The importance of timber prices and other factors for harvest increase among nonindustrial private forest owners

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Abstract

Increased harvest is high on the forestry and climate policy agenda in several countries. We explored to what extent private non-industrial forest owners in Norway are willing to increase harvest due to elevated hypothetical prices by carrying out a national-wide survey of forest owners. The results indicate that owners who have not harvested timber for sale the last fifteen years do not respond to large price shifts. Instead, ownership objectives and knowledge of a key policy instrument predict willingness to enter the timber market among these owners. The willingness among owners who have sold timber the last fifteen years depends on these factors, in addition to price, forest area, income and gender. Female owners were significantly less willing than male owners to increase harvest. Once the decision to harvest was taken, the stated timber supply volume per area unit decreases with productive forest area both among active and inactive owners. With regard to sources of information, owners who have not harvested timber the last fifteen years use to less extent the information sources other owners do. Forest policies and extension services should acknowledge that for stimulating forest owners outside the timber market to supply wood, other factors than price are important, and that alternative information pathways should be explored for reaching these owners.

Key words: *Roundwood supply, timber supply; Scandinavia, boreal forests, wood mobilization, family forest owners, information sources*

I. Introduction

Wood mobilization is high on the policy agenda in the EU (European Commission 2012) and Norway (Norwegian Ministry of Food and Agriculture 2011) for meeting socio-economic and climate-change mitigation objectives. This priority is supported by rapid accumulation of forest growing stock, due to timber harvests that on average are 30% below growth in Europe (FOREST EUROPE 2015). In the 28 countries that together form the European Union, more than 60% of the forest belong to non-industrial, private forest owners (NIPF) (FOREST EUROPE 2015), which thus are of major importance for timber supply. In a survey carried out among small-scale forest owners in eight European countries, timber supply was on average considered a lower importance management objective than enhancing natural resources, landscapes, biodiversity, recreation and bequest values (Wiersum et al. 2005). In Norway, timber was harvested for sale over the last twenty years on about half of the forest properties (Statistics Norway 2017).

The reservation prices of the timber harvested for sale are equal to or lower than the prevailing timber prices. However, the reservation prices of forest owners who do not harvest are higher than the market prices, but unknown how much higher and thus at which point the owners may decide to enter timber markets. The concept of reservation price in forestry was first applied by Brazee and Mendelsohn (1988) and Lohmander (1988), and later reviewed by Gong and Löfgren (2007). Fina et al. (2001) analyzed how reservation price strategies depend on landowner debt. Stated-preference framework may help in the understanding of forest owner preferences not observable as behavior in the markets. Only the behavior of forest owners selling timber is observable, which may differ from the behavior of forest owners who do not participate in timber markets.

Contrasted to the rich literature of timber supply studies in the revealed preferences framework (see e.g. Silver et al. (2015) and Beach et al. (2005) for reviews), there are only a few studies of timber supply behavior not based on historical records, all from the US. Kennedy (2001), Conway (2002) and Vokoun et al. (2006) studied reservation prices of NIPF owners in Virginia by using a multiple bounded discrete choice questionnaire; Conway's study included also Mississippi. Absentee owners and owners with high income were found to have lower reservation price than others. Environmental motives, recreation, long ownership tenure and bequest motives suggested high reservation prices. Cai et al. (2016) asked NIPF owners in Michigan, Minnesota and Wisconsin about their willingness to harvest timber and biomass. The most important predictors of willingness to harvest were timber and biomass prices, supporting harvest of woody biomass, interest in firewood production and intentions of future timber sales.

Besides these few studies, we have not come across studies of how owners would respond to hypothetical price shifts. Motivations for owning forest land and owner behavior may vary with the geographical, social and economic context. Few direct comparisons between American and Norwegian/Scandinavian ownership exist, but Håbesland et al. (2015) reported that the way of acquiring forestland vary considerably between the U.S. and Norway. It is therefore important to have more analyses outside the regional scope of the cited studies. Also, the quoted studies did not compare directly differences between forest owners who are selling timber with owners who are not. The main objective of this paper is to assess forest owners' increased willingness to harvest due to elevated hypothetical prices and to scrutinize differences between forest owners who already sell timber and those who do not. Specifically, the following research questions are addressed:

a. To what extent do higher timber price and other factors impact on the willingness to harvest among NIPF owners?
b. What are the main differences regarding the willingness to harvest between forest owners who already sell timber and those who do not?

To analyze these questions, we conducted a unique survey of Norwegian NIPF owners. The survey data were combined with data from the nationwide property and tax registers administrated by Statistics Norway.

We continue by presenting the theory and hypotheses before the data. Then the results are provided, and finally the findings are discussed and conclusions drawn.

II. Methodology

Theory and hypotheses

Let $u = u(H_j \times p, A_j, i)$,

Where u is an owner's utility from the forest, H_j is harvest volume, p the offered timber price, A amenities, i the interest rate and j a binary variable (1 or 0) denoting whether the landowners accepts the offered price (j = 1) or not (j = 0). $H_0 = 0$, and $H_j > 0$ for j = 1. Amenities is defined as all non-timber values arise today as well as future value of timber stock. The function is separable.

It follows that the rational owner will accept the offered price if

$u(Hj \times p, A_1, i) > u(A_0, i)$.

u is assumed to increase in A, but at a decreasing rate; i.e., $\partial U/\partial A > 0$; $\partial^2 U/\partial A^2 < 0$.

However, it can be assumed that the utility derived from amenities varies with forest and owner characteristics, i.e.

$u(A_j) = f(O, F)$

where O are owner characteristics and F are forest characteristics. The main variables determining O are assumed to be non-forest (exogenous) income and wealth and ownership objectives. The main forest characteristics determining the utility are assumed to be age and state of forest including qualities relevant for current and future timber price, production opportunities in current and future stand as well as growing stock.

Based on the literature about NIPF timber supply and economic theory, we set up the variables in Table 1 that we hypothesize will impact the willingness to harvest. The higher the offered price, the more forest owners are willing to harvest, as found in several studies reviewed by (Beach et al. 2005). Female owners have been found to harvest less than male owners (Kuuluvainen et al. 2014), while bequest values may dampen willingness to harvest, in line with findings in Kennedy (2001). Ambiguous impacts of the owner's financial situation in terms of net wealth and income have been found; owners who do not depend on timber income may value amenities higher and thus harvest less (Vokoun et al. 2006; Bolkesjø et al. 2007; Kuuluvainen et al. 2014), while net wealth has been found to impact positively on harvest (Kuuluvainen et al. 1996).

