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Forest owners' preferences for contract-based management to enhance environmental values versus timber production

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ABSTRACT

Forests are sources of multiple ecosystem services (ESs) essential for human wellbeing. Forest owners are critical actors to decide which benefits they produce from their forests. To support the uptake of alternative forest management strategies in a way that is beneficial from the perspective of society as whole, new incentive schemes could be implemented in the future. We applied the choice experiment method to investigate Finnish forest owners' potential participation in an incentive scheme in which they were asked to practice a 'Timber Oriented' or a 'Nature Oriented' management strategy according to the terms of a hypothetical contract. We found that the majority forest owners are willing to participate in the considered contract-based payment scheme, especially those supporting biodiversity and non-market ESs. Non-profitability attributes including biodiversity, carbon stock, and probability of climate change induced damage were highly valued. Forest owners prefer the management contract with the Nature Oriented strategy. Forest owners' preferences for the contract-based management and associated effects are heterogenous.

1. Introduction

Forests are sources of multiple ecosystem services (ESs) essential for human wellbeing, such as wood and non-wood forest products, climate change mitigation by carbon sequestration, renewal and purification of water resources, and social benefits including recreation possibilities. Forest biodiversity underlies the delivery of all forest ESs and enhances ecosystem resilience to major disturbances such as pests and pathogens as well as abiotic damage (Brockerhoff et al., 2017; Jactel et al., 2021; Morin et al., 2014). Biodiversity also has its own intrinsic value (Chan et al., 2016). Provision of non-wood ESs and the preservation of biodiversity may however be challenging due to conflicting needs to provide income from timber to landowners (Howe et al., 2014). For example, several studies have shown that timber production is in trade-off with biodiversity maintenance and non-timber ESs (Pukkala, 2016; Pohjanmies et al., 2017; Blattert et al., 2020). Forest owners are critical actors to decide which benefits they produce from their forests. Hence their preferences for biodiversity and ecosystem services (and associated profitability of forest management) basically determine how they manage their forests.

There is considerable variation in forest ownership and the goals set for forest management. For example, in Finland most forest land (61%) is owned by private non-industrial forest owners, whereas the state owns only 26%. In addition, companies own 8% and other owners 5% of forest land (Natural Resources Institute Finland, 2021). Concerning forests owned by the state or companies, relatively few actors decide on the management of large forest areas. In contrast, hundreds of thousands of private non-industrial forest owners, all of whom individually, within the frame of national legislation, decide on the management goals of their forest in Finland. Due to the large area of privately owned forests, forest owners have a considerable effect on the condition of forests and the provision of ESs at the country level. However, private forest owners

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are a diverse group (Ficko et al., 2019), and their motivations, goals, and capacities are influenced by their specific cultural and social backgrounds (Weiss et al., 2019). In addition, structural diversification is taking place among private forest owners due to generational transition, economic restructuring, and urbanization across Europe and in Finland (Živojinović et al., 2015). The decisions made by this large ownership group are therefore challenging to predict or guide.

Forest management is generally controlled by legislation in each country and can also be guided by financial incentives, recommendations, and information or education campaigns. However, the ability of existing forest management policies to ensure that society's current and future needs are met are brought into question by the growing understanding of the diversity of those needs. Not only raw material used by industry but also the mitigation of climate change, forest resilience to major disturbances, and the preservation of biodiversity are essential to the wellbeing of current and future generations. For example, in Finland, the primary goal of forest policy measures for a long time was to secure a high but temporally constant yield of timber (Kotilainen and Rytteri, 2011). Thus, the incentives were focused on actions needed for securing timber production in the rotation-based forestry (e.g. tending of young stands, ditch network maintenance), and potential adverse environmental impacts of the subsidized actions were not considered. On the other hand, incentives were paid to forest owners when they participated in voluntary biodiversity protection schemes that precluded timber harvesting (Juutinen et al., 2013). The development of more coherent incentives that support synergies and recognize potential trade-offs between biodiversity and timber production can further enhance the provision of various ecosystem services to society.

Despite the management of private forests being influenced by different policy instruments, forest owners make the final management choices. However, forest owners' choices vary based on the relative values they place on the different ESs provided by their forests, and thus these choices likely also vary with respect to the financial incentives and other measures required to influence their decisions (Kline et al., 2000; Tyrväinen et al., 2020). Policy measures that are not aligned with forest owners' needs and preferences may however have unintended and suboptimal outcomes (Sarvašová et al., 2018). In Finland, forest legislation was changed in 2014 to allow a broader range of management practices, including continuous cover forestry or uneven-aged management and traditional rotation forestry with a shortened rotation period (Juutinen et al., 2020). In order to support the uptake of alternative forest management strategies in a way that is beneficial from the perspective of the whole of society, new incentive schemes could be implemented in the future. However, effective strategy design requires information on forest owners' preferences and willingness to change their current management strategy (Prokofieva, 2016).

The relationship between forest ownership and management has over the last years been a central topic in forest policy research. The influence of ownership characteristics on management activities and their outcomes has been studied in particular concerning wood mobilization (Lawrence, 2018). In contrast, forest owners' goals related to other ESs and actions targeting these goals require more research (Weiss et al., 2019). Previous studies have also examined the willingness of private forest owners to participate in different types of incentive schemes, for example, to enhance biodiversity (Lindhjem and Mitani, 2012), to sustain landscape and recreational values (Mäntymaa et al., 2018), or to increase carbon sequestration (Markowski-Lindsay et al., 2011). Many studies have used a stated preference method Choice Experiment (CE) which is well-suited for this purpose, because a wide variety of incentive scheme designs can be studied and new, yet unimplemented schemes can be considered. In CE, forest owners can be asked how they would respond to incentive schemes that differ in terms of contract attributes and relative importance of considered attributes can be evaluated by estimating marginal willingness-to-accept (WTA) values for the attributes (Vedel et al., 2015; Smith et al., 2016; Tyrväinen et al., 2020). For example, Sheremet et al. (2018) examined a programme designed to reduce risks from invasive pests and diseases and considered five attributes: specific disease management options, contract length, inspection and reporting frequency, annual grant (participation) payment, and an agglomeration bonus payment if at least one neighbouring forest owner also enrols.

