SCANDINAVIAN FOREST ECONOMICS
No. 41, 2006

Proceedings
of the Biennial Meeting of the
Scandinavian Society of Forest Economics
Uppsala, Sweden, 8th-11th May, 2006

Lars Lönnstedt and Björn Rosenquist (eds.)

Uppsala

SCANDINAVIAN FOREST ECONOMICS

SSFE Board

Finland

Heikki Pajuoja
(heikki.pajuoja@metsateho.fi)
and Ritva Toivonen (deputy)
(ritva.toivonen@ptt.fi)

Sweden

Lars Lönnstedt
(Lars.Lonnstedt@spm.slu.se) and
Anders Roos (deputy)
(Anders.Roos@spm.slu.se)

Denmark

Bo Jellesmark Thorsen (bjt@kvl.dk)
and Carsten Smith Olsen (deputy)
(cso@kvl.dk)

Norway

Hans-Fredrik Hoen (chairman)
(Hans.Hoen@umb.no)
and Sjur Baardsen (deputy)
(sjur.baardsen@umb.no)

COORDINATORS OF THE WORKING GROUPS

BUSINESS ECONOMICS OF FORESTRY & FOREST MANAGEMENT AND PLANNING
Niels Strange, Denmark (nst@kvl.dk)

FOREST POLICY
Jussi Leppänen, Finland (Jussi.Leppanen@metla.fi)

FOREST INDUSTRY & FOREST PRODUCTS MARKETS
Anders Roos, Sweden (Anders.Roos@spm.slu.se)

INTERNATIONAL FORESTRY
Ole Hofstad, Norway (Ole.Hofstad@umb.no)

Scandinavian Society of Forest Economics
No. 41, 2006

Proceedings
of the Biennial Meeting of the
Scandinavian Society of Forest Economics
Uppsala, Sweden, 8th-11th May, 2006

Scandinavian Society of Forest Economics

ISSN 0355-032X

Tierps Tryckeri AB
Tierp, Sweden 2006

Foreword

These Proceedings contain papers presented at the biennial seminar of the Scandinavian Society of Forest Economics, SSFE, May 8-11, 2006 in Uppsala, Sweden. The seminar was organized by the Department of Forest Products and Markets, Faculty of Forest Science, at the Swedish University of Agricultural Sciences.

The Proceedings are structured after the names of the authors. I did not dare to organize the manuscript according to subjects. I am sure that my way of classifying the contributions would have been disputed. The corresponding author of the papers is marked with "*", if we know who it is. A list of the names of the authors with a page number of the article(s) can be found at the end of this document. A list of participants, the program, the SSFE song and a poem are also given.

I would like to thank all the participants for coming and for the very interesting presentations that were given. I am most impressed that so many of you have taken the effort to write a paper for these Proceedings. They give an excellent overview of forest economics research in the Nordic countries in a broad sense and as well as in some other places around our globe.

These seminars are excellent meeting places. Senior researchers and young Ph.D.students come together for interesting discussions. It is a good opportunity for network building. However, presentations and discussions must be mixed with some social activities that stimulate the "getting together". Thus we have the seminar dinner which this year took place at one of the fraternities of Uppsala. We spent a couple of hours together with guides to get to know Uppsala's history a little better and hear about the not always so good relationships between the Nordic countries in the bad old times. The last day was used for an excursion to one of Setra group's sawmills, Nyby, and the forests of the Sätuna estate.

I want to thank the key note speakers of the conference, Staffan Brege (Linköping University) and Paul Nouro (Metla), and all the chairpersons. I also want to thank the hosts of the excursion, Mikael Eliasson (Setra group), Åke Eriksson (Nyby sawmill), Agneta Borgenstierna (owner of the estate), Lennart Eriksson (SPM) and Anders Lindhagen (SPM).

Last but not least I want to thank the Nordic Forest Research Cooperation Committee (SNS) for their financial contribution.

Uppsala 27 September 2006

Lars Lönnstedt
Chairman

Table of contents

Profit Efficiency in Norwegian Timber Supply: A Stochastic Frontier Function for Active NIPFs

Sjur Baardsen

Abstract
The primary objective of the paper was to analyse how marginalisation affects profit efficiency, a secondary to identify and analyse some other possible inefficiency factors. In order to do this we estimated a translog restricted profit frontier function with an integrated inefficiency module. An unbalanced panel of 2161 observations of active Norwegian forest owners over the years 1991-2004 was used. The more marginal forestry income becomes relative to wage/agricultural income, the less/more profit efficient becomes the forest owner. Efficiency differences are likely to be caused by different information levels. The average forest owner could potentially increase his profit by 7.7% by catching up with the front. We suggest lease contracts as a policy means to ensure efficient timber supply without requiring much attention from the forest owner.

Key words: forest ownership, efficiency, stochastic profit frontier

Introduction

The forest property of the average Norwegian non-industrial and private forest owner (NIPF) is about 50 hectares, and from this he makes about NOK 8,000 (USD 1,100) annually from timber sales. This income makes only about 3% of his steadily increasing total income. Also the lion's share of his employment is now undertaken off the property. In addition, forest owners are increasingly engaging in non-timber productions on their properties (tourism etc). Thus, a major trend in Norwegian forestry is the marginalisation of traditional forestry as an income source.

Previous studies of NIPFs have concluded that forest activity is influenced by non-timber activities on the properties (e.g. Kuuluvainen *et al.* 1996), and by off-property income (e.g. Løyland *et al.* 1995, Tahvonen and Salo 1999). Increased focus on other production strategies is found not only in Norway and other Nordic countries but also in the rest of Europe as well as in USA (Amacher *et al.* 2003).

While increasing total income is surely welcomed by the forest owners themselves and also by society, our main hypothesis is that the marginalisation is likely to affect their resource allocation. Typically, the research focus has been on roundwood production and timber supply, employing production, cost and supply functions. In this paper we will take a slightly different approach. Timber production and supply is only a means to obtain profit. We believe that the private forest owner is engaged in making profits from his timber sales, although sometimes marginal. A way to conclude on the effect of marginalisation is thus to analyse how it affects the profit. This is the primary objective of the paper. While marginalisation is not an argument of the neoclassical profit function, we will include it as an inefficiency term in a frontier profit function. We will also identify and analyse some other possible inefficiency terms in order to explain whether and how these influence the profit efficiency of the modern NIPF, and the distribution of profit efficiency will be mapped.

In order to test our main hypothesis we need to define, estimate and test an inefficiency model. This implies a subset of hypotheses and tests for functional criteria and statistical significance of variables included.

A secondary objective of the paper is to investigate the distribution of efficiency and overall inefficiency losses.

Finally, we also aim at estimating short-run price elasticities of timber supply and input demand

In addition to providing information on where potential sources of inefficiency originate, their influence and distribution, the results may also provide a basis for adjusting current policies and means or designing new ones.

The model is almost identical to Battese and Coelli (1995), except for the profit (rather than production) specification and Rahman (2003), except for use of panel data (rather than a single cross-section).

Theoretical framework

Production inefficiency consists of three components. *Technical inefficiency* is present when the output level of the production unit lies below the production frontier (i.e. the maximum feasible output) for a given set of inputs or, alternatively, the input level lies above the input frontier (i.e. the minimum required input) for a given set of outputs. The production unit is *allocatively inefficient* if its input proportions are inoptimal, given input prices and output level. This inefficiency arises from not equating the ratios of marginal products with the input price ratios when attempting to minimize cost. Finally, size or *scale inefficiency* exists when the chosen output level is inoptimal, given all prices. This happens when the product price does not equal the marginal cost when attempting to maximise profit.

Both parametric and nonparametric approaches may be used to analyse efficiency performance. This study allows a parametric approach, since we have access to a rich data source. Parametric efficiency analyses are rare in forestry, especially when it comes to profit function approaches and stochastic frontiers. There are, however, a few production frontier studies (e.g. Carter and Cubbage 1995, Siry and Newman 2001).

All efficiency studies present their efficiency results, but very few identify factors that cause inefficiencies, and even fewer estimate the impacts of such environmental factors in a consistent way. Some have regressed the predicted efficiency scores against a number of factors using a two-stage procedure (e.g. Sharif and Dar 1996). This method is, however, inconsistent with its assumed independency of inefficiency effects in the two estimation stages (Coelli 1996). Battese and Coelli (1995) suggested to express the inefficiency effects as a linear function. Their model allows a consistent single-stage simultaneous estimation of the individual efficiency scores and the variables causing inefficiencies. We denote the latter the "inefficiency module". So far there have been no such integrated approaches in the forest economics literature, but a production function approach was presented at the SSFE-2006 conference, and later the paper has been submitted to a journal (Lien *et al.* 2006).

Due to factors like geographical location, timber quality, logging distance and timber transport forest owners receive different net prices of timber. This, and the fact that the owners possess different factor endowments make the frontier profit function superior to the far more commonly used frontier production function (Ali and Flinn 1989).[1] The frontier profit function is, however, difficult to estimate. There are several reasons for this. First, negative profits may well occur in the short run, and this complicates estimation as applied functional forms are often based on logarithms. Second, scale inefficiency comes in addition to technical and allocative inefficiencies. Third, input prices are almost never recorded in timber production.

Two additional difficulties should be mentioned. First, timber production is multioutput, and profit function approaches thus require, in principle, a set of output prices. Second, timber production is by nature long-run and involves more than logging costs. In this

[1] In addition, while inputs and outputs are in general exogenous in the single-equation production function approach, and output is exogenous in the cost function approach, the profit function approach treats both input and output variables as endogenous (Kumbhakar 2001).

paper we will assume weak separability in output, allowing an average timber price to represent output prices, and we will define a short-run model.

Finally, we note that price expectations are ignored in the model, and inefficiency variables are assumed to be independent of prices.

The profit frontier and inefficiency terms

The stochastic profit function is defined as

$$\pi_i = f(\mathbf{P}_i, Z_i)\exp(\xi_i)$$

where π_i is profit of the *i*th forest property defined as gross revenues from timber sales less variable costs related to timber sales, divided by property-specific average timber price[2]; $\mathbf{P}_i$ is the vector of variable input prices divided by the same timber price; Z_i is a fixed factor of the *i*th property (standing volume); ξ_i is the error term; and $i = 1,2\ldots, n$ is the number of forest properties in the sample.

The error term is specified according to the frontier concept, i.e. $\xi_i = v_i - u_i$, where $v_i \sim \text{IIN}(0, \sigma_v^2)$ are two-sided random errors, independent of the random inefficiency variable

$$u_i \sim \text{IIN}(\mu_i = \delta_0 + \sum_d \delta_d W_{di}, \sigma_u^2),$$

which represents inefficiency and is non-negative and truncated at zero. W_{di} is the *d*th inefficiency variable on property *i,* and δ_0 and δ_1 are parameters to estimated. In this paper we assume $\delta_0 = 0$ in order to avoid unexplained inefficiencies.

The profit efficiency of farm *i* is (Rahman 2003)

$$EFF_i = E\left[\exp(-u_i) \mid \xi_i\right] = E\left[\exp\left(-\sum_d \delta_d W_{di}\right) \mid \xi_i\right]$$

where E represents the expectation operator.

Within this framework the values of the unknown parameters are obtained simultaneously using maximum-likelihood estimation, employing the programme Frontier 4.1 (Coelli 1996). The algorithm uses the reparameterizations $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma^2$. If γ is not significantly different from zero, the variance of the inefficiency effects is zero, and the model reduces to a mean response function in which the inefficiency variables may enter directly.

Empirical model

Dropping the property-specific subscripts (*i*) the chosen translog restricted frontier profit function has the following form

$$\ln \pi(\mathbf{P}, Z, \mathbf{W}) = \ln \beta_0 + \sum_{j=1}^{4} \beta_j \ln P_j + \frac{1}{2}\sum_{j=1}^{4}\sum_{k=1}^{4} \beta_{jk} \ln P_j \ln P_k + \beta_Z \ln Z + \frac{1}{2}\beta_{ZZ}(\ln Z)^2$$

[2] Since the profit function is linearly homogenous in all prices (inputs and outputs), we may choose any price as a numeraire in this "normalisation" procedure. We have chosen the output price, measured by average timber price. Thus, the output price becomes implicit in our formulation.

$$+\sum_{j=1}^{4}\beta_{jZ}\ln P_j \ln Z + v - \sum_{d=1}^{4}\delta_d W_d$$

where π is still the normalised profit. The subscripts *j* and *k* on variable and normalised (by output price) input prices (***P***) and respective parameters (***β***) refer to input prices of *own logging*, *entrepreneurial logging*, *administration* and *appropriation* for *j,k* = 1,2,.., 4, respectively. There is only one fixed input, *standing volume,* which is denoted *Z*. The efficiency variables (***W***) and respective parameters (***δ***) are *average logging distance, final fellings ratio, and two forestry income marginalisation ratios (against wage income and agricultural income)* for d = 1,2,…, 4. All parameters are assumed to remain constant over time.

Data

All data are from the survey "Account results in agriculture and forestry" 1991-2004, kindly provided by the Norwegian Agricultural Research Institute. The survey covers holdings where a substantial share of the total income comes from the holding itself, and where the farmers are fully or partly self-employed. We have used the subset of 3029 observations which includes 412 holdings with both agriculture and forestry. Skipping 868 observations satisfying at least one of the following criteria:

- no felling and no timber sale,
- neither forestry income nor wage income,
- missing observation on logging distance,
- unit costs or unit prices above NOK 1000 (≈ USD 138 in average 1991-2004)

left us with a sample of 2161 observation. The sample is an unbalanced panel containing 1-14 annual observations of 381 different holdings (cross-sections). A full panel would consist of 381 * 14 = 5,334 observations. Thus, the unbalanced panel contains 41% of a full one.

Missing values have been replaced by sample average of positive values for the respective year (cross-section) for the profit, wage rate in off-farm work and for the input price proxies. There are four such proxies:

- *Own logging pric*e: variable cost of self-employed logging per cubic metre, defined as the unit cost of own time, equipment, fuel and maintenance, where own time includes the hours worked by the owner and his family, valued by the wage rate.
- *Entrepreneurial logging price*: variable cost of entrepreneurial logging per cubic metre, defined as the unit cost of hired labour and equipment.
- *Administration price*: variable cost of administration per cubic metre.
- *Appropriation price*. Paid allocation cost per cubic metre.

All four input price proxies are normalised by the property-specific output price, namely the average timber price. The normalised profit has been added a constant in order to ensure positivity, and thus allow transformation to logarithms.

The fixed input, *standing volume,* represents all standing volume, not only in mature stands.
There four efficiency variables are defined as:

- *Average logging distance*: Volume weighed logging distance for the annual felling.
- *Final fellings ratio*: final fellings divided by total fellings
- *Marginalisation ratio against wage*: Wage income divided by the sum of forestry income and wage income.
- *Marginalisation ratio against agriculture*: Agricultural income divided by the sum of forestry income and agricultural income.

Results

Summary statistics before normalisation and before adding a constant to the profit are presented in table 1. Although the values are nominal and represent a period of fourteen years, they give us some important information. First, the average profit is moderate (less than USD 7,000) and relatively variable. Negative profits exist (almost 14% of all observations are negative). Second, except for the administration price, all prices show relatively low variation. Third, the average own logging price is more than the double of entrepreneurial price, and almost as high as the timber price. We note that the calculated unit cost of time makes about 37% of this price, and that this price may be overestimated since it was assessed by the wage rate. Third, the marginalisation ratios are high and with little relative variability, implying that - in general - wage income and agricultural income dominate over forestry income.

Table 1. Descriptive statistics.*

Variable	Label	Mean	St. Dev.	Coef. of Var.	Min	Max
Profit, NOK	π	50,731	74,065	1.46	-90,693	1.104,600
Output price						
Timber price (normalising variable), NOK	P_0	329.16	68.45	0.21	18.30	853.50
Input prices						
Own logging price, NOK	P_1	315.89	181.74	0.58	0.17	984.12
Entrepreneurial logging price, NOK	P_2	131.82	36.00	0.27	1.25	833.50
Administration price, NOK	P_3	34.75	68.19	1.96	0.13	879.50
Appropriation price, NOK	P_4	12.03	6.12	0.51	0.16	125
Fixed variable						
Standing volume, cubic metres	Z	10,060	10,477	1.04	626	95,000
Efficiency variables						
Average logging distance, m	W_1	703	678	0.96	9	9000
Final fellings ratio	W_2	0.79	0.37	0.47	0.00	1.00
Marginalisation ratio against wage	W_3	0.91	0.25	0.27	0.00	1.00
Marginalisation ratio against agriculture	W_4	0.97	0.11	0.11	0.02	1.00

* USD 1 = 7.25 NOK in average 1991-2004

The maximum-likelihood estimates of the parameters in the translog restricted frontier profit function are presented in Table 2.

Note that the estimated values of the inefficiency module give inefficiency impacts. Thus, negative values indicate efficiency. All inefficiency variables are highly significant. Profit efficiency decreases with increasing logging distance, and it increases with increasing final fellings ratio. The more marginal forestry income becomes relative to wage income, the less profit efficient becomes the forest owner. The opposite happens when forestry income becomes more and more marginal relative to agricultural income, as this increases the profit efficiency.

The Frontier 4.1 (Coelli 1996) software does not allow systems of regression equations. Therefore, the translog model was estimated as a single equation.[3] This implies that symmetry restrictions could neither be imposed, nor tested. Linear homogeneity in all prices was imposed by normalising input prices by the output price. The estimated function was not monotonous, as some of the fitted input shares were positive.[4] Nevertheless, this paper is first of all about marginalisation and efficiency, concepts on which this irregularity is likely to have minor impact. It will, however, influence the price elasticities.

Table 2. Maximum-likelihood estimates of the inefficiency model.

Variable, label	Parameter	Coefficient	St. error	*t*-ratio
Stochastic frontier				
ln Constant	β_0	11.647	0.360	32.36***
ln Own logging price, ln P_1	β_1	0.079	0.075	1.06
ln Entrepreneurial logging price, ln P_2	β_2	0.290	0.159	1.83*
ln Administration price, ln P_3	β_3	0.227	0.046	4.93***
ln Appropriation price, ln P_4	β_4	0.246	0.105	2.34**
ln Standing volume, ln Z	β_Z	-1.241	0.072	-17.18***
$0.5(\ln P_1 \times \ln P_1)$	β_{11}	0.030	0.008	3.78***
$0.5(\ln P_2 \times \ln P_2)$	β_{22}	-0.080	0.021	-3.84***
$0.5(\ln P_3 \times \ln P_3)$	β_{33}	-0.001	0.004	-0.19
$0.5(\ln P_4 \times \ln P_4)$	β_{44}	-0.034	0.015	-2.22**
$0.5(\ln Z \times \ln Z)$	β_{ZZ}	0.136	0.009	14.59***
$\ln P_1 \times \ln P_2$	β_{12}	-0.085	0.021	-4.09***
$\ln P_1 \times \ln P_3$	β_{13}	-0.009	0.005	-1.60
$\ln P_1 \times \ln P_4$	β_{14}	-0.033	0.013	-2.47**
$\ln P_2 \times \ln P_3$	β_{23}	0.041	0.012	3.57***
$\ln P_2 \times \ln P_4$	β_{24}	0.056	0.025	2.24**
$\ln P_3 \times \ln P_4$	β_{34}	0.034	0.007	4.58***
$\ln P_1 \times \ln Z$	β_{1Z}	-0.036	0.008	-4.69***
$\ln P_2 \times \ln Z$	β_{2Z}	-0.021	0.017	-1.21
$\ln P_3 \times \ln Z$	β_{3Z}	-0.019	0.005	-3.91***
$\ln P_4 \times \ln Z$	β_{4Z}	-0.032	0.010	-3.15***
Inefficiency model				
Average logging distance, W_1	δ_1	0.3E-3	0.2E-4	17.30***
Final fellings ratio, W_2	δ_2	-1.795	0.059	-30.28***
Marginalisation ratio against wage, W_3	δ_3	0.235	0.091	2.59***
Marginalisation ratio against agriculture, W_4	δ_4	-3.431	0.061	-55.91***
Variance parameters				
	σ_u^2	0.401	0.01	3.89***
	γ	0.913	0.005	192.59***
Log-Likelihood function		327.142		

*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

We have already noted that if γ is not significantly different from zero, the variance of the inefficiency effects is zero, and the model reduces to a mean response function in which the

[3] A full "seemingly unrelated regressions" (SUR) model with cost and profit shares would have been an alternative.

[4] All fitted output profit shares were positive. Rahman (2003) claims, with support in Farooq *et al.* (2001), that this is a sufficient criterion for monotonicity of the profit function. This is, however, incorrect. In addition to positive output profit shares, the input profit shares should be negative, and the shadow profit share of capital should be positive for the restricted profit function (Karagiannis and Mergos 2000). Our model was troubled with some positive input shares, while the other criteria are fulfilled.

inefficiency variables may enter directly. We therefore first tested $H_0: \gamma = 0$ against $H_1: \gamma \neq 0$ using the likelihood-ratio (LR) test statistic. This test statistic has a mixed chi-square distribution[5], with degrees of freedom equal to the number of inefficiency variables plus one. The result is shown in Table 3, and it implies that the forest owners are not fully efficient. The mean response function is rejected.

Table 3. Generalised likelihood-ratio tests of hypothesis of the flexible stochastic frontier translog profit function.

Null hypothesis	Log-likelihood	LR statistic	$\chi^2_{0.95}$ -value	Decision
Full model	327.14			
$H_0: \gamma = 0$	223.50	207.29	10.37*	Reject H_0
$H_0: \beta_{ij} = \beta_{iZ} = \beta_{ZZ} = 0$, $i \leq j = 1,...,4$	127.96	398.36	25.00	Reject H_0
$H_0: \delta_i = 0$, $i = 1,...,4$	243.87	166.54	9.49	Reject H_0

* Critical values from Kodde and Palm (1986).

Also the second test reported in Table 3 resulted in rejection of the null hypothesis (global homotheticity), implying that the specified translog functional form should not be reduced to a simple (homothetic) Cobb-Douglas. The third and final null hypothesis, that the variables representing inefficiency effects have zero coefficients, is also rejected by the data. Consequently, the preferred model is the frontier translog profit function with the technical inefficiency module. A significant part of the variability in profits among forest owners is explained by differences in the level of technical, allocative and scale (size) inefficiences.

The gross own- and cross-price elasticities of supply and demand for variable netputs *i* and *j* may be calculated as (Sckokai and Moro 1996):

$$\varepsilon_{ij} = \frac{\partial X_i}{\partial p_j}\frac{p_j}{X_i^*} = \frac{\beta_{ij}}{S_i} + S_j - \delta_{ij}, \qquad \varepsilon_{ji} = \frac{S_i}{S_j}\varepsilon_{ij},$$

where $S_{i\,(j)}$ represents profit share *i* (*j*) and δ_{ij} is the Kronecker delta ($\delta_{ij} = 1$ if $i = j$ and $\delta_{ij} = 0$ if $i \neq j$). These elasticities are consistent when the underlying production function is homogenous. As we have found the profit function nonhomothetic (the second test in Table 3), implying that the underlying production function is nonhomogenous, the elasticities are consistent as long as the inefficiency variables are independent of the price variables (Kumbhakar 2001). Inspection of the correlation matrix revealed some negative correlation between the final fellings ratio (W_2) and own logging price (p_1), entrepreneurial logging price (p_2) and administration price (p_3). The correlation coefficients were in the interval (-0.1) – (-0.2). Although these correlations are small, the results presented in table 4 should be interpreted with caution. We have chosen to present them in order to illustrate the pattern of responsiveness of the forest owners to price changes.