We are not aware of timber supply studies that directly have included knowledge of central policy instruments directed towards forest owners. However, we believe that such knowledge could function as a proxy for the general knowledge and information level of important economic and management aspects in forestry. We hypothesize that owners who

are not familiar with important instruments are less inclined to harvest. In Norway, the so-called "forest fund" is such a policy instrument: forest owners are obliged to set aside minimum 4% (and maximum 40%) of the forestry gross income to this fund. The set-aside amount is not subject to taxes, and if invested in forestry, only 15% is subject to income tax. Knowing about this rule will supposedly stimulate the owner to harvest, due to its substantial effect on the after-tax income and the costs of establishing new stands. There are however a few studies that have looked at the impacts of contact with a forester/technical assistance, as well as membership or contact with a wood owners association, as reported by Silver et al. (2015). Silver et al. (2015) found a positive impact of such contact on the decision to harvest; these variables could potentially capture some of the same underlying effects as our "forest fund knowledge" variable.

Mixed impacts of interest rate on timber supply is reported in the literature (Beach et al. 2005). Ownership objectives have been found to have significant impacts on timber supply. The likelihood that an owner would accept a hypothetical timber bid offer was by Kennedy (2001) and Conway (2002) found to be negatively impacted by bequest motives and positively by investment motivation. According to Conway (2002), owners with environmental motives for ownership and who used their forest for recreation had higher reservation prices than others. A positive relationship between forest area and timber supply engagement has been recognized in several studies (Beach et al. 2005). The effect of distance between home and forest in the literature is mixed (Conway 2002; Beach et al. 2005; Cai et al. 2016).

(Table 1)

Survey and data collection

The questionnaire used for assessing the willingness to increase harvest due to elevated hypothetical prices was part of a larger survey of NIPF owners' perceptions and use of their own forest, presented in Appendix A (Active owners) and B (Inactive owners).

Sampling. The survey sample was drawn by Statistics Norway, the national authority for administration of surveys and recording. Two populations consisting of all forest properties larger than 2.49 hectares productive forest in Norway owned by private persons were created: The *Active* population consists of forest properties where at least 5 m^3 of timber have been harvested for sale during the last fifteen years, while the *Inactive* population consisting of forest properties where less than 5 m^3 of timber have been harvested for sale during the last fifteen years. The owners of these two types of properties are referred to as *Active owners* and *Inactive owners* throughout the paper; we also use the term *All owners* where the two samples are merged. We used three strata dimensions to create the samples, activity (Active/Inactive), county and size class. All 19 Norwegian counties except Finnmark were included, Finnmark being left out due to very limited amount of private forest land. Because small properties constitute large shares of the private properties, eight size classes were used: 2.5-9.9 hectares, 10-24.9 hectares, 25-49.9 hectares, 50-99.9 hectares, 100-199.9 hectares, 200-499.9 hectares, 500-1999.9 hectares, and ≥ 2000 hectares. The following approach was used for assigning sample sizes:

$$\frac{S_i}{\sqrt{P_i}} = \frac{S_j}{\sqrt{P_j}} \text{ and } \sum_{i=1}^{N} S_i$$

where *i* and *j* are strata, S_i is the sample size in stratum i and P_i the population size in stratum i, and N the number of strata. This procedure ensured an over-representation of large properties, which strongly influence the total timber supply. Out of the population of

55 965 active owners, a gross sample of 1502 was drawn and the questionnaire sent to 1498 persons after four persons had died or had invalid address. A gross sample of 1646 was drawn of the population of 72 147 inactive owners. Out of the 1646, 10 persons were deemed outside the target group, and the questionnaire was sent to 1636 persons.

Data collection. The questionnaire was first developed to active forest owners. To fit inactive forest owners' situation, the questionnaire was adjusted by excluding irrelevant questions and adapting others (Table 2). The questionnaires were developed in cooperation with experts in Statistics Norway. In a pilot survey, thirteen out of the fourteen questionnaires that were sent to forest owners were returned and followed by a discussion with each respondent by phone or face-to-face. Statistics Norway administrated the survey, using the Total Design Method (Dillman 1978). The final questionnaire was distributed by surface mail February 2014, with two reminders with the questionnaire enclosed mailed after one and two months, respectively. Data collection ended in June 2014.

To gauge the extent to which hypothetical price increase was a predictor for forest owners' willingness to harvest, the stated preferences method was applied. Three versions of price increases were distributed randomly on the three strata dimensions activity, size class and county. The levels of hypothetical price increases were 50, 100 and 150 NOK/m^3 up from 300 NOK/m^3 (1 NOK ~ 0.12 USD) close to the prevailing average gross timber prices delivered roadside. The levels were chosen to reflect prices that would be high compared to recent fluctuations, in order to cover potentially high reservation prices, particularly among inactive owners. Finally, Statistics Norway added individual and property-level register data for each of the last fifteen years, including income, asset value and annual harvest, as well as productive forest area.

Regression analyses

For the statistical analyses, we applied a two-stage model approach. In the first stage a dichotomous dependent variable measured whether the respondents were willing to harvest more (Y=1) or not (Y=0). Those who were willing to harvest more reported their anticipated increase in harvest volume, and we divided this volume by the size of their productive forest area. The log of this result was the dependent variable log(y) in the second stage. The same set of independent variables was used in both stages.

In the first stage, we used a probit model for forest owners, i,

$$P(Y_i = 1) = \Phi(X_i\beta)$$

where $\Phi(\cdot)$ denote the cumulative normal distribution and where

Xi and β denote vectors of independent variables and coefficients, respectively. In the second stage we used a linear regression model,

$$\log(y_i) = X_i\gamma + \varepsilon_i$$

where γ is a vector of coefficients and ε_i is the error term. Combined, the two stages constitute an exponential hurdle model (Cragg 1971). Estimations were performed separately for the samples of all, active and inactive owners. For the former sample, we used a dummy variable indicating whether the owner was active or inactive.

