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Risk Preferences, Risk Perceptions and Timber Harvest Decisions – An Empirical Study of NIPF Owners in Northern Sweden

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Abstract

A mail survey of NIPF owners in two counties in northern Sweden was conducted to investigate the risk preferences, perceptions of the return and risk of timber investment relative to investment alternatives outside forestry. Our aim was to determine to what extent the NIPF owners' harvesting behaviour was consistent with their preferences and subjective judgments.

A majority of the respondents were risk-neutral or risk-prone. We found that risk preferences have significant impacts on the decision to fell; the more a forest owner likes to take risks, the more likely it is that he/she conducts final felling. The result also shows large variations among NIPF owners with respect to the subjective judgements of the return and risk of the alternative investments.

For each respondent we elicited the most preferred investment alternative based on the stated risk preferences and the subjective judgements of the return and risk of the alternative investments. Owners whose preferred investment alternative is the mature forest are on average significantly less active in harvesting than owners with other preferred investment alternatives. The study reveals indications of the difficulties for NIPF owners to make rational decisions when faced with uncertainties.

Keywords: Risk-preference; Risk-perception; Subjective judgement; Felling decision; Consistency; Preferred investment

1. Introduction

The knowledge of optimal forest management under uncertainty has accumulated rapidly during the last three decades. Since the 1980s a large number of studies have been conducted to determine optimal forestry decisions when the management outcome is uncertain. Sources of uncertainty that have been addressed include the risk of forest destruction due to wildfire, forest damages caused by e.g. insects and storm, the result of forest regeneration efforts, random variations in forest growth,

unexpected fluctuations in stumpage price and interest rate, etc.. Two categories of models have been developed to formally incorporate uncertainty into the analysis of forestry decisions. The first category consists of the so-called anticipative optimization models, which are constructed to determine the optimal management program (i.e. the time schedule of management activities) during an entire rotation period or a given time horizon. Examples of anticipative forestry decision models include Reed (1984), Hogansson and Rose (1987), Caulfield (1988), Gassman (1989), Hof and Pickens (1991), Taylor and Fortson (1991), Valsta (1992), Armstrong (2004).

The second category of models, commonly known as adaptive optimization models in the forest economics literature, are designed to determine the decision rules that specify the optimal management option at each point in time conditional on the then observed values of the relevant stochastic variables. Adaptive optimization models have been developed primarily for determining the final harvest time in even-aged stand management with stochastic timber prices (see e.g. Lembersky and Johnson, 1975; Norstrom, 1975; Risvand, 1976; Lohmander, 1987; Brazee and Mendelsohn, 1988; Haight and Smith, 1991; Gong 1999; Brazee and Bulte, 2000; Insley and Rollins, 2005). Adaptive decision models have also been developed for uneven-aged stand management and for silvicultural decisions under uncertainty (Kaya and Buongiorno, 1987; Lin and Buongiorno, 1998; Jacobsen and Helles, 2006).

Stochastic forestry decision models (anticipative as well as adaptive) have been tested in numerous case studies. These studies have not only demonstrated how to include uncertainties from different sources in forestry decision analysis, but also shown the importance of doing so - in most cases, the incorporating of uncertainty could lead to significantly superior decisions than when uncertainties are ignored. Despite that, it is unclear to what extent stochastic optimization models are applied to incorporate uncertainties in real world forest management. For example, statistics about timber prices and the total harvest volume in Sweden during the past years (Skogsstyrelsen, 2007) show no indication of wide-spread application of the adaptive harvest decision model under conditions of price uncertainty[11].

There are many possible reasons why a forest owner would not turn to a stochastic decision model when choosing among different management options. One reason could be the lack of knowledge about stochastic decision models. Another reason might be that the forest owner does not believe that the existing stochastic models properly describe his/her decision problem. Most of the stochastic decision models maximize the expected net

[11] Application of the adaptive harvest model by a large number of forest owners would lead to a significant increase in the price elasticity of timber supply and to diminishing random variations in timber price in the short-run (Gong and Löfgren, 2007).

present value (NPV) of the cash flow associated to forest management, where the present value is calculated using a deterministic (risk-free) discount rate. Maximization of the expected NPV and the use of a deterministic discount rate are both motivated by the assumption of risk-neutral preferences. A forest owner who values non-market priced benefits of the forest and/or is not risk-neutral may have difficulties to see the relevance of such models. With a single forest stand, one can modify the expected NPV maximization objective to address non-neutral risk preferences or to accommodate the non-market priced benefits (see e.g. Gong, 1998; Gong et al., 2005). However, a forest owner typically owns multiple forest stands, and non-neutral risk preferences or concerns about non-market priced benefits typically make the management decisions for different stands interdependent.

There is no doubt that many forest owners are not risk-neutral. Theoretical analyses of timber harvest decisions of risk-averse forest owners show that the optimal harvest level depends on, among other things, the degree of risk-aversion, the forest owner's position in the capital market, and the relative risks of investments in and outside forestry (Ollikainen, 1993; Gong and Löfgren, 2003; Alvarez and Koskela, 2006). Intuitively, the optimal decision would also depend on the degree of uncertainty of investment in forestry relative to investments outside forestry in cases where the forest owner is risk-prone. Many studies have assessed the expected return and risk of investment in forestry (Redmond and Cubbage, 1988; Binkley et. al., 1996; Penttinen and Lausti, 1999; Lönnstedt and Svensson, 2000; Sun and Zhang, 2001; Lausti, 2004; Lundgren, 2005). It should be pointed out that the return of forestry investment examined in most of these studies was calculated based on restrictive assumptions about forest management decisions. One typical assumption is that timber harvest equals growth on an annual basis, or a forest stand is harvested once it reaches a fixed rotation age. It is obvious that forest owners should not rely on results from this type of studies when determining how to manage their forests in the presence of uncertainties.

Presumably, most forest owners pay attention to uncertainties in forestry decisions. However, many of them do not adopt any formal procedure to incorporate uncertainties in decision-making. This means that the subjective judgements of forest owners about the relative uncertainties of investments in and outside forestry play a key role in their choices among forest management alternatives. Furthermore, without following a formal procedure to incorporate uncertainties, the management behaviour of a forest owner could very well differ from what a theoretical analysis would suggest.

The purposes of this paper are 1) to investigate the risk-preferences of non-industrial private forest (NIPF) owners and their perceptions of the return and risk of timber investment as compared to alternative investments outside forestry; and 2) to examine the relationship between the stated preferences, subjective judgments, and the observed and planned timber harvests. Knowledge about NIPF owners' preferences and their perception of the return and risk of different investment alternatives is essential for improving the understanding of their forest management behaviour. More importantly, such knowledge would make it easier to identify effective means to assist NIPF owners in making rational decisions. Many empirical studies have found statistically significant correlations between some NIPF owner characteristics and the harvest level (see Amacher et al. 2003 for a review). The investigation of the risk-preferences of NIPF owners and their perceptions of the return and risk of different investment alternatives will contribute to improving the understanding of the mechanisms through which owner characteristics affect management behaviour. With the examination of the relationship between the preferences, subjective judgments, and timber harvest activities/plans, our aim is to determine to what extent NIPF owners' management behaviour is consistent with their preferences and judgments.