[5] The t-test reported in Table 2 is, therefore, only indicative.

Table 4. Short-run price elasticities of timber supply and input demand, evaluated at the means of the cost shares.

i⇩, j⇨	Output (timber price)	Own logging price	Entrepreneurial logging price	Administration price	Appropriation price
Timber price	**0.20 (0.16)**	0.64 (0.06)***	0.35 (0.09)***	-0.55 (0.03)***	-0.24 (0.06)***
Own logging price	0.40 (0.13)***	**-0.41 (0.05)** ***	0.11 (0.08)	-0.50 (0.03)***	-0.27 (0.06)***
Entrepreneurial logging price	0.13 (0.12)	0.17 (0.58)	**-4.11 (5.52)**	-0.30 (0.28)	0.03 (0.38)
Administration price	0.30 (0.06)***	0.55 (0.05) ***	0.18 (0.08)**	**-1.47 (0.03)*****	-0.28 (0.06)***
Appropriation price	0.06 (0.02)***	0.71 (0.12) ***	-0.03 (0.17)	-0.65 (0.11)***	**-1.03 (0.15)*****

Own-price elasticities and standard errors in semi-bold. Standard errors in parentheses.
*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

We note that the short-run timber supply price elasticity is insignificant. So is the elasticity for the entrepreneurial logging price, while the three other input price elasticities are significant at 1% level.

The distribution (grouped in a histogram) of profit efficiences are shown in Figure 1, and the cumulative distribution of all observations in Figure 2. We note that average profit efficiency is 0.923 and its standard error is 0.039.

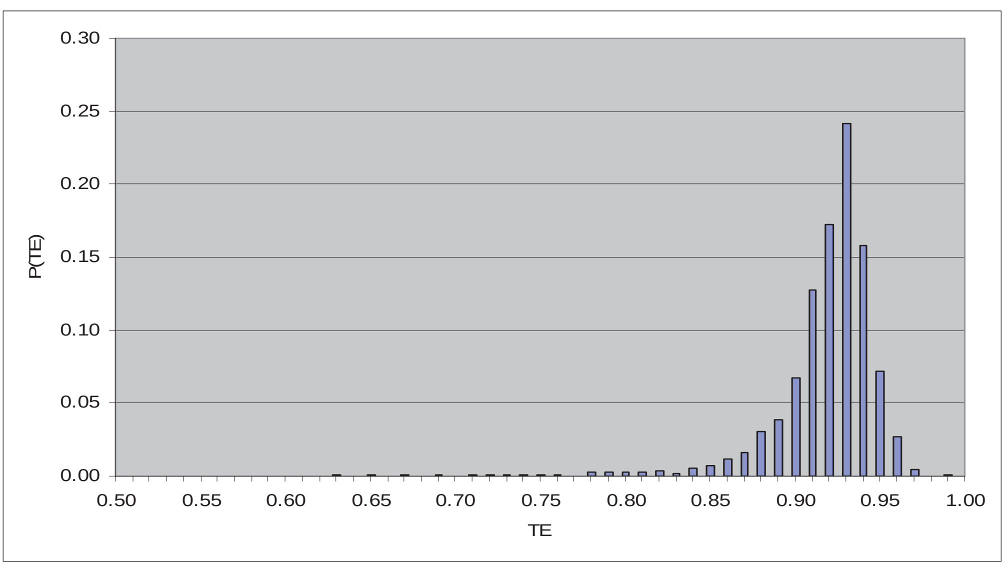


Figure 1. Histogram of technical efficiency (TE) for the sample.

The area above the cumulative distribution in Figure 2 (bounded by the ordinate, the value 1 and the distribution curve) represents the inefficiency of the sample amounting to NOK 8.4 million. Inflating this result to a full panel gives about NOK 20 million over the sample period, i.e. NOK 1.4 million per year. Since the sample makes about 0.36% of the forest owner population, a very rough estimate would be annual losses due to inefficiency of almost NOK 400 million.

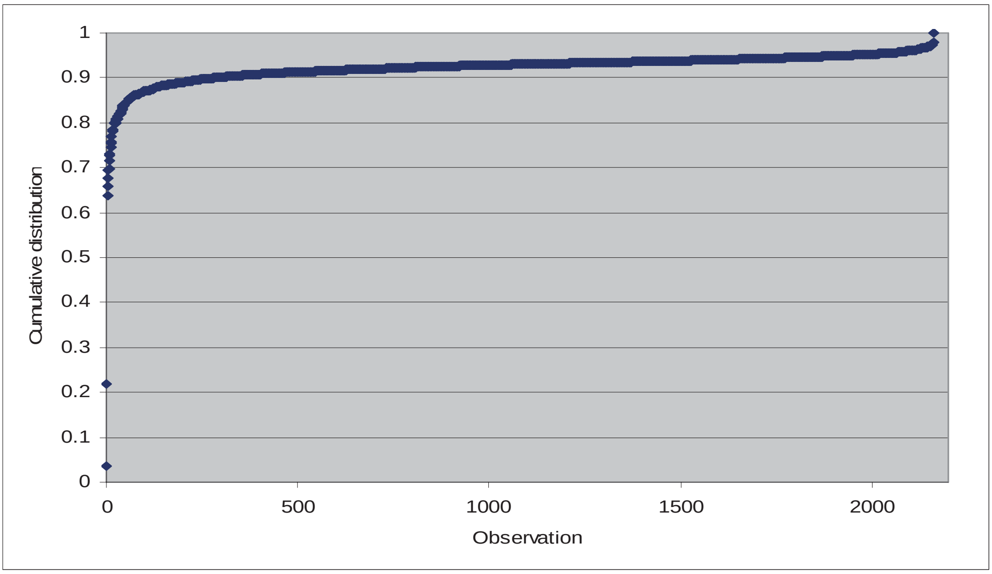


Figure 2. Cumulative distribution of technical efficiency.

Discussion and Conclusions

A main objective of the paper was to analyse how marginalisation affects profit efficiency, another to identify and analyse some other possible inefficiency factors. In order to do this we defined, estimated and tested a translog restricted profit function with an integrated inefficiency module on a relatively huge unbalanced set of panel data. The model showed a god fit to the data (21 significant out of 25 estimated parameters at the 10% level), logical results, and seemed fairly well behaved apart from some non-monotonicity. It could not be reduced into a simpler model.

Unsurprisingly, profit efficiency decreases with increasing logging distance, and increases with increasing final fellings ratio, i.e. when final fellings increase relatively to thinnings.

Less obvious was the result that the more marginal forestry income becomes relative to wage income, the less profit efficient becomes the forest owner. This result is, however, in line with Lien *et al.* (2006), who estimated a stochastic frontier production function with an inefficiency module, based on a cross-section of 3,249 active Norwegian forest owners. The result is also in line with the findings of Løyland *et al.* (1995), who found that work outside the property was likely to impact forest activities negatively. The present study gives no explanation for why increased wage income results in decreased efficiency. Nevertheless, it is plausible that typical wage-earners have less interest in forestry and spend less time on planning and collecting information. Therefore, they may be less informed about their own timber resources, prices, the entrepreneurial market etc. This lack of knowledge may, in turn, lead to bad timing and expensive logging.

The opposite happens when forestry income becomes more and more marginal relative to agricultural income. Profit efficiency increases. Again, this is a result in line with

Lien *et al.* (2006), who explain it by the fact that here are few conflicts related to the joint maximisation of forestry and agricultural production. It might be added that high agricultural income is likely to reflect an active farmer who is well informed about own resources, prices etc.

The average forest owner could potentially increase his profit by (1-0.923) *100% = 7.7% (NOK 3,906) by catching up with the most efficient colleagues. One has to keep in mind, however, that this also implies reduction of logging distance and augmentation of final fellings relative to thinnings, adjustments that are hard or impossible to make for many forest owners. Therefore, the indicated NOK 400 million annual loss due to inefficiency is probably a ceiling.

One may also keep in mind that profit losses in forestry that are due to e.g. wage income, are just a result of the owner's choice and adaptation. He may well be better off loosing some profit in forestry as long as he can compensate the loss by wage income, and still have money left. In other words, inefficient timber supply may well be preferred by the owner himself, and by society, as long as the gain from off-property work can more than compensate the loss.

The distribution of efficiency scores was approximately normal, perhaps a little skew with a thin and long left tail. Since this distribution can take values only in the domain [0,1] and the average was above 0.90, some skewness should be expected. Perhaps more interesting was the low variability. Almost all scores took values in the interval 0.85-0.95. This means that the forest owners are relatively homogenous when it comes to profit efficiency.

Surprisingly, the short-run own price elasticity of timber supply and of entrepreneurial demand were insignificant. The supply elasticity would, however, have been significant on a 11% level. The demand elasticity was far from significant (p-value = 0.23). A plausible reason for this unexpected result is that the input prices are not really prices, but unit costs. The increase in productivity during the period studied, which is embedded in this unit cost, has been significant. As long as we cannot correct for this (contracts are made per cubic metre output), the estimate is likely to be biased.

Finally, the results may provide a basis for adjusting current policies and means or designing new ones. We have seen that the effect of marginalisation is ambiguous. What matters is whether it stems from wage income or agricultural income. We believe that the difference has to do with professional attitude towards forestry. The active farmer is more informed about efficient forestry than the forest owner who makes a living outside the farm. A possible policy implication is therefore, when efficient timber supply is a social goal, to define instruments that ensures efficient timber supply without requiring much attention from the forest owner. An obvious way to go is to develop contract regimes where the forest owner can lease his right to harvest to a broker or an agent, e.g. a forest owner association. The contract could be based on annual payments, payments linked directly to harvests, or other schemes without direct connection between harvest and payments in the short run. This kind of contracts would require little effort from the passive forest owner, and at the same time offer him a flexible way to achieve increased income from the forest.

References

Amacher, G.S., Conway, C. and Sullivan, J. (2003), 'Econometric analyses of nonindustrial forest landowners: Is there anything left to study?', *Journal of Forest Economics*, 9: 137-164.

Battese, G.E. and Coelli, T.J. (1995), 'A model for technical inefficiency effects in stochastic frontier production function for panel data', *Empirical Economics*, 20: 325-332.

Carter, D.R. and Cubbage, F.W. (1995), 'Stochastic frontier estimation and sources of technical efficiency in southern timber harvesting', *Forest Science*, 41: 576-593.

Coelli, T.J. (1996), *A guide to FRONTIER version 4.1: a computer program for stochastic frontier production and cost function estimation*, CEPA working paper 96/07, Center for Efficiency and Productivity Analysis, University of New England, Armidale, Australia.

Farooq, U., Young, T., Russell, N. and Iqbal, M. (2001), 'The supply response of Basmati rice growers in Punjab, Pakistan: price and non-pricedeterminants', *Journal of international development*, 13: 227-237

Karigiannis, G., and Mergos, G.J. (2000), 'Total factor productivity growth and technical change in a profit function framework', *Journal of Productivity Analysis*, 14: 31-51.

Kodde, D.A. and Palm, F.C. (1986), 'Wald criteria of jointly testing equality and inequality restrictions', *Econometrica*, 54: 1243-1248.

Kumbhakar, S.C. (2001), 'Estimation of profit functions when profit is not maximum', *American Journal of Agricultural Economics*, 83: 1-19.

Kuuluvainen, J., Karppinen, H. and Ovaskainen, V. (1996), 'Landowner objectives and nonindustrial private timber supply', *Forest Science*, 42: 300-309.

Lien, G., Størdal, S. and Baardsen, S. (2006), 'Private Forest Owners Harvesting Behaviour and Technical Efficiency: Effects of other Income Sources', Submitted to *Journal of Small-scale Forest Economics, Management and Policy*.

Løyland, K., Ringstad, V. and Øy, H. (1995), 'Determinants of forest activities – a study of private nonindustrial forestry in Norway', *Journal of Forest Economics*, 1: 219-237.

Rahman, S. (2003), 'Profit efficiency among Banlgladeshi rice farmers', *Food Policy*, 28: 487-503.

Sckokai, P., and Moro, D. (1996), 'Direct separability in multi-output technologies: An application to the Italian agricultural sector', *European Review of Agricultural Economics*, 23: 95-116.

Sharif, N.R. and Dar, A. (1996), 'An empirical study of the pattern and sources of technical inefficiency in traditional and HYV rice cultivation in Bangladesh', *Journal of Development Studies*, 32: 612-629.

Siry, J.P. and Newman, D.H. (2001), 'A stochastic production frontier analysis of Polish state forests', *Forest Science*, 47: 526-533.

Tahvonen. O. and Salo, S. (1999), 'Optimal rotation with *in situ* preferences', *Journal of Environmental Economics and Management*, 38: 247-26

Economical success factors of small-scale enterprises in the wood products industry

Backman Riitta & Hourunranta Pertti*

Published in: *TTS Forestry Bulletin 7/2006 (701)*

Abstract

A study was made of the economical success factors of small-scale enterprises in the wood products industry. The study was based on financial statements made during 2002-2004. The study surveyed the core parameters determining the cost-effectiveness of trade describes the small-scale enterprises and their operations and analyses the special features of the most successful companies. The research looked at 40 financial statements of small-scale enterprises, and 22 entrepreneurs were interviewed. On the basis of the financial statement analysis, the enterprises were divided into those which were the most successful economically and others.

The economical success of the 40 enterprises studied was on average at least satisfactory during 2002-2004. Profitability was good or satisfactory when measured by net result. Solvency and liquidity were also at a good level.

The turnover of the most successful enterprises was bigger than the others. More than half of their total turnover came from manufacturing furniture for public function rooms and other special furniture. The least successful enterprises were in manufacturing components and sub-contracting.

The majority of the most successful enterprises focused only on one line of business.

In both groups, other small-scale enterprises were considered as significant competitors. Approximately half of the enterprises considered quality as a competitive tool. Other significant competitive tools were price, reliability of deliveries and customer orientation.

Entrepreneurs were realistic when they estimated the economical success of their enterprise. In most cases successful enterprises considered their profitability, liquidity and solvency to be at a good level, while about half of the other enterprises estimated their profitability, solvency and liquidity as being average.

Key words: small-scale enterprises, wood products, industry

Barriers to Forest Certification in Developing Countries

*Maia S. Becker and Susanna Laaksonen-Craig**

Abstract

In the decade since the conception of forest certification, Forest Stewardship Council (FSC) certification has emerged as the most globally recognized scheme. However, the area of FSC certified forests in the highly forested, developing countries of the tropics has remained relatively small. In this paper, direct and indirect barriers to achieving certification in highly forested (>10 million ha) tropical nations are identified. Direct barriers are defined to be those that alone can stop the establishment of forest certification in a country, whereas indirect barriers negatively impact forest certification. Criteria and indicators for these barriers are developed and used as a tool in determining the presence or absence of each barrier. The analysis indicates that the most significant direct barriers are a lack of land and/or tenure rights; ineffective legislation or policies; poor governance; a weak institutional environment; the high cost of certification; and an inability to sell certified forest products. Indirect barriers, such as international influence; political will; consumer buy-in; FSC's mandate and forest management standards, and forest operation size, have hindered certification of forests in the studied countries.

Key words: Forest certification, FSC, tropical forests, criteria and indictors, non-state market mechanism

1. Introduction

Forests provide important environmental services and values to global stakeholders, but they also supply essential direct benefits to groups and communities. Since forests play such a significant role, concern by governments, environmentalists, forest industry and the public over the sustainability of the world's forests have led in recent years to the signing of international conventions and the exploration of new strategies to ensure the continued health and productivity of forests. Regulatory or 'command and control' mechanisms for promoting sustainable forest management are giving way to non-state market mechanisms. Forest certification is the most developed and long-standing of these in use today. Implemented over ten years ago as a means of promoting the protection and conservation of tropical forests, there is growing concern for the unequal distribution of certification and its dominance in the temperate and boreal forests of the developed world. Tropical forests are one of the most valuable ecosystems in the world but they are located mainly in developing countries that are unable or unwilling to support forest conservation and responsible management.

At first glance, the success or failure of forest certification in a country appears to be based on a random and varied set of political, environmental and social pre-conditions. However, some factors seem to have a stronger impact on the status of certification in any given country. The goal of this paper is to identify these pre-conditions and determine why the expansion of Forest Stewardship Council (FSC) forest certification[1] has not been gaining

[1] The Forest Stewardship Council (FSC) developed the first forest certification scheme in 1993. It will be the only scheme examined in this paper, as it is the only one found in all tropical regions, has the most stringent standards, a transparent process, and accountability through its reporting system. FSC is also generally recognized in the scientific literature (Guilison, 2003), by NGOs (World Wildlife Fund, Greenpeace, Friends of the Earth, The Nature Conservancy) and by forest product suppliers as the most globally relevant certification scheme.

ground in developing tropical regions as quickly as in boreal and temperate forests. Based on the elements of sustainable forest management (SFM) on national level, we derive criteria and indicators that are used to identify the direct and indirect barriers to certification. The identified barriers as well as criteria and indicators can be used to assist stakeholders in evaluating a country's potential for certification and to find practical solutions for overcoming these barriers. The paper is organized as follows. First, forest certification is introduced, followed by the theoretical framework for analyzing the barriers and the criteria and indicators. The methodology used in the paper is then presented and, finally, the results and conclusions.

2. Forest Certification

In the mid 1980's, consumers and environmental non-governmental organizations (NGOs) were increasingly disillusioned with the failure to improve forest management through the use of agreements, policies and legislation. Action was seen to be most important in tropical zones where staggering rates of deforestation threatened some of the world's most biologically diverse and valuable natural resources. It was following the 1992 United Nations Conference on Environment and Development (the Earth Summit) held in Rio de Janeiro that the concept of forest certification was first conceived as the potential instrument through which a market for sustainable forest management (SFM) could be created.

Forest certification is a voluntary and market-based instrument whereby products that originate from a well-managed forest are identified by a recognized label or trademark. Managed forests are evaluated using rigorous standards by an independent third-party called a certifier, or a certification body, for their environmental value, social impact and the economic realities of those dependent upon them. Compared to previous approaches to SFM, market instruments such as certification are hoped to lead to increased efficiency, effectiveness, and equity in the distribution of costs and benefits (Pagiola et al., 2002). The ability for forest certification to work as a conservation strategy is in its ability to provide a financial incentive and value for SFM versus other land uses (e.g., cattle ranching, agriculture).

The current global state of forest certification is one of growing importance and influence. With over 76 million ha of forests certified in 72 countries (as of June 2006) (FSC, 2006a), they still represent a small fraction (about 2%) of the world's forested area (3,869 million ha) (FAO, 2001). This area however, is increasing at a rapid rate, stakeholders are increasingly involved in forest management decisions, SFM is better understood and more widely applied, and markets for certified forest products are growing. The geographical distribution of certified forest area is indicative of its disparate impact so far. Over 82% of all certified areas are found in Europe and North America, and over half (53%) of all FSC National Initiatives are in Europe alone (FSC, 2006b). Today, tropical forests make up only 12.77% of all FSC forests certified (FSC, 2006c). In fact, all of the forests in Latin America, Africa and Asia-Pacific make up only 18% of certified forests, despite the fact that all of the world's tropical forests (2 billion hectares) and 61% of its forests are found there (FAO, 2001). Within tropical regions, Latin America has the greatest area certified and the most established FSC presence (e.g. eight National Initiatives).

Most forests that are FSC certified are large and publicly owned; almost half (47%) of certificates are awarded to public lands, while less than 3% of the total certified area belongs to community managed properties (FSC, 2006d). Forest tenure rights and ownership in the developing world are changing; Indigenous and rural communities own or administer more than a quarter of the world's forest estate (White et al., 2002) and are increasingly influential players in forest certification. Certificates on public lands also tend to be of a greater size than those for private lands, and communal ones are the smallest of all.

3. Analytical framework

Forest certification falls among the new institutions described as non-state market-driven governance systems. In addition to forestry, these systems have also emerged in, e.g., food sectors, fisheries and tourism, and they have been gaining legitimacy. Cashore et al. (2004) have studied forest certification widely and they argue that there are three structural factors that affect the support the FSC certification can gain from forest companies and forest owners; (i) the place of the country/region in the global economy, (ii) the structure of the domestic forest sector, and (iii) the history of forestry on the public policy arena.

In order to analyze the barriers to a governance system such as forest certification, the system needs to be analyzed as a part of a larger institution. Since forest certification was created to promote sustainable forest management, it shares the same political and institutional linkages with SFM. Sustainable development policy processes, including SFM, require all stakeholders to work closely together. Recognizing this broader institution, Bass (2003) suggested that certification is one instrument that is helping the SFM meta-institution to form, defining its objectives, rewards and attempting to include many players (figure 1).

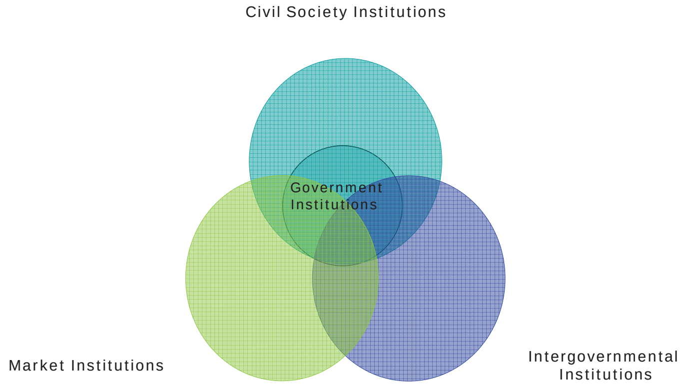


Figure 1. The SFM institution

The barriers to certification of tropical forests should, however, be analyzed on a national level. The necessary framework for studying forest certification at the national level can be derived from the essential elements of SFM by Mayers and Bass (2000). They developed a pyramid of elements that are needed for SFM at the national level (figure2). According to them, there are some foundations that are necessary for certification, as well as elements (tiers 1-6) that are required to help certification function well. Certification may be possible to some extent without them and, in turn, certification may help to strengthen them. The most significant impact certification could have on standards for SFM, is in the promotion of SFM to consumers and in monitoring and verification of SFM. Both of these foundations and elements were used to develop the criteria and indicators for direct and indirect barriers in this paper.