In addition, we estimated mean hypothetical increase in harvest volume for each combination of size class and price. These estimates were obtained using a linear regression model, using in all 24 dummy variables (no constant term),

$$y_i = \sum_k \sum_j a_{kj} s_{kji} + u_i,$$

where y_i is the harvest volume increase the owner i is willing to supply in m^3/year, s_{kji} equals one if the owner faces the hypothetical price k =*350, 400, 450* and belongs to size class j = *1,…,8,* and equals zero otherwise. Each coefficient a_{kj} represents the mean increase in harvest volume while u_i is an error term. This model was estimated separately for active and inactive owners by ordinary least squares. Using similar regression, we then estimated mean actual timber volumes supplied during the 2009-2013 period in each size class.

In all estimations we used sample weights calculated separately for the appropriate sample (all, active or inactive), so that each observation in the sample represented a number of units in the corresponding population stratum. The estimations were performed using Stata 13.1. Variance inflation factors did not indicate multicollinearity, and residual plots did not indicate heteroscedasticity or autocorrelation.

(Table 2)

In order to support the regression results, we compared some additional questions regarding the importance of information sources between the active and inactive owner sample. Two-sided p-values were calculated based on the standard normal test statistic $Z = (\hat{p}_x - \hat{p}_y)/SE(\hat{p}_{pooled})$, where $\hat{p}_x$ and $\hat{p}_y$ denote the sample proportions for active and inactive owners, respectively, and where $SE(\hat{p}_{pooled})$ denote the estimated standard error of the pooled sample proportion.

III. Results

Sample description

842 questionnaires were returned from active forest owners and 795 questionnaires from inactive forest owners, providing response rates of 56% and 49%, respectively. The question underlying the dependent variable Willingness to harvest was answered by 805 active and 692 inactive owners. Out of the respondents providing answer on the Willingness to harvest question, 315 active and 144 inactive provided a non-negative number on the Harvest more question, that forms the basis for the second-stage dependent variable Harvest volume. Only respondents that answered all questions that were used for creating the variables were included in the regression models.

For analyzing the representativeness of the net sample, we compared net sample numbers with the population of properties owned by individuals. The average property size in the net sample using weighted numbers is 44.1 hectares, compared to 45.6 hectares in the population (Statistics Norway 2018) (and 119.5 hectares in the unweighted net sample). The share of properties with female owner is 25.2% in the net sample, and 25% in the population (Steinset 2015). The average gross income in the net sample is 0.50 million NOK, close to the population figure of 0.49 million NOK (Statistics Norway 2018).

Comparing the samples (Table 3), active owners are on average more willing to supply timber than inactive owners. While 36% of the active owners state that they are willing to increase harvests, 18% of the inactive owners say that they will supply timber with the hypothetical prices. Also, the mean of Harvest more is more than double among active owners compared to inactive owners. The largest difference between the two owner groups is found in the acquaintance with the forest fund policy instrument: 27% of the active

owners contrasted to 2% of the inactive owners express having good policy knowledge, while 17% of the active owners indicate having no policy knowledge compared to 66% of the inactive owners. Wealth, heritage, economic and recreational objectives and productive forest land area are higher in the active than in the inactive-owner sample. Inactive owners have on average more nature conservation objectives and live further away from the property.

(Table 3)

Regression analyses

The regressions of increased willingness to harvest due to elevated hypothetical price, reveal that while the size of the offered price is significant among all owners and active owners, it is not significant among inactive owners (Table 4). Among all owners and active owners, female forest owners are significantly less inclined to increase harvest if prices shift upwards than male owners, while no gender effects were found among inactive owners. Plans to transfer the property within three years was not found to impact on the willingness to harvest more in any sample; income contributes positively to the willingness among active owners and wealth negatively among inactive owners.

Having good knowledge about a key policy instrument, contrasted to some knowledge, does not impact on the inclination to harvest more, while in all the three samples, owners with no knowledge are significantly less inclined to harvest. Owners in the all owners and inactive owners samples for whom heritage is an important reason for owning forest, are more inclined to engage in harvests. Owners with economic objectives in all three sample groups are more responsive than others, while all owners and active owners with nature

conservation objectives are less responsive. Active owners with recreational objectives are more inclined to harvest than others, while productive forest area impacts positively on the willingness to harvest among owners in the all owners and active owners sample. Distance from home to forest do not impact on the stated willingness to harvest in any of the samples.

The marginal effects, reported alongside the regression output in Table 4, were calculated by using the means of each explanatory variable. In the all and active owner samples, being female or having no information about the forest fund are the most important barriers for engaging in harvesting when offered the hypothetical price upturn. Being female reduces the likelihood of acceptance with about 9% among all owners, and about 13% among active owners. Likewise, having no information about the forest fund reduces this probability by about 12-17% in all three samples, most in the active sample. As productive forest area was log-transformed into the variable Productive forest area, 2.718 times larger productive forest area implies 6.8% higher probability that an active owner will harvest more; the corresponding number for all owners is 3.9%. In the all owners sample, belief in higher interest rate increases the probability of harvest. Economic ownership objectives increases the likelihood of harvest in all three samples.

(Table 4)

The second-stage linear model assessed how much (more) forest owners are willing to harvest, given that they stated willingness to increase harvest in the first-stage probit model. The dependent variable is measured in m^3 harvest volume per hectare of productive forest over the next five years. As in the first-stage model, the second-stage regression displayed that the hypothetical price is insignificant for inactive owners and significant and positive for active owners (Table 5). However, it is no longer significant for all owners. Wealth is

significant and of negative sign in the active owner group. Income shows mixed effects: it is significant for all owners and active owners. However, the sign is negative in the all owner sample and positive in the active owner sample. Forest owners in all three groups who have in-depth knowledge of the forest policy instrument are significantly more inclined to harvest more than others. While economic objectives are important for the harvest volume inactive and all owners are willing to supply, this factor is insignificant in the active owner group. Forest land size is important in all owner groups, but with negative sign. Finally, the distance from home to the forest negatively affects the harvest volume among active owners.

In terms of coefficient size, good knowledge of the forest fund implies that all owners would be willing to harvest exp(0.450)=1.57 m^3/ha more over the next five years, other things being equal. Good knowledge would mean another 1.46 m^3/ha from active owners, and 2.48 m^3/ha from inactive owners, over five years. Economic objectives would release 1.21 m^3/ha more timber harvest from inactive owners. 10% increase in productive forest area would reduce property-level timber supply by 5-6% across all samples. If an active owner lives 10% further away from the forest, (s)he would *ceteris paribus* supply about 1% less timber.

