



DETERMINANTS OF FOREST ACTIVITIES — A STUDY OF PRIVATE NONINDUSTRIAL FORESTRY IN NORWAY

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ABSTRACT

This study reports on the main findings of an analysis of the effects on various forest activities of subsidies to silvicultural work, management plans and road building. It is an exploratory microeconomic study based on Norwegian census-data for 1988 for about 41,500 properties. The results suggest that the means generally have a positive effect both on timber supply and various silvicultural activities. Some findings are also obtained on the effects of property- and property-owner characteristics, as well as on second order interaction term effects of management plan on one hand and other means and property- and property-owner characteristics on the other.

Keywords: Forest policy, private nonindustrial forestry, timber supply, silvicultural activities.

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INTRODUCTION

The main purpose of this paper is to report on the findings of an analysis of the effects of three policy means used in the implementation of Norwegian forest policy.¹ In a central government white paper to the Norwegian parliament, different main goals of the forest policy are presented.² They partly aim at a regional redistribution by means of the forest activities, partly they concern optimal forest resource utilization, and partly they focus on stable and reliable timber supply both in the short and in the long run. Of special concern in these contexts is the cut/growth-ratio which is

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¹ Further details are presented in Ringstad, Løyland & Øy (1994).

² Cf. Stortingsmelding (white paper) no. 18, 1984–85.

a rough indicator of the degree of forest resource utilization.³

In Norwegian forest policy a wide variety of means are used (Baardsen, 1991). The empirical basis used in this study allows us to study only some of the means, namely subsidies to silvicultural activities, forest management planning and road building. They are evaluated by trying to identify their effects on four different goals and goals-related magnitudes; cut for sale (timber supply), thinning, planting and seeding activities and young growth tending activities. The data used do also contain information about property- and property-owner characteristics. These are also likely to affect the goal — measures — and they are included in our analysis mainly to avoid missing variable-biases in the estimated effects of the forest policy measures. They do, however, also allow new testing of hypotheses explored in several previous studies, as well as testing of some hypotheses which, as far as we know, have not (so far) been investigated empirically. This concern in particular interaction effects between policy-measures and property- and property-owner characteristics.

PREVIOUS ANALYSES AND THE MEANS EVALUATED

Central governmental forest policy has a long tradition in Norway. Between 1850 and 1860 the first public transfers to private non-industrial forest owners were introduced. Subsidies to silvicultural activities came in 1931, subsidies to road building in 1933 and finally subsidies to forest management planning were introduced in 1971 (Baardsen, 1991). The purposes of the different policy means have changed during time, especially for the two introduced in the thirties. Originally, they were triggered off by the high unemployment in this period. They have, however, also been aimed at increasing the timber supply, but this goal was relatively unimportant in the start. Later, as unemployment decreased, the assumed timber supply-effect became the main issue. The main purpose of subsidising forest management planning has been the same since the start:

³ During the period from 1989 to 1993, the cut was about two thirds of the growth, cf. Tomter (1994).

Increased roundwood cut and silvicultural activities in order to ensure a high and stable short and long run timber supply. Later on, environmental and wildlife considerations have been added.

The approximate amount spent in 1988 on the three groups of means (with their share of total gross value of roundwood cut for sale in parentheses) was (Baardsen, 1991); 115 mill. NOK on silvicultural activities (3,3%), 100 mill. NOK on road building in private hold forest (2,9%) and 28 mill. NOK on forest management planning (0,8%)

In spite of the long history of, and the relatively large amounts spent on, these policy means, there has been carried out few evaluations of their effects. Tufte & Tømmerås (1976) analysed the effects of the rate of silvicultural subsidies on the extent of silvicultural activities. They did not, however, find any significantly positive effect. Neither did Nyberger & Aakre (1991) in their analysis based on time series data.