2. Method

2.1. Study area and sample

A mail survey was sent to NIPF owners in the counties of Västerbotten and Västernorrland in northern Sweden. Both counties are located in the boreal zone (Ahti et.al. 1968) and have their eastern border at the Baltic Sea. Their western borders are however different. The county of Västerbotten reaches all the way to the Norwegian border in the west, while Västernorrland reaches roughly half as far to the west, see Figure 1.

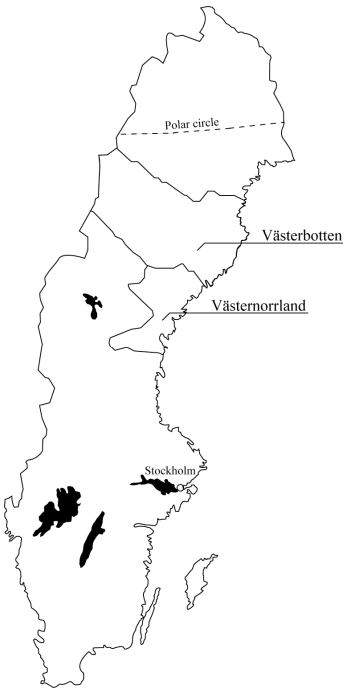

Figure 1. Map of Sweden, with the location of the study area.

The western part of northern Sweden is dominated by mountains and the productivity of the land is comparatively low. It can hence be expected that, when comparing mean values for Västerbotten and Västernorrland, the latter shows higher timber stocks. In Västerbotten there are around 20,250 NIPF holdings[12] and 43 % of the forest land is owned by NIPF owners. In Västernorrland there are around 14,100 NIPF holdings and 43.4 % of the forest land is owned by NIPF owners (Skogsstyrelsen, 2007). Some characteristics of the forest land in the two counties and of the whole of Sweden are presented in Table 1. At the national level, 51 % of the forest land is owned by NIPF owners (Skogsstyrelsen, 2007). The total area of forest land in the two counties is nearly 5 million hectares and account for 21.3 % of all forest land in Sweden. Looking at the fellings in each of the counties, the NIPF accounted for 39.9 % of the total area reported for final felling in Västerbotten in 2006, and in Västernorrland the corresponding share was 46.8 %. In the period 2003-2005 the annual gross felling on NIPF land in Västerbotten was 3.1 million cubic meters or 41.7 % of the total volume felled in the county. For the same period, 3.0 million cubic meters, or 48.3 % of the total volume felled in Västernorrland came from NIPFs.

[12] The number is an approximation based on taxation units. A NIPF holding refers to an estate owned by private persons, including deceased persons.

Together the two counties accounted for 6.3 % of the fellings in Sweden in the period 2003-2005 (Skogsstyrelsen, 2007).

Table 1. Forest land, timber stock (averages for 2001-2005) and annual fellings (average for 2003-2005)in Västerbotten, Västernorrland and Sweden in total. Shares (%) of the total in parentheses. Source: Skogsstyrelsen, 2007.

		Västerbotten	Västernorrland	Sweden
Forest land (10^3 of ha)	NIPF	1,366 (43.0)	753 (43.4)	11,758 (51.0)
	Public, companies	1,814 (57.0)	982 (56.6)	11,281 (49.0)
	Total	3,180	1,735	23,039
Total stock (10^6 of m^3)	NIPF	140.7 (46.7)	118.2 (48.8)	1,728.4 (57.6)
	Public, companies	160.8 (53.3)	124.0 (51.2)	1,271.2 (42.4)
	Total	301.5	242.2	2,999.6
Stock of timber (m^3/ha)	NIPF	103	157	147
	Public, companies	88	126	112
	Total	95	140	130
Fellings (10^6 of m^3)	NIPF	3.121 (41.7)	3.034 (48.4)	61.192 (62.8)
	Private companies	2.415 (32.3)	3.116 (49.7)	24.443 (25.1)
	State and other public	1.942 (30.0)	0.115 (1.8)	11.865 (12.1)
	Total	7.478	6.265	97.500

Forestry is important in the Swedish economy, and with the large share of NIPF lands the NIPF owners play a key role. In 2005 nearly 19 million hours of work were conducted in Swedish small-scale forestry. In total around 100.000 persons were employed in forestry, the wood manufacturing industry and the pulp- and paper industries in 2005 (Skogsstyrelsen, 2007). The value of all production in the forestry sector in 2004 was estimated to 185 billion SEK. The value of exports of timber and forest industry products was 12.2 % of the total value of exports and 4.3 % of GDP (Skogsstyrelsen, 2007).

For each of the two counties, addresses to NIPF owners with an area of forest of 25 hectares or more were obtained from the Swedish Forest Agency. Owners of properties of less than 25 hectares were excluded since it was expected that such properties had little potential of having economic significance to its owners. A pre-test was conducted on 100 NIPF owners in the county of Västerbotten and after adjustments the full scale survey of 2,000 questionnaires (1,000 in each of the two counties) was sent in February 2007.

2.2 The survey

The mail survey had four parts with different focuses and a total 40 questions. The first part was demographic information such as the age and gender of the respondents, as well as the importance of forestry income. The second part concerned the respondent's management objectives, attitudes towards risk and his/her judgement of the return and risk of forest investment and non-forest investments. For the purposes of this study it is important to establish whether the respondents have economic objectives or not. For owners without economic objectives it is irrelevant to elicit their attitude towards risk and their preferred investments. One part of the survey was focused on the felling activities during the period 2001-2006 and felling plans for the coming three years (2007-2009). This line of information was to be used for determining the effect of risk preferences on the felling behaviour. It was assumed that 6 years was a reasonably short period for the forest owner to correctly recall, or recollect, the desired information, yet long enough to get a reasonable amount of observations on fellings (in the area studied, owners of small properties may not even make final fellings in each decade). The future period was chosen shorter since is was assumed that the felling decisions, as well as the motivations for felling, would be hard to overview in detail for any longer period. In this survey, focus was on final fellings only and did not include thinning or clearing. This was explicitly explained to the respondents. The final part of the survey consisted of questions about the possession, use and evaluation of forest management plans. The aim of the questions about management plans was to evaluate to what extent such tools are used and how much they effect the felling decisions of the NIPF owners.

