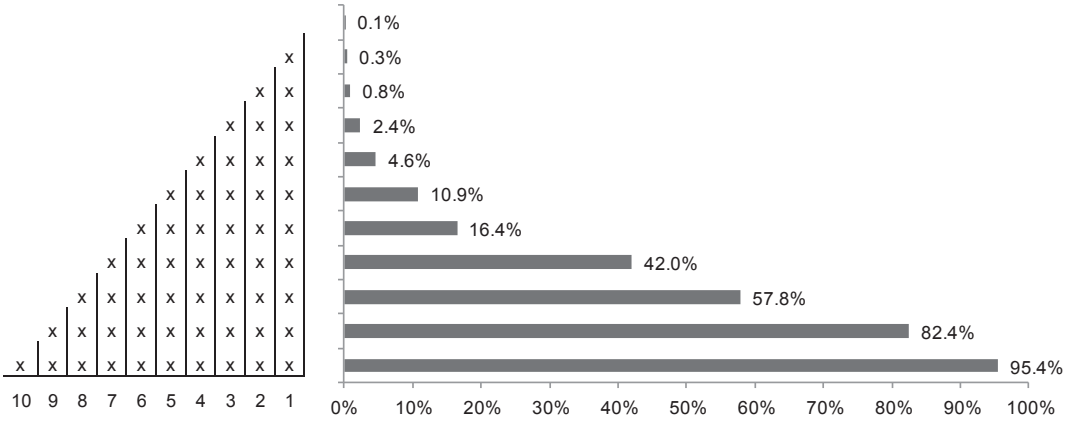
total income (TINC) to the model was clear and obvious. The probability increased consistently by the increase of the income. The objectives of forest ownership (OBJ) had only one statistically significant class. The odds ratio of the objective group of conservationists and recreationists was 0.4, indicating that the owners who appreciated mostly conservation and recreation had lower probability to expand the ownership than the multiobjective owners, who appreciated especially economic aspects of the forest ownership.

Forest owner's district of residence (DIST) was also found to be a significant factor. The odds ratio of living in countryside was 2.4, indicating that the odds of increase of forestland were 2.4 times higher among forest owners living in rural areas than among ones living in cities. Number of visits in the forest estate in year 2008 (TIME) had one statistically significant class in the model. The odds ratio of the class "51–364 days per year" was 2.0, which indicated that the odds of increase of forest were two times greater for owners who visited their forests at least once a week, but did not live there, compared to those who lived in their forest estate. The odds ratio for male versus female (SEX) was close to two, indicating that the acquisition of the additional forestland was more common among males. The odds of an increase of forestland were two times greater among owners who worked in the forest sector than among those who did not (OCCUP). The odds of increase for owners who had a forest plan (PLAN) were one and half times higher than for those who did not have one, indicating that owners who acquire additional forestland, manage their forests according to the plan. The estimated odds ratio for owned forestland area (FOR) was 1.2, indicating that for every increase of 100 owned forest hectares, the odds of expanding forest ownership increased 1.2 times.

3.3 Probabilities of Increase

The odds ratios indicate the changes in the odds of increase of forestland, but not changes in the probability of increase of forestland. Probabilities for the increase of forestland area were calculated for different categories of forest owners formed by combining the variables (Fig. 1).

The lowest probability of increase of forestland, 0.1%, was calculated for a forest owner



1. Age less than 40 2. Lives in countryside 3. Visits at least once a week at the estate, but does not live there 4. Male 5. Owns 500 hectares 6. Have forestry plan 7. Had total income more than 56 000€ in 2007 8. Works in the forest sector 9. Appreciates economic security 10. Had purchased the estate originally on the open market

Fig. 1. Probabilities for increase of forestland area for different categories of forest owners. Over 60 years old female, living in a city, owning 10 hectares, not having forestry plan, with low total income and not working in the forest sector, appreciating conservation and recreation and having acquired the forest estate through inheritance or gift constitute a reference group with 0.1% probability for an increase.

with the following characteristics: over 60 years old female, lived in the city, spent at maximum 10 days per year in the forest estate, owned 10 hectares, did not have forestry plan, had low total income, did not work in the forest sector, appreciated conservation and recreation and had acquired the forest estate through inheritance or gift. The highest probability calculated was 95.4%, for a male owner who was less than 40 years old, lived in countryside, visited at least once a week at the estate but did not live there, owned 500 hectares, had a forestry plan, had annual total income more than 56 000 €, worked in the forest sector, appreciated economic security of forest ownership and had originally purchased the property on the open market.

4 Discussion and Conclusions

In this study, differences between forest owners who had acquired some additional forestland between years 2004 and 2008 and owners whose forest property had not changed were examined by estimating a logistic regression model. The probability of increasing the forestland was explained by ownership related factors.