In other countries several related studies have been carried out. For instance, Brännlund, Göransson & Löfgren (1985) analysed the effects of subsidised regenerational measures on the short-run supply of roundwood in Sweden. They found that the subsidies had a significantly *negative* effect on the short-run supply of sawtimber and a negative, but not significant effect on short-run supply of pulpwood. This, rather surprising result, is explained by time inconsistency in the central government forest policy.⁴

The effects of forest management planning are evaluated in several Norwegian studies. Nersten (1975), Høsteland (1978), Ringstad (1991) and Rørstad & Solberg (1992) do all find a significantly positive effect of this means. Selfselection bias, however, causes identification problems in these studies. "High quality" properties and property owners are more likely to have a forest management plan than others and a management plan variable therefore is likely to select systematically units with a high level of forest activities. Thus, the estimated effects of the forest management plan are likely to be biased upwards. This problem is also present in the analysis presented here.

⁴ For further discussions, cf. Löfgren (1986) and Brännlund (1990).

The effects of road building are evaluated in some Norwegian studies, but they mainly focus on whether or not the roads would have been built without the subsidies. Egeberg (1975) find that these subsidies are important in this respect.

RELATIONS AND ESTIMATION METHODS

We assume the following relationship:

$$X = f(M, Y, Z) \quad (1)$$

where X is a vector of forest policy goals -, or goal-related magnitudes, M is a policy means vector, Y is a vector of property-owner characteristics (age, education etc.) and Z is a vector of property characteristics (inventory, productive forest area etc.). We assume that for a particular period the property-owner makes a two stage decision: *Whether or not* to carry out a certain forest activity. *And if so* he *then* determines the level of the activity concerned.

Following Fischer (1962), we assume that the decisions at both stages are determined by the same set of explanatory variables, but the effect of a variable may be quite different at the two stages.⁵ Thus we have:

$$\text{First stage:} \quad \text{Prob}(X > 0) = f_1(M, Y, Z) \quad (2)$$

$$\text{Second stage:} \quad (X | X > 0) = f_2(M, Y, Z) \quad (3)$$

This framework can easily be combined with *the twin linear probability model* (Fischer, 1962 and Goldberger, 1964) where both stages are estimated by ordinary least squares, or an improvement of this model described by Cragg (1971). The latter estimate the first stage by means of the *probit* technique and thus avoids some obvious problems present in the linear probability model.⁶ In our analysis we use the

⁵ Fischer (1962) applied the two-stage decision framework in the study of consumer durable goods expenditures.

⁶ For further readings on the problems with the linear probability model, cf. Maddala (1983).

Cragg-modification and assume a normal distribution of the error term which imply that a normit model is employed.⁷

DATA AND VARIABLE DEFINITIONS

The information used is collected from the 1989 Norwegian Census of Agriculture and Forestry. The census covers a total of about 183,100 agricultural properties, and the information provided is for 1988. We have selected individual non-industrial forest owners — properties⁸ with at least 25 ha. productive forest area. We have excluded some units which turned out to have incomplete information on one or more variables. All in all we end up with a sample of 41,505 units. Information about a regionally differentiated subsidy for silvicultural activities is added to the data, cf. later.

The X -vector consists of one timber supply variable, two silvicultural activities and one which is both, namely cut from thinning:

$\ln(C_s)$: Timber supply; roundwood cut for sale during the census year, measured in cubic metres (m^3) solid wood.

$\ln(C_t)$: Cut from thinning measured in m^3 .

PS : Planting and seeding activities measured as the share of planted and seeded area in the total of all productive forest area.

GT : Young growth tending activities measured as the share of young growth tended area in the total of all productive forest area.

This makes one of the two sets of dependent variables. The second consists of a corresponding set of binary variables:

$$D_X = \begin{cases} 1 & \text{if } X > 0, \\ 0 & \text{otherwise.} \end{cases}$$

$$X = C_s, C_t, PS, GT.$$

⁷ We use the term probit model for a family of non-linear regression models, consisting of e.g. the normit, logit or gompit specifications depending on the assumptions made about the distribution properties of the error term (cf. for instance Maddala, 1989, section 8.9).

⁸ 96% of the properties belong to this group of ownership.