(Table 5)

Impacts of property size

Regressing the area-based harvest volume increase on property size class and hypothetical price, several patterns emerge (Figure 1 Left and Right). For most size classes, the volume increases with price; however, the trend is less clear for inactive than active owners. The figure also show that the larger the size class, the smaller the volume per area.

(Figure 1)

The willingness-to-harvest figures on a per-hectare basis were for active owners compared to the actual, average harvest per hectare in the size class samples for the 2009-2013 period (Figure 2). The harvest responses to the highest prices on properties up to 499.9 hectares in size correspond to 58-85% of the historical harvest figures. This relative response declines for properties beyond 499.9 hectares for all prices; so does the difference in response between the three hypothetical prices.

(Figure 2)

Sources of information

The main information source among the active forest owners is the local forest owner organization (Table 6). 61% state that this information source is very important, in contrast to 32% of inactive owners. Information sources such as public authorities, media and other individuals are all stated to be more important among active than inactive owners. 76% of the active owners have been in contact with the local forestry authorities, contrasted to 37% among the inactive. Furthermore, 72 % of the active owners are members of a forest owner organization, while 17% of inactive owners state the same. When asked whether they receive sufficient information about public grants for forestry, the Forest Fund and their responsibility to consider environmental aspects in forestry, between 64 and 68 % of the active owners agree that they do. This is roughly the double the share of the inactive owners that agree. However, 41% of the active versus 48% of the inactive owners agree with the statement “With more/better information, I could have increased the activity level in my forest”. When testing of whether the proportions that agreed were statistically different

between the active and inactive sample, all variables displayed in Table 6 was significantly different at the 1% level.

(Table 6)

IV. Discussion

Comparing active and inactive owners' increased willingness to harvest due to elevated prices, we found that inactive owners' decision to enter timber markets and the volume they are willing to supply is determined by other factors than price. This is in contrast to active owners, who state more willingness to increase supply with higher offered price. However, owners holding economic motives are more willing to harvest in both the active and inactive sample. This possible inconsistency may be explained by lack of knowledge of the impact of the offered price among the inactive, or that they put greater emphasis on non-economic forest values that need to be traded off against harvest. We did not include data on forest characteristics, but inactive owners could reject the offer because their forest have qualities that lead to higher amenity values that inactive owners. This may be more explored in future studies. Contrasted to the active owners, heritage motives triggers willingness to harvest among inactive owners. These owners may consider that harvest actually improves the value of the property for the next generation, possibly because they believe that they should harvest more in order to avoid the forest becoming too old and of reduced value. No policy knowledge is a strong predictor for reduced willingness to harvest, but stronger in the active than in the inactive sample. Likewise, a female, active owner is significantly less likely to harvest more than a male, active owner; in the inactive sample, gender is not significant. Follo (2008) argues that female owners in general have less forestry competence than male

owners. If the gender effect is caused by a competence gap, this gap thus stretches beyond the forest fund knowledge. Once an active owner has decided to harvest, the gender effect disappeared in the second stage. If the threshold to supply timber is caused by a lack of competence, it seems to not be relevant for owners who already have sold timber. Results from Finland also showed that the timber supply volume is not gender dependent (Kuuluvainen et al. 2014). More variables are significant in the regressions of the active sample than in the inactive, and these models explain a little more in terms of pseudo R^2 and R^2. We hypothesize that there is more variation in objectives and reasons among owners who decide to not participate in timber markets than among those who are participating, and there might be factors not captured in our questionnaire. One possible reason for inactive owners not to respond to price is a lack of mature forest to harvest. However, productive forest area is a significant, negative predictor for the harvest volume response in all three owner groups, which could be explained by higher potential for harvest increase on small properties due to higher productivity and considerably larger growing stock close to harvest maturity on these properties (Hobbelstad and Ørnelund Nilsen 2006; Statistics Norway 2017). In addition, distance to road is probably shorter on small properties that tend to be more centrally placed. Actual harvest volume per hectare is on average about the same across property sizes in Norway (Statistics Norway 2018); in our survey, it varied from 1.2 m^3/ha/year in the size classes 200-500 hectares and 500-2000 hectares to 3.4 m^3/ha/year in the size class up to 9.9 hectares. Previous studies have also found that owners of large properties are less price-responsive than others, which may be caused by the higher dependence of timber income (Bolkesjø et al. 2007).

Our results provide information on how the timber supply curve may look beyond current prices. Surveying inactive owners complement analyses based on historical harvest, as these owners' objectives and reasons for not harvesting differ from active owners. The results feed not only into the ongoing discussions on how to ensure enhanced timber supply for reaching climate change mitigation and socio-economic objectives in Norway (Norwegian Ministry of Food and Agriculture 2011), but also in the EU (European Commission 2012), where the average forest holding size is 2.7 hectares (Nabuurs et al. 2015). In Norway, the share of properties with harvest for sale in a given year has been halved in twenty years (Rognstad and Steinset 2012). The properties with no harvest for sale during the last twenty years represent about 22% of the productive forest area. This share decreases from 70% in the smallest area size class (2.5-9.9 hectares) to 10% in the largest size classes (> 200 hectares) (Statistics Norway 2017). With more forest properties not being harvested regularly and timber income becoming less important (Statistics Norway 2018), it may be suggested that the relevance of our findings will increase in the future.

V. Conclusions

While the offered timber price in our study had a significant and positive impact on active owners' willingness to increase harvest, the price did not impact on inactive owners' inclination to engage in harvest. In both owner groups, not having information of a key forest policy instrument was the main barrier to engage in harvest. Female active owners were significantly less willing to increase harvest due to elevated prices; however, gender effects disappeared once the decision to harvest more was taken.

In the literature, inactive forest owners have been given relatively little consideration compared to owners already participating in the timber market. If decision-makers want to a larger extent reach out to the inactive owners and stimulate them to enter the timber market, they may want to focus on other factors than prices. Our study shows that information is a key to both active and inactive owners. Only a small share of inactive owners are members of forest owner's organizations and regard the organizations as an important information source. In contrast to active owners, most inactive owners consider the information they receive to be insufficient, and to a larger extent than active owners, they state that more information could trigger more activity on their forest land. For reaching inactive owners, who are not members of forest owner's organizations, new pathways may have to be considered. In addition, inactive owners with economic or heritage objectives are more willing to enter the timber market. One possible reason why inactive forest owners do not respond to price, is that they do not recognize the economic gains in the hypothetical price. If that is the case, information could also mitigate this problem.