The type of acquisition by which a forest owner received the main forest holding in his/her possession seems to have a strong effect on the probability of increasing the forestland area. The results indicate that those owners who originally bought the estate from the open market are the most likely ones to expand their ownership. In contrast, those forest owners who have originally received the estate through inheritance or as a gift were the least likely to expand their ownership. This finding is consistent with Majumdar et al. (2009) who found that in the U.S. inheritors were significantly less likely than other family forest owners to intend to buy more forestland in the next five years although inheritors were more active forest managers for both timber and nontimber forest products. Unlike in the U.S., where forestland is mostly (80%) acquired by purchase on the free market (Butler 2008), in Finland, 85% of forest land is either acquired by inheritance or is purchased from parents or other relatives (Hänninen et al. 2011). Also the age of the forest owner strongly affected the probability to expand the forest property. The younger the owner, the more likely he was to expand his/her forest property. This result is interesting to relate to the development of ageing in forest ownership. In Finland, as in many other countries, forest owners are rapidly ageing, the average age being 60 years (e.g. Hirsch et al. 2007, Butler 2008, Schmithüsen and Hirsch 2009, Leppänen 2010, Schwarzbauer et al. 2010). With respect to the total income, the probability of expansion increases when the income increases. In terms of the variable describing the objectives of the forest ownership, our results suggest that owners with conservationist and recreational values (19% of all family forest owners), are unlikely to expand the extent of their forest ownership. This may be because a smaller forest area is sufficient to meet with their needs supporting the argument by Zhang et al. (2005) that the marginal value of forestland for non-timber purposes is diminishing much faster than that for timber production. In contrast, the multiobjective owners, who appreciate especially economic values, are the most likely ones to increase their forest property.

The probability to acquire additional forestland seems to be greater for those who live in countryside than for city dwellers. However, those forest owners who visit their forest estate at least once a week within a year but do not live there, will be more likely to expand their forest property than owners who live in their estate. In addition, according to the results of this study, increasing forestland area is most likely among men, among owners working in the forest sector, and among those who have a forest plan. The probability to acquire additional forestland is also the higher, the larger their current forest holding is.

Our research design had some limitations and the conclusions should therefore be considered with caution. Most importantly, we analyzed the areal increases by the established forest owners only, increases being most frequently purchases on the open market. However, established forest owners account for some 80% of all forestland purchases in Finland (Hannelius 2008). As new owners were excluded from our data and no information for sellers was provided, our results neither provide any conclusion about the average size of the family forest holdings nor give an overall

picture of changes of the family forestland holdings. To get a more comprehensive and balanced view on the structural change, panel data based on holding-based sampling (see Ripatti 1996) and enabling the construction of a transition probability matrices (Ko and He 2011) would be needed in future studies. In this study, the probability of increasing the forestland area was explained by the ownership related factors. Alternatively, those increases could have been explained by market or forest related factors. For example, Pan et al. (2009) argued that studying the holding size optimization of forestland owners within an economic framework requires including a host of relative prices in the model: home prices, food prices, transportation costs, timberland prices, timber price, capital costs and wages. Obviously, more theoretical development for holding size optimization and adjustments is still needed. Modern portfolio theory and portfolio optimization (e.g. Hyytiäinen and Penttinen 2008) may provide some new insights for the dynamic holding size optimization. In the common capital asset pricing model the investor's choice (i.e. whether to buy or sell forestland), however, depends only on (monetary) return and risk. This objective for ownership is quite restrictive for most family forest owners although the general optimization could be tailored by case-specific details (e.g. public cost-sharing, differences in tax treatments and exceptional transaction costs).

It would have been interesting to include the area of the increases into the analysis. In our binary logistic regression the characteristics of a forest owner who had acquired one additional hectare of forest land was given as much weight as the characteristics of an owner acquiring additional 100 hectares, even if these cases in reality have very different contributions to the forest ownership structure. Finally, most of the independent variables in this study were recoded into few categories and consequently some important information might have been lost.

One of the main objectives in the current Finnish forest policy is to restrain forest parcelization and to enhance enlargement of family forest holdings. This development is expected to improve the profitability of private forestry and ensure sustainable timber flow from private forests. A key issue in designing effective policy measures is finding out the characteristics and objectives of those forest owners who are likely to enlarge their forest property. The results of this study show that young owners who have bought their forestland on market, appreciate economic values of the forest ownership, are active users of their forest estates, and who have a forest plan, are those who most often expand their forest property. The probability to acquire additional forestland also increases the larger is the current holding. These can be considered as encouraging results from the point of view of the political objective to boost the forest management activity by increasing the average size of holdings. It seems that Finnish policy measures designed to encourage older forest owners to make the transfer of a forest holding to a descendant during their life-time instead of leaving an inheritance, or to sell their forest property on the free market, are in line with this objective.