We applied the CE method to investigate forest owners' potential participation in an incentive scheme in which they were asked to practise a 'Timber Oriented' or a 'Nature Oriented' management strategy according to the terms of a hypothetical contract that ensures the long-term commitment of forest owners to the required management strategies. The Timber Oriented strategy was designed to enhance timber production and the use of wood for the purpose of the bioeconomy through rotation forestry with a shortened rotation period and intensive management. The Nature Oriented strategy aimed at improving the provision of environmental values such as biodiversity and carbon storage via uneven-aged forestry. Forest owners typically have numerous options in managing their forests, including options that are all incentivized but have opposite goals as part of different policies. It, therefore, seems incomplete to explore forest owners' choices without simultaneously considering alternative policies on forest use. Therefore, we explored not only forest owners' preferences for different management strategies but also how the potential consequences of forest management strategies would affect forest owners' participation in the incentive schemes.

The main aims of our study were: 1) To analyse forest owners' preferences for a contract-based management with varying outcomes in terms of profitability and non-timber ESs (biodiversity, carbon storage, and probability of climate change-induced damage); 2) To assess the relative importance of the considered outcomes in terms of WTA; 3) To investigate the magnitude of compensation claims associated with alternative contract scenarios targeting either enhanced timber production or biodiversity and non-timber ESs. The study is based on Finnish private non-industrial forest owners. Lessons learnt in the Finnish context will have international relevance as similar forest management and policy issues are of global concern (Lawrence et al., 2020).

2. Materials and methods

2.1. Survey design

The questionnaire development started in spring 2019 in cooperation with researchers from Austria, Finland, Germany, Slovenia, and Sweden.[1] After the research group had reached a common view on the layout of the choice experiment questions and potential attributes, a focus group meeting was held with 10 forest owners in Finland to define the most relevant attributes and to ensure that the scenario description was understandable, accepted, and viewed as credible by respondents. Based on the feedback received from the focus group, the questionnaire was further developed, after which it was tested by interviewing six forest owners that responded to the preliminary questionnaire. A pilot survey was then conducted in Finland with approximately 30 forest owners to test the next version of the questionnaire. The final questionnaire, edited based on the feedback to the pilot survey, consisted of four parts (supplement). The first part explored respondent socio-economic status. The second part included questions about forest holdings. The third part investigated forest owner management practices. The fourth part contained the CE and the related debriefing questions.

[1] The survey was conducted in ValoFor project involving partners from these five countries. The aim was to use the same questionnaire in each country. Therefore, the scenario description, the layout of choice experiment questions and the attributes and their levels were designed to be suitable and relevant for all these countries to allow comparison of the results.

CHOICE SET 1	Alternative A	Alternative B	Alternative C
Management strategy	Conventional management (no contract)	Nature Oriented (15-year contract)	Timber Oriented (15-year contract)
Profitability (without additional subsidy)	Current level	Decrease 20%	Current level
Biodiversity	Current level	Increase	Decrease
Carbon stock	Current level	Current level	Decrease
Probability of climate change induced damages	Current level	Increase	Decrease
Additional subsidy (lump sum payment, €/hectare)	0	300	750
My choice is:	○	○	○

Fig. 1. An example of the choice experiment questions.

In the CE, respondents were presented with six sets of possible payment schemes and prompted to choose one in each set (Fig. 1). Respondents were asked to consider the choice sets as individual situations and answer each choice set. Each choice set included three alternatives, whereby alternative A, Conventional Management as management strategy, was the reference (i.e. the attribute levels were fixed at current level, additional subsidy is zero). The other two management strategies were Timber Oriented and Nature Oriented that varied between the choice sets regarding their specific effects in alternatives B and C. The underlying assumption behind the proposed schemes was that the government would offer forest owners monetary incentives to undertake the specified management strategies to promote bioeconomy development (Timber Oriented) or to safeguard biodiversity (Nature Oriented). This setup enabled the use of the WTA approach. The respondents were asked to imagine that they can make a 15-year management contract with a local authority. They were further asked to imagine that they have a 50-year spruce-dominated forest stand and consider choosing alternative A, B or C for this hypothetical stand (see also Sheremet et al., 2018; Mostegl et al., 2019).

Nature Oriented management strategy was defined as continuous cover forestry. The respondents were told that in the hypothetical stand, the Nature Oriented strategy involves first a transition harvest to promote the formation of an uneven-aged structure and then a second selection harvest at the end of the contract period. The Timber Oriented strategy involved intensive even-aged forestry with short rotation periods, which provides a higher proportion of pulpwood for industrial use. The Timber Oriented strategy also included strong thinning and fertilization at the beginning of the contract period, and final felling and regeneration at the end of the contract period. Conventional Management (no contract) was explained to include one thinning within the next 15 years and other harvests, including clear-cutting, thereafter.

The potential long-term effects of management strategies were described by four attributes including profitability, biodiversity, carbon stock, and climate change induced damage; the additional financial subsidy was included as the fifth attribute. These attributes were chosen to be relevant for forest owners and policy makers (Bennett and Adamowicz, 2001). To ensure that the respondents had enough information for their choices and to mitigate hypothetical bias, the attributes were described verbally to the respondents before the choice tasks were presented. After the description the respondents were asked to reveal to what extent they believed the respective attribute to influence their management decisions (supplement, Questions 25–29).

Excluding additional subsidies, the attributes were specified to have three levels: current level associated with Conventional Management and the increase and decrease from the current level. However, based on the feedback from the focus group and results from previous studies Nature Oriented practice was assumed to have positive or neutral effects on biodiversity and carbon storage (Peura et al., 2018) and Timber Oriented practice was assumed to have negative or neutral effects on biodiversity and carbon storage (Mönkkönen et al., 2014). The magnitudes of decrease and increase were not specified for the attributes except for profitability, which was a straightforward attribute to quantify. The focus group discussions revealed that forest owners preferred using decreasing and increasing levels on most attributes. Levels of profitability included a 20% decrease and increase along with the current level. The profitability of forest management depends on several stand-specific and economic factors along with the management practice used, and therefore, it may vary in the Nature Oriented and Timber Oriented strategies from decrease to increase as has been shown in previous studies (Mönkkönen et al., 2014; Rämö and Tahvonen, 2017; Juutinen et al., 2018a). Similarly, the probability of climate change induced damage involves many factors, including abiotic (draught stress, storm and snow damages) and biotic (bark beetles, other insects) damage, and may vary from an increase to a decrease depending on applied forest management strategy. For example, continuous cover forest management (uneven-aged stand structure) may decrease vulnerability to storm damages and reduce the risk for damage from a variety of insect pests, but favour spread of root rot (Hanewinkel et al., 2014; Pukkala et al., 2016; Piri and Valkonen, 2013; Klapwjk et al., 2016). The additional subsidy was defined as a lump sum payment at the

Table 1
Attributes and their levels with variable names used in the analysis.