References

Beach, R.H., Pattanayak, S.K., Yang, J.-C., Murray, B.C., and Abt, R.C. 2005. Econometric studies of non-industrial private forest management: a review and synthesis. Forest Policy and Economics **7**(3): 261–281. doi:10.1016/S1389-9341(03)00065-0.

Bolkesjø, T.F., Solberg, B., and Wangen, K.R. 2007. Heterogeneity in nonindustrial private roundwood supply: Lessons from a large panel of forest owners. Journal of Forest Economics **13**(1): 7–28. doi:10.1016/j.jfe.2006.08.003.

Brazee, R., and Mendelsohn, R. 1988. Timber Harvesting with Fluctuating Prices. Forest Science **34**(2): 359–372.

Cai, Z., Narine, L.L., D'Amato, A., and Aguilar, F.X. 2016. Attitudinal and revenue effects on non-industrial private forest owners' willingness-to-harvest timber and woody biomass. Forest Policy and Economics **63**: 52–61. doi:10.1016/j.forpol.2015.11.007.

Conway, M.C. 2002. Targeting Nonindustrial Private Landowner Groups for Timber Market Entry. PhD thesis, Virginia Polytechnic Institute, Blacksburg, VA. Available from http://scholar.lib.vt.edu/theses/available/etd-09162002-113744/unrestricted/mcconwayETD.pdf.

Cragg, J.G. 1971. Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods. Econometrica **39**(5): 829–844. doi:10.2307/1909582.

Dillman, D.A. 1978. Mail and Telephone Surveys: The Total Design Method, Journal of Marketing Research. John Wiley & Sons, New York.

European Commission. 2012. Innovating for Sustainable Growth: A Bioeconomy for Europe. Brussels, Belgium.

Fina, M., Amacher, G.S., and Sullivan, J. 2001. Uncertainty, Debt, and Forest Harvesting: Faustmann Revisited. Forest Science **47**(2): 188–196.

Follo, G. 2008. The Norwegian family forestry, its female and male owners, mangement activity - and metaphorical relations [Det norske familieskogbruket, dets kvinnelige og mannlige skogeiere, forvaltningsaktivitet – og metaforiske forbindelser]. Norwegian University of Science and Technology, Trondheim, Norway. Available from http://kilden.forskningsradet.no/c16878/publikasjon/vis.html?tid=53333&strukt_tid=16878.

FOREST EUROPE. 2015. State of Europe's Forests 2015. Ministerial Conference on the Protection of Forests in Europe.

Gong, P., and Löfgren, K.G. 2007. Market and welfare implications of the reservation price strategy for forest harvest decisions. Journal of Forest Economics **13**(4): 217–243. doi:10.1016/j.jfe.2007.06.001.

Håbesland, D., Kilgore, M., Snyder, S., Becker, D., Solberg, B., Sjølie, H.K., and Lindstad, B.H. 2015. An Assessment of Norwegian Family Forest Owner Interest in Carbon Offset Programs and Comparisons to the Lake States. Department of Forest Resources, Unviersity of Minnesota, St. Paul, Minnesota. Available from https://conservancy.umn.edu/bitstream/handle/11299/182332/staffpaper237.pdf?sequence=1&isAllowed=y.

Hobbelstad, K., and Ørnelund Nilsen, J.-E. 2006. 2 Forest Resources in Norway [2 Skogressursene i Norge]. *In* Vennesland, B., Hobbelstad, K., Bolkesjø T., Baardsen, S., Lileng, J., Rolstad, J., Forest Resources in Norway 2006 [Skogressursene i Norge 2006]. Norwegian Forest and Landscape Institute, Ås, Norway. p. 94.

Kennedy, N.S. 2001. Reservation prices and willingness to accept price offers for nonindustrial forest landowners in Western Virginia. Master of Science thesis, Virginia Tech, Blacksburg,

Virginia. Available from http://lumiere.lib.vt.edu/sample_theses/submitted/trash/etd-06272001-103553/withheld/S.pdf [accessed 23 September 2013].
Kuuluvainen, J., Karppinen, H., Hänninen, H., and Uusivuori, J. 2014. Effects of gender and length of land tenure on timber supply in Finland. Journal of Forest Economics **20**(4): 363–379. doi:10.1016/j.jfe.2014.10.002.
Kuuluvainen, J., Karppinen, H., and Ovaskainen, V. 1996. Landowner Objectives and Nonindustrial Private Timber Supply. Forest Science **42**(3): 300–309.
Lohmander, P. 1988. Pulse Extraction Under Risk and a Numerical Forestry Application. Journal of Mathematical Modelling and Simulation in Systems Analysis **5**(4): 339–354.
Nabuurs, G.-J., Delacote, P., Ellison, D., Hanewinkel, M., Lindner, M., Nesbit, M., Ollikainen, M., and Savaresi, A. 2015. A new role for forests and the forest sector in the EU post-2020 climate targets. European Forest Institute.
Norwegian Ministry of Food and Agriculture. 2011. The Agricultural and Food Policy [Landbruks- og matpolitikken]. Norwegian Ministry of Food and Agriculture, Oslo, Norway.
Rognstad, O., and Steinset, T.A. 2012. Agriculture and Forestry in Norway 2011 [Landbruket i Norge 2011). Statistical Analyses, Statistics Norway, Oslo-Kongsvinger, Norway.
Silver, E.J., Leahy, J.E., Weiskittel, A.R., Noblet, C.L., and Kittredge, D.B. 2015. An Evidence-Based Review of Timber Harvesting Behavior among Private Woodland Owners. j for **113**(5): 490–499. doi:10.5849/jof.14-089.
Statistics Norway. 2017. Færre høgg tømmer for sal – samla hogst aukar [Fewer harvest timber for sale - total harvest increases]. Available from https://www.ssb.no/jord-skog-jakt-og-fiskeri/artikler-og-publikasjoner/faerre-hogg-tommer-for-sal-samla-hogst-aukar [accessed 18 October 2018].
Statistics Norway. 2018. Agriculture, forestry, hunting and fishing. Available from https://www.ssb.no/en/jord-skog-jakt-og-fiskeri [accessed 28 October 2018].
Steinset, T.A. 2015. New times for the forest owner. Statistics Norway.
Vokoun, M., Amacher, G.S., and Wear, D.N. 2006. Scale of harvesting by non-industrial private forest landowners. Journal of Forest Economics **11**(4): 223–244. doi:10.1016/j.jfe.2005.10.002.
Wiersum, K.F., Elands, B.H.M., and Hoogstra, M.A. 2005. Small-scale forest ownership across Europe: Characteristics and future potential. Small-scale Forestry **4**(1): 1–19. doi:10.1007/s11842-005-0001-1.