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Total of 40 references

Appendix 1. Descriptive statistics of the variables used to estimate the logistic regression model.

Variable definition (name)	Classes	Frequency (%)
age (AGE) (n = 2310)	15–39	5.2
	40–59	42.3
	60–	52.5
district of residence (DIST)	living in coutryside	56.7
(n = 2310)	in town, less than 20 000 inhabitants	16.6
	in town, more than 20 000 inhabitants	26.7
time spent in the forest estate	0–10 days per year	22.4
(TIME) (n = 2310)	11–50 days per year	20.0
	51–364 days per year	13.5
	living in the estate	44.1
gender (SEX) (n = 2310)	male	77.8
	female	22.2
owned forestland area in total (FOR)	continuous (in 100 hectares)	mean 0.47
(n = 2310)		SD 1.13
existence of forestry plan (PLAN)	yes	65.2
(n = 2310)	no	34.8
professional education (PEDU)	no degree	27.9
(n = 2271)	vocational school	35.8
	polytechnic	22.6
	academic degree	13.7

Appendix 1 continued.

Variable definition (name)	Classes	Frequency (%)
social status (STATUS) (n = 2295)	employee	33.3
	agricultural or forestry entrepreneur	17.3
	other entrepreneur	7.2
	pensioner	40.2
	other	2.0
wage income (WINC) (n = 2310)	–13 000 €	21.3
	13 001–27 000 €	21.2
	27 001–43 000 €	26.5
	43 001– €	31.1
total income (TINC) (n = 2310)	–18 000 €	20.8
	18 001–34 000 €	21.6
	34 001–56 000 €	28.4
	56 001– €	29.2
type of ownership (OWN) (n = 2310)	family	86.6
	joint ownership	0.8
	heirs	12.5
occupation (OCCUP) (n = 2310)	not working in the forest sector	89.3
	working in the forest sector	10.7
objectives of forest ownership (OBJ) (n = 2310)	Opponents of conservation	15.8
	Economic security owners	21.7
	Conservationists and recreationists	18.4
	Indifferent owners	14.8
	Economical multiobjective owners	29.1
way by which forest owner had got the main forest holding in his/her possession (POSSES) (n = 2310)	inheritance or gift	40.5
	purchase from parent or other relatives	45.4
	purchase on the open market	14.2
satisfaction with the current forest management methods (SATISF) (n = 2147)	satisfied	71.3
	neither	17.2
	dissatisfied	11.6
volume of timber sales per hectare per year during 2004–08 (VOL) (n = 2100)	0 m^3	35.2
	0.1–2 m^3	17.2
	2.1–5 m^3	21.2
	5.1– m^3	26.3
timber price expectations until 2020 (EXPECT) (n = 2229)	increase	56.8
	unchanged or decrease	19.2
	can not say	24.0

Appendix 2. The original statements related to the goals of forest ownership with the response scale from 1 to 5 (1 = completely irrelevant, 2 = quite irrelevant, 3 = I cannot say, 4 = quite important, 5 = extremely important).

Statements (variables)
Outdoor recreation and leisure time
My forest is part of my leisure time or residential environment (Residential environment)
My forest affords me opportunities for picking berries and mushrooms (Berry and mushroom picking)
My forest affords me opportunities for outdoor recreation (e.g. walking, jogging, hiking) (Outdoor recreation)
My forest affords me opportunities for doing silvicultural works (providing at the same time functional exercise) (Forest work)
Timber production and timber harvest revenues
My forest affords me regular income for consumption (Regular sales income for consumption)
My forest is for me a financial asset for major purchases (house, car, agricultural buildings and machineries) (Funding of big investment)
My forest affords me labor income (Labor income and employment)
I gain household timber from my forest (Household timber)
Forest environment and scenery
My forest affords me an opportunity for maintaining and treasuring biodiversity (diverse flora and fauna) (Biodiversity)
My forest affords me aesthetic experiences (Aesthetic value)
My forest is for me an object of nature conservation (Nature conservation)
Economic security
My forest property improves my credit rating (Credibility)
My forest affords economic security for my old age (Security for old age)
My forest affords security against exceptional situations (Security against exceptional situations)
My forest property is an asset for hedging against inflation (Security against inflation)
My forest comprises a bequest for my heirs (Inheritance)
Sentimental values
Forestland ownership has intrinsic value for me (e.g. family estate) (Inherent value)
My forest is for me a site for enjoying the silence and meditation (Solitude and meditation)
Through my forest I am connected to my native region (Connection to native locality)
Investment object
My forest is for me an investment object (Investment)