The *M*-vector contains three elements:

SS: This variable is a regionally differentiated subsidy for silvicultural activities added to the census-data. The variable measures the share in total costs of planting and seeding and young growth tending covered by the central government. The subsidy rate is differentiated in the same way for the two activities, except for the central forest districts in the south-eastern part of Norway. In this part of the country, forest owners did not receive any subsidy for planting and seeding activities in 1988, while they got a 25% subsidy of the costs of young growth tending activities. In our calculations *SS* is measured as the former. Thus $SS = 0$ in the central forest districts. Outside these districts in the south eastern parts of the country *SS* varies between 25 and 50%. Owners in the counties in Western Norway and in Trøndelag obtain 40–60%, while those in the three counties in Northern Norway obtain 65–70%.

$$MP = \begin{cases} 1 & \text{for properties with a forest management plan,} \\ 0 & \text{for others.} \end{cases}$$

The forest management plan is heavily subsidised and obviously affect the likelihood of acquiring a management plan.

SR: This variable measure the truck and tractor road density on the property by road kilometres per square kilometres productive forest area. (Forest road building is heavily subsidised, and as demonstrated by a study by Egeberg, 1975 this (not unexpectedly) stimulates the road-building activities.)

The *Y*-vector contains following characteristics:

$$WP = \begin{cases} 1 & \text{if owner and/or owner family member is} \\ & \text{working (part- or fulltime) outside the property,} \\ 0 & \text{otherwise.} \end{cases}$$

YC: The number of years with roundwood cut the last four years preceding the census year.

$$LP = \begin{cases} 1 & \text{if the owner lives at the property,} \\ 0 & \text{otherwise.} \end{cases}$$

$$AT = \begin{cases} 1 & \text{if at least one person has agrivocational training,} \\ 0 & \text{otherwise.} \end{cases}$$

AG: The age of the property owner.

The **Z**-vector contains:

$\ln(I)$: Investments in new buildings, reconstructions of old buildings, machines and other dead stock, with subtraction of any sales of the dead capital stock, in 1 000 NOK.

$\ln(A)$: The productive forest area in ha.

$\ln(B/A)$: Indicator of the *quality* of the property, measured by the property's *balance quantity* (B) in relation to total productive forest area. B is measured in cubic metres solid wood.⁹

To explore any interaction effects between policy-measures, and between policy measures on one hand and property- and property-owner characteristics on the other, we introduce a selection of second order interaction terms. We limit our analysis to possible interaction between MP on one hand, and the other means and a selection of property- and property-owner characteristics on the other. Thus we introduce the variables:

$$IA_J = MP^*J \quad (J = SS, SR, WP, AT, AG, \ln(A))$$

Moreover, we limit the analysis to the effects on timber supply.

HYPOTHESES AND FINDINGS

Results for the first order effects (i.e. when no interaction variables are included), are presented in Table 1. The main hypotheses and findings can be summarised in the following way:

- The subsidy of silvicultural activities has two main aims: to *increase*, and to *level out* regional differences in these activities as well as in timber supply. Our results suggest that

⁹ *Balance quantity* is a shorter description of *maximum non-declining felling path*. Cf. for instance Eid (1992).

the subsidy more than level out the regional differences in the likelihood of planting and seeding activities, while the regional differences in the level of these activities seem to be approximately eliminated by the subsidy. Obviously this is likely to have a positive long-run effect on timber supply.

- The purpose of the management plan is to stimulate all types of forest activities covered in this study. Thus we would expect *MP* to have a significantly positive effect on all dependent variables. This is confirmed by our results except that the effect on the probability to thin is significantly negative. This finding could be explained by the possible profitability of concentrating the thinning activities, and the management plan making it easier to evaluate the economy of this concentration.
- We would also expect the road density of the property to affect all goals-measures positively. This is also confirmed by our results even if they quite likely overstate these effects: High level of forest activities (for some reason), demands high road density.

Thus according to our findings the means investigated generally have an impact on the goals as expected. We do not have the data necessary to carry out more interesting types of evaluation, however, such as efficiency-evaluation (the cost-efficiency of the means, and which means is more cost-efficient) or cost-benefit analysis (whether or not a means implies (or all forest policy means together imply)) bigger benefits than costs, thus contributing to a bigger social surplus from Norwegian forestry.