Tables

Table 1: Variables expected to affect the two dependent variables: willingness to (increase) harvest and the volume willing to harvest.

Variable	Hypothesized direction of impact	Reference
Hypothetical price offered	+	Silver et al. (2015)
Gender (2 = female, 1 = male)	-	Kuuluvainen et al. (2014)
Plan to transfer/sell the property	-	Kennedy (2001)
Net wealth	?	Bolkesjø et al.
Income	?	Kuuluvainen et al. (1996)
Knowledge of a key forest policy instrument	+	
Belief in interest rate being higher in five years than today	?	Beach et al. (2005)
Heritage values important reason for owning forest	-	Kennedy (2001), Conway (2002)
Economic values important reason for owning forest	+	Vokoun (2006)
Preservation of nature important reason for owning forest	-	Conway (2002)
Recreation opportunities important reason for owning forest	-	Conway (2002)
Area of productive forest	+	Kennedy (2001)
Distance from home to forest property	?-	Beach et al. (2005)

Table 2. Description of variables. Willingness to harvest is dependent variable in the probit models and Harvest volume in the linear models.

Variable name	Question Active owners	Question Inactive owners	Variable type
Harvest	Assume that the current, average timber price on your property is 300 NOK/m^3, and that it increases to 350/400/450 NOK/m^3* and stays there. Would you then harvest more timber for sale during the next five years than if the price stayed at 300 NOK/m^3?	Assume that the current, average timber price on your property is 300 NOK/m^3, and that it increases to 350/400/450 NOK/m^3* and stays there. Would you then harvest timber for sale during the next five years?	4-point ordinal[1]: Yes, I am sure that I would harvest [more] (1); Yes, I believe I would harvest [more] (2); No, I believe I would not harvest [more] (3); No, I am sure that I would not harvest [more] (4); only used for constructing the variable Willingness to harvest
Willingness to harvest	1 if Harvest = 1 or 2; 0 if Harvest = 3 or 4		Dichotomous
Harvest more	How much more timber do you think you would harvest? Provide total increase in quantity over the next five years compared with the case if the price remained 300 NOK/m^3	How much timber do you think you would harvest? Provide total quantity over the next five years	Non-negative; only used for constructing the variable Harvest volume
Harvest volume	Ln(Harvest more/Productive forest land area), if Harvest more > 0		Non-negative
Active	Has harvested timber for sale the last 15 years = 1; Has not = 0		Dichotomous
Price	350, 400 or 450 NOK/m^3 according to version		
Gender	Female = 2; male = 1		Dichotomous
Property transfer	Answered “within 3 years” on the question “In how many years do you plan to transfer your property to family/sell it?” (Alternatives: within 3 years, 3-5 years, 5-10 years, more than 10 years, no concrete time plan for transferal/sale of property)		Dichotomous
Wealth	Taxable net wealth 2012 (from Statistics Norway) in millions NOK		Rational number

Income	Average annual gross income before tax (sum of salaries, pensions, income from self-employment and capital) for 2010, 2011 and 2012 (from Statistics Norway) in millions NOK	Rational number
Good policy knowledge	Answered "Yes, good knowledge" on the question "Do you have knowledge about the forest fund"? (Alternatives: "Yes, some knowledge", "Yes, good knowledge", "No")	Dichotomous, "Yes, some knowledge" = 0
No policy knowledge	Answered "No" on the question "Do you have knowledge about the forest fund"? (Alternatives: "Yes, some knowledge", "Yes, good knowledge", "No")	Dichotomous, "Yes, some knowledge" = 0
Interest rate	How do you think the levels on interest rates (loans and bank deposits) will be in five years?	Ordinal 3-point: Lower than today (1); same as today (2); higher than today (3)
Environmental objectives	How important reason for owning forest is "The forest is part of the environment where I live or spend my leisure time"?	
Hunting objectives	How important reason for owning forest is "The forest provides me the opportunity to hunt"?	
Nature experience objectives	How important reason for owning forest is "The forest provides me the opportunity of nature experiences"	
Protection objectives	How important reason for owning forest is "The forest provides me the opportunity to protect and preserve nature's diversity"?	Ordinal 4-point: Not important at all (1); slightly important (2); of relatively great importance (3); of decisive importance (4). Only used for constructing the variables I_HERI, I_ECON, I_NATURE and I_RECREATE
Conservation objectives	How important reason for owning forest is "The forest is first and foremost a nature conservation object for me"	
Income objectives	How important reason for owning forest is "My forest provides me income"?	
Economic security objectives	How important reason for owning forest is "My forest provides me economic security"	
Investment objectives	How important reason for owning forest is "My forest is an investment object for me"?	
Intrinsic objectives	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)"?	
Transfer objectives	How important reason for owning forest is "My forest will be inherited by close family"?	
Relaxation objectives	How important reason for owning forest is "In my forest I can relax, find silence and contemplate"?	

Native area objectives	How important reason for owning forest is "I keep contact with my native area through my forest"?	
Heritage objectives	Heritage objectives = Intrinsic objectives + Transfer objectives	Ordinal (2 to 8)
Economic objectives	Economic objectives = Income Heritage objectives + Economic security Heritage objectives + Investment objectives	Ordinal (3 to 12)
Nature objectives	Nature objectives = Protection objectives + Conservation objectives	Ordinal (2 to 8)
Recreation objectives	Recreation objectives = Environmental objectives + Hunting objectives + Nature experience objectives + Relaxation objectives	Ordinal (4 to 16)
Productive forest area	Size of productive forest area, in hectare, log-transformed	Non-negative
Distance	The natural logarithm of the answer on the question "How many kilometers from the forest property do you live?"	Non-negative

* 350, 400 or 450 NOK/m^3 according to version.

[1] The alternatives for active owners were "Yes, I am sure that I would harvest more" and so on; for inactive owners "Yes, I am sure that I would harvest" etc.