Attribute	Level	Variable name[a]
Management strategy	Nature oriented Timber oriented	NatureOri (reference level)
Profitability	Decrease 20% Current level Increase 20%	ProfitDec (reference level) ProfitInc
Biodiversity	Decrease Current level Increase	BiodivDec (reference level) BiodivInc
Carbon stock	Decrease Current level Increase	CarbonDec (reference level) CarbonInc
Probability of climate change induced damage	Increase Current level Decrease	DamageInc (reference level) DamageDec
Additional subsidy[b]	400, 700, 1000, 1300, 1600, 2000 (€/ha)	Subsidy

[a] Variables were dummy coded for the analysis except that the additional subsidy was treated as a continuous variable.
[b] A lump sum payment for a 15-year contract. The unit in the analysis was k€/ha.

beginning of the contract period. The respondents were told that the payment is tax free. The bid vector was set based on the questionnaire testing.[2] The attributes and their levels are shown in Table 1.

Given that our CE included one attribute with two levels, four attributes with three levels, and one attribute with six levels, all possible combinations of attributes and their levels would result in (2*3*3*3*3*6) = 972 combinations, so a full factorial design was not possible. To reduce the total number to reasonable number of combinations presented to the respondents, the experimental design was created using a Bayesian efficient design with prior information from the pilot survey and optimized for D-efficiency for the MNL model (Ngene, 2018). The D-efficient design was estimated with restrictions that increase (decrease) of biodiversity and carbon storage were not allowed when management scenario was Timber Oriented (Nature Oriented). The resulting 36 choice sets were blocked into six groups. Hence there were six versions of the questionnaire that were distributed randomly between the respondents.

2.2. Materials

The survey data were collected in the spring of 2020 through a nationwide questionnaire sent by mail to a random sample of 3000 Finnish family forest owners with at least two hectares of forestry land in Finland. The sample was stratified according to number of forest holdings with a minimum area of 2 ha in each 18 Finnish regions (Åland excluded). Individual owners and those with a spouse, private partnership, or heirs were collectively considered to belong to the sample of family forest owners. The sample was derived from the Finnish Forest Centre's nationwide forest owner register. Of the 3000 addresses, 39 were not valid, giving a net sample of 2961.

The response rate was 31.8%, with a total of 942 responses after two reminders. Of the respondents, 90.8% replied by mail, and the rest through the web survey. Non-responding forest owners were further studied by telephone, interviewing 50 randomly chosen owners to determine both their background characteristics and the reasons for non-response. The most important reasons for non-response were that the forest owners forgot to respond to both the survey letters sent to them, did not have time to respond to the survey, or did not receive the survey letters.

The database pre-examination of the choice experiment revealed that 372 respondents always selected the reference alternative A in the choice sets, i.e. Conventional Management. However, according to a specific follow-up question (supplement, Question 31), only 145 out of these 372 respondents truly considered it as the best alternative in the choice set. 212 respondents revealed some other reasons for their choices (15 respondents did not reveal any reason). The other reasons to always select the reference alternative were "I did not find the contract-based alternatives B and C realistic" (22 respondents), "I do not want to make management contracts" (163), and "Other:__" (27). The first two other reasons can be interpreted as representing lexicographic preferences or protest responses. These answers cannot be taken to reflect the respondent's actual valuation of the management alternatives per se. Therefore these 185 responses were removed from the database before choice experiment analysis. In addition, 42 respondents were removed from the database, because they did not answer any choice sets. Hence the number of respondents used in further analysis was 715 with 4180 observations of respondents' choices.[3] The analysis database was unbalanced because some respondents did not answer all six choice sets.

2.3. Models and welfare analysis

The CE data were analysed using the mixed logit (MIXL) model, also called the random parameters logit (RPL) model, with specifications of utility in the preference and willingness-to-pay (WTP) spaces. The MIXL model specified in preference space was used to examine preference heterogeneity. WTP-space specification was used to derive marginal WTA estimates to show the importance of the management attributes and to calculate the welfare effects of policy scenarios.

MIXL models can be derived from a random utility model (McFadden, 1974) assuming respondents maximize their utility through their choices over the alternatives presented in a series of choice cards (Train, 2009). In preference space, the utility to an individual i from selecting an alternative j in a choice situation t described by K observed attributes $\boldsymbol{x}_{ijt} = \{x_{ijt}^1, \ldots, x_{ijt}^K\}$ is defined as:

$$U_{ijt} = \alpha_{ij} + \boldsymbol{\beta}_{ik}^{'}\boldsymbol{x}_{ijt} + \varepsilon_{ijt} \tag{1}$$

where α_{ij} is an alternative-specific constant, $\boldsymbol{\beta}_{ik}$ is a vector of coefficients for attributes, and ε_{ijt} is an i.i.d. Gumbel distributed error term. The probability of a respondent making a choice is[4]:

$$Pr(y_{it} = j) = \frac{exp\left(\alpha_{ij} + \boldsymbol{\beta}_{ik}^{'}\boldsymbol{x}_{ijt}\right)}{\sum_{q=1}^{J} exp\left(\alpha_{iq} + \boldsymbol{\beta}_{ik}^{'}\boldsymbol{x}_{iqt}\right)} \tag{2}$$

The choice-specific constants α and preference parameters β vary between respondents. In this study, individual-specific factors that the explain heterogeneous preferences of the alternative-specific constant were examined in more details utilizing the following formula:

$$\alpha_{ij} = \alpha_j + \boldsymbol{\delta}_j^{'}\boldsymbol{z}_i + \vartheta_{ij} \tag{3}$$

where α_j is an alternative-specific constant, and ϑ_{ij} is normally distributed (with zero mean) heterogeneity of the alternative-specific constant. The parameter distribution of α_{ij} is also heterogeneous with respondents' individual characteristics $\boldsymbol{z}_i$with vector of weights $\boldsymbol{\delta}_j$.

[2] In addition, the bid vector was set to be applicable for the five countries participating in ValoFor project.

[3] There number of respondents varied between the six versions of questionnaire from 102 to 135 per version.

[4] The dependent variable in the analysis is a dummy variable which equals to one when an alternative (A, B or C) is selected and zero otherwise.