We have also obtained some interesting findings of first-order effects of property- and property-owner characteristics, of which we would like to point out the following:

- Work outside the property (*WP*) is likely to have two effects on the forest activities; both negative: First there is an income effect; income from outside sources implies less economic importance of the forest resources. Second, there is a time-budget effect; less time is available for work on the property. The results for the timber supply confirm our hypothesis. The results for cut from thinning could also be considered consistent with it; the time budget makes it necessary to spread this work over time, with a lower level of

TABLE 1. POLICY GOALS

Effects of forest policy means and property- and property-owner characteristics on forest policy goals.*

INDEP. VARIAB.	DEPENDENT VARIABLES							
	D_{Cs}	$\ln(C_s C_s>0)$	D_{Ct}	$\ln(C_t C_t>0)$	D_{PS}	$PS PS>0$	D_{GT}	$GT GT>0$
SS	-0.4688 (0.033)	-1.1840 (0.031)	-0.7914 (0.030)	-0.7489 (0.040)	0.2451 (0.033)	+	-0.5135 (0.033)	-0.5931 (0.196)
MP	0.1597 (0.016)	0.2227 (0.015)	—	0.0870 (0.020)	0.2169 (0.016)	+	0.1087 (0.016)	0.2219 (0.0196)
SR	0.0049 (0.0003)	0.0017 (0.0002)	0.0022 (0.0002)	0.0032 (0.0003)	0.0030 (0.0002)	0.0039 (0.0008)	0.0041 (0.0002)	0.0071 (0.096)
WP	-0.0484 (0.016)	-0.0504 (0.015)	0.0284 (0.014)	-0.0622 (0.019)	+	+	0.0748 (0.016)	+
YC	0.3823 (0.005)	0.0494 (0.005)	—	0.1149 (0.006)	0.2718 (0.005)	-0.1558 (0.018)	0.1823 (0.005)	-0.1383 (0.033)
LP	0.2048 (0.019)	-0.1756 (0.020)	0.4085 (0.018)	-0.0531 (0.025)	0.0995 (0.020)	-0.2644 (0.071)	0.0535 (0.021)	-0.4099 (0.127)
AT	0.1304 (0.016)	0.0366 (0.014)	0.0733 (0.014)	0.1152 (0.019)	0.1967 (0.015)	—	0.1967 (0.016)	+
AG	-0.0042 (0.0006)	-0.0046 (0.0006)	0.0019 (0.0005)	—	—	-0.0120 (0.002)	+	+
$\ln(I)$	0.0426 (0.004)	0.0163 (0.003)	0.0130 (0.003)	0.0233 (0.004)	0.0263 (0.004)	0.0414 (0.011)	0.0244 (0.004)	0.0502 (0.021)
$\ln(A)$	0.2844 (0.012)	0.7745 (0.009)	0.0642 (0.009)	0.5123 (0.012)	0.2101 (0.010)	-0.7734 (0.030)	0.1996 (0.011)	-1.1382 (0.054)
$\ln(B/A)$	0.2118 (0.012)	0.5460 (0.013)	-0.0417 (0.011)	0.1800 (0.014)	0.1863 (0.013)	0.2219 (0.045)	0.1514 (0.013)	0.2479 (0.084)
Log-L	-19153.56		-26609.82		-20306.56		-18792.62	
R ²	0.44		0.33		0.09		0.07	

* The D_x and X -equations ($X = \ln C_s, \ln C_t, PS, GT$) are estimated by normit analysis and ordinary least squares, respectively. Standard errors in parentheses. In the results presentation we follow the same procedure as used by Griliches and Ringstad (1971): Estimates with corresponding parameters not significant at the 5% level are presented with their signs only. Wald-tests and t-tests are applied to the parameters in the D_x and X -equations, respectively.

DEPENDENT VARIABLES:

D_{Cs} : 1 if roundwood cut for sale, 0 otherwise. $\ln(C_s)$: Roundwood cut for sale (m³). D_{Ct} : 1 if cut from thinning, 0 otherwise. $\ln(C_t)$: Cut from thinning (m³). D_{PS} : 1 if planting and seeding activities are carried out, 0 otherwise. PS : Area with planting and seeding activities as a share in productive forest area. D_{GT} : 1 if young growth tending activities are carried out, 0 otherwise. GT : Area with young growth tending activities as a share in productive forest area.