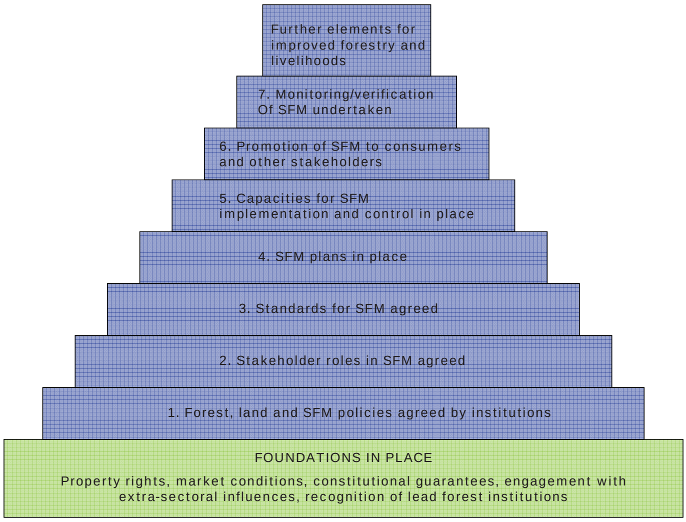


Figure 2. Elements of SFM at national level

4. Materials and methods

In this study, based on the analytical framework, the barriers to forest certification in developing tropical countries were identified. To qualify each barrier, criteria and indicators were developed to allow for identification of the key characteristics and components of the barriers. The criteria were the desired conditions or states of the barrier, and the indicators were the measures of these. Where possible, indicators that are used by international monitoring agencies were selected. The developed criteria and indicators are presented in Appendix 1.

A barrier was defined to be any element whose presence greatly hinders the establishment of forest certification in a particular country or region, and the barriers were further classified as 'direct' or 'indirect'. Direct barriers are those that are explicitly and singly responsible for the inability of forest certification to be launched in a country, and should be addressed first in any implementation strategy. If even one direct barrier exists, then the ability of forest certification to progress will be seriously affected. Indirect barriers are those that play important roles in limiting certification but alone are unable to block its development. When two or three indirect barriers are present they can act as a significant obstacle to certification.

The data for identification was collected by examining previous literature and case studies, conducting interviews[2], and an analysis of statistical data[3] for highly forested (>10 million ha) developing tropical countries, both with and without established certification. Even a larger sample of countries would have been beneficial but was unfortunately out of the scope of this study.

---

[2] Survey of National Initiatives of FSC Latin America Regional Office. August 2004. Maia Becker, FSC Bonn, Germany. Countries surveyed were Argentina, Bolivia, Brazil, Chile, Colombia and Equador, as well as Indonesia.

[3] FAO (FAOSTAT) and World Bank (World Development Indicators) data for 65 geographical, forestry, political and socio-economical variables corresponding to the developed indicators for Brazil, Bolivia, Guyana, Peru, India, Indonesia, Malaysia, Mayanmar, Democratic Republic of Congo, Tanzania, Zimbabwe, and Zambia.

5. Results and discussion

The establishment and/or expansion of forest certification will depend foremost on the existence of strong, stable land ownership and/or tenure rights; the presence of legislation and policies supporting sustainable forestry; a government that is democratic, fair and accountable; an institutional environment promoting markets and trade; the cost effectiveness of certification; and ultimately the ability for a producer to sell certified forest products. These are the direct barriers to the establishment of forest certification (table 1). Other factors that will impact forest certification, the indirect barriers are: whether a country values its forest resources; the nature of the FSC's certification process; the role of international players in a country and in certification; a government's will to promote sustainable practices; the strength of demand for certified products; the size of a forest operation; and the empowerment of a nation's populace (table 1).

Table 1. Identified direct and indirect barriers

Direct barriers	Indirect barriers
1. Land ownership and/or tenure rights	1. National value of forests
2. Legislation and policies	2. FSC mandate and forest management standards
3. Governance	3. International influence and initiatives
4. Institutional environment	4. Political will
5. Cost of Certification	5. Consumer buy-in
6. Access to markets for certified forest products	6. Small scale of forestry operation
	7. Social capital

Direct Barriers

Land Ownership and/or tenure rights - Developing tropical countries are plagued by complex and insecure land tenure conditions, and corrupt or ineffective political and legal systems unable to confront these. Lack of land ownership and/or tenure rights is a direct barrier to FSC certification for two reasons: the financial incentive for companies, individuals or communities to manage and sustain land in a manner consistent with forest certification would require them to have defined long-term rights and responsibilities for the land and the products derived from it; and qualification for FSC certification also requires proof of tenure and use rights and responsibilities (FSC Principle 2[4]) (FSC, 2000).

The determination of tenure rights is accomplished through legislation and policies put in place and enforced by governments and institutions. The essence of these is ensuring that the rights and responsibilities of landholders and users are identified, and support responsible practices. Delineating land boundaries can strengthen land ownership and tenure rights, particularly if accompanied by a fair dispute mechanisms to challenge encroachment, squatting or land use claims. Forest certification may play a unique role in this; in the Philippines landowners demonstrating sustainable forest management through certification have successfully negotiated new rights (Scherr et al., 2002).

Even where land ownership legislation does exist, this does not presuppose that such laws encourage responsible use of natural resources, or can be effectively enforced. For example, tenurial rules in Africa assign property rights over public forests to private parties on condition that such lands are `developed' or `improved'. These rules have facilitated the expansion by small farmers into forests, and in some countries have been used by wealthy

[4] The FSC system is based on ten internationally defined Principles and 57 Criteria for forest management which are the guiding framework for developing regional forest stewardship standards appropriate to local social, ecological and economic conditions.

parties to amass large holdings for speculative reasons (FAO, 2002). The rights of indigenous peoples and the unique management structure of operations (e.g. community) must also be specified in these agreements.

Legislation and Policies - Government legislation and policies can have a strong positive or negative influence on sustainable forest practices. Legislation is often considered the strongest instrument for policy implementation (Nilsson, 2004), and is made up of laws that deal directly with forestry, and those that are regulations outside of forestry, but affect it all the same.

If national legislation and policies are poorly developed, they are unclear, contradictory, or lack implementation mechanisms, they often work as financial or legal disincentives for long-term and sustainable forest management. Legislation that deals with tenure rights, property taxation and land-use responsibilities are particularly relevant to the establishment of forest certification. The opportunity cost of using land for forestry instead of agriculture will determine what land-use is most profitable for owners, and therefore how they manage land resources, as most landowners will choose the land-use and management method which maximizes their return. For example, in Latin America high opportunity cost of land caused by, among other things, agricultural subsidies have a significant impact on forests (Haltia and Keipi, 1997).

The issue of what constitutes 'good' forest policy is to some extent subjective. Policies that help establish 'good' practices are often defined to be those that are based on sound science; require the development of a forest management plan and use of low impact harvesting; place limits on the size and location of forestry infrastructure; forbid clearing of natural forest for plantations; require reforestation of harvested areas, preferably with native species; protect watercourses with buffers in riparian areas; utilize wildlife habitat or corridors; and encourage forest product industries to invest in local wood processing capacity (Kilgore and Blinn, 2003).

Governance - A governance structure that does not promote an open and democratic dialogue, that is corrupt and prone to an inequitable distribution of benefits, or one in which there is no stability acts as an overwhelming roadblock to certification. Corruption is the most pervasive and crippling element of poor governance. Although found in all societies, its effects are most debilitating for developing ones, which lack the economic, social and institutional structure to withstand its negative consequences. Corruption impacts forest certification by promoting illegal forest activities, increasing business costs (due to bribes and other inequalities), lowering timber prices due to over-supply, and creating uncertainty for individuals of whether they will receive the long-term benefits of investing in SFM (e.g., Whiteman, 2003).

An open and fair governance system depends largely on the democratic nature of the government. Measures such as requiring governments to publicly provide information, audits, training of public servants, and reforming the justice sector are key elements of improving transparency and accountability. While a forest governance approach should look at government structure, it should also allow a role for civil society, forest users and other government agencies to determine the direction and nature of how forests are used (RECOFTC, 2004).

Institutional Environment - Without a strong institutional environment - the framework for political, economic and social interactions within a country consisting of the 'size of government', the 'structure of the economy and use of markets', and the 'freedom to trade with foreigners' (Gwanney et al., 2001) - it is difficult for forest certification to establish itself. A study by van Kooten et al. (2005) found these characteristics to be influential in assisting or deterring forest certification, depending on whether the respective components of the institutional environment are high or low. High government participation in the economy (low 'size of economy[5]' index), as is found in major wood exporting countries such as Sweden and Canada, indicates companies are more likely to voluntarily seek certification. When the allocation of goods and services occurs entirely via markets (high 'structure of economy[6]' index), there is a greater chance that a country will certify SFM practices. This is because the non-state nature of certification makes it dependent on the voluntary will of private enterprises. The better the ability for firms to produce and sell wood products abroad (high 'freedom to trade[7]' index), the more likely it is that firms will certify forest management practices since they will be able to use it as an export marketing strategy.

Cost of Forest Certification - The high cost of forest certification is often a strong disincentive for producers, and more so to small or medium sized enterprises than large industrial ones. There are direct and indirect costs to certification. Direct costs of obtaining and maintaining certification tend to be higher in tropical countries where there are fewer locally operating certification bodies, and the road infrastructure needed to access forest management units poorly developed (Bass et. al., 2001). Guillison (2003) found that certification in the United States added about 2-3 cents per cubic meter to costs, while for tropical producers the cost ranged from 26-110 cents per cubic meter. In comparison, small producers in Latin America can pay up to 400 cents per cubic meter for certification (Guillison, 2003). Bigger companies also tend to have more in-house expertise and better forest inventories, therefore reducing costs of audits and management plans.

The second type of costs, the 'indirect' costs, are due to raising management practices to those required by the FSC standards. These are often the most difficult to overcome, particularly for producers in developing tropical countries. The management of tropical forests is more heterogeneous and complex than in temperate zones, sustainable management is less understood, and the current level of forest management is generally much lower than in northern forest regions that have been faced with strict environmental regulations and a watchful public for many years. The effect is that firms with already high management practices have lower indirect costs, and the forest operations which would actually benefit most from the improved management (i.e. poorly managed tropical operations) are actually the least likely to become certified (Ramesteiner and Simula, 2003). Compliance costs associated with altering procedures and practices to meet certification requirements are estimated to range from 10-20% of average tropical log prices for developing countries (Sikod, 1996). A study in Mexico (Chapela and Madrid, 2002) found that the cost of improving forest practices to reach certification standards was about US$10,000 per year (during the five-year validity of certificates). The indirect costs can be so high as to eliminate any profit from certification. In Bolivia for example, calculations show that even if consumers paid 15% more for certified wood, this would not be enough to tilt the commercial balance in favor of SFM (Bojanic and Bulte, 2000). The barrier to certification posed by these higher costs is made all the worse by the fact that there is no or little credit available to these enterprises.

Access to Markets for Certified Forest Products - Market access is an important factor hampering forest certification in developing and tropical countries. Access to markets requires a demand for certified forest products; knowledge of where the demand is located

---

[5] Size of the economy: constructed from data on government, consumption, expenditures as a percent of total consumption and on government transfers and subsidies as a percentage of GDP. (Gwanney et al., 2001)

[6] Structure of the economy: Constructed from the extent of public enterprises and public investment as a percentage of the economy; the extent of price controls; the top marginal income tax rate and the threshold at which it applies; and the degree to which a county's military relies on conscripts. (Gwanney et al., 2001)

[7] Freedom to trade: Based on taxes on international trade (revenues from taxes as a percentage of exports plus imports, mean tariff rate, and variation in tariff rates), and the actual size of the trade sector compared to its expected size. (Gwanney et al., 2001)

and how to reach it; a cost effective and reliable manner of transporting the product; and price competitiveness. There is a lack of market knowledge and an inability of producers in developing tropical countries to connect with, and meet requirements of foreign buyers. Linking certified producers to buyers therefore requires information as to the real (vs. perceived) costs and benefits of certification, and a way in which producers can contact buyers, and vice versa. Quite often certification is 'sold' to producers as a way for them to acquire huge financial gains within markets, when in reality this is not a reasonable assumption for all producers, and should probably not be the main impetus for becoming certified. Communities in particular are negatively affected by the difficulty in identifying market opportunities, and are highly dependent upon intermediaries to establish market relationships (Markopoulos, 1999). CFP Buyers' (and Producers') Groups are the mechanism through which market networks are currently being built to assist in overcoming this barrier.
The existence and location of demand for certified forest products is a much-contested topic. While demand is currently in North America and Europe, the ability to establish a niche for CFPs in domestic markets is viable as these markets increase in size and importance[8]. In the tropics, only Brazil currently has a significant domestic market. The sale of certified forest products to local consumers will also depend on their knowledge and understanding of certification, their interest in sustainable forest management and conservation, and ultimately their income level.

Indirect Barriers

National value of forests - Forestry must be important to the economic and social prosperity of a country for forest certification to occur. In particular, those countries with a high percentage of export revenue and a high percentage of GDP generated from the forestry sector are more inclined to invest in sustainable forest management, and hence certification (e.g., van Kooten et al., 2005). High export revenue generated from forestry is also important as this indicates a relatively high dependence on international markets where environmental goods are more valued. Using forest certification to demonstrate legal and sustainable forest management is a way of maintaining existing export markets and potentially gaining new ones.

The value a country places on its natural resources can be seen, in part, by the area they have under protection, and their ratification of international environmental agreements or conventions. Pressure for the conversion of forests due to population growth also appears to act as a stimulus for forest certification as this often creates an incentive to re-visit or reform policies and legislation, or to institute environmental protection measures.

FSC mandate and forest management standards - The scope of support and strategic leadership provided by FSC, and the manner in which certificates are given are currently not sufficient to increase certification in developing tropical regions that face unique ecological challenges and political and social structures. For certification to firmly establish in these regions would require the FSC to create clear and measurable objectives to better focus and guide Regional Offices, National Initiatives and partners; work to coordinate activities and information within its network; improving communication between the FSC offices and creating a reporting mechanism for the organization to be better aware of the events on the ground. The role of raising forest certification awareness of forest certification, creating demand for CFPs, and linking producer and buyer markets must also be shared between the FSC, certified companies, and the various stakeholders. Due to the complexity and heterogeneity of tropical systems, the local managers and producers should be supported in

[8] The demand for environmental goods and amenities typically increases as income rises (e.g., Panayotou, 1993; Barbier 1994).

gaining access to expertise and training on how to develop and attain management standards, and educational and research institutions should be approached to create partnerships that can facilitate the development of standards based on sound science, and to provide access to improved silvicultural methods.

Certification's effectiveness is also limited by its focus on the forest management unit (FMU) when many of the environmental and social services demanded of SFM arise at the landscape level. The conservation of regionally important biodiversity cannot be secured by FMU certification, unless the FMUs are very large, or unless many contiguous FMUs are certified.

International influence and initiatives - International markets, donors and governments are a powerful influence on forest certification. The role of funding or subsidies for the development of forest certification in developing countries is the impetus for many existing programs, which would not have developed of their own accord due to the high costs of certification. This has resulted in some small or community forestry enterprises becoming certified and trying to access international markets before sufficient domestic marketing expertise has been obtained (Richards, 2004).

The role of the World Wildlife Fund (WWF) in promoting FSC certification is particularly powerful. Many of the FSC National Initiatives are tightly linked financially and operationally to the WWF, and work out of their offices. As a proxy to determining the interest of international NGOs and governments in forest certification, one can look at the total number of international NGOs working in a country, and the amount of foreign aid that is being delegated to it. Traditionally, international funding from bilateral and multilateral sources in the form of official development assistance has remained the primary source of support to the forestry sector in developing countries. This has changed in recent years where most is from private sector investment (FAO, 1997).

Since the current demand for certified forest products is in international markets, the extent of a country's exports and their relationship with foreign ownership are an important motivation for investing in certification. Foreign direct investments (FDI) have increased rapidly in the forest industry since the 1990s and one of the main motivations for investments in the forest sector has been resource seeking, and therefore, certification could play a more significant role in the future (Laaksonen-Craig, 2004).

Political will - The biggest barriers to forest certification often fall at the government level. Majority of the direct barriers identified in this paper are the result, or lack, of government processes and policies (land ownership and/or tenure rights; legislation and policies; governance; institutional environment). Political will refers to the government's interest in instituting SFM incentive programs, but also their will to support forest certification. Governments' knowledge and understanding of forest certification and how it can potentially benefit the country may be a key element in overcoming these barriers. Many producer countries are skeptical of forest certification and see it as another way in which they are being excluded from international markets. Brazil's FSC National Initiative responded in a survey that it felt its government's attitude towards forest certification is 'open and accepting', and that its knowledge and understanding of certification is 'advanced' (FSC Brazil, 2004). Although this in itself is not conclusive, Brazil is the developing tropical country with the largest area of certified forest, 2.8 million ha (FSC, 2004), and no other country in Latin America indicated such strong government support or awareness.

Consumer buy-in - The role of the consumer in a market-based mechanism such as forest certification is important in its success. Certification is based on the premise that consumers will differentiate and perhaps be willing to pay a price premium for products originating from well-managed forest ecosystems. There is a serious concern that consumer confusion over the abundance of different certification will diminish their acceptance of forest certification. Ultimately, if consumers are not willing to pay more for certified products, then there are fewer incentives for producers to pay the extra costs to produce them, or for retailers to supply them.

The likelihood of a consumer buying certified goods depends on their knowledge that the forest product is from a legal and sustainable source. Awareness of certification and recognition of the FSC logo or label is low in most countries. The FSC has renewed efforts to raise awareness of certification, and various FSC National Initiatives, particularly the UK, Germany, and the Netherlands have already achieved success in consumer awareness campaigns. Adding to this problem is the fact that most products that are certified do not bear the FSC trademark or logo. The reason for this in the past was a lack of Chain of Custody (CoC) certificates. As these increase in number, there are now over 3,300 issued, the situation is slowly changing.

A series of studies have indicated that a sizable portion of consumers would be willing to pay a premium for certified forest products (Anderson, 2003; Donovan and Nicholls, 2003; Vlosky et al., 1999; Ozanne and Vlosky, 1997, 2003). For example, about half of US consumers are willing to pay a premium of around 12% for certified wood products (Ozanne and Vlosky, 2003; Vlosky et al., 1999; Anderson, 2003). A study by Veisten (2002) looked at the differences in European consumer's estimated mean willingness to pay for certified forest products, and found it ranged from 1.4% in France to 4.9% in Austria, with approximately 60% of the survey respondents stating a positive willingness to pay. Since there is apparently a willingness on the part of consumers to purchase certified products once they are aware of what it means and implies, the main limitation to the existence of CFP markets may therefore be a lack of information and knowledge by consumers.

Small scale of forest operations - The size of forestry operations is a barrier since it results in higher costs to certification and lack of access to markets for smaller operations. Large industrial players are likely to benefit more easily from certification since they can access information, exhibit economies of scale, and are better able to bear risks and costs. The forest management standards used to assess forests also tend to be designed for larger management systems. The disadvantages for smaller producers are greater in developing and tropical countries where the costs of certification and ease of market access tend to be harder to achieve. As community and private ownership grows in these regions, creating incentives for sustainable forest management and making the process to become certified accessible will be all the more important.

The niche foreign markets for certified forest products also require high product quality, minimum product volumes and timely delivery, which many small or medium sized forestry enterprises cannot meet. Buyers in the U.K for example have cited difficulties in maintaining consistent product supplies from tropical or southern producers (Jenkins, 2004).

Social capital - Social capital is the extent to which a country's citizens are empowered. Without strong social capital, forest certification will have difficulty establishing. One important measure of empowerment is a country's overall literacy rate. Countries with higher rates of literacy are more likely to have a greater proportion of their forests certified (van Kooten et al., 2005). Perhaps more important than literacy in terms of its impact on forests and the environment is the role of women in society (Rodda, 1993). Forest degradation can have a largely negative impact on the poor in developing countries, and particularly on women, who depend quite heavily on a variety of products from forests (van Kooten et al., 2005). In countries where women are suppressed or simply have fewer opportunities than men, the level of social capital will be lower and women will have less opportunity as stakeholders to influence efforts to protect forests (van Kooten et al., 2005).

6. Conclusions

Economic, political and social pressures threaten the health of rich and extensive natural resources in developing tropical countries. Forest certification in these areas has not established or expanded as it has in industrialized regions. The main reasons for this are the overwhelming institutional, political and legislative barriers to effective and equitable resource management; the high costs of certification; and limited access to markets for certified products. As developing tropical nations often lack the motivation or ability to address this situation, action and support from international agencies, organizations, governments, companies, the media and the public are required. There are a variety of potential strategies that may help overcome the barriers discussed in this paper:

A stepwise or phased approach to certification can be used to address the high costs of certification. This approach involves an initial independent audit of the FMU to identify gaps between current practice and the SFM standard, development of an action plan that distinguishes levels of achievement (or steps) to tackle these weaknesses, and continual independent verification of progress. Once key phases in the progression are completed, incentives can be provided to producers in the form of tax breaks or access to suppliers who will buy 'transitional timber'. Making this system reliable and determining how to manage chain of custody verification is a significant challenge to be overcome (Richards, 2004). A variety of initiatives have also been created to help to lower certification costs, such as the FSC's SLIMF (Small and Low Intensity Managed Forests) standards; training of local auditors; group certification; price competition amongst certification schemes and inspectors; streamlining of audit procedures; focusing on outputs or environmental/social outcomes to permit flexibility for producers; and national working groups developing local standards.

Linking producers and buyers of Certified Forest Products (CFP) is essential for improving access to markets and lowering costs of certification. There is currently a lack of information on the type, specifications, quantity, quality, tree species, and characteristics of certified products, which must be available to buyers for certification to be effective as a market mechanism. Producers need more information who the buyers are, what they need, and how to do business with them. Increased research into markets for CFPs should be conducted. Buyer and producer groups are the method that could best support the demand and supply side of this market. Buyers' groups consist of retailers, wholesalers, brokers, distributors etc. that have made a commitment to buy, where possible, only certified forest products. Producer networks work together to create a product of the quality and volume demanded by the buyer and to lower costs. Efforts to link markets for certified forest products are being spearheaded by the FSC, the World Wildlife Fund (WWF), the Tropical Forest Trust (TFT), funding agencies, and various businesses and interest groups.

Building good governance requires a government and institutional structure that is free of corruption, transparent, accountable and has an unbiased and effective justice system. The battle for good governance tends to focus on developing integrated financial management systems, strengthening the justice sector, reducing the government's control over the economy, and training and technical assistance for audit institutions and anti-corruption institutions. Ways of overcoming abuses of the system are through deregulation, de-licensing, privatization, and competitive procurement. To minimize corruption requires commitment and support of governments and international agencies to establish general economic and political liberalization.

Corporate involvement in sustainable forest management should focus on strategic business partnerships, corporate social responsibility and timber procurement policies. Other innovative financing strategies that consider environmental and social sustainability are popping up around the world. For example, commitment to forest certification is now one of the criteria used when rating companies using the Dow Jones Sustainability Index (DJSI).

Investment banks worldwide are also using what they call the 'Equator Principles'[9] to identify the risk associated with providing financing for a project (e.g., Citibank Inc, CIBC, HSBC Group, ABN-AMRO).