In this study, the alternative-specific constant was a dummy variable, which was equal to one for the contract alternatives (see alternatives B and C in Fig. 1). The current situation (alternative A) was treated as a reference level equal to zero. The alternative-specific constant captured all systematic effects on selection of alternatives that were not captured by the other explanatory variables. Because the attribute variables were dummy coded (Table 1), it also captured the effects of reference levels of these variables, particularly the effect of Timber Oriented management strategy. Hence, the alternative-specific constant reflected respondent preferences for the contract-based management that required to apply Timber Oriented management strategy. The coefficient of alternative-specific constant can also be interpreted inversely (the opposite of sign) as reflecting preferences for the current situation described by alternative A (Conventional Management). In any case, the influence of different factors reflected by the alternative-specific constant were confounded, it was not possible to evaluate them separately.

Note that the observed attributes include a price attribute and non-price attributes. In this study, the former was a payment paid to landowner to compensate for the loss caused by applying the forest management practice specified in the contract (i.e., willingness-to-accept (WTA) was examined). The price parameter was specified as having one-sided triangular distribution given the theoretical expectations of positive utility for compensation payment.[5] The non-price parameters were assumed to follow normal distribution with zero mean.

To specify the MIXL model in WTP space, define coefficients of price-attribute and non-price attributes as β_{ic} and $\boldsymbol{\beta}_{in}$, respectively. Define further the implied WTP for a non-price attribute as the ratio of the non-price attribute's coefficient to the cost coefficient: $\omega_{in} = \frac{\beta_{in}}{\beta_{ic}}$. Accordingly, the utility in WTP space can be presented as (Train and Weeks, 2005):

$$U_{ijt} = -\beta_{ic}p_{ijt} + (\beta_{ic}\boldsymbol{\omega}_{in})'\boldsymbol{x}_{ijt} + \varepsilon_{ijt} \tag{5}$$

In the WTP space speciation the probability of choice is:

$$Pr(y_{it} = j) = \frac{exp\left(-\beta_{ic}p_{ijt} + (\beta_{ic}\boldsymbol{\omega}_{in})'\boldsymbol{x}_{ijt}\right)}{\sum_{q=1}^{J} exp\left(-\beta_{ic}p_{igt} + (\beta_{ic}\boldsymbol{\omega}_{in})'\boldsymbol{x}_{iqt}\right)} \tag{6}$$

The MIXL model in WTP space provided estimates for marginal WTA values of considered attributes. The welfare impacts of alternative contact designs and associated compensation requirements were assessed using the compensating variation (CV) formula modified for the results of WTP specification (Juutinen et al., 2014).

3. Results

3.1. Sample characteristics

We examined the representativeness of our data by comparing the characteristics of respondents to both the characteristics of non-respondents of this study and to the respondents of recently published large nationwide Finnish Forest Owner Survey (Karppinen et al., 2020) (Table 2). Non-respondents slightly deviated from the sample used in this analysis, which indicate that the sample was not entirely random representing all forest owners. Non-respondents were younger, lived more often in rural areas and were more often farmers or (forestry) entrepreneurs, or presented the occupation group "other", as compared with respondents. In addition, the size of the forest holding was larger among non-respondents than respondents. However, the characteristics of non-respondents of this study differ from the characteristics of the nationwide forest owner survey more than do the characteristics of respondents of this study. Thus, the non-respondents probably do not represent typical forest owners.

Table 2
Description of the background characteristics of respondents, non-respondents, respondents used in the choice experiment analysis, and the respondents to the Finnish Forest Owner Survey 2020.

	Sample all respondents ($n = 942$)*	Sample non-respondents ($n = 50$)	Sample used in the analysis ($n = 715$)*	Finnish Forest Owner Survey 2020** ($n = 15{,}419$)*
Gender, %				
Female	24	24	23	26
Male	76	76	77	74
Age, %				
<45	7	16	7	9
45–64	38	50	40	38
>64	54	34	52	52
Average age	64	59	64	64
Place of residence, %				
Rural	55	66	55	53
Population centre	18	16	19	18
City (>20,000 habitants)	27	18	27	29
Occupation, %				
Wage earner	25	26	26	33
Farmer or forestry entrepreneur	9	18	10	8
Entrepreneur	8	14	8	6
Pensioner	55	36	54	51
Other (student, unemployed etc.)	2	6	2	2
Average size of forest area, ha	56	79	56	51

* The number of observations vary from question to question due to the item non-response.
** Karppinen et al. (2020).

The respondents' characteristics corresponded with the nationwide forest owner survey (Karppinen et al., 2020). The proportion of wage-earners was slightly smaller and proportion of pensioners was slightly higher among respondents of this study than in the Finnish Forest Owner Survey. In addition, the average forest area (incl. All holdings) was larger among the respondents in the present study, but these figures are not comparable, because in Karppinen et al. (2020) the forest area included only holdings in a province in which respondent's primary holding is located, and the minimum size of holdings was set to 5 ha.

The respondents formed a heterogeneous group of forest owners in terms of their management practices and objectives. For example, when inquiring about their intentions for applying different forest management strategies in their forests (supplement, Question 24), the results showed that only 86% of them would likely or very likely use the currently applied forest management strategy (Conventional Management). In contrast, 17% would prefer a more intensive management strategy (Timber Oriented) and 61% a more nature-focused strategy (Nature Oriented). Note that respondents were able to report using multiple management strategies simultaneously. Social values associated with their forest holding were regarded as the most important value aspect followed by economic values and environmental values (Fig. 2). Several goods and services from their forest holding were considered important for the respondent's personal economy and/or well-being

[5] Several alternative distributions were tested. One-sided uniform distribution fit the data slightly better than one-sided triangular regarding MIXL model with preference space specification. One-sided triangular distribution was, however, used in the both specifications to ensure comparability of the results, because it was not possible to use one-sided uniform distribution with WTP-space speciation in NLogit6 which was used to estimate the models.

(Fig. 3).

Compared with the sample including all respondents the sample used in the analysis included slightly more men. The average age was the same in the all respondents and the analysis sample, but there were fewer over 64-year-old respondents and pensioners in the analysis sample. A binary logit model analysis with $45 < \text{age} < 65$, $\text{age} > 64$, men, population centre, city, wage earner, farmer or forestry entrepreneur, pensioner and size of forest area as explanatory variables (results not shown) revealed that the probability of a respondent being in the sample used in the choice experiment analysis was significantly higher with men and 45–64 year old respondents and it increased significantly with the size of forest area. The probability of being in the sample used in the choice experiment was significantly lower with respondents over 64 years of age.