INDEPENDENT VARIABLES:

SS: Regional differentiated subsidy for silvicultural activities MP: 1 for properties with a forest management plan, 0 for others. SR: Truck and tractor road density on the property in kilometres per square kilometer productive forest area. WP: 1 if the owner and/or owner-family members is working (part- or fulltime) outside the property, 0 otherwise. YC: No. of years with cut for sale the last four years. LP: 1 if the owner lives at the property, 0 otherwise. AT: 1 if at least one person in the owner-family has agrivocational training. AG: Age of the owner. $\ln(I)$: Net investments in dead capital stock at the property. $\ln(A)$: Productive forest area (ha.). $\ln(B)$: Balance quantity (m³).

activity than what would otherwise be the case.

- Number of years with roundwood cut the last four years preceding the census year (YC) could also have two effects; one positive and one negative. The positive one is based on an assumption of a difference in attitude among the owners. Some are more active and utilize the forest resources regularly. More years of the four previous years with cut for sale suggest an active owner with a high probability of forest activities, and a high level of these activities also in the census-year. This could be called the "active-owner effect". The negative effect could be called the "reduced stock-effect". High timber supply the previous years reduces the forest capital stock available for cut in the census year. This implies a negative effect, at least on timber supply.

Our results suggest that the *active-owner effect* is bigger than the "reduced-stock effect". The results also suggest a substantial difference between property-owners concerning the concentration/spread of silvicultural activities. The data do not allow a further exploration of the possible causes of these differences, however.

- Owners not living on the property could be different *on the average* from those who do, and thus are likely to behave differently concerning the forest activities analysed here. If so, this should be reflected in the effects of *LP*. We have, however, no results from other analyses or any auxiliary information on which to base more specific hypotheses.

Our results suggest strongly that systematic differences really are present. Moreover, while the effect of *LP* on the *inclination* to carry out an activity is significantly *positive* for all activities, they are *negative*, and significant on the *level* of these activities. We are not able to do more than suggest tentative explanations *ex post* on these findings. The most likely one is that owners living on the property are more inclined to carry out the forest activities themselves. The time budget constraint implies a spread over time of these activities. For owners not living on the property it is likely to be more convenient to concentrate the activities, possibly to a large extent with hired labor, and have a correspondingly higher level of activity when the activities are actually carried out. The results for YC seem

to support this hypothesis. We have not been able to explore this hypothesis further, however.

- Some other studies suggest that the age of the owner has a negative impact on the timber supply.¹⁰ This is confirmed by our results.
- We would expect a significantly positive *change-of-capital-portfolio* effect of $\ln(I)$ on timber supply — as is also confirmed. The other results for $\ln(I)$ are somewhat intriguing since it does also — for no obvious reasons — have a significantly positive effect on the other dependent variables. It could be due to an “active owner” effect. If so, this factor should be considered as a property owner characteristic rather than a property characteristic as done here. It does also imply that the estimated effect on the probability and level of cut for sale is not a pure change-of-capital-portfolio effect.
- The main reason for including the productive forest area $\ln(A)$ is to net out the effect of *size* in the estimates on the effects of the other independent variables. For obvious reasons we expect both the probability and level of cut (both for sale and from thinning) to be strongly and positively affected by size — as is also demonstrated to be the case in Table 1. It does also, as expected affect positively the probability of the other two silvicultural activities, while the level of these activities are affected negatively. This is quite reasonable, the way these variables are measured (as the shares the areas with such activities make of the total) taken into account.
- As expected the quality of the property — variable $\ln(B/A)$ — has (with one exception) a significantly positive effect on all forest activities studied.

We have made a small selection among all interaction effects which could be analysed on the basis of our data. We have limited this part of the analysis to interaction between management plan on one hand and the other means, and a selection of the other independent variables on the other. Moreover, only the effects on timber supply are explored.

¹⁰ Cf. for instance Rørstad & Solberg (1992).