3. Results

3.1. The respondents

After sending one reminder the final response rate ended up at 52.6 %. There was no significant difference between the two counties concerning the response rate. Descriptive statistics of the respondents are shown in table 2. In total about one third of the respondents were women. The share of female respondents from Västernorrland was significantly higher than from Västerbotten. According to official statistics, 38.6 % of the NIPF owners in Västernorrland and 36.1 % of the NIPF owners in Västerbotten are women (Skogsstyrelsen, 2007). The lower share of women from Västerbotten is however not extreme and is not expected to affect the reliability severely. The respondents were asked to state their main occupation and these results are also shown in Table 2. Ownership length was significantly longer in Västerbotten. The average number of owners on each property was for

Västerbotten in line with official statistics, 1.7 owners in the survey and 1.6 owners according to statistics (Skogsstyrelsen, 2007). For Västernorrland, however, the result from the survey is significantly higher than the official statistics, 2.2 owners in the survey and 1.5 according to the statistics (Skogsstyrelsen, 2007). The reason for this difference for Västernorrland is unclear. In Västernorrland significantly more NIPF owners were also members in a NIPF owners association, compared to Västerbotten. Overall, a large share of the respondents had either a permanent or a leisure home on their forest property.

Table 2. Descriptive statistics of the respondents.

	Västerbotten	Västernorrland	Total	Standard deviation
Response rate (%)	54.7	50.5	52.6	
Share of females/males (%)	25.0*/75.0*	34.6*/65.4*	29.6/70.4	
Mean age (years)	59.7	59.1	59.4	11.9
Number of persons in household[a]/persons younger than 20 years	2.4/0.49	2.4/0.49	2.4 /0.49	1.08/0.93
Occupation[b] (% of respondents)				
Employed	47.0	47.1	47.1	
Retired	38.8	34.5	36.7	
Farming/Forestry	9.1	11.9	10.5	
Other business	8.4	10.5	9.4	
Other occupation	2.9	3.0	3.0	
Length of ownership (years)	24.1*	21.9*	23.0	12.9
Number of owners	1.7*	2.2*	2.0	1.7
Membership in NIPF owner association (%)	55.3*	68.2*	61.5	
Home (permanent or leisure) on property (%)	78.6	75.4	77.1	

* Indicates statistical significance at the 5 % level of confidence.
[a] Households of more than five persons are counted as five persons.
[b] Some respondents state more than one occupation which results in shares of more than 100 percent in total.

3.2. The NIPF properties

The mean land area of the NIPF holdings was 248.9 hectares of which 177.4 hectares[13] were productive forest land. The mean stock of timber on the properties was around 15,630 m^3 and the mean stock of timber per hectare was 91.6 m^3 (see Table 3). As can be seen in the table, the NIPF owners in Västerbotten had slightly larger properties in total, but somewhat smaller areas of productive forest land and smaller mean stocks of growing timber compared to the owners in Västernorrland. The difference was

[3] Productive forest land is defined as the land with a MAI of1 m^3/ha/yr or higher with normal management intensity.

probably due to the different locations of the two counties as mentioned in the *method* section.

Table 3. Characteristics of the respondents´ properties.

	Västerbotten	Västernorrland	Total
Total land area (ha)	251.4	245.9	248.9
Area of productive land (ha)	176.0	179.0	177.4
Stock of timber per ha (m^3)	81.5*	103.9*	91.6

* Indicates statistical significance at the 5 % level of confidence.

For both counties, the mean stock of timber according to the survey, was less than the mean stock on NIPF land according to the National Inventory of Forestry; 103 m^3/ha in Västerbotten and 157 m^3/ha in Västernorrland (Skogsstyrelsen, 2007). In this survey, the respondents were asked to state the volume of their forests. Some of them, it can be assumed, stated quite accurate figures, based on recent inventories, while others probably stated older figures or figures based on their best guesses. Plausible reasons for underestimating the stock of a property are that inventory data were old and recent growth was not accounted for, or the owner considered only older stands when answering the question about total stock.

3.3. Management objectives

A NIPF owner typically has several objectives associated to the ownership and management of his/her forest. Moreover, there are large variations among different NIPF owners in the set of and in particular the ranking of objectives (e.g. Carlén, 1990; Berlin et al., 2006). Theoretically, how a NIPF owner manages his/her forest depends to a large extent on the main objectives. Economic return and risk are relevant only if the forest owner actively manages the forest to obtain economic benefits. In order to form a picture of the ownership/ management objectives of NIPF owners in the study area, we asked in the survey each respondent to specify the three most important objectives of owning/managing the forest. A list of eight objectives was provided in the questionnaire. A respondent could choose from the list and/or specify any other objectives which he/she considered important.

Table 4 presents the objectives listed in the survey, together with the share of respondents who choose each of the objectives. The item “Other objectives” in Table 4 consists of all the objectives specified by the respondents. The survey shows that nearly 56 % of the respondents chose “economic contribution to the household” as one of their most important objectives. This figure is very close to the results of two earlier surveys of

NIPF owners' ranking/valuation of the benefits of forest ownership in Sweden (Carlén, 1990; Berlin et al., 2006).

Table 4. NIPF owners' objectives of ownership. Share of respondents who stated each objective as one of their objectives.

Objective	Share of respondents (%)	Active	Objective	Share of respondents (%)	Active
Economic contribution to the household	55.8	67.4*	Amenities around residence	24.7	50.2*
Keeping forestry tradition of the family	61.1	59.4	Conservation of biodiversity	15.1	55.0
Hunting opportunities	29.4	56.3	High timber stock	29.1	72.9*
Recreation (other than hunting)	24.5	45.4*	Other objectives	6.6	56.5
Quality leisure time activities	33.8	59.7	All with stated objectives		58.1

* Indicates statistical significance at the 5 % level of confidence.
[a] m^3 per hectare of productive forest land.

A majority of the respondents (61 %) stated that keeping the tradition of forestry within the family is one of the most important objectives. Carlén (1990) reported that about 25 % of the NIPF owners who responded to his survey chose the opportunity of keeping forestry tradition as one of the three most important benefits of forest ownership. Berlin et al. (2006) reported that 50 % of the respondent indicated that keeping forestry tradition was important or very important. In addition to the opportunity of keeping forestry tradition, the earlier surveys included another category of directly related benefits[14] which is not found in the list of objectives presented in our questionnaire. The respondents in our survey may have interpreted the objective "keeping forestry tradition" in such a way that it includes keeping contacts with native location and with relatives and friends. This is most likely the reason why this survey shows a larger share of the respondents who considered keeping forestry tradition as an

[14] Named "opportunity of keeping contacts with native location and with relatives and friends" (Carlén, 1990), or "maintain contact native locality" (Berlin, et al. 2006).

important objective. For each objective, the column Activity in Table 4 shows the share of all the owners with that objective that had been active in final fellings. It can be seen that NIPF owners with the objectives of economic contribution to the household and high timber stock had been significantly more active in fellings and that owners with the objectives recreation and amenities around the residence had been significantly less active in final fellings.