Environmental service payments (ESP) are an ever-growing sector, which includes forest certification (e.g., Powell et al., 2002). Certification has the potential to be used as an independent assessment and monitoring tool for justifying and attracting other ESPs.

Government legislation and policy reforms need to take place in the area of land rights and ownership, forest management, taxation, institutional structure, monitoring and enforcement. Better knowledge of forest tenure and disputes could be accomplished by mapping tenure, delimiting property, reforming legal frameworks, revising regulations and establishing new enforcement mechanisms. Laws should make explicit reference to basic criteria for decision-making, provide for public review and comment on legislation, create oversight bodies including members drawn from non-forestry sectors and civil society, and create a public right to information (Christy et al., 2000). Failures of the market to value forests and their services should be corrected by creating efficient incentive systems or economic instruments that internalize environmental costs. Most forest subsidies and tax incentives favor well-off landowners and large forest industry. These should be replaced with fee systems that reflect the real value of forest products and encourage forest activities.

Forest certification in developing tropical regions will have an impact only if more land is certified, a greater number of small and community enterprises are supported so they can reach certification, and the financial return of this market mechanism increases. There is a need for coordination and communication between the FSC and other international agencies and bodies to streamline development efforts. With limited financial and technical resources, these must be used in a more efficient and expedient manner. The trend towards greater corporate and government involvement in, and responsibility to, the environment and society must also be facilitated and promoted wherever possible. Governments provide the framework, regulations, and authority needed to make certification possible, and international and local companies are the financial engines and income providers of struggling economies in the tropics. Changes and advances made by these forces are often motivated by social pressure, unrest or activism. These require that the public and companies be educated about issues such as forest certification.

Disclaimer: This paper represents the views of the authors and should not be thought to represent those of the Forest Stewardship Council.

References

Anderson, R. 2003. Do forest certification ecolabels impact consumer behavior? Paper presented at CINTRAFOR'S 20th Annual International Forest Products Markets Conference, October 16–17. Seattle, WA.

Barbier, E.B.1994. National capital and the economics of environment and development. In:

Janson, A., M. Hammer, C. Folke and R. Costanza (eds.). Investing Natural Capital: The Ecological Economics Approach to Sustainability. New York: Columbia University Press.

Bass, S. 2003. Certification in the Forest Political Landscape. In: Meidinger, E., C. Elliott and G. Oesten (eds.). Social and Political Dimensions of Forest Certification. www.forstbuch.de, Remagen-Oberwinter, Germany.

Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and M. Grieg-Gran. 2001. Certification's impacts on forests, stakeholders and supply chains. Instruments for Sustainable Private Sector Forestry Series. International Institute of Environment and Development: London, UK.

[9] See www.equator-principle.com

Bojanic, A., and E.H. Bulte. 2000. Financial Viability of Natural Forest Management in Bolivia: Environmental Regulation and the Dissipation and Distribution of Profits. The Netherlands.
Cashore, B., G. Auld and D. Newsom. 2004. Governing Through Markets. Forest Certification and the Emergence of Non-state Authority. Yale University Press. New Haven and London.
Chapel, F. and S. Madrid. 2002. La Certificación en Mexico: Los Casos de Durango y Oaxaca. Unpublished case study and background paper. Cited in: Molnar, A. 2003. Forest Certification and Communities: Looking forward to the next decade. Forest Trends, Washington, D.C.
Christy, L, A. Mekouar, and J. Lindsay. 2000. Why Law Matters: Design Principles for Strengthening the Role of Forestry Legislation in Reducing Illegal Activities and Corruption. Food and Agriculture Organization (FAO). Rome, Italy.
Donovan, G.H., and D.L. Nicholls. 2003. Estimating Consumer Willingness to Pay a Price Premium
for Alaska Secondary Wood Products. USDA, Forest Service, Pacific Northwest Research Station Research Paper PNW-RP-553.
FAO. 1997. State of the World's Forests. United Nations Food and Agriculture Organization. Rome, Italy.
FAO. 2001. State of the World's Forests. United Nations Food and Agriculture Organization. Rome, Italy.
FAO. 2002. December. Proceedings from: Workshop on Tropical Secondary Forest Management in
Africa: Reality and Perspectives, Nairobi, Kenya, 09 - 13 December 2002. United Nations Food and Agriculture Organization: Rome, Italy.
FSC. 2000. Principles and Criteria. Document 1.2. Revised February 2000. Forest Stewardship
Council: Bonn, Germany.
FSC. 2004. News + Notes. July 31 2004. Accessed Nov 2004 from www.fsc.org. Forest
Stewardship Council: Bonn, Germany.
FSC. 2006a. FSC Forest Management certificates by continent. Forest Stewardship Council
International Centre. Bonn, Germany. June 21 2006.
FSC. 2006b. FSC National Initiatives, Document 5.1.2. Forest Stewardship Council
International Centre. Bonn, Germany. May 15 2006.
FSC. 2006c. Biomes. Forest Stewardship Council International Centre. Bonn, Germany.
January 9 2006. www.certified-forests.org
FSC. 2006d. Land Tenure. Forest Stewardship Council International Centre. Bonn, Germany.
January 9 2006. www.certified-forests.org
FSC Brazil. 2004. Personal Staff Communication. Email, Nov. 2004.
Guillison, R.E. 2003. Does Forest Certification conserve biodiversity? Oryx, 37(2).
Gwanney, J., Lawson, R., Park, W., and C. Skipton. 2001. Economic Freedom of the World: 2001
Annual Report. Cato Institute: Boston.
Haltia, O. and K.Keipi 1997. Financing forest investments: the issue of incentives. No. ENV-113. Inter-American Development Bank, Washington, DC.
Jenkins, A. 2004. Comments at the Workshop for FSC National Initiatives. FSC 10th Year Anniversary Conference. Bonn, Germany. September 2004.
Laaksonen-Craig, S. 2004. Foreign direct investments in the forest sector: implications for sustainable forest management in developed and developing countries. Forest Policy and Economics, 6:359-370.
Leiteritz, S. 2003. Market for Certified Forest Products. Forest Stewardship Council. Bonn. Germany.

Markopoulos, M. 1999. Community Forestry Enterprise and Certification in Mexico—A Review of Experience with Special Reference to the Union of Zapotec and Chinantec Forestry Communities, Oaxaca. Oxford Forestry Institute: Oxford.

Mayers, J. and S. Bass. 2000. The forest policy pyramid: planning and assessing step-wise progress to improved forest conservation, management and livelihoods at a country level. Paper prepared for the WB/WWF Forest Alliance. IIED. London.

Ozanne, L.K., and R.P. Vlosky. 1997. Willingness to pay for environmentally certified wood products: the consumer perspective. *Forest Products Journal* 47(6):1–8.

Ozanne, L.K., and R.P. Vlosky. 2003. Certification from the US consumer perspective: a comparison of 1995 and 2000. *Forest Products Journal.* 53(3):13–21.

Pagiola, S., J. Bishop, and N. Landell-Mills. 2002. Selling Forest Environmental Services.

Earthscan Publications Limited. London, UK.

Panayotou, T. 1993. Empirical tests and policy analysis of environmental degradation at different

stages of economic development, Working Paper WP238, Technology and Employment Programme. Geneva: International Labor Office, 1993.

Powell, I., A. White, and N. Landell-Mills. 2002. Developing Markets for the Ecosystem Services of

Forests. Forest Trends. Washington, D.C.

Ramesteiner, E. and M. Simula. 2003. Forest Certification – an instrument to promote sustainable forest management? *Journal of Environmental Management.* 67: 87-98.

RECOFTC. 2004. *About Forest governance*. www.recoftc.org/forgov/info.html

Richards, M. 2004. Certification in complex socio-political settings: Looking forward to the next decade. Washington, D.C. Forest Trends.

Rodda, A. 1993. Women and the Environment. Zed Books, London.

Scherr, S., White, A., and D. Kaimowitz. 2002. Making Markets Work for Forest Communities. Forest Trends. Washington, D.C.

Sikod, F. 1996. Certification in Sustainable Forest Management: Economic Concepts and

Indicators. Paper presented at the Conference on Economic, Social and Political Issues in Certification of Forest Management, 12-16 May, Malaysia.

van Kooten, G.C., H. Nelson, and I. Vertinsky. 2005. Certification of sustainable forest

management practices: a global perspective on why countries certify. *Forest Policy and Economic*s, 7:857-867.

Veisten, K. 2002. Potential demand for certified forest products in the United Kingdom and Norway. Forest Science, 48:767-778.

Vlosky, R.P., L.K. Ozanne, and R. Fontenot. 1999. A conceptual model of US consumer willingness-to-pay for environmentally certified wood products. *Journal of Consumer Marketing*.16(2):122–140.

White, A., A. Molnar, A. Martin, A. Contreras-Hermosilla, S. Scherr, and M. Jenkins. 2002. To

Johannesburg and Beyond: Strategic Options to Advance the Conservation of Natural Forests. Discussion paper for the Global environment Facility (GEF) Forest Roundtable. March 11, 2002. New York.

Whiteman, A. 2003. Illegal activities in the forestry sector. Paper presented at the XII World Forestry Congress, September 2003. Quebec City, Canada.

Appendix 1.

Table 1A. Direct barriers to forest certification in developing tropical countries.

DIRECT Barriers	Criteria	Indicators
Land ownership and/or Tenure Rights	*Legal and regulatory framework*	Legislation outlining rights and responsibilities of landholders or users. Regulatory mechanism and institution for implementing land tenure legislation or policy. Internal and external audit of the responsible institution. Independent judicial arbitration system.
	Clear and secure tenure rights	Mapping of land area and boundaries. Provision of official land title agreements. Mechanism for filing and disputing land ownership or land use claims. Legal definition of stakeholder roles. Legal process required for involuntary removal from land.
	Fair distribution of tenure rights	Rules guiding allocation of land licenses or concessions. Public access to information (transparency in activities). The percentage of land owned or managed by communities and Indigenous Peoples.
	Respect for traditional or customary rights	Recognition of Indigenous land treaties. Flexibility in land use policy to allow for more traditional or community management systems.
	Policies that support responsible practices	Long-term concessions requiring management plans and regular audits. Create incentives for SFM (e.g. subsidies, tax breaks, technical support)
	Establishment of a relationship between forest stakeholders	Public consultation with forest stakeholders on policy and land tenure issues. Support for activities that involve public education, legal activism, or information exchange.
Legislation and policies	*Establish land user's responsibility for forest's long-term health*	Forest management plan (short and long term). Clear land use and/or tenure rights.
	Financial incentives for SFM	Taxes or subsidies favoring forestry over other land uses. Streamline government policies. Taxes paid per area harvested. Tax deduction or credits for afforestation.
	Promotion of sustainable forest practices	Support research into SFM practices. Afforestation program(s). Sustainable silvicultural methods. Restrictions on conversion of natural forests or clearing of old-growth forests. Protection of endangered plant and animal species. Protection of other land values (water, wildlife, biodiversity, landscape, aesthetics).
	Monitoring and enforcement of forest practices	Training of auditors, officers, personnel. Regular field audits. Punitive charges for non-compliance. Unbiased dispute panel or court.
	Support services for land users and owners	Technical training program or access to expertise. Market development/access program or initiative.

Governance	*Open and democratic governance*	Government type (e.g. democracy, dictatorship etc.). Level of democracy or autocracy. Civil liberty. Fair and effective justice system.
	Stable governance	Political stability
	Accountability and competence	Transparency of government and forestry sector. Provision of information. Internal and external audit system. Training of public servants.
	Fair and equal access to resources	Corruption Perceptions Index (From Transparency International). Equal distribution of income (e.g. GINI Index)
Institutional environment	*Strong forestry department*	Sufficient staff and resources for forest area.
	Ability for regions and municipalities to make decisions	Decentralization of government power.
	Right to trial of claims or disputes	Fair and unbiased legal system.
	Multi-stakeholder involvement in decision-making	Meetings, consultation and venues for public opinion.
	Role of government in economy	Size of government index (gvt. consumption expenditures as % of total consumption; gvt. transfers and subsidies as a % of GDP).
	Allocation of goods and services occurs via private enterprises and markets	Structure of the economy index (extent of public investment as % of economy; extent of price controls; top marginal income tax rate; degree of military's reliance on conscripts).
	Ability for firms to produce and sell wood products abroad	Freedom to trade index (taxes on international trade revenues as a % of exports and imports, mean tariff rate, variation in tariff rate).
Cost of certification	*Low fixed (direct) costs*	Cost of application, audit and monitoring conducted by certification body. Presence of certification body operating in the country or region. Net revenue of forest operation. Size of area harvested.
	Low indirect costs (good management practices)	Extent of alteration to procedures and practices that is needed. Number of conditions placed on the FM certificate.
	Access to financing	Availability of capital loans. Interest rates.
Access to markets for certified forest products	*Forest product exports*	Value of forest product imports vs. exports. Forest products as % of export revenue. Type of forest products exported (and % of total).
	Forest product exports to North America and Europe	Percentage of forest products destined for North America or Europe.
	International demand for CFPs	Quantity and type of CFPs demanded by large retailers (e.g. IKEA, Home Depot) or governments. Number of CFPs on the market.
	Domestic demand for CFPs	GDP per capita. Population below the poverty line. Equal distribution of income (GINI index).

Ability to meet international requirements for certified forest products	Volume of certified forest products available. Product compliance with international quality norms. Tree species harvested.
Competitive prices	Cost of certification. Percent change in price of tropical timber. Price of tropical timber relative to grain crops.
Cheap and reliable transportation	Presence of reliable port, rail or road infrastructure. F.O.B. shipping cost to North America and Europe.
Access to information and to buyers	Presence of national Buyer or Producer groups for certified forest products. Industry trade fairs held in the country or region. Market development programs from government or other source. Presence of FSC National Initiative or contact person.

Table 2A. Indirect barriers to forest certification in developing tropical countries.

INDIRECT Barriers	Criteria	Indicators
National value of forests	*Economic value of forestry sector*	Forestry sector as percentage of GDP. Forestry sector as percentage of export revenue.
	Social value of forestry sector	Forestry 's contribution to employment. Percentage of private, Indigenous or community forest management. Forest area per capita. Percentage of population that is rural.
	Pressure for exploitation placed on forests	Population density. Human Development Index (HDI). Population living below poverty line. Net deforestation rate. Crop cover as percentage of land.
	Environmental value placed on forests or natural resources	Percentage of protected area as percent of total land area. Ratification of international agreements and conventions.
FSC mandate and forest management standards	*Clearly defined goals for forest certification in tropical regions*	International vision and list of quantifiable objectives for FSC. Regional strategic vision and list of quantifiable objectives (for each FSC Regional Office in the tropics: Latin America, Asia, Africa)
	Coordination of activities and information on forest certification	Presence of FSC national Initiative or Contact Person. Regional Offices able to deliver services (e.g. training, marketing, communications) and coordinate projects. Regular reporting between FSC National Initiatives, Regional Offices and International Center. FSC information, standards, and guidelines in main regional languages (e.g. Spanish for Latin America, French for Asia). Networks of FSC suppliers, buyers and stakeholders.
	Raising awareness of FSC forest certification	International, regional and/or national communication and/or marketing plans. Corporate, NGO, and government partnerships. Involvement of FSC national and international members.
	Access to training and expertise	Number of certification bodies operating in the region. Availability of training or consultation for producers on forest management standards. Availability of training or consultation for producers on accessing funding, markets and business. Network of regional and national technical expertise. Partnerships with educational institutions, government ministries, and research groups.
	Country-specific forest management standards	Existence of national management standard working group. FSC accreditation of forest management standard(s).
	Flexibility of standards	Group certification number of certificates under the Small and Low Intensity Management Forest (SLIMF) standard Establishment of research partnerships. Standard (e.g. stepwise or phased) that recognizes the complexity of tropical forests.

International influence and initiatives	*Financial and political involvement of international NGOs*	Number of international NGOs. Development assistance per capita. Official development assistance (ODA) received.
	Presence of funding agency or NGO that promotes forest certification	For example, World Wildlife Fund (WWF) or GTZ office.
	Foreign investment interest	Foreign Direct Investment (FDI). GDP real growth rate.
Political will	*Government knowledge and support for forest certification*	Institutionalization of forest certification.
	Government knowledge and understanding of SFM	Scientific and technical expertise of staff. Programs supportive of SFM. Policies and legislation supportive of SFM.
	Promotion of SFM to forest stakeholders	Meetings, training sessions and discussion groups.
Consumer buy-in	*Consumer knowledge of forest certification concept*	Spontaneous recognition by consumers of FSC logo, and ability to state what it represents.
	Consumer willingness to pay a price premium for certified forest products	A price premium for certified forest products is paid by consumers (generally more than 5%)
	Consumer's understanding (and lack of confusion) of the different certification schemes	The consumer is able to differentiate between certification schemes.
Small scale of forestry operation	*Forest suitability: tenure, ease of management*	Ownership or management of operation (private or community vs. industrial). Intensity of forest management: rotation age; silvicultural method; stems harvested; harvesting technique etc. Road access to Forest Management Unit (FMU). Size of forest management area.
	Technical, marketing and production capacity	Forestry knowledge of personnel. Developed and effective product distribution channels. Management and market knowledge of personnel. Financial and technical expertise to create new products and maintain high quality of standards.

	Economies of scale	Low investment risk for improving capacity of operation. Costs are easy to absorb.
	Access to information	Size of business network, access to new information.
Social capital	*Empowered population*	Literacy rate. Population living below poverty line.
	Population health and development	Human Development Index (HDI) Infant mortality rate.
	Role of women in society	Disparity in literacy rate between men and women. Number of women in politics.

Marketing of Forest Products: Income and Employment Perspective - An Analysis

** Dr. G. BHASKAR*
Dr. M.YADAGIRA CHARYULU

Abstract
One phenomenon inherent in the nature of the plural society of the Indian subcontinent is the co-existence often in narrow space of populations varying greatly at the level of material and intellectual development (Haimendorf 1985). Confrontation and eventual harmonization are the two possible outcomes of such a state of affairs ((Haimendorf 1985). Though such a state of affairs have influenced and affected many distinct groups, main focus can be diverted towards socially, economically and politically powerful groups on one side and autochthonous societies / groups which persisted until recently in an archaic and in many respects primitive life–style on the other ((Haimendorf 1985). This is about 84.32 millions of tribal population of India according to 2001census, which constitute 8.2 percent of the total population. They are generally called Adivasis implying original inhabitants and are believed to be the earliest settlers in Indian peninsula. Out of such total tribal population, nearly 80 percent are found in central India, 12 percent in North Eastern States and the remaining in Southern India(Verma 1990). The recent studies under "people of India projects" have identified 636 communities among Scheduled Tribes(Singh 1993). From isolated and primitive bands like jarwas, Shompens of Andaman and Nicobar Islands the accultured Bhils, Parajs, Gonds, Chenchus and Koyas which are encysted in multi ethnic milieu, the country presents a colorful mosaic of tribal Life(L. P. Vidyarthi et. al, 1982). We usually find similar features among tribes such as:
They live in relative isolation in hills and forests.
Their sense of history is shallow and mixed with mythology.
They have a very low level of socio economic development.
In terms of their cultural ethos, language, customs, institutions, and beliefs they stand out from other sections of the society.
As Adivasis, the triblas claim to be original inhabitants of India(L. P. Vidyarthi et. al, 1982). Yet for centuries they have been treated as second class citizens. They have remained the poorest of the poor, illiterate, ignorant and cut off from modern economic activity. During the British regime, tribes were totally neglected and were exploited, by then officials and it resulted in a number of revolts against the foreign rule. Many of the tribals sacrificed their lives in the freedom struggle and exemplified as martyrs (K. C. Pandey and P. C. Satapathy, 1989). This has given a fillip to the freedom movement. The independent modern India, inspired by high ideals of human dignity, equality and social justice that have been guaranteed by the constitution of India, the government has taken a keen interest in uplifting the tribals from their voews. The government of India has initiated a hoast of area and group specific activities during the Five Year Plans. As a part of Tribal sub-plan approach, the Govt. of India has taken up Modified Area Development Approach (MADA). At present Tribal sub-plan covers 184 Integrated Tribal Development Projects, 256 pockets of Tribal concentration, 8 clusters and 73 projects for primitive tribal groups. It spread over 19 states and union territories covering 5.01 sq. km and 37.2 million tribal population.
There are 4.2 million Tribals in the state of Andhra Pradesh and it constitutes 6.15 percent to the total population and it is 7.41 percent of the total tribal population of India as per 2001 census. The scheduled area in the state is 29,683 sq. km and it is spread over in 9 districts including Warangal, which is the area of present study. There are as many as 33

tribes in Andhra Pradesh. Gonds, Koyas, Konda Reddy's, Nayakapods, Chenchus and Savaras are some of the important tribes. Each tribe has typical problems of its own due to different socio-economic-political, historical, cultural, ethnic and environmental conditions. Depending on these factors these tribes remain at different levels of socio-psychological orientation, political and economic development but most of them are away from the national main stream. Even, we can find striking difference between tribes living in deep forest and those living in plains in their living conditions, nature of activity, mode of cultivation, employment, income levels, customs, social and cultural manifestations. To protect the interest of the Tribals the Government of Andhra Pradesh in accordance with Govt. of India has come up with a number of regulatory acts time to time such as,

1) Andhra Pradesh scheduled areas land transfer regulation act of 1955
2) Andhra Pradesh scheduled areas money lenders regulation act of 1960
3) Andhra Pradesh debt relief regulation act of 1960
4) Andhra Pradesh scheduled areas land transfer regulation act of 1970(Gopal Rao. N, 1978).

Along with the above specified regulatory acts, the Government of Andhra Pradesh has established Girijan Co-operative Corporation(GCC), Girijan Development Agency (GDA) and Integrated Tribal Development Agency(ITDA) to support the tribes in their production and marketing activities and in promotion of education, employment and general living levels.

TRIBALS AND FOREST – INTERDEPENDENCY:

The forest and the tribals are inseparable, very rightly the tribals consider the forest as their nourishing mother (S. G. Deogaonkar, 1980). India's tribal areas are mostly in forest and adjoining forest land of 63.3 million hectares, which ensures the availability of wide range of forest products. The indigenous people, listed in the constitution of India as scheduled tribes, live in harmony with nature and dependent upon forest and agriculture for their lively hood (Harimendorf,1985). All the tribal populations of Andhra Pradesh were traditionally closely associated with forest, and they are somehow even today spend the greater part of their lives in the forests (TRIFED Approach paper, 2006).