TABLE 2. ROUNDWOOD CUT

*Results for interaction effect on roundwood cut.**

INDEPENDENT VARIABLES	DEPENDENT VARIABLES					
	D_{Cs}	$\ln(C_s C_s>0)$	D_{Cs}	$\ln(C_s C_s>0)$	D_{Cs}	$\ln(C_s C_s>0)$
SS	-0.4714 (0.034)	-1.1839 (0.031)	-0.4684 (0.034)	-1.1861 (0.031)	-0.4721 (0.034)	-1.1812 (0.031)
MP	0.1655 (0.016)	0.2186 (0.015)	0.1604 (0.016)	0.2227 (0.015)	0.1612 (0.016)	0.2228 (0.015)
SR	0.0049 (0.0003)	0.0017 (0.0002)	0.0049 (0.0003)	0.0018 (0.0002)	0.0050 (0.0003)	0.0017 (0.0002)
WP	-0.0454 (0.017)	-0.0450 (0.015)	-0.0486 (0.017)	-0.0506 (0.015)	-0.0507 (0.017)	-0.0507 (0.015)
YC	0.3812 (0.005)	0.0482 (0.005)	0.3819 (0.005)	0.0490 (0.005)	0.3823 (0.005)	0.0494 (0.005)
LP	0.2050 (0.019)	-0.1743 (0.020)	0.2053 (0.019)	-0.1750 (0.020)	0.2052 (0.019)	-0.1759 (0.020)
AT	0.1332 (0.017)	0.0417 (0.014)	0.1302 (0.016)	0.0371 (0.014)	0.1302 (0.017)	0.0370 (0.014)
AG	-0.0042 (0.0006)	-0.0045 (0.0006)	-0.0042 (0.0006)	-0.0046 (0.0006)	-0.0042 (0.0006)	-0.0046 (0.0006)
$\ln(I)$	0.0427 (0.004)	0.0166 (0.003)	0.0427 (0.004)	0.0165 (0.003)	0.0425 (0.004)	0.0164 (0.003)
$\ln(A)$	0.2848 (0.012)	0.7770 (0.009)	0.2841 (0.012)	0.7741 (0.009)	0.2847 (0.012)	0.7742 (0.009)
$\ln(B/A)$	0.2127 (0.012)	0.5455 (0.013)	0.2110 (0.012)	0.5444 (0.013)	0.2113 (0.012)	0.5468 (0.013)
IA (MP*SS)	0.3868 (0.062)	0.5937 (0.055)				
IA (MP*SR)			-0.0025 (0.0005)	-0.0017 (0.0004)		
IA (MP*WP)					-0.0802 (0.031)	0.0737 (0.027)
Log-L	-19134.37		-19143.71		-19150.14	
R ²		0.45		0.45		0.45

As far as we know no corresponding analyses have been carried out previously. Thus we have no support in previous results or other types of information to base specific hypotheses about the nature of these effects (if any). Thus our analysis is of a rather exploratory nature, with tentative explanations *ex post* of the findings obtained. Later

TABLE 2. ROUNDWOOD CUT (CONTINUATION)
Results for interaction effect on roundwood cut.*

INDEPENDENT VARIABLES	DEPENDENT VARIABLES					
	D_{Cs}	$\ln(C_s C_s > 0)$	D_{Cs}	$\ln(C_s C_s > 0)$	D_{Cs}	$\ln(C_s C_s > 0)$
SS	-0.4701 (0.034)	-1.1845 (0.031)	-0.4695 (0.034)	-1.1825 (0.031)	-0.4703 (0.034)	-1.1864 (0.031)
MP	0.1594 (0.016)	0.2226 (0.015)	0.1610 (0.016)	0.2227 (0.015)	0.1622 (0.016)	0.2315 (0.015)
SR	0.0050 (0.0003)	0.0017 (0.0002)	0.0050 (0.0003)	0.0017 (0.0002)	0.0050 (0.0003)	0.0017 (0.0002)
WP	-0.0485 (0.017)	-0.0504 (0.015)	-0.0493 (0.017)	-0.0493 (0.015)	-0.0487 (0.017)	-0.0524 (0.015)
YC	0.3824 (0.005)	0.0494 (0.005)	0.3824 (0.005)	0.0495 (0.005)	0.3822 (0.005)	0.0506 (0.005)
LP	0.2055 (0.019)	-0.1754 (0.020)	0.2058 (0.019)	-0.1774 (0.020)	0.2059 (0.019)	-0.1724 (0.020)
AT	0.1307 (0.016)	0.0369 (0.014)	0.1305 (0.016)	0.0370 (0.014)	0.1305 (0.016)	0.0376 (0.014)
AG	-0.0042 (0.0006)	-0.0046 (0.0006)	-0.0041 (0.0006)	-0.0047 (0.0006)	-0.0042 (0.0006)	-0.0046 (0.0006)
$\ln(I)$	0.0425 (0.004)	0.0164 (0.003)	0.0425 (0.004)	0.0165 (0.003)	0.0426 (0.004)	0.0160 (0.003)
$\ln(A)$	0.2843 (0.012)	0.7746 (0.009)	0.2844 (0.012)	0.7743 (0.009)	0.2832 (0.012)	0.7588 (0.009)
$\ln(B/A)$	0.2117 (0.012)	0.5460 (0.013)	0.2112 (0.012)	0.5469 (0.013)	0.2112 (0.012)	0.5416 (0.013)
IA (MP*AT)	-	-				
IA (MP*AG)			0.0024 (0.001)	-0.0035 (0.001)		
IA (MP* $\ln(A)$)					0.0472 (0.023)	0.1391 (0.018)
Log-L	-19152.14		-19151.13		-19151.48	
R ²	0.44		0.44		0.45	