3.2. Choice experiment analysis

The results of the MIXL model specified in preference space show that the (mean) coefficients of considered variables were all significant at the 1% level (Table 3, MIXL). The coefficient of the Contract variable had a negative sign, which means that on average respondents derive lower utility from subscribing to some suggested schemes that include monetary compensation than not joining any scheme. That is, they liked to continue to apply Conventional Management. In addition, it can also indicate a possible dislike for the Timber Oriented (TimberOri) management strategy option. Recall, however, that only 20% of the respondents always selected Conventional Management alternative as the best alternative. Hence, the majority of respondents participated in the payment schemes by selecting at least once a contract alternative.[6] The coefficients of Profit decrease (ProfitDec), Biodiversity decrease (BiodivDec), Carbon decrease (CarbonDec), and Increase of the probability of climate change induced damage (DamageInc) attributes also had negative signs decreasing the probability of accepting the proposed contract. In contrast, the coefficient of Nature Oriented (NatureOri) strategy had positive sign indicating that this is more preferred relative to Timber Oriented (TimberOri) strategy, which was the omitted level for the management strategy attribute. The coefficients of Profit increase (ProfInc), Biodiversity increase (BiodivInc), Carbon increase (CarbonInc), Decrease of the probability of climate change induced damage (DamageDec) also had positive signs, so the respondents liked these properties. As expected, the coefficient of Additional subsidy (Subsidy) attribute was positive, meaning that a higher subsidy increased the probability of subscribing to some suggested schemes.

Given that the estimated standard deviations around the sample means were statistically significant, excluding Biodiversity decrease (BiodivDec) and Carbon increase (CarbonInc), the results also show that there was considerable variability of respondent preferences regarding the considered attributes (Table 3, MIXL). The preference heterogeneity was further studied using MIXL model with interactions between Contract and individual-specific variables applying data-driven exploration (Table 3, MXL + interaction terms). Interestingly, several variables that reflect the respondents' demographic characteristics and experience were statistically significant in explaining the preference heterogeneity associated with Contract variable. The coefficients of variables describing the age (Age) and place of residence of the respondent in rural areas (Rural) had a negative sign, which means that the elderly respondents and those living in rural areas were less likely to accept the proposed payment scheme than the other respondents. In contrast, the coefficients of variables describing respondent's high education (HighEdu) and duration of forest ownership (DuraOwn) had a positive sign, so these respondents were more likely to enter the contract. The respondents were also more likely to enter the contract if they had a management plan (ManaPlan) or if they had not used long rotation forestry previously (NoLongR).

3.3. Marginal willingness-to-accept values

The respondents agreed to a compensation of on average €3469 per ha as a lump sum payment (i.e., €231 per ha per year) to accept a 15-year contract to apply the Timber Oriented management strategy (Contract) as shown in Table 4. The average expected compensation was €1752 per ha (i.e., €117 per ha per year) to apply the Nature Oriented management strategy. Regarding Profit, Biodiversity, Carbon, and Probability of climate change induced damage attributes, Carbon decrease (CarbonDec) had the strongest influence on the compensation claim followed by increased Probability of climate change induced damage, Profit decrease, and Biodiversity decrease in descending order. If forest management was expected to have a negative effect on carbon storage, the compensation claim increased by €1615 per ha. Interestingly, the influence of Biodiversity, Carbon, and Probability of climate change induced damage attributes on the compensation claim was asymmetric: weakening had a much stronger influence than improvement in absolute terms. The influence on the compensation claim in terms of absolute values varied from €1358 to €1615 and from €273 to €827 for weakening and improvement, respectively. The asymmetry between ProfitDec and ProfitInc was not as strong.

3.4. Contract scenarios

Six scenarios were created to show how the contract features and expected effects of forest management would affect forest owners' economic welfare and compensation claims (Table 5). Scenarios 1–3 represented contracts with the Timber Oriented management strategy, and Scenarios 4–6 contracts with the Nature Oriented strategy. Regarding the expected effects on profit, biodiversity, carbon stock, and probability of climate change induced damage, the scenarios represented three cases: no impact (Scenarios 1 and 4), worst potential case (Scenarios 2 and 5), and best potential case (Scenarios 3 and 6). Recall that biodiversity and carbon decrease were assumed to be relevant only for the Timber Oriented strategy and biodiversity and carbon increase only for the Nature Oriented strategy. Therefore, the best potential case for the Timber Oriented strategy (Scenario 3) includes current levels for biodiversity and carbon, not increased levels. The worst potential case for the Nature Oriented strategy (Scenario 5) includes current levels for biodiversity and carbon, not decreased levels, respectively.

In Table 5, a positive compensating variation (CV) indicates compensation claim. Compensation claims varied from €1975 to €9312 per ha in Scenarios 1–3 where the terms of the contract required the Timber Oriented strategy depending on the expected effects. Hence, the expected effects strongly influenced compensation claims, especially when the negative effects were expected. The same also applied to Scenarios 4–6 that involved the Nature Oriented strategy. The highest compensation claim (€4621/ha) was in Scenario 4 in which the expected effects were negative regarding the profitability of forest management and the probability of climate change induced damage and the effects were at the current level regarding biodiversity and carbon stock. Interestingly, in Scenario 6 the CV was negative (€-987/ha), which means that forest owners were willing to use the Nature Oriented management strategy without any compensation, when the expected effects were all positive.

4. Discussion and conclusions

Given that the respondents (74%) typically selected at least once a contract-based alternative in the choice sets, our study shows that the majority of responding forest owners were willing to participate in a contract-based payment scheme targeted to enhance either timber

[6] 25% of respondents selected two different management strategies and 42% selected the all three different management strategies showed to them in the six choice sets.