It is for this reason that they were often referred to as 'Jangali', today a derogatory term standing for 'uncivilized' but literally meaning "forest dweller" (Haimendorf,1985). In most parts of the tribal areas of Andhra Pradesh the conditions of middle ages still prevail (Haimendorf,1985). Communities living near forests depend on them for building material, fuel, fodder and often also food in the form of wild fruits and tubers. Preservation of the resources on which the tribes relied on for their different needs was of their own interest, and as long as there is interference from outsiders (advanced non-tribes) the ecological balance was usually well maintained. The forests are in-built elements of the tribal economy. The forest is not only a nourishing mother to them but also protects their inherent culture, which is of utmost value to the tribals. Tribals usually prefer to live in thick forests and for that reason they remain in isolation from the rest of the world and hence they are deprived of the fruits of modern development. Tribal areas lack communication and transportation facilities. Heavy rainfall, existence of a number of rivers and rivulets, *Flora & fauna* are some of the features of the forest. Thus it envelops two different dimensions, on one side forests are an important element in their economy and on the other these have proved to be obstacles in their development. Hence forest policy of any form is to be framed for the maximum of utilization of physical as well as human resources (S. G. Deogaonkar). As the forests are a part of the tribal economy, any forest policy with less concern on tribal development will be a lopsided one. On the other hand, any plan for tribal development also should give priority to exploitation of forest resources for the benefit of the tribals. As the life of tribals is intertwined with the forest, plans must be interlinked at every stage of development. This is an essential pre-condition when we want to raise the standard of living of the tribals and at the same time to preserve their cultural identity.

As the economy of tribals is agro forest based, most of these communities depend on agriculture. But the tribal agriculture is basically a subsistence agriculture and their produce is barely enough for their consumption. The topographical conditions have had direct bearing on the low productivity in tribal agriculture. The location of tribal areas at the altitudes between 1000 and 3000 feet, the terrains being hilly, loss of fertility by soil erosion adversely affects productivity of the soil. The agricultural patterns practiced by the tribals in various parts of the country are of 3 types.

EMPIRICAL STUDY

In order to observe and understand the marketing of forest products by the tribals at micro level a study has been conducted in five tribal habitations of Eturnagaram revenue division of Warangal District of Andhra Pradesh State, India. 20 tribal respondent house holds each from five tribal habitations* viz. Chinnaboyenapally, Dodla, Shivapuram, Lingapuram, and Kondai have been selected at random to study their living conditions ,literacy levels, land particulars, mode and process of collection of forest products and their marketing. The study also aimed to assess the employment and income levels of tribal respondents. For this, a structured questionnaire has been served to collect the primary data. To process and analyze the data bi-variable tables, bar diagrams and live charts are prepared. Among the selected 100 respondent households 60 percent are families of Chenchu tribe and remaining 40 percent are Guthi koyas and most of them are migrated from near by Chattisgadh state. 84 percent of the respondents are below age group of 50 years, and that is to say, most of them are at an younger age. The total population of respondent households is 497 and among them 49 percent are male and 51 percent are female population. Surprisingly, the female population outnumbered the male population and this is in contrast to the general tendency of sex ratio in non-tribal areas. Tribals are very backward in education, and more than 75 percent of the respondent family members are illiterates. To be precise, only 24.35 percent are literates. The literacy level among the sample tribal area is less than the national average of tribal literacy level. Among the five sample habitations illiteracy is strikingly high in Lingapuram and Kondai hamlets. In these hamlets 80 to 88 percent are illiterates. of the total population 62.78. percent are working population and 37.22 percent are nonworking population and most of them are either children are aged. It indicates high work culture among the tribal families. In the total sample 53 percent of respondents are in possession of landed property. Out of a total of 150 acres of land, 40 percent is dry land and 60 percent is wet land. In Lingapuram no respondent is in possession of land. The average size of land holding is less than 3 acres. Among the respondents only Chenchu tribe families are engaged in cultivation. Even today, Guthi Koyas do not know the mode of cultivation. Even for the Chenchus the agriculture produce is not sufficient to meet their minimum needs and therefore they depend on forest products for their livelihood. The money transaction have become common among the tribals and that too particularly among Chenchus residing in Chinnaboyenapally, Dodla and Shivapuram where the transactions in kind are less but in Lingapuram and Kondai where the Guthi Koyas reside. The researchers have observed that among these two tribes, the Guthi Koyas are economically and socially very backward than the Chenchus. Even today, inspite of tribal development activities, the Guthi Koyas do not wear clothes. and their language is unintelligible for outsiders. The researchers have engaged of a 'dubasi' (translator) from Eturnagaram, who knows their dialect well to understand their views on various issues.

MARKETING: INCOME AND EMPLOYMENT

Though some of the tribals possess small pieces of land, it is rainfed. When man soon fails the produce hardly meets their minimum needs. So, they depended on forest products. The tribals collect 22 varities of forest products, these include Gum, Tamarind, Honey, Mohwa, Myrobalans, Dry Amla, Wild Broom, Cleaning Nuts, Marking Nuts, Pungamseed, Nuxvomica and Bee Wax. The tribals usually go into deep forest to collect these items and they spend nearly 90 to 150 days on an average in a year to collect them in different seasons depending on the availability of the products and climatic conditions. In Chinnaboyenapally and Shivapuram villages, where agriculture is also a part of activity, the tribals spend less mandays than those living Dodla, Lingapuram and Kondai whose main activity is collection of forest products. On an average each person is able to collect 8 kgs of forest product per day. These tribals in the remaining days used to work as farm labour and in non-farm activities provided by individuals and sponsored by the

ITDA. Marketing is one of the basic problems of the tribals. The tribals do not have proper transportation and knowledge to market their forest products. Petty traders, merchant-cum-money lenders by taking advantages of ignorance of the tribals try to exploit them. The tribals have to go miles and miles into the deep forest to pick up the forest products and also to go miles to dispose off them and purchase daily requirements. This renders the tribals with weak bargaining power in both the ways. Thus the tribals get very low price to their produce and have to pay relatively high price to the required food and non-food items. With the set up of GCC in 1956 and TRIFED in 1987 and establishment of ITDA at Eturnagaram in 1986 as a monitoring agency, marketing problems of the tribals living in adjacent forest areas have been mitigated to some extent. In the study area the tribals gave us a positive response with regard to the function of G.C.C. G.C.C, with active support form ITDA of Eturnagaram is inculcating awareness among the tribals regarding proper collection and marketing of forest produce. The G.C.C is paying competitive price to the tribals by opening sales counters in tribal village itself to far middlemen in both selling forest products and buying of essentials by the tribals. The minimum and maximum price ranges between Rs. 4/- per kg for tamarind seeds to Rs 140/- per kg for Thabsi Gum of Type I. Their average annual income ranges from Rs. 9,912/- to Rs. 12,380/-. The highest average income is of Dodla hamlet and lowest is of Shivapuram village. All most all the respondents spend more than 50 percent of their income on food items. Tribes also spend some amount of their income on health, education and clothing. Tribals of Lingapuram and Kondai are spending more of their income on food than other tribals. Expenditure on health, education and clothing by tribals of Chinnaboyenapally, Dodla and Shivapuram is relatively more than the others. The income and expenditure of the tribal of study areas is lowest than the tribals of plains and non-tribals. All the tribal families are living in utter poverty.

The present study, though linked up the marketing of forest products and employment and income pattern of the tribals, is not sufficient to generalize the situation of triblas accross the country. As it has been mentioned earlier socio-economic condition of tribals vary from one sect to other sect and from one area to the other. It is because of unique the features of individual tribes, forest area and the policies of the various state Governments also vary. In the present study, ITDA and G.C.C are working together to protect the interests of the tribals in sales and purchases, but this cannot be generalised. It depends upon the vision of the policy makers and mostly on officials who implement such policies at gross root level. Though most of the sample tribals are satisfied with the working of G.C.C and ITDA , lot more is to be done to change the living conditions of tribals. Whatever measures that have been implemented by these agencies are able to make the tribals to continue their earlier life style i.e., doing some cultivation for food products. As far as there is no breakthrough in the policies of the concerned governments, the state of living of tribals will not change. Land alienation, deforestation and modern economic development are adding more harm to tribals. Gradually they are loosing their identity. In order to protect the tribals from exploitation and identity crisis, a comprehensive to tribal development approach is essential. Conservation of forests, recognition and protection of tribal rights, re-assignment of land to the tribals, convincing them to participate the process of modern economic development with assurance to uphold their dignity and identity should be some of the aspects in such an approach.

Abbreviation :

GCC : Girijan Co-operative Corporation.
ITDA : Integrated Tribal Development Agency.
GDA : Girijan Development Agency.
MADA : Modified Area Development Approach.
TRIFED : Tribal Co-operate Marketing Development Federation of India Limited.

TABLE – 6 : WORKING PATTERN

VILLAGE NAME	WORKING	NON-WORKING	TOTAL
CHINNABOYENAPALLI	54	42	96
DODLA.	65	38	103
SHIVAPURAM	59	34	93
LINGAPURAM	70	35	105
KONDAI	64	36	100
TOTAL	312	185	497

Source: Field Data

TABLE – 7: LIST OF FOREST PRODUCTS COLLECTED BY SAMPLE TRIBALS

SL.NO	NAME OF PRODUCTS	RATE (FOR 1KG)
1	DRY AMLA	20/-
2	GUM (different varieties)	60/- TO 140/-
3	MOHWA FLOWER	6/-
4	MOHWA SEEDS	11/-
5	WILD BROOMS	12/-
6	BEE WAX	100/-
7	PUNGAM SEEDS	15/-
8	TAMARIND	9/-
9	TAMARIND SEEDS	4/-
10	ROCK BEE HONEY	80/-
11	CLEANING NUTS	15/-
12	MARKETING NUTS	7.50/-
13	NUXVOMICA	2/-
14	TENDU LEAVES (for 100 leaves)	2/-

Source: Field Data

TABLE - 8: AVERAGE MONTHLY EXPENDITURE OF RESPONDENT FAMILIES (IN RUPEES)

Sl.No	Village name	Health	Education	Cloths	Food	Others	Total
1	CHINNABOYENAPALLI	125	125	166.66	416.66	166.66	1000
2	DODLA.	100	83.33	116.66	583.33	125	1008.33
3	SHIVAPURAM	91.66	33.33	116.66	483.33	100	833.33
4	LINGAPURAM	100	25	41.66	666.66	166.66	1000
5	KONDAI	150	66.66	83.33	583.33	100	983.33

Source: Field Data

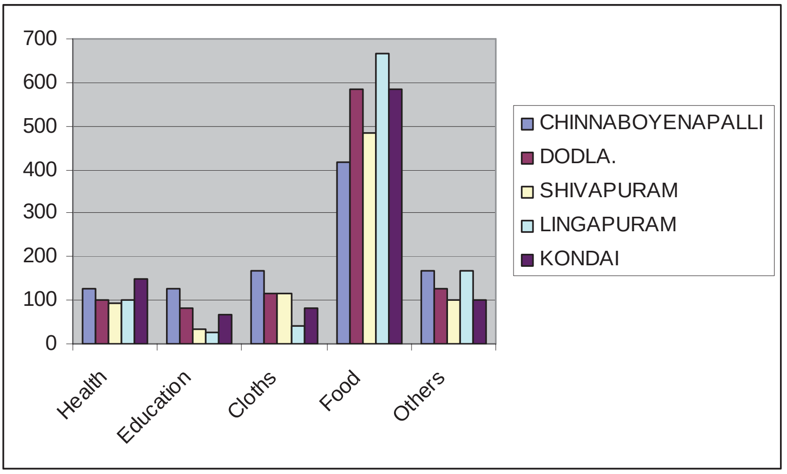


Figure 1

TABLE- 9: EMPLOYMENT AND INCOME POSITION

SL. NO	VILLAGE NAME	NO.OF WORKING PEOPLE	NO. OF MAN DAYS	AVERAGE COLLECTION OF FOREST PRODUCTS (IN KGS)	TOTAL QUANTITY (IN KGS)	INCOME FROM FOREST PRODUCTS (Rs.)	INCOME FROM OTHER ACTIVITY(Rs.)	TOTAL (Rs.)	AVERAGE INCOME FROM FOREST PRODUCTS (Rs.)	AVERAGE INCOME FROM OTHER SOURCES(Rs.)	AVERAGE INCOME (Rs.)
1	CHINNABOYENAPALLI	54	90	8	38880	388800	250000	638800	7200	4630	11830
2	DODLA.	65	120	8	62400	624000	180000	804000	9600	2780	12380
3	SHIVAPURAM	59	90	8	42480	424800	160000	584800	7200	2712	9912
4	LINGAPURAM	70	150	8	84000	840000	-	840000	12000	-	12000
5	KONDAI	64	120	8	61440	614400	140000	754400	9600	2187	11787

Source: Field Data.

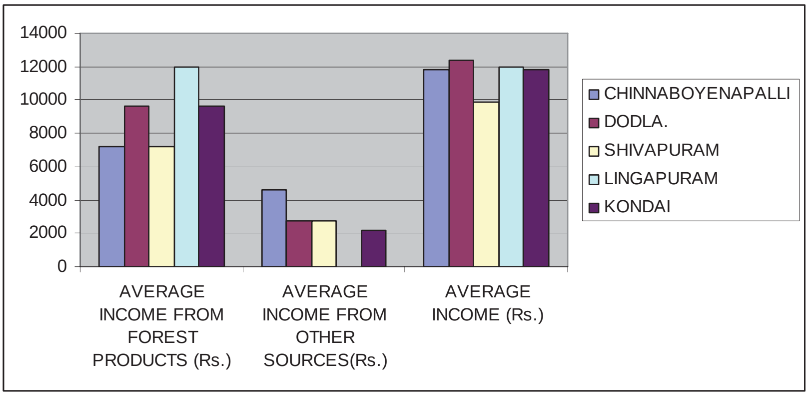

14000
12000
10000
8000
6000
4000
2000
0
AVERAGE INCOME FROM FOREST PRODUCTS (Rs.)
AVERAGE INCOME FROM OTHER SOURCES(Rs.)
AVERAGE INCOME (Rs.)
CHINNABOYENAPALLI
DODLA.
SHIVAPURAM
LINGAPURAM
KONDAI

Figure 2

Sensitivity to scale in stated preference valuation methods. A comparison of methods based on valuation of heath in Denmark

Jette Bredahl Jacobsen, Bo Jellesmark Thorsen and Alex Dubgaard*

Abstract
We compare two methods of stated preference valuation techniques – dichotomous choice contingent valuation and choice experiments – to test for the prevalence of embedding. The test is based on a survey of willingness to pay for the preservation of heath areas in Denmark. Using only one outcome alternative and a status quo in the choice experiment we can compare the two methods using exactly the same estimation procedure. Thereby the differences found can be attributed to the different questioning formats alone. We find differences between the methods, especially regarding the sensitivity to scale.

***Keywords*:** Environmental valuation, stated preferences, choice experiment, contingent valuation, heath, nature conservation

1. Introduction

To be able to design and implement the best possible decisions concerning e.g. environmental conservation and biodiversity protection, policy makers need commensurate value assessments of the non-marketed benefits associated with these activities. One approach to the measurement of non-markets benefits is economic valuation in monetary terms. Economic valuation is based on the assumption that individual preferences for a non-market good can be measured in terms of individuals' Willingness To Pay (WTP) for the provision of the good in question. While the theoretical basis for economic valuation is by now well defined there are still unresolved methodological problems associated with the estimation of WTP. A fundamental question is how do we best make respondents reveal their true preferences, if they have any? Another issue is the intermittent lack of economic rationality in the WTP pattern observed. Insensitivity to scale of the good considered is a special problem in this context. It has proven to be particularly difficult to verify the consistency of individuals' choices where non-use values[1] are involved. Stated preference techniques are the only methods which can capture non-use values; and unfortunately these techniques rely on hypothetical transactions rather than observed behaviour. In this study we will compare two such methods – contingent valuation and choice experiments and discuss the difference in information provided and WTP obtained.

It is beyond the scope of this paper to address all problems associated with stated preference valuation methods. A comprehensive description of these techniques can be found in Bateman et al. (2002). In the following we will focus on the probably most central problem associated with habitat valuation, i.e. embedding. Embedding means that WTP is insensitive to scale or quality of the good being valued. For example, respondents may state the same WTP for a small part of an environmental good as for the entire good.

[1] Non-use value is usually attributed to individuals' satisfaction from knowing that species and ecosystems exist (existence value) and satisfaction from considering the interests of future generations (bequest value).

2. Stated preference valuation techniques

Contingent Valuation and Choice Experiments are the most significant expressed preference techniques within the field of economic valuation. The *Contingent Valuation* (CV) method stipulates a scenario for the preservation or provision of a non-market good, e.g. an environmental service. Having explained the characteristic of the service, the rules of provision, access, method of payment etc. respondents are asked to consider their willingness to pay (e.g. through taxes) for the benefit in question. Whereas CV focuses on a whole scenario *Choice Experiments* (CE) examine the response of individuals to changes in the attributes of a scenario. For example, a habitat improvement could be characterised by the levels of various species it supports, recreational access and payment levels. The choice experiment then examines the trade-offs made by individuals when choosing between different attribute profiles.

2.1 The Contingent Valuation Method

Contingent valuation has been used extensively to estimate use as well as non-use values of environmental goods during the last three decades (for an overview see Smith, 2004). Several WTP elicitation methods have been developed. The *open-ended* format allows respondents to freely state their willingness to pay, whereas the *dichotomous choice* or closed-ended format asks if the respondent would pay some specified amount (varied across the sample). The dichotomous choice procedure resembles the way consumers make choices in a real market. Particular impetus was given to the dichotomous choice approach when it was recommended by the NOAA panel (Arrow et al., 1993).

As noted the CV method faces some critical problems, especially related to respondents' comprehension of the good provided. This may lead to embedding as defined above (see e.g. Carson et al., 2001; Carson and Mitchell, 1995; Hanemann, 1995). Failure to bring about rational responses has caused some economists to question the validity of the method (Kahnemann and Knetsch, 1992; Kahneman *et al*., 1999), whereas others have emphasised the need for better design in surveys and awareness of possible reasons for lack of scale sensitivity (Carson et al., 2001; Giraud et al., 1999; Rollins and Lyke, 1998). Asking respondents several questions concerning different levels of the good may bring about internal sensitivity to scope (though not necessarily, e.g. Giraud et al., 1999), but already the NOAA panel (Arrow et al., 1993) noted that this procedure may force consistency because respondents will feel bound by their first response, and answer the following in a way to be consistent. Hence, it is generally recommended to evaluate scope in split samples, e.g. expose respondents in subsamples varying first questions with regard to willingness to pay.

2.2 The Choice Experiment Method

CE and CV are quite different in their description of changes in an environmental good. CV relies on the precise description of a change in the environmental good as such, whereas CE relies on the precise description of changes in the attributes of the environmental good (Boxall et al., 1996).

The first application of CE within environmental economics was Adamowicz et al. (1994) and the first application to non-use values was Adamowicz et al., 1998a). In CE respondents are asked to choose between different choice sets. The choice sets are described by attributes of the environmental good – e.g. a habitat as outlined above – which facilitates the estimation of marginal values of the attributes. It may be a way to get around embedding problems since sensitivity to the level of the good provided is to a larger extent inherent in the method (see e.g. Hanley et al., 1998b; Lehtonen et al., 2003). In CE the respondents are asked to choose between often quite complex choice sets, where the level of attributes is varied across choice sets. Often the level of more than one attribute is changed from one choice set to another and that makes it much more difficult for the respondent to control/manipulate his internal consistency in choices. Therefore, internal evidence of scope sensitivity is a stronger test here than in CV. This is especially important for non-use valuation since external validity tests are more difficult here (Adamowicz et al., 1998b).

2.3 Using CV and CE to test for embedding problems

When using CE a crucial question is whether environmental goods can be described by their components alone (as also questioned by Hanley et al., 1998b). Is an attribute based description of an environmental good better or worse than a more 'holistic' description? It can be argued that it is not always possible to describe an environmental good by its attributes. It is obvious that preserving for example certain species is not possible without preserving habitats supporting these species. Nor is it possible to enjoy the recreational values of an environment if it is not preserved. On the other hand, many of the environmental projects being evaluated relates to specific changes in habitats – establishment of trails, increased protection of biodiversity, etc. – which actually represent marginal changes in just the attributes of an environmental good (see e.g. Hanley et al., 1998b).

As mentioned, especially CV is apt to problems of embedding (see e.g. Carson et al., 2001; Carson and Mitchell, 1995, Kahnemann and Knetsch 1992). Economic theory tells that the value of a comprehensive environmental good should be higher than the value of a part of that good. But what if it turns out that the part is valued higher than the whole? For example it could be that a specific species shows a higher value in a valuation study than the habitat with this as well as other species. This could be due to differences in interpretation of the good being valued – that the divisibility and quantification is of the good is not so easily understood by respondents. One could also imagine that if parts are being valued, then the sum of the parts might be larger than the value of the whole – because the single components are not so easily forgotten or caries other cognitive values than does the whole. On the other hand, if important attributes are not considered, or the interdependencies between them are overlooked, a larger value of the whole than of the sum of the parts would be expected. In the present study we have investigated the embedding possibilities mentioned above using CE as well as CV techniques.

2.4 Comparisons of CV and CE results

Previous comparisons of WTP estimates in CV and CE show diverging results. . In a study of hunter's preferences Boxall et al. (1996) find much lower values from CE than CV. They argue that part of the reason for this might be that the hunters did not fully understand the scenario described in the CV survey. Comparing CE with an open ended CV Hanley et al. (1998b) find little difference between the two methods. In another study Hanley et al. (1998a) find little difference between CE and a dichotomous choice CV, but in both cases WTP values were considerably larger than from an open-ended CV specification. Also Lehtonen et al., 2003) find little difference between CV and CE in a comparison of forest conservation programmes as do Adamowicz et al. (1998a). In a study of charity Foster and Mourato (2003) find that WTP-measures from CE was larger than for CV when the whole of the good was valued and smaller when only parts was valued. Accordingly, they conclude that CE is more sensitive to the quantity provided, not only in upward direction, but also downward. As seen, the empirical results are ambiguous with respect to the type of difference found when comparing WTP estimates in CV and CE. This is probably due to differences in survey settings. Therefore, the precise framing of the WTP scenario in the two methods is important. This will be the focus in the following.

CE and CV are quite different in their description of changes in an environmental good. CV relies on the precise description of a change in the environment as such whereas

CE relies on the precise description of the attributes constituting such a change (Boxall et al., 1996). This points at the importance of the description and thereby the interpretation of the good being valued. Adamowicz et al. (1998b) argue that since it is not an everyday task for respondents to value environmental goods the structure of CE as compared to CV might cause respondents to create preferences on the way – after reflecting on the information provided. In a CV setting they have shorter time to form preferences.

Another complication is the statistical methods applied to estimate WTP. CV and CE share the same theoretical background – the random utility framework (e.g. Boxall et al., 1996; Hanley et al., 1998b; McFadden, 1974). However, WTP may be estimated using different statistical approaches. As e.g. Leon (1996) shows different estimators can result in very different results. In the present study we have applied the same statistical approach (a logit model) in the two valuation surveys, using CV and CE respectively. In order to do so the CE survey was specified with only one outcome alternative (and a status quo scenario) for each choice set. Thereby its construction is conceptually identical to the CV scenario. Hence, any differences estimated will be due to the different valuation scenario formats and presentations – and not differences in statistical estimation procedures. In this respect our approach differs from previous comparisons of CV and CE. In the investigations that we know of more than one alternative to the status quo have been presented in the CE choice sets. Consequently, a conditional[2] model has been used to estimate the results (see e.g. Greene, 2002).