* The variables entering the interaction terms are calculated from their empirical means. In the results presentation we follow the same procedure as used by Griliches and Ringstad (1971): Estimates with corresponding parameters not significant at the 5% level are presented with their signs only. Wald-tests and t-tests are applied to the parameters in the D_s and X-equations, respectively. Variable definitions are presented in the forth section and in note to Table 1.

IA: Interaction term, $MP*J$, where $J = SS, SR, WP, AT, AG, \ln(A)$.

these could make the basis for further analyses based on fresh data. The results are presented in Table 2. Note that the variables entering the interaction terms are calculated

from their means, making the estimated first-order effects in Table 2 comparable to the corresponding effects in Table 1.¹¹

Among the findings of this part of the analysis we would like to point out the following:

- We find a strongly *positive* and significant interaction effect between forest management planning (MP) and silvicultural subsidies (SS), both concerning the inclination to cut for sale and the level of the cut among those carrying out this activity in the census year. This implies that the two means are of a strongly complementary nature. It does also suggest that one should take a closer look at the *means-mix* in the attempts made to level out regional differences in forest activities. An efficiency-analysis could quite well show substantial leeway of a more cost-efficient policy in this respect.
- There is a significantly *negative* interaction effect between management planning and road density both on the inclination and the level of cut for sale. This could be explained in different ways. The more likely explanation seems to be that it reflects an “information effect”: Properties with low road density are likely to be less easily accessible, not only because of few roads, but also for topographical reasons (which of course also affect the road density). The owners of such properties probably *on the average* has less information about their forest capital than owners of properties with high road density, and are therefore more likely to benefit from a management plan.
- There is a significantly *negative* interaction effect on the inclination of cut for sale of management plan and work outside the property. On the level of this activity there is a significantly *positive* effect. This could be explained as a time-budget effect with two elements: Less time for the owner to collect information about his property and less time to carry out the cut himself. The latter effect implies an economy in concentrating the cut as the results for *LP* also suggest. The management plan seems to provide in-

¹¹ The interaction variables between *MP* and *SS* for instance is defined as:

$IA_{ss} = (MP_i - \overline{MP})(SS_i - \overline{SS})$, where \overline{MP} and \overline{SS} are empirical means.

formation about the economy of such concentration, thus reducing the inclination to cut for sale even more for units with $WP = 1$, while it neutralizes the negative income and time-budget effects on the level of this activity.