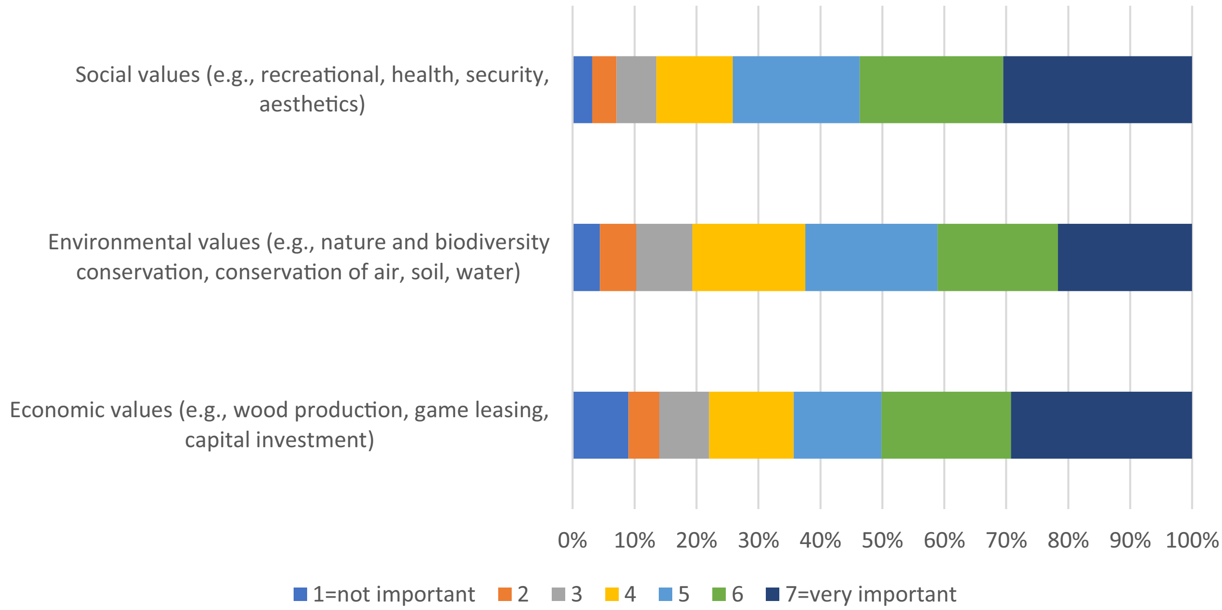

Fig. 2. Proportions of importance of different values on forest property for respondents.

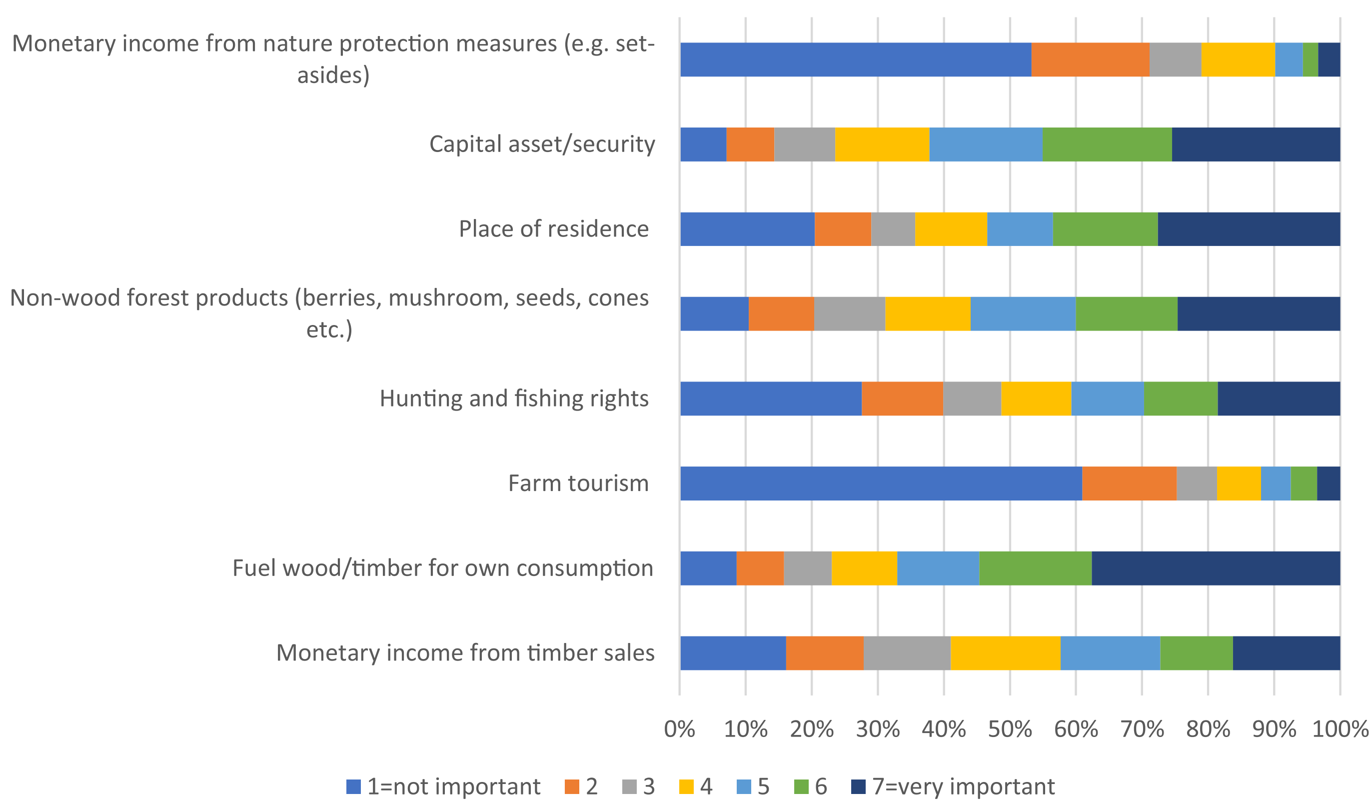

Fig. 3. Proportions of importance of different goods and services from forest holding for personal economy and/or well-being of respondents.

production or environmental values, if the compensation was high enough. This outcome is good news for forest policy makers aiming to develop new mechanisms to diversify forest management and to encourage forest owners to implement the planned activities in their forest. The participation in the scheme was relatively high compared, for example, with findings by Mitani and Lindhjem (2015) and Mäntymaa et al. (2018). In contrast to those previous studies, two alternative policy options were considered simultaneously, which may have increased this study's participation rate. Many of the respondents who did not want to participate in the proposed payment scheme considered conventional management as the best management strategy. This result is consistent with findings by Juutinen et al. (2020) showing that forest owners often plan to use the same management practices in the future as they have used in the past.

Forest owners preferred the management contract with the Nature Oriented strategy to the contract with the Timber Oriented strategy. There may be several reasons for this outcome. A possible explanation is that forest owners expect the short rotation period applied in the Timber

Table 3
Results of Mixed Logit models specified in preference space.