We will start by describing the case area (heath) and thereafter the valuation approaches. Section 4 describes the survey and Section 5 the results. We will finish in Section 6 by a discussion of the results put in relation to the description of the good and the question of embedding.

3. Heath in Denmark

The origin of the Danish heath can be traced back to over-exploitation of poor soils since the bronze-age, and they covered more than 600,000 hectares by the year 1822 (Hansen, 1970). Today, the Danish heath areas are mainly located in the western and northern parts of Jutland and cover roughly 80,000 hectares, or approximately 2% of the total land area (Buttenschön, 1993). The drastic reduction in area can be attributed largely to cultivation of the heath (Hansen, 1970). Today, heath areas are protected by law from being converted into other uses. Nevertheless, atmospheric nitrogen deposition and lack of the nutrient-removing traditional agricultural practices are causing grass, bushes and trees to take over. The natural process of nitrogen deposition is currently accelerated by nitrogen being deposited from nearby farms and traffic. The nutrient-poor heath has a special flora and fauna which is not found elsewhere in Denmark. 25 species are red-listed as either acutely threatened or vulnerable (Stoltze and Pihl, 1998), and in Denmark are only found on the heath. All species also exist outside Denmark. Furthermore, the heath has a cultural value as a landscape type, e.g. described in the national romantic literature. A brief telephone survey among responsible regional and state authorities suggests that currently about a fourth of the area is managed such as to preserve the heath ecosystem; the reminder is slowly being overgrown.

4. Method

Both CV and CE are based on the random utility framework (McFadden, 1974). Furthermore CE builds on the idea that the utility of a good is a function of its attributes (Lancaster, 1966). The underlying assumption is that respondents will choose such as to maximise their utility. Hence, the well-known random utility model is the fundament for estimation:

[2] Conditional on the alternatives within a choice set.

$$U_{ij} = V_{ij}\left(x_j, z_i, t\right) + \varepsilon_{ij} . \qquad (1)$$

In this model U_{ij} is the i'th individual's utility of the good j. V_{ij} is a deterministic term depending of the good's characteristics x_j, z_i the individual's characteristics and the price t. The term ε_{ij} is stochastic in the sense that its variation can not be observed by the analyst. The probability that the respondent will choose alternative 1 (over alternative 0 – the status quo) can then be described as

$$\Pr(yes_i) = \Pr\left(u_1\left(y_i - t_i, z_i, \varepsilon_{1i}\right) > u_0\left(y_i, z_i, \varepsilon_{0i}\right)\right) \qquad (2)$$

where u_1 is the utility of good 1, u_0 of good 0 and y_i is the individual's income. The other parameters are as above. Assuming that u is linear in income and its other deterministic parameters and the error term is logistically distributed, the probability of an individual i choosing an alternative can be defined by the logit model:

$$\Pr(yes_i) = \frac{1}{1 + \exp(-(\mathbf{az}_i / \sigma_L - \beta t_i / \sigma_L))} , \qquad (3)$$

where α, β, σ_L are parameters of the model. For further description of the model see e.g. Haab and McConnell (2003). As we have only a status quo and one alternative in CE, the responses were difference coded, making them directly comparable with CV.

5. Survey

Each respondent received a questionnaire with a separate fact sheet, describing the current status, distribution and amount of heath, the biodiversity unique for the heath, the extent of public access and the recreational facilities. Biodiversity was described as a specified number of threatened species. The respondents were told that specific initiatives could be made to preserve the endangered species. This to distinguish it from habitat preservation which could to a large extent be secured without preserving the particular endangered species.

The questionnaire consisted of three parts. The first part contained introductory questions about knowledge and opinions of heath and general nature conservation issues. Then came a dichotomous choice question of WTP. The second part contained the choice experiment and a short description of the attribute levels. The attribute levels are shown in Table 1. The payment vehicle was an extra yearly income tax earmarked for that and only that purpose. The third part contained questions regarding the respondents' socio-demographic characteristics.

Table 1. Attributes and their levels and coding. Bold marks status quo

Attribute	Description given to the respondent	Coding and levels
Area	Area of the total 80,000 ha, which appear as typical heath.	**0 = 20,000 ha** 2 = 40,000 ha 4 = 60,000 ha 6 = 80,000 ha
Species preservation	How many of the 25 red-listed species on the heath will be preserved	**0**, 5, 12 or 25 species
Access	The extent of public access to heath areas	**0 = Access everywhere** -1 = Access restricted to paths and roads
Recreational facilities	The presence of facilities such as tables and benches, toilets, etc.	**0 = No** 1 = Yes
Price	Extra yearly income tax on your household	**0**, 50, 100, 200, 300, 500, 700 or 1,000 DKK/year

In the CV we chose to split the sample such that half of the respondents received questions regarding preserving 40.000 ha and the other half 80.000 ha. This design allowed for an external scope test between the splits, with respect to area. The price levels were the same (except for the zero cost). The contingent valuation question was described by text as (translated from Danish):

'*Imagine a project regarding protection of the Danish heathlands. The project will increase the area which is treated and thus preserved as typical heath from 20.000 ha today to 40.000 ha /80.000 ha. Thereby no heath area/40.000 ha heath will disappear over the coming years*[3]*. With an increased and targeted preservation effort all the 25 endangered plant- and animal species will survive in Denmark. Access and facilities will not be changed.*

Imagine that the above mentioned project will only be accomplished if decided in a referendum. If the majority of Danes vote in favour of the project it will be adopted by law and all Danish households will pay an extra yearly income tax which exactly finance the proposal. This extra income tax will be placed in a special fund which will only be used for this purpose. If the proposal would cost your household XX DKK per year in extra income tax, would you then vote yes or no? (mark one of the boxes below – please bare in mind that the money would be withdrawn from your normal budget whereby you would have less at your disposal for other goods)'

Following this, respondents were asked why they had answered as they did, and after reminding them that the proposal only concerns the preservation of the heath and related endangered species and not other nature protective initiatives, whether they would still vote in favour.

In the choice experiment the respondents were asked to choose between a status quo case and one alternative. An example of a choice-set is given in Figure 1. We used a fractional factorial design of 32 questions (both orthogonal and balanced), which again was

[3] 'Some years' is not specified further, also not on the information sheet

blocked into 4 blocks, such that 4 groups of respondents (for each version) were presented with 8 choice sets[4]. The order of the choice sets within the blocks was randomised.

Choice set 2: Do you prefer the present situation or the suggested alternative?

	Present situation	Alternative
Typical heath of the total 80,000 ha	20,000 ha	80,000 ha
Number of preserved species	0	0
Access	Access everywhere	Restricted to roads and paths
Recreational Facilities	No	Yes
Extra yearly income tax on your household	DKK 0	DKK 500

Choose only one .... ☐ ☐

Figure 1. An example of a choice set (translated from the Danish questionnaire). The example shown is from the version with a quantitative description of species. The qualitative description of species only differs in the second attribute.

The socioeconomic characteristics of gender, age, education, employment status, geographic location and household income of the survey respondents were asked in the end of the questionnaire and compared to relevant information from Statistics Denmark. In general the respondents represented the Danish population well (see Boiesen et al., 2005 for further details).

In May 2004 the questionnaires were sent to a random sample of 784 Danish citizens between the ages 18 and 70 drawn from the Central Office of Civil Registration. After 3 weeks 40% had responded and a new questionnaire was sent to the remaining 60%. In total this gave a respond rate of 59% with 2% lacking too much information to be useable.

6. Results

Table 2 shows the logit estimates for the choice experiment, and Table 3 shows the logit estimates for the similar contingent valuation. As we had follow-up questions in the contingent valuation study, we sorted the results such that ‘don’t-know’ responses were coded as no, respondents who only marked the reason for support was ‘general environmental support’ were removed (they also had the option to choose heath specifically) as were respondent who did not believe the scenario or were otherwise indicating protest to the method. Finally respondents who had said ‘yes’ and when reminded that it was only support for heath and not other environmental goods said ‘no’ were coded as ‘no’. Protests to the payment vehicle was tried included, but due to bad formulation of the question and a contemporary tax stop by the government which was very popular, the large majority, even of the yes-sayers ticked that box. Consequently we found it hard to interpret as protests, but rather as an indication of a general political opinion. The logit estimates of this interpreted result are shown in Table 4. As probit estimates gave very similar results, only the logit estimates are shown.

[4] Fractional factorial design is a reduced design as compared to all combination possibilities where focus is on securing balance and orthogonality between the different attributes. For a good description of these design issues, see Kuhfeld (2004)

Tabel 2. Logit estimates from the choice experiment

Variable	Coefficient	Std.err.	z	P>z	MRS
Area (10.000 ha)	0,0560323	0,0169974	3,3	0,001	25,25
No. of surviving species	0,0238459	0,0040295	5,92	0,000	10,74
Access	0,2052769	0,0760723	2,7	0,007	92,49
Recreational facilities	-0,0011098	0,0757489	-0,01	0,988	-0,5
Price	-0,0022195	0,0001281	-17,33	0,000	1
Constant	0,2984336	0,1013072	2,95	0,003	134,46
N=3168 (453 respondents replying on 1-8 choiceset)					
Log likelihood	-1997				
χ^2	384,64				
Pseudo-R^2	0,0878				

Table 3. Logit estimates for the contingent valuation survey, full sample

Variable	Coefficient	Std. Error	z	P>|z|	MRS
Constant	1,3624	0,3911	3,48	0,000	737
Area	-0,0194	0,0557	-0,35	0,727	-11
Price	-0,0018	0,0004	-5,15	0,000	
N	376				
Log likelihood	-233,66				
X^2	0,0000				
Pseudo-R^2	0,0567				

Notice that the 'Area' preserved attribute is not significant in the CV model whereas it is in the CE. Also the number of species preserved and access to the areas are significant in the choice experiment (these were not varied in CV). Only facilities do not seem to be important.

Table 4. Logit estimates for the contingent valuation survey when the sample is reduced according to interpretation
of follow-up question

Variable	Coefficient	Std. Error	z	P>|z|	MSR
Constant	1,0070	0,3884	2,59	0,010	375
Area	-0,0245	0,0550	-0,45	0,656	-9
Price	-0,0027	0,0004	-6,85	0,000	
N	389				
Log likelihood	-239,58				
χ^2	0,0000				
Pseudo-R^2	0,1062				

Table 5 compare the derived WTP estimates from the different models with a non-parametric estimate (a lower-bound Turnbull estimate, see Haab and McConnell, 2003) for calculation procedure hereof). It is seen that the results for CE and the full sample of CVM are very similar when both are estimated with a logit model, whereas the the lowerbound Turnbull estimates gives lower results. The CV shows no sensitivity to the amount of heath preserved, whereas CE clearly does (and also does for the number of species preserved). Consequently the WTP for the CE logit estimates, where a small area is preserved, is lower for CE than for CV (logit), whereas the opposite is the case when the large area is preserved.

A crucial question is how to perform interpretation of the CE data through follow-up questions. If we make the rough assumption that the respondents excluded from CVM are also excluded from CE the respective WTP estimates becomes 451 DKK[5]/40 000 ha and 558 DKK/80 000 ha respectively. Alternatively we could exclude respondents who consequently rejects or accepts an alternative. This results in estimates of 510 DKK/40 000 ha and 596 DKK/80 000 ha, but some of the excluded respondents might be true zero bidders or have WTP higher than the suggested bids.

Table 5. WTP estimates for the different models, DKK

WTP estimates	**Logit-estimator**			**Lowerbound-turnbull**	
	CE	**CVM -full sample**	**CVM - interpreted sample**	**CVM -full sample**	**CVM - interpreted sample**
Preserving 40.000 ha	596	695	339	524	295
Preserving 80.000 ha	697	653	302	516	322

7. Discussion and conclusion

Like several other studies the present investigation demonstrated the prevalence of embedding. For the CV part of the analysis the questionnaire allowed for an *external* test of scope-sensitivity. As the results in Table 3 and Table 4 clearly indicate, the 'Area' attribute has no explanatory power in the Logit-models and hence the null-hypothesis of 'no scope-sensitivity' cannot be rejected. In fact, in most of the models, the 'Area' attribute even have the wrong sign (it is not significant though). Only when we use the Turnbull-estimator on the reduced sample do we arrive at a set of WTP-estimates, where larger area is related to larger WTP – but still not in significant measures. Accordingly, when using the CV methods we experience embedding problems.

The CE-results presented in Table 2 permit an *internal* scope-sensitivity test and here the results reject the null hypothesis of 'No scope sensitivity' as the model implies a linear increase in WTP with 'Area' of 25 DKK/10,000 ha/year/household. The scope-sensitivity is found in a setting where each respondent is faced with a number of different choice sets. Therefore, the question arise if the more attribute focused structure of the CE implies that people become aware of their true tradeoffs among attributes – as Adamowicz et al. (1998b) argue – or if the structure inspires them to express preferences which they realise fit the purpose of the questionnaire, but preferences they do not truly hold. This latter possibility would be an argument in support of the NOAA-panel pointing out the potential weakness of internal scope-sensitivity tests (Arrow et al 1993).

However, there is a great difference between the complexity facing the respondent in a CE setting and the CV questions applied in many embedding analyses. Typical examples are those of Heberlein et al. (2005) and Veisten et al. (2004), where respondents in a CV survey are presented with two or three questions concerning parts of a good or the entire good, e.g. one or two species or the entire biodiversity of a particular habitat. This should make it quite easy for the respondent to consider the consistency of his answers in relation to scope. In the CE, on the other hand, the respondents are asked to consider often quite complex choice sets, where the level of attributes is varied across choice sets. Often the level of more than one attribute is changed from one choice set to another and that makes it much more difficult for the respondent to check the internal consistency of his choices. In the

[5] One Euro is equal to about 7.5 DKK.

current case two attributes were varied across four different levels and the two remaining across two levels – creating a much larger complexity. Therefore, internal evidence of scope sensitivity is a stronger test here than in CV.

A second question relates to the magnitude of the WTP estimates in the surveys using CV and CE respectively. As mentioned previously when using the same estimator differences in WTP estimates between CE and CV must be due to differences in the valuation setting – and not differences in statistical estimation techniques. When using the "full sample" in the CV survey CV and CE provide WTP estimates of similar manitudes. But in CV surveys the sample often has to be reduced due to protest zero bidding and strategical bids[6]. Such a trimming of the sample is more difficult to perform in CE due to the many choice sets where the reckoning behind the answers may be different in different choice sets. Follow-up questions in the CE survey were not used in the present study. Part of the problem may have been solved by the inherent internal scope test in CE, but the difference in size of WTP shows that it might not be sufficient. External scope tests as well as removal of strategic answers would be useful in future CE studies. But probably the problem lies as much in the CV as in the CE – do the follow-up questions in CV reveals the true? It would be interesting to analyse the difference in a study where the CV scenario was described in the same reductionist way – with focus on attribute levels – as in CE. Thereby it could be tested whether it is the description of the good which causes the difference between the two methods or the evaluation scenario as such.

We conclude that the CE survey presented here provides reasonably strong indications of scope sensitivity. In other words, there is no inherent evidence of embedding in the CE survey – in contrast to the parallel CV experiment. Thus, the findings in the present study support the conclusion in Munro and Hanley, 1999) that, all other things being equal, CE provides higher, but also more correct estimates for goods which can be described by their attributes.

References

Adamowicz, W., Louviere, J. & Williams, M. 1994a. Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities. *Journal of Environmental Economics and Management* 26, 271-292.

Adamowicz, W., Boxall, P., Williams, M. & Louviere, J. 1998a. Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation. *American Journal of Agricultural Economics* 80, 64-75.

Adamowicz, W., Louviere, J. & Swait, J. 1998b. Introduction to Attribute-Based Stated Choice Methods. *NOAA - National Oceanic and Atmospheric Administration, Resource Valuation Branch, Damage Assessment Center*

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R. & Schuman, H. 1993. Report of the NOAA Panel on Contingent Valuation. *Federal Register* 58, 4602-4614.

Blamey, R. K., Bennet, J. W. & Morrison, M. D. 1999. Yea-Saying in Contingent Valuation Surveys. *Land Economics* 75, 126-141.

Boisen, J.H., Jacobsen, J. B., Thorsen, B. J., Strange, N. & Dubgaard, A. 2005. Værdisætning af de danske lyngheder. *Skov & Landskab, KVL Arbejdsrapport Skov & Landskab* 14, 68 pp.

Boxall, P. C., Adamowicz, W. L., Swait, J., Williams, M. & Louviere, J. 1996. A comparison of stated preference methods for environmental valuation. *Ecological Economics* 18, 243-253.

[6] A protest zero bid is voting 'no' as a protest against the payment vehicle or valuation scenario whereas a strategic answer is voting 'yes' expecting that 'someone else' are going to pay and not the respondent himself. See e.g. Blamey et al. (1999) for a discussion hereof.

Carson, R. T., Flores, N. E. & Meade, N. F. 2001. Contingent Valuation: Controversies and Evidence. *Environmental & Resource Economics* 19, 173-210.
Carson, R. T. & Mitchell, R. C. 1995. Sequencing and Nesting in Contingent Valuation Surveys. *Journal of Environmental Economics and Management* 28, 155-173.
Foster, V. & Mourato, S. 2003. Elicitation Format and Sensitivity to Scope. *Environmental and Resource Economics* 24, 141-160.
Giraud, K. L., Loomis, J. B. & Johnson, R. L. 1999. Internal and external scope in willingness-to-pay estimates for threatened and endangered wildlife. *Journal of Environmental Management* 56, 221-229.
Greene, W. H. 2002. *Econometric Analysis*. Prentice Hall, New Jersey, 1026 pp.
Haab, T. C. & McConnell, K. E. 2003. *Valuing Environmental and Natural Resources, The Econometrics of Non-Market Valuation*. Edward Elgar, Cheltenham, 326 pp.
Hanemann, W. M. 1995. Contingent Valuation and Economics. In: Willis, K. G. and Corkindale, J. T. (eds.). *Environmental Valuation: New Perspectives*. CAB International, Wallingford, pp. 79-117.
Hanley, N., Macmillan, D., Wright, R. E., Bullock, C., Simpson, I., Parsisson, D. & Crabtree, B. 1998a. Contingent Valuation versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland. *Journal of Agricultural Economics* 49, 1-15.
Hanley, N., Wright, R. E. & Adamowicz, V. 1998b. Using Choice Experiments to Value the Environment. *Environmental and Resource Economics* 11, 413-428.
Heberlein, T. A., Wilson, M. A., Bishop, R. C. & Schaeffer, N. C. 2005. Rethinking the scope test as a criterion for validity in contingent valuation. *Journal of Environmental Economics and Management* 50, 1-22.
Kahnemann, D. & Knetsch, J. L. 1992. Valuing Public Goods: The Purchase of Moral Satisfaction. *Journal of Environmental Economics and Management* 22, 57-70.
Kahnemann, D., Ritov, I. & Schkade, D. 1999. Economic Preferences or Attitude Expressions?: An Analysis of Dollar Responses to Public Issues. *Journal of Risk and Uncertainty* 19(1-3), 203-235.
Kuhfeld, W. F. 2004. Marketing Research Methods in SAS - Experimental Design, Choice, Conjoint and Graphical Techniques, *Technical report* TS-677E. SAS Institute Inc., 782 pp.
Lancaster, K. J. 1966. A New Approach to Consumer Theory. *The Journal of Political Economy* 74, 132-157.
Lehtonen, E., Kuulivainen, J., Pouta, E., Rekola, M. & Chian-Zhong, L. 2003. Non-market benefits of forest conservation in southern Finland. *Environmental Science & Policy* 6, 195-204.
Leon, C. J. 1996. Double bounded survival values for preserving the landscape of natural parks. *Journal of Environmental Management* 46, 103-118.
McFadden, D. 1974. Conditional logit analysis of qualitative choice behaviour. In: Zarembka, P. (ed.): *Frontiers in Econometrics*. Academic Press Inc., New York, pp. 105-142.
Munro, A. & Hanley, N. 1999. Information, Uncertainty, and Contingent Valuation. In: Bateman, I. and Willis, K. G. (eds.): *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*. Oxford University Press, pp. 259-279.
Rollins, K. & Lyke, A. 1998. The case for diminishing marginal existence values. *Journal of Environmental Economics and Management* 36, 324-344.
Smith, V.K. 2004. Fifty years of contingent valuation, in Tietenberg, T. & H. Folmer (Ed.): *The Yearbook of Environmental and Resource Economics 2004/2005*, Edward Elgar.

Veisten, K., Hoen, H. F., Navrud, S. & Strand, J. 2004. Scope insensitivity in contingent valuation of complex environmental amenities. *Journal of Environmental Management* 73, 317-331.

Implementing international standards for phytosanitary measures: impacts and challenges

Majella Clarke

Abstract
To combat the introduction of exotic pests and pathogens via the trade of plants and wood products, phytosanitary measures have been applied at national and international levels. Over the last decade, the International Plant Protection Convention (IPPC) has established a total of twenty-four International Standards for Phytosanitary Measures (ISPMs) to facilitate the flow of trade whilst secure common and effective actions to prevent the introduction of pests from plants and plant products, and promote appropriate control and eradication measures.

These ISPMs are in the general process of being implemented by the IPPC's 144 members at their national levels. The broad context and nature of these ISPMs require both exporters and importers to have up-to-date information from guidelines, systems and requirements, to pest reporting and certification marks.

This paper will present a general overview on the role and function of phytosanitary measures in the trade of wood products at both the national and international level. It will examine the impact that specific implemented standards have had on certain wood product industries, using the ISPM No. 15 and its impact on the international trade of wood packaging materials as an example.

The paper concludes by addressing the imminent challenges of implementing financially viable bioinvasion prevention strategies at a global level. It will discuss the challenges that these ISPMs can have for developing countries. The overview should yield a deeper understanding into the role of phytosanitary measures and the various challenges that National Plant Protection Organisations (NPPOs) and exporters will face in meeting phytosanitary standards.

Keywords: Exotic pests, phytosanitary certification, plant protection organisations, trade, wood

1. The Importance of Phytosanitary Treatments

Phytosanitary measures are becoming an increasingly important issue facing international trade and the sectors that exchange plant material. The accession of their importance can be attributed to the Convention for Biological Diversity (CBD) which released the finding that Invasive Alien Species (IAS) are the second most direct threat to endangered species after habitat destruction. Moreover, several studies in the last decade have emphasised that the economic cost of IAS in terms of eradication programmes and damage to the environment, can no longer be ignored.

Pimental et al (2000) estimate that non-indigenous species in the USA cause major environmental damage totaling approx. USD 137 billion per year. In this study, plant pathogens and pests attacking forest ecosystems caused the loss of approximately USD 7 billion worth of forest products each year in the USA, approx 30% of this is incurred by non-indigenous pests.