Table 3: Descriptive statistics of the variables included in the models. Weighted numbers. SD = standard deviation.

Variable name	N All	N Active	N Inactive	Mean All	Mean Active	Mean Inactive	SD All	SD Active	SD Inactive
Willingness to harvest	1497	805	692	0.26	0.36	0.18	0.44	0.48	0.38
Harvest more	671	398	273	474	656	287	1076	1274	682
Harvest volume	459	315	144	2.34	2.09	2.77	1.27	1.06	1.53
Price	1637	842	795	399	399	399	40	41	40
Gender	1637	842	795	1.25	1.23	1.26	0.43	0.42	0.44
Property transfer	1637	842	795	0.08	0.09	0.06	0.27	0.29	0.25
Wealth	1637	842	795	1.34	1.50	1.12	7.05	9.03	4.16
Income	1637	842	795	0.50	0.52	0.48	0.42	0.42	0.38
Good policy knowledge	1567	828	739	0.13	0.27	0.02	0.34	0.45	0.15
No policy knowledge	1567	828	739	0.45	0.17	0.66	0.50	0.38	0.47
Interest rate	1488	806	682	2.61	2.61	2.62	0.64	0.76	0.53
Heritage objectives	1484	800	684	5.81	6.29	5.44	1.93	1.74	2.01
Economic objectives	1475	799	676	5.01	5.84	4.30	2.33	2.51	1.90
Nature objectives	1470	795	675	4.41	4.34	4.45	1.58	1.48	1.66
Recreation objectives	1476	796	680	11.13	11.56	10.77	3.33	3.21	3.36
Productive forest area	1637	842	795	2.93	3.53	2.44	1.20	1.20	0.98
Distance	1580	831	749	1.69	1.41	1.91	1.81	1.59	1.94

Table 4. Probit regression analyses of all, active and inactive owners. Significance levels: * = 10%, ** = 5%, * = 1%. Dependent variable: Willingness to harvest.**

	- - - - - ALL (N=1341) - - - - -			- - - - - ACTIVE (N=748) - - - - -			- - - - - INACTIVE (N=593) - - - - -		
	Coef.	SE	Marg. effect	Coef.	SE	Marg. effect	Coef.	SE	Marg. effect
Active	-0.034	0.103	-0.011						
Price	0.002**	0.001	0.001	0.004***	0.001	0.002	-2.14×10^{-4}	0.002	-5.21×10^{-5}
Gender	-0.287***	0.103	-0.089	-0.346***	0.134	-0.129	-0.199	0.174	-0.048
Property transfer	-0.133	0.164	-0.041	-0.123	0.205	-0.046	-0.272	0.275	-0.066
Wealth	0.002	0.004	7.3×10^{-4}	0.013	0.012	0.005	-0.057*	0.029	-0.014
Income	-0.178	0.132	-0.06	-0.391**	0.184	-0.146	0.210	0.223	0.052
Good policy knowledge	-0.027	0.113	-0.008	-0.093	0.124	-0.035	0.177	0.354	0.043
No policy knowledge	-0.504***	0.113	-0.157	-0.469**	0.190	-0.175	-0.509***	0.156	-0.124
Interest rate	0.109*	0.063	0.034	0.119	0.075	0.044	0.119	0.135	0.029
Heritage objectives	0.066**	0.029	0.020	0.023	0.037	0.008	0.105**	0.043	0.026
Economic objectives	0.103***	0.021	0.032	0.088***	0.025	0.033	0.119***	0.035	0.029
Nature objectives	-0.106***	0.034	-0.033	-0.157***	0.044	-0.058	-0.023	0.053	-0.006
Recreation objectives	0.028	0.018	0.009	0.050**	0.023	0.019	-0.007	0.027	-0.002
Productive forest area	0.126***	0.039	0.039	0.182***	0.050	0.068	0.062	0.071	0.015
Distance	-0.024	0.026	-0.008	-0.039	0.037	-0.015	-0.016	0.039	-0.004
constant	-2.244***	0.517		-2.902***	0.647		-1.693*	0.912	
Pseudo R^2		0.1486			0.1354			0.1194	

Table 5. Linear regression analyses active and inactive owners. Significance levels: * = 10%, ** = 5%, * = 1%. Dependent variable: Harvest volume**

	ALL (N=429)		ACTIVE (N=300)		INACTIVE (N=129)	
	Coef.	SE	Coef.	SE	Coef.	SE
Active	-0.214	0.140				
Price	$3x10^{-4}$	0.001	0.003**	0.001	-0.005	0.004
Gender	0.102	0.152	0.033	0.154	0.231	0.408
Property transfer	-0.099	0.218	-0.320	0.232	-0.092	0.616
Wealth	-0.004	-0.003	-0.005**	0.003	-0.090	0.075
Income	-0.410*	-0.200	0.500*	0.300	0.400	0.500
Good policy knowledge	0.450***	0.117	0.375***	0.132	0.907***	0.325
No policy knowledge	-0.045	0.202	-0.394	0.333	0.295	0.329
Interest rate	0.065	0.082	-0.023	0.061	0.388	0.325
Heritage objectives	-0.006	0.040	0.033	0.043	-0.043	0.062
Economic objectives	0.049*	0.028	-0.005	0.026	0.190****	0.048
Nature objectives	-0.030	0.052	-0.017	0.048	-0.009	0.107
Recreation objectives	-0.008	0.020	-0.017	0.024	-0.045	0.058
Productive forest area	-0.601***	0.057	-0.560***	0.059	-0.605***	0.133
Distance	-0.016	0.040	-0.116**	0.054	0.076	0.064
Constant	3.883***	0.947	2.988	0.680	4.442	2.905
R^2	0.307		0.325		0.289	

Table 6. Questions regarding importance of various information sources, comparing active and inactive owners. For all questions, the proportion of respondents that gave the answer displayed in the table was significantly different between the active and inactive sample, on the 1% level.