Variable	MIXL		MIXL + interaction terms	
	Coefficient	Standard Error	Coefficient	Standard Error
Means				
Contract[a]	−2.52472***	0.25312	3.14587**	1.26395
NatureOri	1.16598***	0.21553	1.28131***	0.23697
ProfitDec	−0.98835***	0.12696	−1.03987***	0.14540
ProfitInc	0.79769***	0.11546	0.88034***	0.12832
BiodivDec	−0.88364***	0.14592	−0.98061***	0.16609
BiodivInc	0.55478***	0.09822	0.55205***	0.10688
CarbonDec	−1.07121***	0.17164	−1.08145***	0.18743
CarbonInc	0.29710***	0.09925	0.21246**	0.10758
DamageInc	−0.99038***	0.13217	−1.08404***	0.14517
DamageDec	0.21188**	0.09727	0.23974**	0.10740
Subsidy	0.71312***	0.08791	0.82715***	0.09674
Interactions				
Contract*Age			−0.11672***	0.02119
Contract*HighEdu			0.85796**	0.42913
Contract*Rural			−0.85578**	0.40761
Contract*DuraOwn			0.04300***	0.01592
Contract*ManaPlan			1.01636***	0.39154
Contract*NoLongR			0.72612*	0.39820
Std Dev				
Contract	4.45509***	0.28689	3.84932***	0.27437
NatureOri	3.02531***	0.24517	3.09463***	0.26796
ProfitDec	0.88495***	0.19594	1.04747***	0.21062
ProfitInc	0.85393***	0.17653	0.94935***	0.19311
BiodivDec	0.34383	0.45586	0.36555	0.56686
BiodivInc	0.46616*	0.27887	0.40895	0.38556
CarbonDec	1.15228***	0.26012	1.19066***	0.29059
CarbonInc	0.30370	0.38468	0.11696	0.53543
DamageInc	1.17018***	0.18076	1.19440***	0.20680
DamageDec	0.47614*	0.24668	0.58722**	0.25611
Subsidy	0.71312***	0.08791	0.82715***	0.09674
Number of obs.	4180		3446	
AIC	5848.5		4945.6	
Loglik	−2906.271		−2445.819	
McFadden R^2	0.368		0.354	

[a] Constant term, a dummy variable which equals to one for the contract alternatives (alternatives B and C). The effects of management on profitability, biodiversity, carbon storage, and probability of climate induced damage are at the current level (reference). ***, **, * significant at the 0.01, 0.05, and 0.1 levels.

Table 4
Results of the MIXL model specified in willingness-to-pay space. Marginal willingness-to-accept values denote a lump sum payment for a 15-year contract, k€/hectare.

Variable	Coefficient	Standard Error	Confidence interval	
Means				
Contract[a]	3.46942***	0.43271	4.31751	2.62133
NatureOri	−1.71782***	0.38422	−0.96476	−2.47088
ProfitDec	1.37707***	0.22204	1.81227	0.94187
ProfitInc	−1.22054***	0.17990	−0.86794	−1.57313
BiodivDec	1.35814***	0.22046	1.79023	0.92604
BiodivInc	−0.82733***	0.16319	−0.50748	−1.14718
CarbonDec	1.61462***	0.29788	2.19847	1.03078
CarbonInc	−0.41675***	0.17250	−0.07865	−0.75485
DamageInc	1.49330***	0.21512	1.91492	1.07168
DamageDec	−0.27347*	0.15122	−0.02292	−0.56985
Subsidy	Fixed			
Std Dev				
Contract	6.08958***	0.77194	4.57661	7.60256
NatureOri	4.42106***	0.58090	3.28252	5.55961
ProfitDec	1.44056***	0.29622	0.85999	2.02114
ProfitInc	1.06764***	0.26877	0.54086	1.59442
BiodivDec	0.18872	1.00527	−1.78158	2.15902
BiodivInc	0.94377***	0.32168	0.31329	1.57426
CarbonDec	1.37101***	0.36928	0.64723	2.09480
CarbonInc	0.56393	0.45014	−0.31832	1.44618
DamageInc	1.50454***	0.29499	0.92637	2.08272
DamageDec	0.83206**	0.32407	0.19691	1.46722
Subsidy	Fixed			
Coefficient of Subsidy in preference space				
Mean	0.87599***	0.10945	0.66148	1.09051
Std Dev	0.87599***	0.10945	0.66148	1.09051
Number of obs.	4180			
AIC	5822.4			
Loglik	−2890.214			
McFadden R^2	0.371			

[a] Constant term which denotes management contract with the Timber oriented management strategy. The effects of management on profitability, biodiversity, carbon storage, and probability of climate induced damage are at the current level (reference). ***, **, * significant at the 0.01, 0.05, and 0.1 levels.

Oriented strategy to have a detrimental effect on local landscape quality and recreational possibilities. Previous forest landscape preference studies have concluded that people appreciate mature forests with no strong visible signs of forest management (Gundersen and Frivold, 2008; Ribe, 2009). Similarly, Koivula et al. (2020) found that people prefer continuous-cover methods to clear cutting and recommended continuous-cover logging methods in settlement and recreational areas.

At first glance, the average compensation payments requested by forest owners for entering into a management contract (€117–€231/ha/year) in this study seem to correspond to the actual average payment paid (€176/ha/year) in the Finnish conservation programme for temporal 10-year forest protection (Juutinen and Ollikainen, 2010; Juutinen et al., 2013). Notice, however, that in the Finnish conservation programme it was not allowed to harvest the stand during the contract period in contrast to the payment scheme examined in this study in which harvesting was allowed. The opportunity costs associated with a management contract are lower when harvesting is allowed. Therefore, the compensation claim asked for Timber Oriented and Nature Oriented strategies should have been lower than the compensation payment in the Finnish conservation programme. A possible explanation for the high compensation claim can be that forest owners perceive the 15-year contract as an unwanted constraint on their freedom to manage their forests. Previous studies have shown that forest owners prefer short contracts rather than long contracts (Markowski-Lindsay et al., 2011; Sheremet et al., 2018). Tyrväinen et al. (2020) examined contract-based payment scheme and found that the compensation requested by the forest owner (to enhance recreational values) increased by €13.7 per hectare per additional year when the contract period was extended. Given this estimate, the average compensation claim would have been almost €70 per hectare lower in this study, if a 10-year contract period had been applied instead of 15-year period. Hence after adjusting our compensation claims for a 10-year contract (€49–€163/ha/year) they seem to be better in line with the Finnish conservation programme's actual payments. However, a short contract period is not appropriate for management contracts that require forest owners to apply a specified management strategy and to carry out successive forest management operations.