In Australia between 1966 and 2001, the cost for detection surveys and fumigation of West Indian Drywood Termite infested buildings and furniture amounted AUD 5.5 million. In Florida, USA, where the pest is a particular problem, annual pest control amounts to around USD 300 million annually (Wylie, 2001).

The agreed interpretation[1] of phytosanitary measures is "Any regulation, legislation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests or to limit the economic impact of regulated non-quarantine pests." (IPPC, 2006). There are a number of phytosanitary treatments that are applied to plant and wood products mainly affecting the agriculture and forest sectors. These treatments may or may not be approved by the IPPC and include:

Fumigation with such substances like methyl bromide, phospine, sulfuryl fluoride, carbonyl sulphide. Only methyl bromide is an acceptable fumigant for wood at the moment, though other fumigants are in review. There is a present lack of experimental data of phosphine fumigation in relation to raw wood pests, but there is some possibility that this fumigant will be widely used in the future.

Heat Treatment is the process in which a commodity is heated until it reaches a minimum temperature for a minimum period of time according to an officially recognised technical specification. (ISPM No. 15, 2002).

Kiln-drying is the process in which the article is dried in a closed chamber using heat and/or humidity control to achieve the required moisture content. (ISPM No. 15, 2002).

De-barking is the removal of bark from *round wood* and is particularly important to the forest sector. De-barking does not necessarily make the wood bark-free. **Bark free wood** requires that wood from which all bark, excluding the vascular cambium, ingrown bark around knots, and bark pockets between rings of annual growth have been removed. (ISPM No. 15, 2002).

Chemical Pressure Impregnation (CPI) includes such processes like high pressure/vacuum process, double vacuum process, hot and cold open tank process, and sap displacement method.

Irradiation is treatment with any type of ionising radiation (ISPM No. 18, 2003) and includes gamma radiation, x-rays, microwaves, infrared, and electron beam treatment.

2. International Plant Protection Agreements

Article 20 of the General Agreement on Tariffs and Trade (GATT) allows governments to act on trade in order to protect human, animal or plant life or health, provided they do not discriminate or use this as disguised protectionism. The World Trade Organisation's (WTO) Sanitary and Phytosanitary (SPS) Agreement applies to all sanitary and phytosanitary measures which may, directly or indirectly, affect international trade. WTO members may maintain or introduce measures that result in higher standards if there is scientific justification or as a consequence of consistent risk decisions based on an appropriate risk assessment.

This exception, based on scientific evidence and risk, is the core of many disputes that surround the SPS Agreement. Consequently, to diminish the number of disputes, Article 3 of the SPS Agreement aims to harmonise SPS measures based on international standards, guidelines and recommendations. With respect to plant protection, the IPPC has the function of setting, harmonising and implementing International Standards for Phytosanitary Measures (ISPMs). However, neither the IPPC nor SPS Agreement supplement the other, rather they are complementary instruments where they overlap. Concisely, the SPS Agreement makes provision for plant protection in a trade agreement, and the IPPC makes provisions for trade in a plant protection agreement.

Suggestions for topics for ISPMs can be made by National Plant Protection Organizations (NPPOs), Regional Plant Protection Organizations (RPPOs), the IPPC

[1] The agreed interpretation of the term phytosanitary measure accounts for the relationship to Phytosanitary measures to regulated non-quarantine pests. This relationship is not adequately reflected in the definition found in Article II of the IPPC (1997).

Secretariat or the WTO-SPS Committee. Other organizations, industry groups or individuals may submit proposals for standards through the IPPC Secretariat. Priorities are established by the Interim Commission on Phytosanitary Measures (ICPM) in consultation with the IPPC Secretariat.

Once the standard is approved through various committees, it is implemented through 2 channels, either by a top-down approach from the IPPC to the RPPO to the NPPO, or by national delegates of the IPPC straight to their national NPPO.

3. National Plant Protection

National implementation is a much more practical process and can take some time to change the current system. From the public sector, the quarantine and inspection services are most impacted. Many are currently going through a restructuring process to meet the demands of increasing international trade and risk of bioinvasion. Knowledge and information in national plant protection services require constant upgrading, which means the training and recruitment of officials is an on-going process. The international exchange of information on IAS also plays an important part in mitigating the risk of IAS. National plant protection organisations can and should play an instrumental role in sharing information on IAS, requiring technology and infrastructure.

The impact of ISPMs, RSPMs and national phytosanitary measures on the private sector, and specifically the trade of wood products, are also of a different nature. Increasingly, Phytosanitary certification and a variety of treatments, depending on the type of commodity, are required. Time delays at ports can lead to the expiration of phytosanitary treatments, and emergency measures can mean that whole consignments are destroyed or rejected. As a consequence, conforming to increasing number of pest control regulations will increase the cost of international trade in these products.

The bottom line for the quarantine and inspection services (public sector) is that even though the general inspection rate for most developed countries is in a general decline relative to import volumes, the prevention, control and eradication of IAS requires expert knowledge and modern infrastructure, which leads to increased operating costs.

4. ISPM No. 15

To demonstrate the method of implementation of ISPMs and the impact and challenges that implementing ISPMs can have on the forest sector, we examine ISPM No. 15 *Guidelines for regulating wood packing material in international trade*. Some NPPOs have already started to implement this ISPM, while others are in the process. Wood packing material is commonly made of raw, low grade, wood that may not have been sufficiently treated to remove or kill pests. Often the wood packing material is re-used, recycled or re-manufactured. It does not have a trade commodity code therefore it is difficult to determine the origin of the material and its phytosanitary status. Moreover, it has been a pathway of many pests in which economic and environmental costs have been significant.

For example, the Asian long-horned beetle (*Anoplophora glabripennis*) was introduced via wood packing material from China to the USA in the late 1990s. The extent of the environmental and economic damage to New York City and Chicago is estimated to have a present value of USD 59 million over the next 50 years to eradicate and control in urban areas (APHIS, 2003). Due to the risks and international trade disputes, which resulted in approx. 220 standards to deal with individual pests, ISPM No. 15 was an important standard for protecting plants whilst facilitating international trade.

ISPM No. 15 requires the phytosanitary treatment of wood packaging materials. These include pallets, dunnage, crating, packing blocks, drums cases, load boards, pallet collars and skids which can be present in almost any imported consignment. The standard sets out approved measures and measures not yet approved, but are under consideration.

The approved measures include Heat Treatment (HT), requiring the wood packing material be heated in accordance within a specific time-temperature schedule to achieve a minimum wood core temperature of 56 C for a minimum of 30 minutes. The other approved measure is fumigation with Methyl Bromide (MB) as set out in the temperature, dosage rate and minimum concentration schedule. Fumigation with MB has meet with a lot of international scrutiny, because the substance is being phased out under the Montreal Protocol, therefore it has been necessary to consider alternative forms of fumigation and phytosanitary treatment (as detailed in Annex III of the standard). De-barking may also be required, and depends on national standards.

After the wood packing material has undergone phytosanitary treatment with an approved measure, it must be marked with the IPPC mark that specifies the type of treatment and the two-letter ISO country code, followed by the producer number assigned by the NPPO. This naturally adds significant cost to the whole process.

5. Costs and Impacts

Manufacturers of pallets and wood packaging material must pay for the treatment of their wood if they wish to export in the international market. ISPM No. 15 will affect the wood packaging material market. In the USA it is estimated to cost between USD 1.28 - 2.34 per pallet for firms that fumigate with methyl bromide without gas recapture. Because the gas recapture of methyl bromide is required in California and Texas, the cost of fumigating could be 30-50% higher. The cost of chemically treating a pallet would add approximately 25% to the cost of producing a pallet, which is about USD 7-8.

Given that methyl bromide is being phased out, many of the firms involved in pallet manufacturing are citing that heat treatment in a kiln is the way forward, considering the environmental implications of methyl bromide as an ozone depleting substance. In some cases heat treatment in a kiln can be argued as a cost minimising strategy as well, considering that heat sterilization takes around 5-8 hours and a kiln designed for large bundles can be more efficient than fumigation of bundles requiring some 16-48 hours of treatment (Petree, 2003).

It is estimated to cost between USD 20,000 - 50,000 to build a kiln dry structure, so that the cost per pallet will range between USD 2.50 - 5. However, as the technology develops and becomes available, it is expected that these costs should decrease. According to one kiln manufacturer, it may be possible for pallets to be kiln-dried for about USD 0.26 per pallet (APHIS, 2003).

6. Challenges

The biggest challenge for the IPPC is to draft harmonised standards for phytosanitary measures and ensure that they are implemented by the NPPOs. This requires that the standards be technically sound, and can be scientifically agreed upon. Currently, many NPPOs favour their own standards over the IPPC's standards, citing that the IPPC's e.g. fumigation schedule, or required heat treatments are inadequate to exterminate specific pests of quarantine significance. This is particularly the case in Australia, New Zealand, and the USA.

The Working Group on the Role and Functions of RPPOs found that the RPPOs are independent organisations and not under the control or supervision of FAO or the IPPC. Some RPPOs do not have the capacity to implement IPPC tasks. However it is agreed that they have an important role in standard setting and collaborating with the IPPC. It was also agreed that RPPOs should be more prominent in information exchange and implementation activities between the IPPC and the regional NPPOs. (FAO, 2004) Interestingly, some of the RPPOs have set Regional Standards for Phytosanitary Meaures, which are not connected with the IPPC. For example the North American Plant Protection Organization (NAPPO) has its own set of RSPMs along with its own dispute settlement process. RSPMs No. 4, 10 and 11 are superseded by ISPMs No. 18, 17, and 15 respectively.

The IPPC recognised that there is an urgent need for many Less Advantaged Countries (LACs) to update policies, authority and corresponding organizational arrangements so that they can fully realise the benefits of free, fair and safe trade within their IPPC and SPS obligations (AITIC/FAO, 1998).

Most developed countries and economies in transition have well-established plant quarantine and inspection services, which have the resources to respond to standards, set by the IPPC. In contrast, developing countries are constrained in their quarantine efforts. For example, it was found that pest free areas and areas of low pest prevalence had not yet been identified on the African continent. Moreover, other problems faced include inadequate or obsolete phytosanitary legislation, absence of inadequate information on pests, insufficient human resources and inadequate pest surveillance. Inspection and certification were only some of the problems faced when implementing phytosanitary standards in Africa (Olembo, 2004)

Suglo (2005) reports that Ghana's challenges and problems include incomplete pest records as a result of weak human and technical resources for pest surveillance, diagnosis and identification, pose a problem for pest risk assessments in Ghana. With respect to inspection and surveillance, there is limited expertise and capacities for import inspection and certification as well as destination inspection. Research is also limited as the quality of the PRA is based on the access to information including good libraries, Internet and ICT, which are inadequate in Ghana. As a result of constraints in research, data generation and documentation is very limited, thus resulting in poor decision-making. The current phytosanitary legislation of Ghana is out-dated and inadequate. The challenges for Ghana and its international donors is update current Phytosanitary legislation that meets international standards. In doing so, this would require to build expertise and capacity, committing financial resources to ensure adequate pest surveillance (Suglo, 2005).

7. Conclusion

Phytosanitary treatments and plant protection are becoming increasingly important topics in the international trade of raw and semi-processed products from the forest and agricultural sectors, given the potential economic and ecological damage IAS. While a variety of phytosanitary methods exist, few are accepted in relation to raw wood products and there is a general lack of experimental data on potential substances for fumigation. ISPMs are in the general process of being implemented by NPPOs. However, implementation may take some time if the knowledge and infrastructure resources of a particular NPPO are constrained. ISPM No. 15 demonstrates the rationale for implementing an ISPM, even though treatment schedules and certification requirements are expected to increase the cost of WPM. Consequently, there are a variety of challenges for the various levels of plant protection organisations. Developing harmonised and feasible international standards will make the phytosanitary treatment and inspection processes more efficient and transparent. However, successful implementation will require enhanced knowledge, legislation and infrastructure at a national level, and development cooperation at an international level.

References

AITIC/FAO. 1998. Uruguay Round Agreements - Implications for Agriculture Forestry and Fisheries in the Less Advantaged Developing Countries. Session 4: International Plant protection in Trade. 22nd-23rd September 1998, Geneva, Switzerland.

APHIS. 2003. Regulatory Impact Analysis of the Proposed Rule to Adopt the International Standard on Wood Packing Material in International Trade. Riverdale, Maryland, USA. 31 p.

Convention on Biological Diversity (CBD). 2001. Review of the efficiency and efficacy of existing legal instruments applicable to invasive alien species. (CBD Technical Series No. 2) Montreal, Canada. 42 p.

FAO. 2004. Working Group on the Role and Functions of RPPOs. Report, 8th July 2004. FAO Rome.

IPPC. 2006. International Standards for Phytosanitary Measures (ISPM # 5 - revised) Glossary of Phytosanitary Terms. FAO, Rome. 23 p.

IPPC. 2002. International Standards for Phytosanitary Measures (ISPM # 15): Guidelines for Regulating Wood Packaging Material in International Trade. FAO, Rome. 15 p.

IPPC. 2003. International Standards for Phytosanitary Measures (ISPM # 18): Guidelines for the Use of Irradiation as a Phytosanitary Measure. FAO, Rome. 16 p.

North American Plant Protection Organization (NAPPO). [Retrieved 18.02.06]. http://www.nappo.org

Olembo, S. 2004. Problems Associated with the implementation of the ISPMs in Africa. AU/IAPSC 21st General Assembly held in Dakar, Senegal, 24-28 May 2004.

Petree, J. 2003. Company Moves to Sterilization Kilns for Treating Pallets for Export. *Pallet Enterprise*, January 2003.

Pimentel, D., Lach, L., Zuniga, R. & Morrison, D. 2000. Environmental and Economic Costs of Non-indigenous Species in the United States. BioScience. Vol. 50. No.1:53-65

Suglo, J.V. 2005. Ghana's Experiences and Challenges in PRA. International Plant health Risk Analysis Workshop. Conference Paper and Presentation. October 24-28 2005. Niagara Falls, Canada.

World Trade Organisation (WTO). http://wto.org [retrieved 10.02.06]

Wylie, R. The Impact of Exotic Forest Pests in Australia and New Zealand. Exotic Forest Pests Online Symposium. April 16-29, 2001. http://www.apsnet.org/online/ExoticPest/index.html [retrieved 10.04.06]

Taxation issues in Tanzanian forest decentralisation

Jens Friis Lund and Finn Helles*

Abstract
The paper deals with issues of taxation in relation to decentralisation of forest resources. It presents preliminary empirical data from Tanzania in the form of forest taxation records from 12 villages that have gained jurisdiction over forest products taxation through a decentralisation reform. The analysis shows that (i) decentralisation of forest resources can lead to vast improvements of taxation effectiveness and (ii) taxation of forest products may be regressive or progressive in relation to income distribution. Thus, the effects of increased forest taxation effectiveness on poverty alleviation are ambiguous and highly dependent upon the local pattern of forest utilisation. The indication that forest decentralisation can lead to higher effectiveness in the taxation of forest products contradicts some of the general debate on the effects and potentials of decentralisation on taxation, and, hence, provides an argument for continued decentralisation of natural resources.

Keywords: forest decentralisation, taxation, Tanzania, poverty alleviation.

Introduction
Decentralisation of natural resources currently takes place in a large number of developing countries. An important aspect of this process is fiscal decentralisation. As stressed by Ribot (2002) suitable fiscal provisions are essential in decentralisation processes, as the legitimacy of any democratically elected management body rests upon its ability to act, which again is shaped by the financial situation of the body.

In Tanzania decentralisation of forest resources has provided incentives for local communities to protect forests and trees. Under the old Forest Ordinance of 1959 local communities had no rights to adjacent forest resources or trees on farmland and the central government could issue harvesting licenses without consulting or informing the affected communities (URT 1959). The poor incentives for local communities to protect the resources undoubtedly played a role in the degradation of Tanzanian forests and woodlands. Accordingly, the consensus is that handing over of forest resources to local communities may benefit Tanzania by arresting forest degradation and supporting the development and empowerment of rural communities (MNRT 1998, Wily and Dewees 2001). With regard to distributional issues, the effects of forest decentralisation are less clear-cut and several researchers have argued that restrictions on resource use associated with implementation of forest decentralisation may actually have adverse effects on poor, marginalised and forest dependent groups in rural communities (Kumar 2002). The importance of addressing this issue is underlined by the fact that alleviation of rural poverty is stated as one of the main targets of the Tanzanian natural resources decentralisation process, and that poverty alleviation in general is the most important policy objective of the Government of Tanzania (URT 2000).

Forest decentralisation was initiated in Tanzania in the early 1990s with local communities gaining jurisdiction over non-reserved forest areas through declaration of village land forest reserves. In the period 1995-2003 a massive body of legislation was passed in support of the process. Generally, the legislation is progressive in relation to the degree of autonomy entrusted with village councils[1]. Thus, on unreserved land, village councils have

1 The village council is the lowest level of government in Tanzania. The council comprises 25 councillors who are elected every five years by the village assembly, i.e. all villagers above the age of eighteen.

the authority to manage forest resources and collect and retain all taxation revenue from forest products harvested in their forest reserve (URT 2002). In addition to the legislative process, projects were implemented during the late 1990s in various parts of the country, supported by the governments of the Netherlands, Finland, Norway, Denmark, and Sweden. In this process, a large number of village land forest reserves were established and several thousands of private forest reserves were declared (Wily and Dewees 2001). In reserved forests, forest decentralisation has been promoted through the establishment of joint management agreements dividing the rights and responsibilities of forest management between government authorities and local communities. In total, the current decentralised area is estimated at 2 million hectares, and, with funding from the governments of Tanzania, Finland, Norway, and Denmark as well as the World Bank, the Tanzanian Forestry and Beekeeping Division under the Ministry of Natural Resources and Tourism now seeks to utilise the experiences from the project phase to promote a nation-wide implementation of the concept (Blomley and Ramadhani 2004). The efforts to implement natural resources decentralisation on a national scale are currently pursued in 50 of Tanzania's approximately 115 districts. Thus, both in terms of supporting legislation and implementation on the ground, the Tanzanian decentralisation process has come far and is acknowledged as being one of the most advanced and progressive on the African continent.

This paper addresses the changes in taxation of forest products introduced in the decentralisation process. The issue of taxation should attract prominent attention for a number of reasons. First, taxation is central to the issue of resource sustainability, as it may raise the resource price and thus induce resource scarcity. Ample evidence exists that taxation of forest products by forest administrations in Sub-Saharan Africa has been plagued with very low degrees of effectiveness2 (Treue 2001, Chaposa 2002). Forest decentralisation is seen as an opportunity to relieve this problem (World Bank 2001, Danida 2002). Second, taxation constitutes a potentially important economic incentive to local forest managers, and can thus be important in securing a sustained local initiative. Also, studies on taxation and the general decentralisation process in Tanzania indicate that taxation is central to build and maintain good relations between local government and citizens (Kelsall 2000, Fjeldstad and Semboja 2001). Getting taxation right can thus be viewed as important in securing popular participation and support of forest decentralisation. Third, changes in taxation induced by forest decentralisation are central to the effects of the concept in relation to rural development and poverty alleviation. It is of paramount importance to know whether the taxation in forest decentralisation is regressive or progressive, and whether the financial means generated from taxation are used to finance public goods and infrastructure at the local level.

Although forest products taxation is widely acknowledged as central to forest decentralisation, not much is known about how decentralization influences the taxation. Experiences must be drawn from studies of general decentralisation processes and taxation. These studies are, however, rather inconclusive concerning the question whether further devolution of jurisdiction over taxation leads to improved or deteriorated effectiveness. While some argue that decentralisation leads to improved effectiveness due to the better knowledge and nearness of tax collectors to their subjects (Livingstone and Charlton 1998, Ribot 2002), others argue that decentralisation deteriorates effectiveness as local politicians press for laxity in tax collection due to fears that they will lose the support of their constituents (Smoke 1993, Fjeldstad 2001).

---

2 Effectiveness is defined as the share of taxation revenue actually collected over that which according to the legal provisions must be collected. This is often difficult to estimate why we in this paper focus upon registered taxation only and with changes in taxation effectiveness rather than actual levels.

Based upon detailed records of forest taxation by Tanzanian village governments, this paper seeks to explore the following hypotheses of relevance to taxation in forest decentralisation:

Can decentralisation of forest resources lead to increased effectiveness of taxation of forest products?

Is taxation of forest products regressive or progressive in relation to income distribution?

Study area and methodology

The field study was conducted in January-April 2005 in Iringa District in the Southern Highlands of Tanzania. In the miombo woodlands north of Iringa town 15 villages implemented forest decentralisation under donor support from 1999 to 2003. The woodlands in the study area cover approximately 74,000 ha and consist mainly of areas on village land. For the purpose of managing the woodland areas, all 15 villages have elected Village Natural Resource Committees (VNRC) under the village councils. The main tasks of the VNRCs in relation to forest management are patrolling of the woodlands, revenue collection, and dissemination of information on forest decentralisation to the villagers.

The study area receives less than 1,000 mm of rain annually and the woodlands can thus be roughly characterised as dry miombo woodlands (Frost 1996). Generally, the woodlands are in fairly good condition compared to areas surrounding other larger Tanzanian towns. However, degradation is taking place in some areas, mainly as a result of the demand for woodfuel from the 107,000 inhabitants of Iringa town (Koppers 2002).

The 15 villages have 1,500 to 3,000 inhabitants and the primary economic activity is smallholder agriculture. The main subsistence crops are maize, cowpea, beans and groundnuts, while tomatoes, sunflower and tobacco are the most important cash crops. Some Maasai live as pastoralists in the areas, and generally livestock is an important part of the agricultural system. The main forest production activities are charcoal burning, firewood collection and pit sawing. Charcoal production is especially important in the villages situated in the southern part of the study area, within market distance of Iringa town for woodfuel products. Furthermore, large amounts of firewood are collected in some villages for use in local industries, such as tobacco and fish curing.

Of the sample of 15 villages, 12 were chosen for the purpose of this paper, while 3 were discarded on the grounds of data fragmentation. The 12 villages cover some variation in relevant biophysical variables, such as forest cover, local wood consuming industries, market access, and availability of other important natural resources e.g. fresh water fishing areas.

The study focused upon quantifying the overall taxation from forest products by investigation of VNRC accounts that had been submitted to the Iringa District Lands, Natural Resources and Environment Office (DLNRO). Each month every village is required to submit all permits, receipts, and expenditure vouchers along with a monthly summary report in which the monthly revenue collection and spending are summarised. Some of the villages were visited to collect those records which had not reached the office. Although far from complete, the accounts provide a unique picture of the composition of revenue in terms of products extracted and information about the extractors. In addition to the records, interviews and group discussions were performed with a large number of people comprising ordinary villagers, village leaders, traders in forest products, and forest and public officers at various levels.

Results

The evidence in relation to effectiveness of taxation comprises records of forest taxation by the Iringa District Council and 12 villages. From Table 1 it is clear that large variation exists between villages in the amounts collected.