Question	Alternative	Answer	Active	Inactive
How important are the following information sources for you?	The local forest owner organisation/their forest manager	% stating "Rather important" or "Very important"	61	32
	Public authority, for example the forest section or the responsible for forest in the municipality		46	34
	Media and forestry journals		23	12
	Other forest owners/family/neighbours/friends		27	22
Have you ever been in direct contact with the forest section of your municipality regarding forestry issues? By direct contact, we mean phone calls, personal meeting or emails.		% stating yes	76	37
Are you a member of a forest owner organisation?		% stating yes	72	17
We ask you to consider the following statements on the information you receive from either the forest section of your municipality or your forest owner organisation.	I receive sufficient information about public grants for forestry activities	% stating "Agree a little" or "Agree completely"	64	34
	I receive sufficient information on the Forest Fund		68	31
	I receive sufficient information on my responsibility to consider environmental aspects		67	37
	With more/better information, I could have increased the activity level in my forest		41	48

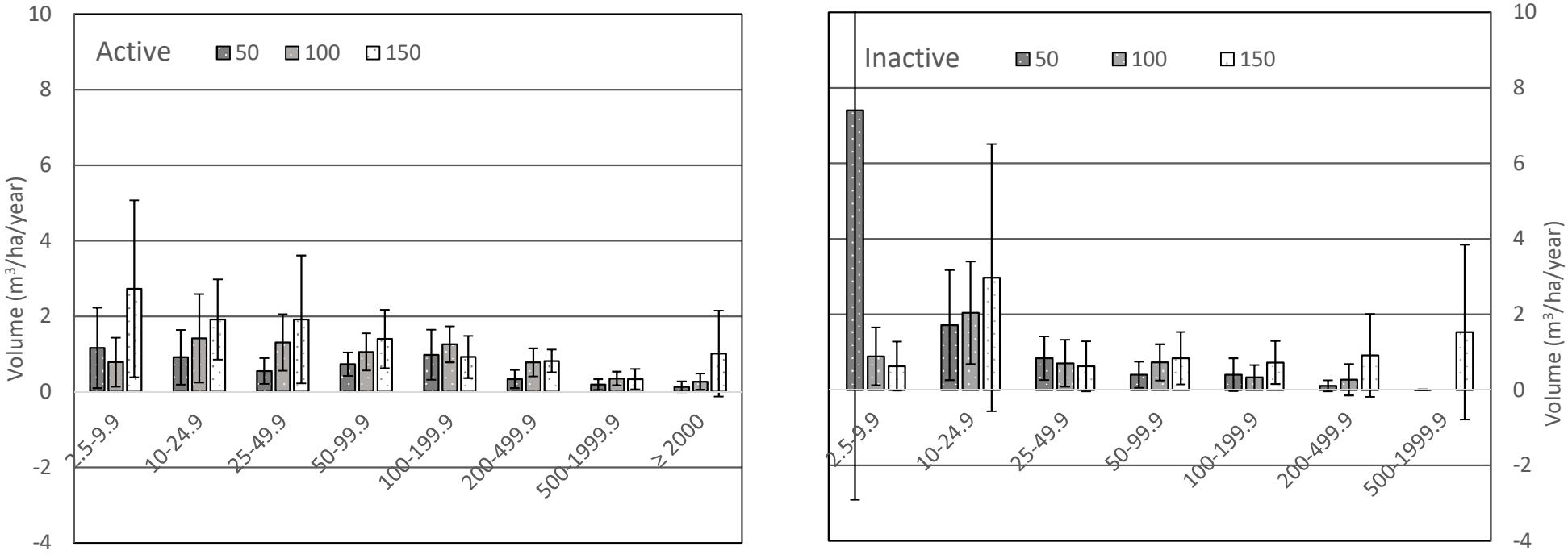

Figure 1: Hypothetical harvest increases in m^3/ha/year for active (left) and inactive (right) owners, hypothetical prices and size classes. Error lines indicate 95% C.I.

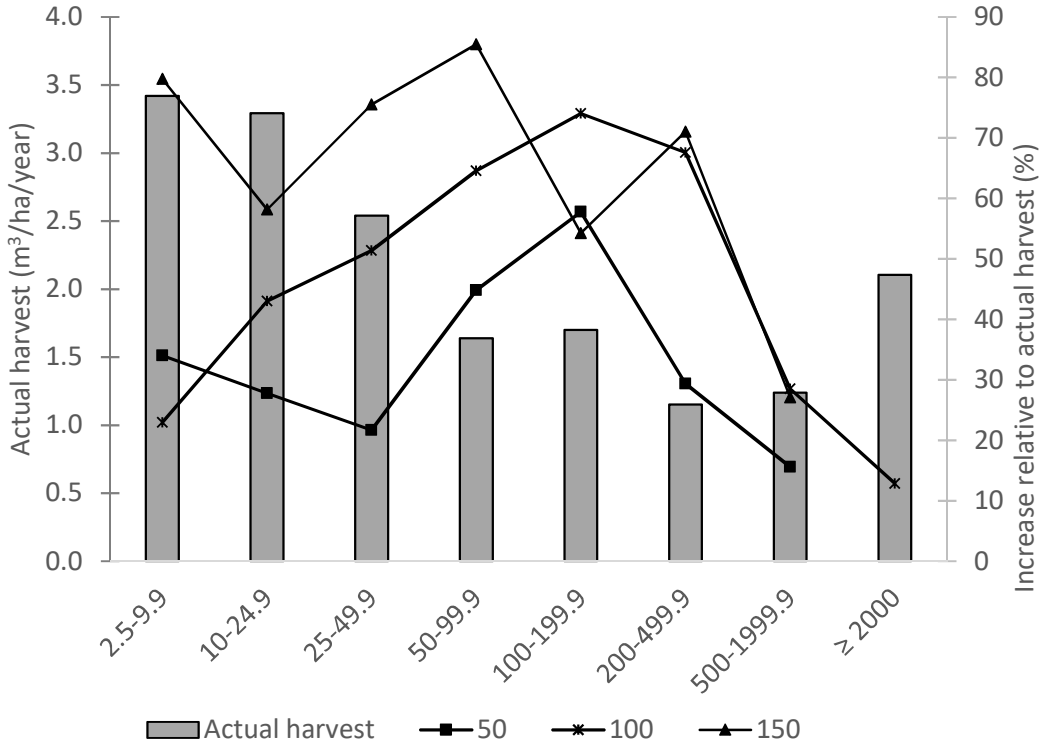

Figure 2: Harvest response compared to the actual, average harvest in the size class samples, active owners only. Left axis (bars): Actual, average harvest (m^3/ha/year) in the period 2009-2013 for size classes. Right axis (lines): Increase in harvest among active owners for size classes and hypothetical prices relative to the yearly, actual 2009-2013 harvest (in percent). Only harvest responses significantly different from zero are displayed.