The share of the respondents who chose maintaining hunting-opportunities as one of the three most important objectives (29 %) is similar to what was reported in the other two studies (Carlén, 1990; Berlin et al., 2006). The shares of respondents who chose "recreation", "quality leisure time activities" and "amenities around residence" are 25 %, 33 %, and 25 %, respectively. In the survey reported in Carlén (1990), about 15 % of the respondents included "open air activities" in the three most highly ranked benefits from the forest. Berlin et al. (2006) showed that about 55 % of the respondents considered "outdoor life and recreation" important or very important benefits of forest ownership.

In the questionnaire we listed biodiversity conservation as one of the potential objectives the respondent could choose. Only 15 % of the respondents indicated that this is one of the three main objectives for them to own/manage the forest. In contrast to this, 29 % of the respondents selected high timber stock as one of the three most important objectives. From our personal experience we knew that there were NIPF owners in Sweden who were resolute in their efforts to build up a large growing stock of timber that can hardly be justified by a standard forest economics analysis. Some of the owners believe that timber assets are much more secure than financial assets. Some owners believe that a large growing stock of timber is an important indicator of good forest management. As to this survey, it is also possible that some of the respondents selected high timber stock as one of the main objectives because they consider that increasing the growing stock of timber is an important means to achieve some other objectives.

The results show that the overall structure of NIPF ownership/management objectives in Västerbotten and Västernorrland are similar to that for the whole country. Practically all NIPF owners own/manage their forests for multiple purposes. Income from forestry is one of the benefits that are highly prioritized by over half of the NIPF owners. Moreover, it should be emphasized that the other objectives, perhaps with the exception of biodiversity conservation, are to some extent compatible with the objective of making profits from the forest through timber production. This means that, for a majority of the NIPF owners, it is important to consider the return and risk of timber investment when making decisions on the management of their forests.

3.4 Timber harvest

For the convenience of expression, we will from here on refer to those NIPF owners who conducted final felling during the period 2001-2006 as *active owners*, and those who did not make any finial felling will be called *inactive owners*. It should be emphasized that here we are focusing on the final felling. An owner who is classified as inactive could very well have been active in conducting other forest management activities.

For the whole sample, 58.1 % of the respondents were active. On average, each active owner harvested 2,426 m^3 during the period 2001-2006. From Table 5 it can be seen that the active owners had a significantly larger area of productive forest land than the inactive owners. Interesting to note is that even though the active owners have conducted felling in the period 2001-2006 they have a larger mean growing stock of timber per ha than the inactive owners. Also, active owners are to a larger share members of NIPF owners associations than inactive owners.

Table 5. Property characteristics for the active and inactive groups. Fellings of the active group and shares of owners in NIPF owner association. Standard deviation in parenthesis.

	Active		Inactive	
Area of productive land (ha)	212.0*	(434.5)	105.1*	(103.5)
Stock of timber (m^3/ha)	94.1		87.8	
Membership in NIPF owner association (%)	69.9*		54.4*	

* Indicates statistical significance at the 5 % level of confidence.

Table 6 shows the main reasons the active owners in the respective counties for deciding to make final felling during 2001-2006. Three options were presented in the questionnaire, and each respondent was allowed to give more than one reason. The most common reason for conducting final felling was that *Stands were mature*. For the whole sample, 73.4 % of the active owners stated that this was one of the main reasons for conducting final felling during the period 2001-2006. A larger share of owners in Västernorrland motivated their harvest by this reason than in Västerbotten. Of the active owners in the two counties nearly 22 % stated that they conducted final felling because of the *Need for capital*. The share of owners in Västernorrland who gave this reason is significantly lower than in Västerbotten. That final felling was made in accordance with their forest

management plans[15] was stated by 18.7 % of the active owners. The share of active owners who harvested for other reasons is 7.8 %. Examples of *other reasons* for having made felling include: coordinated harvesting with neighbouring estates, and to prevent or salvage after damages.

Table 6. The main reasons stated by the active owners for having conducted final fellings. Figures show shares (%) of active owners stating each reason.

	Västerbotten	Västernorrland	Total
Fellings made according to forest management plan	19.4	17.9	18.7
Mature stands	69.8	77.1	73.4
Need for capital	25.4	18.7	21.8
Other reasons	7.5	8.1	7.8

The main reasons why the inactive owners did not make final felling are presented in Table 7. About one fourth of the inactive owners did not make any final felling in the period 2001-2006 because of the lack of mature stands. One third of the owners have mature stands which they have chosen to leave unharvested because they considered the standing timber stock was the best investment alternative. There are no significant differences between the two counties in the reasons stated by the inactive owners to why they have not made final fellings.

[15] A forest management plan contains details of the forest stands and recommendations of management decisions.

Table 7. Main reasons for not having conducted final fellings. The table shows shares (%) of inactive owners stating each reason.

	Västerbotten	Västernorrland	Total
No mature stands	22.6	28.2	24.9
Prohibited by law	1.8	2.7	2.1
Upcoming shift of ownership	13.1	10.1	11.9
Stand(s) regarded as best investment in the period	33.9	32.9	33.5
Stand(s) has aesthetical or recreational values	14.9	20.1	17.0
Other reasons	19.9	15.4	18.1

The respondents were also asked about their felling plans for the coming three years. Of the respondents, 46.5 % stated that they will harvest in the coming three years, 46.1 % stated that they will not, and 7.4 % were uncertain. There was a significant difference between the group of active owners and the group of inactive owners in the harvest plan for the coming three years. As Table 8 shows, slightly more than 50 % of the active owners planned to fell in the coming years, which is significantly higher than the share of inactive owners who had a plan to conduct final felling. Looking at the active group and comparing Table 8 with Tables 6 and 7, one can see that the reasons for planning to fell or planning not to fell in coming years are similarly distributed as the reasons for having felled or not having felled in period 2001-2006.

Table 8. The respondents' plans to fell and plans not to fell, and the reasons for the respective plans.

	active	inactive
Plans to fell	51.7*	38.7*
Why plan to fell?		
Time to fell according to management plan	20.8	21.3
Stands are mature	71.2	67.1
Need for capital	17.7	11.6
Other reason	9.4	8.4
Plans not to fell	39.7*	59.4*
Why plan not to fell?		
Stand(s) best investment in coming period	33.7	28.2
Prohibited by law	1.5	1.6
Upcoming shift of ownership	24.8	17.6
No mature stands	18.8*	28.2*
Stand(s) has aesthetical / recreational values	19.3	20.7
Other reasons	8.4	11.7
Don't know if to fell	8.6	11.6

* Indicates statistical significance at the 5 % level of confidence.