- There is a significantly positive interaction effect between management plan and the size of the property, both concerning inclination to, and level of cut for sale. The level of significance of the former is weak, while it is quite strong for the latter.¹² Thus, it seems to be very important for large properties to have a management plan. They are likely to benefit more from such plans than smaller units for several reasons. It is, for instance more difficult for the owner of large properties to have proper information of his forest capital without such a plan. Large properties are also more likely to have a management plan. In our sample the share with a plan increases from 31% in the sizegroup 25–50 ha., to about 95% for properties with above 2,000 ha.¹³

SUMMARY AND MAIN CONCLUSIONS

Within a two-stage sequential decision framework we have in this paper analysed the effects of three different means in the Norwegian forest policy. The analysis is carried out on the basis of data for 1988 for about 41,500 properties obtained from The Census of Agriculture and Forestry 1989. These units are all individual non-industrial owners — properties with at least 25 ha. productive forest area. The data do also allow analyses and testing of hypotheses concerning the effects of property- and property owner characteristics on the policy goal measures. Moreover we analyse the effects of interaction effects both between means, and means on one hand and property- and property owner characteristics on the other.

The main findings can be summarized in the following way:

¹² Using the least square method also for the first stage, we obtain a negative effect of size on the profitability to cut. This is the only substantive difference in the results using this method as compared to the normit method used here. Cf. Ringstad, Løyland & Øy (1994), Table 5.2 and 5.4.

¹⁴ Cf. Ringstad, Løyland & Øy (1994), Table 5.5.

- The regionally differentiated subsidy to silvicultural activities seems to level out the geographical differences in planting and seeding activities. In the long run this will also contribute to increased timber supply.
- Forest management plans are heavily subsidised and the subsidy is likely to increase the inclination of a property owner to acquire a plan. Our results demonstrate quite convincingly that such plans contribute to increased forest activities. There are, however, likely to be positive self-selection biases in our estimated effects of a management plan on the forest activities.
- Our tests of the effects of roads subsidies are also of an indirect nature since we have information of the road density only. Other studies show that these subsidies (as could be expected) stimulate building of roads. The results obtained for road density provide a fairly strong indication of a positive effect of these subsidies on the level of the forest activities analysed, even if the estimated effects are biased upwards in our calculations.

Thus we arrive at a largely positive conclusion about the *direction* of the effects of the means analysed on the forest policy-goals. We are, however, not able to say anything about the *cost-efficiency* of the means or the *benefit - cost difference* by means of our data.

Among the findings concerning the effects of property- and property owner characteristics we would like to point out the following ones in particular:

- Work outside the property is likely to have a negative effect on the forest activities for two reasons. The forest means less as a source of income and there is less time for these activities. This is confirmed in our results for timber supply.
- Number of years with positive timber supply the four years preceding the census year could have both a positive and negative effect on the forest activities: The positive could reflect differences between owners in utilizing their forest resources, with *active owners* having more years on the average than the others. The negative is a *reduced stock* effect. More of the previous four years with cut is likely to imply less forest stock available for cut in the census year. Our results suggest that the former is the stronger one.

- There seems to be a systematic difference between owners living on the property and those living elsewhere. The former have a systematically bigger inclination to carry out all forest activities analysed, but they have on the other hand a systematically lower level of all activities. The most likely explanation for these differences is a bigger inclination among those living on the property to carry out the activities themselves. The time budget then implies less concentration of the activities.
- Our results support the findings of previous studies that timber supply decreases systematically with the age of the owner.

Concerning the estimated interaction effects we would like to point out the following:

We find a strongly *positive* and significant interaction effect between forest management plan and silvicultural subsidies, both concerning the inclination to cut and the level of cut among those carrying out this activity in the census year. On the other hand there is a significantly *negative* interaction effect between management plan and road density both on the inclination to cut and level of cut for sale. This could reflect an *information effect*. That is; owners of properties which for topographical or other reasons have a low road density, know less about their forest capital than others. Thus they are also likely to gain more from a management plan.

There are also some significant interaction effects between management plan and some of the property- and property owner characteristics.

This analysis could be extended in different directions. The information available is obviously underutilized in several respects. Thus we could have carried out a much more comprehensive study of interaction effects, not only concerning means but also between for instance property- and property owner characteristics. The census does also provide detailed information about the agricultural activities (and also other activities) on the properties. This, obviously opens for analyses of issues outside the scope of this paper such as possible interaction effects between the agricultural and forest characteristics and activities. Moreover, with additional information, especially concerning the

costs of the means analysed, it would be possible to study issues concerning the efficiency of the means and even carry out tentative cost-benefit analyses. This has also, however, been outside the scope of this study.

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