A related finding was that forest owners were willing to choose Nature Oriented management strategy without any compensation to enhance biodiversity and increase carbon stocks, if that option was also increasing profit. In practice, such option may be available in drained Norway spruce dominated peatland forests, where the transition from rotation forestry to selection cuttings has positive influence on profitability, forest carbon stocks and biodiversity (Nieminen et al., 2018; Juutinen et al., 2021).

All attributes related to the potential consequences of forest management strategies had a significant impact on the acceptability of contracts and forest owners' compensation claims. In particular, the other attributes than profitability of timber production were surprisingly highly valued. The decrease of carbon stock had the strongest effect of increasing compensation claims. The result probably reflects that climate change and forest carbon sequestration have been prominently

Table 5
Scenarios and compensating variations (CV).

Contract feature/expected effect	Timber Oriented strategy			Nature Oriented strategy		
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Management strategy						
Timber oriented	1	1	1	0	0	0
Nature oriented	0	0	0	1	1	1
Profitability						
Decrease	0	1	0	0	1	0
Current level	1	0	0	1	0	0
Increase	0	0	1	0	0	1
Biodiversity						
Decrease	0	1	0	0	0	0
Current level	1	0	1	1	1	0
Increase	0	0	0	0	0	1
Carbon stock						
Decrease	0	1	0	0	0	0
Current level	1	0	1	1	1	0
Increase	0	0	0	0	0	1
Probability of climate change induced damage						
Increase	0	1	0	0	1	0
Current level	1	0	0	1	0	0
Decrease	0	0	1	0	0	1
CV (€/ha)	3469	9312	1975	1752	4621	−987

featured in public debate and in the media in Finland recently. The possible introduction of a new carbon payment scheme, such as elaborated by Juutinen et al. (2018b), has also been much discussed. In line with this reasoning, the increase of climate change induced damage had the second strongest influence on compensation claims. The high WTA related to the climate change induced damage emphasize the importance of considering establishment of more robust forest stand with respect to climate change.

Consistent with loss aversion (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991), the findings suggest asymmetric preferences for improvements and deteriorations in the attributes describing the potential effects of forest management strategy on environmental values: the losses associated with a decline in the biodiversity and carbon storage attributes were more considerable than gains associated with an equivalent increase in the same attributes. Similar asymmetric findings have been made in the context of travel route choices (Hess et al., 2008), freight transport (Masiero and Hensher, 2010), rural development and conservation programmes (Glenk, 2011), and conditions of water quality (Ahtiainen et al., 2015). According to this result, a forest policy that prioritizes the protection of natural values in forests rich with natural values leads to more significant welfare gains for society than a policy that seeks to improve natural values in forests with few natural values (Ahtiainen et al., 2015). This possesses challenges for the design and implementation of the payment schemes considered in this study. Given that management contracts targeted to enhance timber production probably have negative effect on forest amenity benefits (Mönkkönen et al., 2014), they should focus on stands with no special nature values, while contracts targeted to enhance or maintain environmental values should focus on stands with special nature values. An interesting and new finding is that loss aversion was stronger with the environmental attributes than with profitability of forest management. The outcome may indicate that environmental characteristics of forests do not have close substitutes and if these are lost it will take a long time before they recover, if ever. Benefits associated with goods traded in the market, such as profitability of forest management, generate income with numerous substitutes.

It is also worth mentioning that our findings indicate significant heterogeneity in preferences for the considered attributes, and therefore, care must be taken when generalizing the average results.[7] Several individual-specific variables were found to explain the preference heterogeneity. For example, elderly respondents and those living in rural areas were less likely to accept the proposed payment scheme than the other respondents. The result indicates that forest owners may be increasingly ready for contract-based forest management in the future: the aging trend is reversing and forest owners will be increasingly living in the cities or towns (Karppinen et al., 2020). Further studies are needed to evaluate how this holds in other countries, where ownership structure and current incentive systems deviates from the conditions of this study.

Further, the preference heterogeneity may reflect the non-precise attribute level descriptions (i.e. decrease and increase levels without quantitative description) used in this study. We recognize that the attribute level description should be as precise as possible to ensure that respondents are considering the same changes of the attributes. We used the non-precise approach, because the focus groups discussion revealed that the non-precise descriptions were easier to understand. However, the respondents may not have considered the changes of the attributes in the same way. This may manifest itself in the results as a heterogeneity of preferences. Hence, our results may overestimate the preference heterogeneity to some extent.

Another issue to be considered is that our CE included basically two monetary attributes: profitability and additional subsidy. The additional subsidy was included because the focus was on contract-based payment scheme. The forest management strategies influence profitability, and therefore, profitability was included as an attribute as well. Importantly, we used the additional subsidy as the basis when calculating the marginal WTAs. Hence, the WTAs can be interpreted only in terms of how large compensations (i.e. subsidies) forest owners are agreeing to accept a 15-year contact. In addition, it is possible that respondents had assumed that profitability and probability of climate change induced damage attributes are not independent, which may bias our results regarding the CV estimates in scenario analysis. To avoid this potential bias, it is possible to compare scenarios where profitability is equal to current level. For example, the highest CV (associated with scenario 2) reduces from €9312 to €7935, if profitability does not decrease but stays at current level.

[7] Recall also that the sample used in the analysis is not fully representative.

We conclude that many forest owners are willing to participate in the considered incentive schemes, especially those supporting biodiversity and non-market ecosystem services. Non-profitability factors including biodiversity, carbon stock, and probability of climate change induced damage are important for forest owners. However, on average, they are asking for a reasonably high fee for contract-based forest management. Forest owners' preferences for the contract-based management and associated effects are, however, heterogenous. Therefore, there is likely a segment of forest owners willing to make a contract at a lower compensation level. It is an interesting research question for future studies to identify different segments of forest owners and assess the feasibility of proposed policy mechanism in more detail. Another critical success factor for the payment scheme is that forest owners doubt about the viability and profitability of new forest management practices such as continuous cover forestry and may not be aware of their positive impacts on biodiversity and other ecosystem services. Therefore, to promote the adoption of new management strategies and participation in contract-based payment schemes information and education campaigns are likely needed.

Declaration of Competing Interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.forpol.2021.102587.

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