3.5 Attitudes toward risk

The survey contained two questions aimed to elicit information about NIPF owners' attitudes toward uncertainty in the monetary gains from forestry. The questions were formulated as follows:

Suppose that you have decided to carry out a final felling and sell the timber next year. Based on the timber prices in the past 10 years you have estimated that the market price of timber next year will fall in the interval 360-440 SEK/m^3 and the expected timber price is 400 SEK/m^3. Now, a

timber buyer offers to buy your timber at a fixed price of 400 SEK/m^3, to be paid when the harvest takes place one year later. You can either accept the offer, which means that you will receive a sure price of 400 SEK/m^3 for the timber felled next year, or wait to sell the timber at the prevailing timber price which lies in the interval 360-440 SEK/m^3.

> Question A: Would you prefer to accept the offer of a fixed price of 400 SEK/m^3, or would you rather wait and sell at the prevailing market price next year?
> Question B: If you can negotiate with the timber buyer on the fixed price, what is the lowest price you would require for agreeing to sign a contract and fix the price today?

The respondents were asked to answer question A by checking one of four alternatives: accept the offer, wait and sell at the market price, indifferent between the two alternatives, or do not know. Based on the answer to the first question, the respondents were divided into four groups: risk-averse, risk-neutral, risk-prone, and unsure owners. The group of risk-averse owners includes those who prefer to accept the offer and thereby avoid uncertainty in the harvest revenue. Risk-neutral owners are those who are indifferent between the two options. The third group, risk-prone owners, consists of those who prefer to wait and sell at the market price next year. The unsure group includes all respondents who stated that they did not know which of the options was better. An intuitively reasonable interpretation of such an answer is that the two options appeared to be almost equally desirable to the respondent, which means that a respondent who is unsure which of the options he/she prefers is risk-neutral. There are, however, other possible reasons why a respondent could not decide which option he/she prefers, and hence a respondent who did not know which was the preferred choice could be risk-averse or risk-neutral. For this reason, we listed the respondents who answered the first question by checking do not know in a separate group.

Table 9 presents the number of respondents in each risk preference group, together with some descriptive characteristics of the forest and the harvest activity/plan. The result shows that the largest group of respondents (39.6 %) was risk-prone, i.e. they stated that they would rather take the risk by waiting for the market price instead of accepting the fixed price of 400 SEK/m^3. The smallest group of respondents (16.0 %) was risk-averse – they displayed an aversion to taking the risk. About one-forth of the respondents were indifferent between the two options. With respect to the average area of productive forest land and the average timber per unit area, the differences between these three groups are small. It means that, in the current context, the size of forest property and the growing stock of timber

do not have any obvious impacts on the forest owner's attitudes toward risk. There are significant differences among the three groups in the share of owners who have conducted final felling during the past 6 years. The share of active owners within the risk-prone group is much higher than in the risk-neutral group, which in turn has a larger portion of active owners than the risk-averse group. The differences in the share of active owners suggest that a forest owner's attitudes toward risk had significant impacts on his/her final felling decision: the more a forest owner likes to take risks, the more likely that he/she conducts final felling. However, such a trend does not exist with respect the share of owners who planed to harvest in the coming 3 years.

Table 9. Number of respondens, average size of forest, and the share of active owners in different risk-preference groups.

	Risk-averse	Risk-neutral	Risk-prone	Unsure	Whole sample
Number of respondents	148	224	365	184	921
Mean area of productive land (ha)	151.7	151.1	166.7	102.4	149.5
Mean growing stock of timber (m^3/ha)	89.1	97.0	91.4	88.2	92.1
Share of active owners (%)	52.0	56.7	67.1*	45.7*	57.9
Share of owners who plan to fell in coming 3 years (%)	55.3	48.9	51.7	34.1*	48.1

* Indicates statistical significance at the 5 % level of confidence.

About 20% of the respondents fall into the group of unsure owners. On average, a respondent in the unsure group had a smaller area of productive forest land than respondents in the other groups. Compared to owners in the other three groups, a lower share of the unsure owners had conducted final felling in the past 6 years, and an even lower share planned to harvest in the coming 3 years. A plausible interpretation of the result is the following: owners in the unsure group were less experienced in comparing different selling strategies because they had not conducted final felling in the past years, alternatively they were less motivated to make the

comparison because they did not plan to harvest, than owners in the other groups. This could be one of the reasons why they stated that there did not know which option they preferred.

About one half of the respondents who answered question A answered also question B. The answers to question B are presented in Table 10. Theoretically, a respondent's answer to this question also reveals his/her attitudes toward risk. However, this question is more difficult to answer than question A, which is clearly indicated by the different numbers of respondents who answered these questions. The difficulty of question B implies that, in addition to a low response rate, the answers are more uncertain. Thus, this question is less suitable for the purpose of determining the attitudes to risk than question A. Our purpose of asking the respondents to answer question B is to examine the potential for the NIPF owners to make consistent choices involving uncertainty.

Given that the market price lies in the interval 360-440 SEK/m^3, it obviously does not make any sense for a NIPF owner to accept any price lower than 360 SEK/m^3, neither is it logical for a NIPF owner to reject a sure price of 440 SEK/m^3 and wait for the market price instead. A risk-averse owner, who stated that he/she would accept a sure price of 400 SEK/m^3 rather than waiting for an uncertain price in the interval 360-440 SEK/m^3, should be willing to accept a sure price within the interval 360-400 SEK/m^3. Similarly, for a risk-prone owner the lowest sure price which is more desirable than the uncertain market price must be greater than 400 SEK/m^3. The risk-neutral owners indicated that they were indifferent between accepting a sure price of 400 SEK/m^3 and waiting for an uncertain price in the interval 360-440 SEK/m^3. Clearly, a sure price which is lower than 400 SEK/m^3 could not be preferable to the uncertain market price for a risk-neutral owner. For risk-neutral owners, the lowest sure price that is preferable to the uncertain market price should be higher than 400 SEK/m^3. For an owner who did not know his/her preferences between a sure price of 400 SEK/m^3 and the uncertain market price, the lowest sure price that is preferable to the uncertain market price could be anywhere between 360 and 440 SEK/m^3.

Based on the above arguments and the result presented in Table 10, we can tell that 40 % of the answers to question B were (likely) consistent with the attitudes toward risk revealed in the answers to question A. About one forth of the answers is obviously inconsistent with the attitudes toward risk. And nearly one third of the respondents did not give a sensible answer: some of these respondents stated that they would accept a sure price lower than 360 SEK/m^3 instead waiting for the market price that is at least 360 SEK/m^3; others stated that a sure price could be the preferred choice only if it was greater than 440 SEK/m^3.

Table 10. Distribution of respondents over the lowest preferable sure price for different risk-preference groups.

Lowest preferable sure price (SEK/m^3)	Risk-averse	Risk-neutral	Risk-prone	Unsure	Sum
0 – 359	14	4	5	2	25
360- 399	13[a]	2	4	1[b]	20
400	69	29	35	6[b]	139
401-440	3	70[b]	113[a]	8[b]	194
>440	2	39	97	4	142
Sum	101	144	254	21	520

[a] Consistent with the answer to question A.
[b] Probably consistent with the answer to question A.

As pointed out earlier, question B is much more difficult to answer than question A. That a respondent did not give a reasonable answer to question B does not mean that he/she did not know the true answer to question A. However, an inconsistency between the answers to the two questions is a strong indication that the respondent was uncertain about the answers to both questions, or he/she answered the questions in an arbitrary manner. In either case, it is likely that the respondent failed to identify the truly preferred choice between the fixed price of 400 SEK/m^3 and the uncertain market price.

3.6. Perceptions of return and risk

With a mature forest stand (a stand in the final harvest stage), a forest owner can harvest the stand and invest part of the revenues somewhere outside forestry. He/she can also wait with harvesting the stand and keep the capital in the forest. Which option the forest owner chooses depends on, among other things, his/her perception of the returns and risks of the alternative investments. In this study we considered three investment alternatives outside forestry. These are the forest account[16], an ordinary

[16] The forest account is a special bank account which enables a NIPF owner to spread parts of his or her timber income from a particular year over the coming ten years, and thereby reduce his or her tax burden.

bank account, and a portfolio of stocks and bonds. For each alternative, the respondents were first asked to determine whether it gave a lower, equal or higher return as compared to the mature forest stand. Then they were asked to determine whether the risk of the investment was lower, equal or higher than the risk of the keeping capital in the mature stand. The active and inactive respondents' judgements of the return and risk are summarized in Table 11 and Table 12, respectively. The results show that the respondents hade widely different perceptions of the relative returns and risks of each investment alternative.

Table 11. Judgements of the return of three alternative investments relative to the mature forest. Share of active owners (AO) *and inactive owners* (IAO) *with different judgements.*

	Bank account		Forest account		Stocks/bonds	
	AO	IAO	AO	IAO	AO	IAO
Lower return	72.0	76.7	58	62.8	28	27
Equal return	23.4*	17.2*	33.5	28.7	21.2	25.7
Higher return	4.7	6.1	8.5	8.6	50.9	47.4

* Indicates statistical significance at the 5 % level of confidence.

A majority of the owners (over 70 %) displayed a belief that the ordinary bank account gave a lower return than the mature forest. About 20 % of the respondents believed that the return from the bank account was equal to the return from the mature forest. And about 5 % of the respondents stated that the return from the bank account was higher than the return from the mature forest. Compared to the ordinary bank account, a smaller share of the respondents believed that the forest account gave a lower return than the mature forest, and a larger share of the respondents believed that the return from the forest account is equal to or higher than the return from the mature forest. The result indicates that most of the respondents were aware of the fact that the forest account normally gives a rate of return than an ordinary bank account. Even so, a majority of the respondents believed that the mature forest outperformed the forest account in terms of the expected return.

About 50 % of the respondents believed that stock/bonds would give a higher return than the mature forest. Almost 30 % of the respondents stated that stocks and bonds gave lower return than the mature forests. The result is somewhat surprising, since the timber growth rate in mature forests

is generally very low. A possible explanation is that the respondents in general had very optimistic expectations about the development of timber prices in the foreseeable future. “Skogsbarometern 2006” (Gällstedt et. al., 2006) reported that there was a very optimistic view among NIPF owners about the timber prices during the next three years.

NIPF owners had widely different opinions about the risks of different investment alternatives. A majority of the respondents believed that the bank account as well as the forest account had a lower risk than the mature forest. However, a much larger share of the respondents believed that the bank account had a higher risk than the mature forest, as compared to the share of respondents who believed that the risk of investment in the forest account is higher than the mature forest. This difference is difficult to explain. Table 12 shows that about 85 % of the respondents believed that investment in stocks or bonds was more risky than keeping the capital in the mature forest. At the same time about 4 % of the respondents believed that the risk involved in stocks and bonds was lower than in the mature forest.

Table 12. Judgements of the risk of three alternative investments relative to the mature forest. Share of active owners (AO) *and inactive owners* (IAO) *with different judgments.*

	Bank account		Forest account		Stocks/bonds	
	AO	IAO	AO	IAO	AO	IAO
Lower risk	40.2	38.4	59.3	54.1	4.1	3.7
Equal risk	41.0	39.4	30.7	33.6	9.5	11.8
Higher risk	18.8	22.2	10.0	12.3	86.4	84.4

In the survey we did not specify what the mature forest looked like. Even if we did, the respondents may still have quite different opinions about the return and risk of the mature forest, due to different perceptions of the biological and economic factors that affect the return and risk of the mature forest. The differences in the judgments of the return and risk of the mature forest among the respondents would have contributed to the different beliefs about the relative return and risk of the alternative investments. However, the widely different perceptions of the return and risk of each investment alternative indicate that NIPF owners make different judgements about the return and risk of investment outside forestry.

3.7 Impacts on harvest intensity

In order to examine the impacts of uncertainty on the final felling decision, we identified the preferred investment alternative for each respondent based on his/her attitudes toward risk and on his/her judgement

of the relative return and risk of different alternatives. For example, if a respondent displayed an aversion to taking risks, and at the same time believed that the bank account gave a higher or equal return but a lower risk than the mature forest, then the bank account is preferred to the mature forest. Since we are interested in examining the impact of uncertainty on the final harvest decision, what is important is whether a NIPF owner prefers to keep the capital in the forest or to harvest the forest and invest in some of the alternatives. If a NIPF owner prefers one of the three alternatives to the mature forest, then we say that the preferred investment is outside forestry. If none of the three alternatives outside forestry is preferred to the mature forest, then his/her preferred investment alternative is the mature forest. A third possibility is that, based on a forest owner's attitudes toward risk and his/her perceptions of returns and risks, we can not determine if (some of) the alternatives outside forestry is preferred to the mature forest. In that case, we say that the preferred alternative is indecisive.

According to the preferred investment alternative we grouped the respondents into three groups. Figure 2 presents the growing stock of timber per ha of productive forest land for NIPF owners with different preferred investment alternatives. Intuitively, forest owners who prefer the mature forest to the investment alternatives outside forestry are less likely to conduct final felling than those whose preferred investment alternative is indecisive. And forest owners with indecisive investment alternative are less likely to conduct final felling than owners who prefer one of the investment alternatives outside forestry to the mature forest. Thus, we would expect forest owners whose preferred investment is the mature forest to have a larger growing stock of timber per ha than those whose preferred investment is indecisive, and the latter group of owners to have a larger growing stock of timber per ha than those who prefer an investment outside forestry. The result presented in Figure 2 displays a very weak, statistically insignificant, correlation between the average growing stock of timber per ha and the preferred investment alternative.

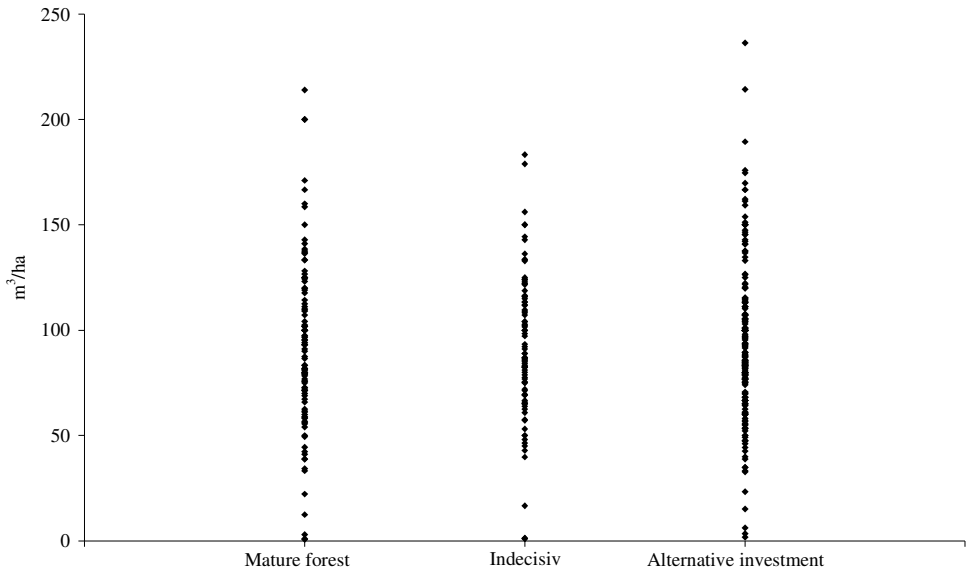

Figure 2. The growing stock of timber (m^3/ha) on productive forest land. Respondents are grouped according to their preferred investment.

Figure 2 shows that there are great variations in the growing stock of timber per ha among the respondents within each group. It means that there are other factors (in addition to the harvest intensity) that affect the growing stock of timber. Therefore, even if the preferred investment alternative has significant impacts on the harvest intensity, it may happen that such effects can not be identified by examining the growing stock of timber.

Table 13 shows the share of owners with different preferred investment alternatives and also the area of productive land, the growing stock of timber, and the share of owners who conducted/planned to conduct felling activities for each owner group. For the active owners, we calculated the volume felled per hectare of productive forest land (i.e. the total volume a forest owner felled during the past 6 years divided by the area of his/her productive land and divided by 6 to get the annual volume) as a measure of the harvest intensity. ANOVA shows that there are no significant differences between the owner groups with respect to the mean areas of productive land and the mean growing stocks of timber per hectare. The share of active owners among those who preferred the mature forest to the other investment alternatives is lower than in the other groups. The average harvest volume per ha productive land is also lower for the active owners whose preferred investment alternative is the mature forest than owners with other preferences over the investment alternatives. The result suggests that on average NIPF owners who prefer the mature forest to other investment alternatives harvest less intensively than owners in the other groups.

Table 13. Owners with different preferred investments, area of productive forest land, growing stock of timber, and felling activities.

	Mature forest	Indecisive	Alternative investment	All with preferred investment
Share of respondents (%)	26.3	25.6	48.1	
Area of productive land (ha)	127.4	169.2	172.4	149.6
Growing stock of timber (m^3/ha)	92.0	91.8	92.4	92.1
Share of active owners (%)	54.3	64.6	62.8	57.9
Annual volume felled per ha of productive land (Standard deviation in parenthesis)	2.60 (5.44)	2.77 (6.05)	2.73 (4.51)	2.71 (5.12)
Share of owners who plan to fell in coming period (%)	49.7	50.9	53.2	48.1

The felling per hectare of productive forest land of each respondent for the whole period 2001-2006 is plotted in figure 3 below. The figure shows, although weakly, a positive correlation between increased felling per hectare and preference for some of the alternative investments. There is also a positive relationship between preference for the alternative investments and having been active in final fellings in the period surveyed.

In table 14, active and inactive owners are shown after risk-preference and preferred investment. In the risk-averse group, the share that has preference for some of the alternative investments is significantly lower than the share among all respondents that have a preferred investment. Even though not statistically significant from the overall mean, the risk-averse group has the highest share of owners with preference for the mature forest. The table also shows that the risk-prone group has the highest share of owner with preference for some of the alternative investments.

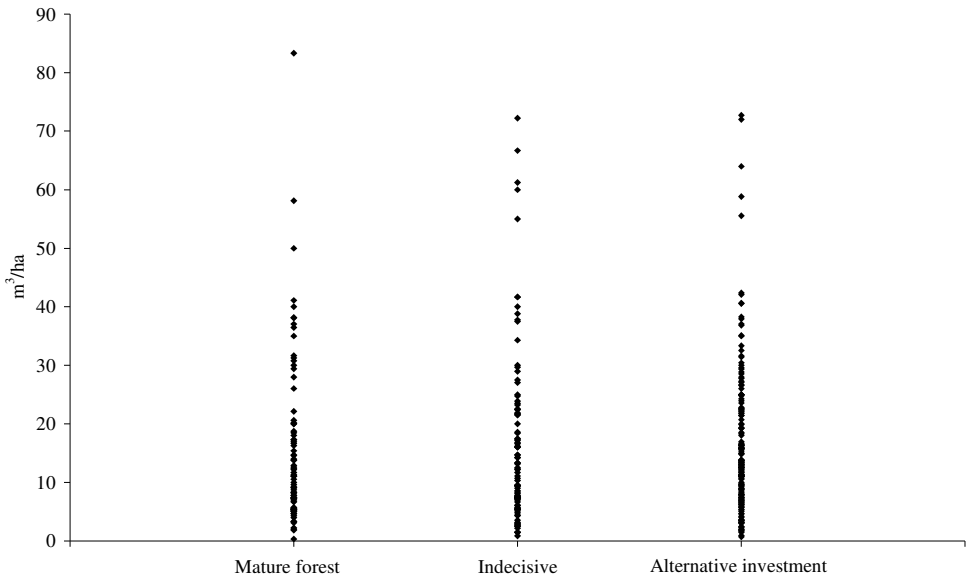

Figure 3. Fellings per hectare of productive forest land. Respondents are grouped after their preferred investment.

Table 14. The shares (%) of owners in each of the risk preference groups having been active and inactive, reported after preferred investment. Risk-averse owners are 130, risk-neutral owners are 215, and risk-prone owners are 335 respondents in total.

		Active	Inactive	Total
	Preferred investment			
Risk preference	Mature forest	14.6 *	17.7 *	32.3
Risk-averse	Indecisive	27.7	19.2	46.9*
	Alternative investment	12.2	9.1	20.7*
	Mature forest	8.4*	14.9 *	23.3
Risk-neutral	Indecisive	16.7	9.3	26.0
	Alternative investment	31.6	19.1	50.7
	Mature forest	17.6	7.8	25.4
Risk-prone	Indecisive	12.2	5.1	17.3*
	Alternative investment	36.4	20.9	57.3*
	Mature forest	15.9	10.1	26.0
All with preferred investment	Indecisive	16.0	9.7	25.7
	Alternative investment	29.4	18.8	48.2

* Indicates statistical significance at the 5 % level of confidence.

4. Summary and Discussion

In this paper we report a study on NIPF owners' risk preferences and their assessments of the return and the risk of alternative investments relative to keeping mature forests standing. We also study the relationship between the risk preferences, the assessments of the return and risk, and the felling activities conducted by the NIPF owners. Our starting point is that the subjective judgements made by NIPF owners about the return and risk of different investment alternatives, together with their risk preferences influence their decisions. Our aim is to acquire a better understanding of the reasons why NIPF owner characteristics affect their behaviour.

The assessments of the return and risk in the mature forest relative to alternative investments vary widely among the respondents. The results show that a majority of both active and inactive owners assessed that a mature forest stand gave a higher return than a forest account or an ordinary bank account, and a rather large share of the owners believed that a mature forest gave a higher return than the stocks and bonds as well. One factor that may have affected the respondents to appreciate the return from the mature forest is a strong belief in rising timber prices in the next few years. In our survey, we do not give the respondents any definition of the term risk since we are more interested in the effects of what he or she perceives as the risk. The results from the assessments of risk show that a majority of both the active group and the inactive group associates the forest account with lower risk and a vast majority associate stocks and bonds with higher risk compared to mature forest.

Our study showed that almost half of the NIPF owners were risk-prone, which might seem to be a rather large share. Only a unit price was mentioned in the survey and if the respondent regarded this as the total amount at stake it is possible that he or she took a more gambling attitude. However, a large share of NIPF owners being risk-prone was also found by Lönnstedt & Svensson (2000) who in addition found that NIPF owners showed decreasing absolute and relative risk aversion. Our result showed that the NIPF owners risk preference had significant impacts on the decision to fell timber. The owners who were risk-prone were significantly more active in final fellings than the other groups.

When sorting the respondents into groups after their preferred investment, it was found that the largest group was the one with preference for one of the alternative investments. This group and the group with indecisive preference had higher shares of active owners than the group of owners with preference for the mature forest. The result indicates that preference for mature forest as investment increases the length of the intervals between fellings and also makes the owner fell less on each occasion. It was further found that risk-averse owners tend to prefer keeping

capital in the mature forest to a larger extent than the other risk preference groups, while risk-neutral and risk-prone tend to move capital to some alternative investment to a larger extent. This tendency is particularly strong for the risk-prone owners.

When it comes to the consistency between preferences and management behaviour, the results show that the management differs between groups of owners with different preferences. If we for simplicity assume that there are only two types of risk-preference among NIPF owners, risk-averse and risk-prone, we can say that consistency between preferences and management can be fulfilled both in the case when management activities are the same in both groups, and when they differ. If both groups prefer to keep mature forests, their behaviours are consistent with their preferences if the risk-averse group judges the forest as less risky and the risk-prone group judges the forest more risky, than the alternative investments. If the two groups, however, makes the same judgements about the risks, their management behaviour must differ in order to achieve consistency between preferences and judgements. The result of our study implies the latter situation, where the groups show differences in the management behaviour. It should be pointed out that the result is not a sufficient condition for consistency, there is still the possibility that neither group is managing their forests consistently with their preferences.

Awareness of the many different assessments and preferences might give the NIPF owner reason to reassess his or her assessment. Many forest owners would benefit by more actively thinking of their forests in terms of investments and evaluate whether this investment, or some other investment, is the type that best corresponds to their preferences. In the valuation of how consistent the forest investment is to the preferences of the NIPF owner, clearly other properties than the risk and return, such as all the non-timber benefits, must also be included. This clearly complicates the process, but the process would benefit from more objective information about the risks involved with forest investments. Here is also need for policy makers to consider how to provide as objective information as possible to the NIPF owners.

A NIPF owner should be aware of the objectives and reasons underlying their forest management. Ideally, the NIPF owner should consider what benefits and risks he or she wants. But it might be that he or she listens to advice of others, or tries to achieve a management that he or she has perceived as the most socially acceptable. NIPF owners who to a large degree base their management decisions on advice from others must make sure that their own preferences are consistent with the management proposed by their advisors. If not, they should not listen to the advices given to them. With awareness of the variety in judgements and preferences, the NIPF owner could more independently decide the best management for him

or herself. NIPF owners should also ideally be willing to continuously re-evaluate the risk and return of their forest stands. The risk and return of the forest stand is not constant over time.

As mentioned, the results imply a need for policy-makers to provide information to NIPF owners concerning the risk and return in the forest investment in order to aid them in making their optimal allocations. Policy-makers should also be aware of the heterogeneity in both the assessments of risk and return and the risk-preferences. If the policy maker has the objective in influencing the management behaviour of NIPF owners, the policy maker must be aware of that the use of any single policy instrument may have different effects on different types of owners. Considering that NIPF owners have different preferred investments, policy makers might need to provide more information about the management alternatives to the NIPF owners. Also, the policy makers would need more information on how owners can be expected to react to different policy implementations.

Our result shows that whenever possible, research on NIPF owners should be conducted in a way allowing other preferences than risk-neutrality. The risk-preferences' effect on the decision to fell implied that more research is needed on the mechanisms underlying the risk-preferences. Many studies have found significant correlations between owner characteristics and management behaviour. We believe that further studies on risk-preferences will give insights to how owner characteristics might form risk-preferences, which in turn affect the decision to conduct final felling. Also, more research could reveal how risk-preferences affect other management activities than final fellings. To continue that investigation on the consistency between preferences and behaviour we believe that studying how revenues from NIPF fellings are invested is one possible way.

It should be emphasised that we do not regard the different objectives, judgments and preferences among NIPF owners per se as problematic. Rather that the variety of attitudes and perceptions might not be sufficiently reflected in their management behaviour. That every NIPF owner manages his or her forest in accordance with their objectives and preferences is a necessary condition for achieving a socially optimal forest management.

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