Table 1: Annual forest tax collection in Tanzanian Shillings (Tshs) 2002-2005 (Tshs 1,000 ≈ USD 1.0)[3]

Village \ Year	2002	2003	2004	2005	Average
Chamdindi	464,640	252,825	NA	NA	358,733
Itagutwa	487,680	602,640	733,200	847,500	667,755
Izazi	758,900	1,054,000	NA	NA	906,450
Kinywang'anga	564,480	409,100	409,700	939,000	580,570
Kitapilimwa	83,250	97,200	202,000	707,314	272,441
Kiwele	511,920	1,491,420	2,378,400	2,079,050	1,615,198
Makatapora	340,114	550,500	370,200	NA	420,271
Mangawe	747,600	454,140	582,764	873,600	664,526
Mfyome	1,329,000	1,490,700	2,414,200	2,313,400	1,886,825
Migoli	2,210,860	2,573,400	2,256,720	NA	2,346,993
Nyang'oro	502,200	566,550	1,048,500	NA	705,750
Usolanga	147,429	171,429	464,572	NA	261,143
Total					10,686,655

Records of district forest revenue collection were available from the Iringa DLNRO which held records of collection of cess and royalty[4]. Table 2 presents the total amount of forest taxes collected by the DLNRO from 1993 – 2002. Unfortunately, we were unable to obtain more recent figures. In 2001, two independent investigations estimated that forest products valued at Tshs 420-700 million were liable to payment of royalty and cess in Iringa Rural District (Mallango 2001, Koppers 2002). It appears from Table 2 that the actual forest revenue collection in 2001 was Tshs 4.4 million, giving a compliance rate of around 1 per cent.

Table 2: Annual forest tax collection (Tshs) in Iringa Rural District 1997 – 2002.[5]

Year	1997	1998	1999	2000	2001	2002
Royalty	9,820,280	5,591,000	797,550	1,232,000	NA	4,400,420
Cess	7,433,710	6,640,380	1,361,240	195,000	NA	1,491,280
Total	17,253,990	12,231,380	2,158,790	1,427,000	4,395,280	5,891,700

---

3 For each month the reported figure is the highest of the monthly report figure and the sum of individual receipts, as we assume that villages have no incentive to over-report revenue collection. As figures were not available for all months, the annual figures have been calculated as 12 times the average monthly figure for a particular year. Years for which figures were available for fewer than three months have been designated *not available* (NA).

4 The taxation of forest products from non-decentralised forest areas of Tanzania comprises two parts (i) district cess and (ii) central government royalty.

5 Source: Based on DLNRO (2005) and Koppers (2002)5

When comparing Tables 1 and 2 one can see that the 12 villages have collected more than the tax collected in the rest of the IRD comprising 176 villages6. This is a strong indication that effectiveness of taxation has increased as a consequence of decentralisation.

In relation to income distribution effects of forest taxation, the evidence is in the form of records of product categories being taxed, information on whether the taxes have been paid by villagers or outsiders, and literature studies and observations. Table 3 shows that taxation of charcoal and firewood together comprise almost 75 per cent of total taxation revenue. Charcoal is mainly sold to traders who supply Iringa town, while firewood is both sold to town markets and used for brick burning and tobacco and fish curing.

Table 3: Forest taxation shares in percentages per product category based on 2002-20057

Product / Village	Charcoal	Dry firewood	Fresh firewood	Timber tree	Canoe tree	Farm clearing	Grazing permit	Canoe permit	Tourism	Sale of impounded goods	Fine	Other
Chamdindi	9.8								72.5		4.9	12.8
Itagutwa	39.0	39.6	16.3			0.1					4.6	0.4
Izazi	2.2	22.4		20.0	54.9							0.4
Kinywang'anga	63.8	35.4										0.8
Kitapilimwa	49.9	0.2	47.3								2.7	
Kiwele	23.2	33.4	27.0	4.9			1.8		2.3	0.4	1.2	5.8
Makatapora	0.1	12.4	3.9	27.7	8.3		15.2			6.9	20.7	4.7
Mangawe	31.8	5.4	0.3	4.8	0.5		9.8		1.5	2.2	43.0	0.8
Mfyome	64.9	22.2	4.9	3.1			0.2		0.6	0.8	2.4	0.9
Migoli	8.3	20.8	12.3	3.9	2.5		0.3	18.7	17.1	1.5	13.7	0.9
Nyang'oro	57.5	13.1	1.3	2.4	4.2	3.2	2.0				12.3	4.0
Usolanga				36.7		31.4					31.8	0.7
Share of total	37.1	24.2	12.5	4.0	1.4	0.6	1.7	2.8	4.0	0.8	8.4	2.5

Through identification of names on receipts we have estimated that at least 34 per cent of forest products taxes are paid by non-villagers, being mainly traders from Iringa town. In one village, Mfyome, this share is almost 65 per cent. The actual effect of the tax, however, depends on the relative market power of producers and traders. This question was investigated through interviews, but no clear result appeared. There are, however, indications that the market power of producers has improved as a consequence of decentralisation. Previously, almost all production of charcoal was illegal and it happened that traders simply took the products from the producers without paying, under threat that they would report the illegal production to the district forest officers. According to the producers interviewed, such incidences no longer take place and they now receive a better price for their products. Thus, the actual costs of taxes are shared among producers and traders, implying that the traders provide a net cash flow into the village economy.

The above discussion does, however, not deal with the distributional effects of the tax internally in the village. Also in relation to this, the evidence is mixed. A study from Malawi showed that people producing charcoal and firewood for selling to traders are among the poor in village communities (Fisher 2004). Conversely, people who grow tobacco are usually not

6 The figures from before 2002 also include taxes collected from the 12 study villages.

7 These figures are based exclusively on the tax revenue reported on the individual receipts.

found among the poorest. Thus, the effects differ from village to village, which can be exemplified by the village Kiwele. From Table 3 is seen that 60 per cent of the taxation revenue in the village of Kiwele stems from dry and fresh firewood, a large share of which is used to cure tobacco. Before the season for collecting firewood for tobacco curing in 2005, the DLNRO issued a notice to the villages stating that the tax on firewood for tobacco curing should be increased from 4,000 Tshs per cubic metre to 12,000 Tshs. Thus, the relatively wealthy tobacco growers of Kiwele now contribute considerably to the village public finances through the increased tax on firewood.

The strengthening of the taxation induced by the decentralisation of forest resources has, however, had other effects of relevance to income distribution. While production of forest products could previously be done for free by villagers as control was limited to the transport from the forests to town markets, control has now been extended to include also the forests. Thus, villagers seeking to produce charcoal or timber are now required to obtain and pay for a production license before entering the forest to produce. Unfortunately, the cash cost of this license keeps the poorest from producing independently. Accordingly, some of the poorest now produce charcoal or sawn wood as lowly paid casual labourers for more wealthy villagers or traders. The extension of the control to the village level has, however, also had positive effects in relation to the income distribution, as products used mainly by more wealthy villagers who were previously not taxed, such as firewood for tobacco curing and grazing of livestock, are now subject to taxation.

Finally, VNRCs have financed public goods at the village level. Expenditures for these public goods comprise 2 to 20 per cent of total expenditures. This level seems rather low, but the judgment should be mediated by the fact that the total recorded expenditures only cover between 13 and 80 per cent of total taxation income[8]. All villages have opened bank accounts, in which a share of the revenue, which is unaccounted for in the expenditure vouchers, is deposited. Unfortunately, these amounts are unknown to us. The public goods financed by forest taxation include transport of food aid, bridge construction, salary for a school guard, village tractor maintenance and running costs, timber for a school building, expenditures for meetings where forest producers and forest patrol guards solve problems, secondary school contribution, and the construction and maintenance of a water pipe between two villages.

Discussion

The case study has clearly indicated that decentralisation can lead to considerable increases in taxation effectiveness. A decisive factor for the relative success in this case is that jurisdiction to both collect and retain taxation revenue was devolved. Undoubtedly, this provided a strong incentive for village managers to excel in revenue collection, as the revenue collected directly benefited their own finances. One can, however, ask why, if the incentive to collect and retain village finances is so strong, the authority of village councils to arrange campaigns of village contributions to finance schools and other public goods has not been utilised more in the past. Such campaigns are a common source of village council finances in Tanzanian villages. We propose that the answer to why the decentralisation of taxation of forest resources has proved so effective compared to other local revenue sources is fourfold. First, the revenue raised from campaigns of village contributions cannot be used for allowances to village counsellors, but must be used strictly for the purpose for which it has been collected. Thus, village counsellors do not perceive a personal economic incentive to collect. Second, while other

8 The purposes of expenditures can only be seen from the individual expenditure vouchers. Thus, not all the total forest taxation income of the villages is accounted for.

taxes, such as the development levy9, have affected the majority of villagers, the taxation of forest products affects only smaller groups within the villages, and often groups that are poor and politically marginalised, i.e. charcoal producers living in isolated hamlet away from the main village. Third, it is generally acknowledged in the villages that utilisation of forests resources contributes to environmental degradation and impoverishment of the nation (Brokington unknown). It is thus socially acceptable to tax such utilisation. Finally, there is no doubt that the successfulness of the 12 villages in taxation is partly due to the influence of the Danida financed project activities that focused upon capacity building activities at the village level.

Whether the taxation is regressive or progressive depends upon the income status of households that pay the taxes, the relative market power of the actors in the chain-of-custody for the products being taxed, and how the taxation revenue is distributed in the village. The empirical evidence from the case study is hardly conclusive. In areas where the forest is used mainly for tobacco curing or where tight supply of charcoal pushes traders to bear the taxation cost and the taxation revenue is spent upon public goods at the village level, the taxation can be progressive. The evidence in the literature that (i) the poorest depend more on natural resources (Cavendish 2000, Fisher 2004) and (ii) rather than being a way out of poverty, natural resources serve as safety nets in periods of economic distress (Angelsen and Wunder 2003) does, however, indicate that care must be taken when designing the taxation regime for it not to become very regressive. In addition, the related aspects of production licenses and the extension of control from the roads and markets to include the production processes in the forest, should be carefully considered, as they imply higher entry costs to commercial forest production activities and an inherent risk of power abuses against poor and politically marginalised forest users. Thus, the trade-off between tight control with resource use and risk of further marginalisation of certain groups demands sincere consideration.

Conclusion

The paper has shown that decentralisation of forest resources can lead to considerable increases in effectiveness of taxation of forest products and that whether taxation of forest products is regressive or progressive in relation to income distribution is highly dependent upon the local circumstances. The paper speaks to the general decentralisation debate saying that (i) decentralisation of natural resources should be pursued as it may strengthen taxation of natural resources benefiting both the resource and the local democracy and (ii) the decentralisation-taxation effectiveness linkage is complex and depends upon who can collect and retain taxation revenue, and the groups being targeted by the taxation. Moreover, the case study has provided evidence that the contribution of forest products taxation to village public finances is considerable. Thus, decentralisation of natural resources may assist general decentralisation efforts through providing the fiscal means by which local government can act.

Acknowledgements

We would like to express our sincere thanks to the Iringa District Natural Resources Office and the people of Iringa District, Tanzania who have provided information for this paper. The Danish Council for Development Research, O.H.F. and A.J-E. Heilmanns Fond, and Oticon Fonden kindly provided funding.

---

9 The development levy is an annual head tax collected by local government. It was introduced by the British colonial power under the name ‘hut tax’ and was abandoned by the Government of Tanzania as of 2003.

References

Angelsen, A. and S. Wunder 2003. Exploring the forest-poverty link: key concepts, issues and research implications. CIFOR Occasional Paper No. 40, 58 pp.

Blomley, T. and H. Ramadhani 2004. Going to Scale with Participatory Forest Management: Early Lessons from Tanzania, unpublished.

Brockington, D. 2004. Local government, taxation and natural resource management. Corruption, accountability and democratic performance in Tanzania. Unpublished.

Cavendish, W. 2000. Empirical regularities in the poverty-environment relationship of African rural households: Evidence from Zimbabwe. World Development 28:1979-2003.

Chaposa 2002. Charcoal Potential in Southern Africa. Final Report. INCO_DEV: International Cooperation with Developing Countries 1998-2002. Contract number: ERBIC18CT980278.

Danida 2002. Participatory forest management 2003-2007: Tanzania. Environment Support Programme (ESP). Environment, Peace and Stability Facility (MIFRESTA). Danish Ministry of Foreign Affairs. Copenhagen.

DLNRO 2005. Accounts, reports and personal comment. District, Land, Environment and Natural Resources Office. P. O. Box 148. Iringa. Tanzania.

Fisher, M. 2004. Household welfare and forest dependence in Southern Malawi. Environment and Development Economics 9:135-154.

Fjeldstad, O.-H. 2001. Fiscal decentralisation in Tanzania: For better or for worse? CMI Working Paper 2001:10. Chr. Michelsen Institute. Bergen. Norway.

Fjeldstad, O.-H. and J. Semboja 2001. Why People Pay Taxes: The Case of the Development Levy in Tanzania. World Development 29:2059-2074.

Frost, P. 1996. The ecology of miombo woodlands. In: Campbell, B. (ed.) 1996: The Miombo in Transition – Woodlands and Welfare in Africa. Centre for International Forestry Research. Bogor. Indonesia. 266 pp.

Kelsall, T. 2000. Governance, local politics and districtization in Tanzania: the 1998 Arumeru tax revolt. African Affairs 90:533-551.

Koppers, B. 2002. MEMA – Improving Natural Resources Markets in Iringa District – Part I. K Consult. unpublished. 14 pp.

Kumar, S. 2002. Does “Participation” in Common Pool Resource Management Help the Poor? A Social Cost-Benefit Analysis of Joint Forest Management in Jharkhand, India. World Development. 30:763-782.

Livingstone, I and R. Charlton 1998. Raising local authority district revenues through direct taxation in a low-income developing country: evaluating Uganda's GPT. Public Administration and Development 18:499-517.

Mallango, A. S. M. 2001. Improvement of Forest Royalty Collection – A case study of Iringa district. Paper presented at Makambako DNRO’s Workshop 20 - 21/04/2001 by the DNRO of Iringa District. unpublished. 5 pp.

MNRT 1998. National Forest Policy. The United Republic of Tanzania. Dar es Salaam. March 1998. Government Printer. Dar es Salaam. Tanzania. 59 pp.

Ribot, J. C. 2002. African Decentralization. Local Actors, Powers and Accountability. United Nations Research Institute for Social Development. Democracy, Governance and Human Rights – Paper no. 8.

Smoke, P. 1993. Local Government Fiscal Reform in Developing Countries: Lessons From Kenya. World Development 21:901-923.

Treue, T. 2001. Politics and Economics of Tropical High Forest Management – A Case Study of Ghana. Forestry Sciences 68. Kluwer Academic Publishers. 212 pp.

URT 1959. The Forests Act. Order No. 30 of 1st of April 1959. Cap. 389. The United Republic of Tanzania. Government Printer. Dar es Salaam. Tanzania.

URT 2000. Poverty Reduction Strategy Paper PRSP. The United Republic of Tanzania. Government Printer. Dar es Salaam. Tanzania.
URT 2002. The New Forest Act: No. 7 of 7th June 2002. The United Republic of Tanzania. Government Printer. Dar es Salaam. Tanzania.
Wily, L. A. and P. A. Dewees 2001. From Users to Custodians – Changing Relations between People and the State in Forest Management in Tanzania. Policy Research Working Paper. WPS 2569. The World Bank. 31 pp.
World Bank 2001. Tanzania Forest Conservation and Management Project. Project Information Document. Report No. PID8931. World Bank

To plant or not to plant – developing a model to analyse rural households' tree planting behaviour

Jens Friis Lund and Henrik Meilby*

Abstract

This paper deals with rural households' decision regarding tree planting on farmland in developing countries. This has been the topic of numerous descriptive socio-economic studies. In many cases the findings and claims of these studies are ambiguous, although there is a general agreement about the importance of imperfect markets. In addition, no studies that we know of have formalised the tree planting decision in a prescriptive format. In this paper we develop and evaluate a predictive theoretical rational-behaviour model to explore the tree planting decision that encompasses household factor endowments and market characteristics. We elaborate upon the model characteristics and discuss the strengths and weaknesses of the model. In addition, we assess the data needs for the model and the data availability in a Tanzanian context.

Key words: decision model, labour-land ratio, trees outside forest, trees on farmland

Introduction

Ever since the early concerns of environmental degradation following population growth in developing countries, policies and measures to promote tree planting have been part of donor strategies. The integration of trees on private farmland is recognised as a means for improving farmers' livelihoods in areas facing increasing scarcity of forest products. Accordingly, rural households' decision to plant trees has been studied intensively with regard to purposes of tree planting and constraints and opportunities to enhance tree planting. The studies have found that the roles and functions of trees and purposes of tree planting are manifold. Trees may serve to improve crop yields in agriculture (Franzel 1999), alleviate risk through livelihood diversification (Patel *et al.* 1995), function as a capital asset (Dewees and Saxena 1995), alleviate labour requirements in woodfuel collection (Aalbæk 2001), provide fodder for livestock (Hoekstra 1994), improve health through diversification of the diet (Warner 1993), and provide a number of intangible services, such as shade, improvement of microclimate, and erosion control. With regard to opportunities and constraints for enhancing farmers' tree planting the studies emphasise land scarcity (Warner 1993), insecurity of land tenure (Gausset *et al.,* in prep.), adverse climatic conditions (Nyadzi *et al.* 2003), high time preference rates of farmers, poor access to germplasm (Aalbæk, 2001), and the presence of cattle (Warner 1993) as constraining factors, while factors conducive for tree planting are wood scarcity (Patel *et al.* 1995), labour scarcity (Dewees and Saxena 1995), lack of capital to invest in cash crops and paid labour (*ibid.*), and high population density (Patel *et al.* 1995). The effect of access to markets for wood products is ambiguous (Warner 1993, Aalbæk 2001) and some studies argue that insecurity of land tenure is less of a constraining factor in Africa than elsewhere (Warner 1993, Meijerink 1997).

The overall picture obtained from the literature is that the tree planting decision is very complex. Most studies on tree planting are descriptive, and the decision-making process of farmers with regard to tree planting remains thus to be described and analysed in a prescriptive format. Although many of the factors acknowledged to influence the tree planting behaviour of rural households cannot easily be included in a deterministic economic model, we find it useful within such a framework to seek a better understanding of the conditions under which tree planting may be a viable land use alternative. The opportunities and constraints to farmers' tree planting can be grouped in those directly related to the household and those external to the household. Thus, tree planting behaviour is influenced by household preferences and endowments of capital, land and labour in combination with the availability, productivity, and markets for tree products, land, and labour.

The land and labour endowments of a household develops from the time of establishment by a young couple over the period of raising children to the stage where these children either (i) to an increasing degree take over the farm production functions or (ii) establish their own farm or migrate to town leaving the handling of the farm to their elderly parents. When ageing households face declining labour-land ratios surplus land can be sold, rented out, lent to somebody or left unutilised for re-growth of secondary forest. Tree planting may be a fifth and economically superior option. The demographic development of the household is influenced by a number of factors. At the regional level, migration from rural to urban areas leads to labour deficits and a declining area in agricultural production in certain rural areas. In such areas, plantation activities on surplus farmland may yield a higher return to labour and comprise a means by which the remaining population (often dominated by women and children) can enhance their livelihoods. A prescriptive model of households' tree planting behaviour should be able to encompass such aspects. In this paper, we seek to develop such a model.

The model

Our model describes the household from the time of establishment by a young couple, t_0, to the time when the household is dissolved and the children take over the possessions of their parents, T.

Objective function

The objective of the household is to maximise the net present value of the sum of income, I, obtained during the lifetime of the household and the realisation value, R, of the household's assets at time T. The household obtains income by selling firewood from either plantation, I_p, or the forest, I_f, through agriculture, I_a, and by selling land, I_l, and labour, I_w, as well as by withdrawing part of previous years' own savings, I_s. The household's assets comprise the value of agricultural land, plantations and savings, S. Thus, the household's problem can be expressed as:

$$\max\left\{ I + R \right\} = \max\left\{ \sum_{t=t_0}^{T} \frac{I_p(t) + I_f(t) + I_a(t) + I_l(t) + I_w(t) + I_s(t)}{(1+r)^t} + \frac{R_a(T) + R_p(T) + S(T)}{(1+r)^T} \right\} \qquad (1)$$

Households allocate land, labour and cash from own savings to earn income from the above activities. Land is accumulated either through clearing, L_c, or buying, L_b, and households may sell, L_s, land at will. Equation 2 shows that land in agriculture, L_a, equals the sum of net land accumulation and the initial land endowment, L_0, (land inherited) minus land occupied in plantations, which equals the area of plantation established, L_{pe}, within the period $t-n$ to t, where n denotes the rotation time of the plantation. It follows from this that land in plantation is automatically released to agricultural production in the year following clearing of the trees.

$$L_a(t) = \sum_{\tau=t_0}^{t-1} \left(L_c(\tau) + L_b(\tau) - L_s(\tau) \right) + L_0 - \sum_{\tau=t-n}^{t} L_{pe}(\tau), \quad t_0 \le t \le T \qquad (2)$$

Equation 3 shows that households can accumulate savings that will earn an interest and from which they can withdraw to pay cash expenses. Thus, we define savings as an interest bearing investment, such as livestock or other businesses.

$$S(t) = S(t-1)(1+r) - I_s(t), \quad t_0 \le t \le T \qquad (3)$$

where $S(t_0 - 1) = S_0$ is inherited.

Constraints

Households use their own or bought labour as input in production, and may sell their labour. With regard to income generating activities, we distinguish between two seasons, namely dry, d, and rainy, r. Thus, agriculture and plantation establishment can only be done in the rainy season, while the other activities can be performed in both seasons. We have exogenously defined a household demographic typology according to which the labour endowment of the household, w_h, develops over time. α_r denotes the share of the labour endowment available in the rainy season. Households use their own labour endowment or bought labour, w_b, as input to clearing of land, w_c, agriculture, w_a, forest work, w_f, plantation establishment, w_{pe}, and tending, w_p, and for earning income as casual labour, w_s. Thus, the labour constraints are:

$$w_a(t) + w_{pe}(t) + w_{cr}(t) + w_{fr}(t) + w_{pr}(t) + w_{sr}(t) - w_{br}(t) \le \alpha_r w_h(t), \quad t_0 \le t \le T$$
$$w_{cd}(t) + w_{fd}(t) + w_{pd}(t) + w_{sd}(t) - w_{bd}(t) \le (1 - \alpha_r) w_h(t), \quad t_0 \le t \le T$$

To simulate food security concerns, we have included a minimum household agricultural income, $I_{a,\min}$, that is related to the household demographic typology. To describe the poorly functioning capital markets we have introduced a requirement for households that engage in activities involving cash expenses, such as tree planting or buying of land and labour, that they can pay all these costs, $C(t)$, from their accumulated savings from the previous years. To reflect the need for firewood we have included a minimum firewood consumption, $F_{\min}$, that the households must reach either from harvesting in their own plantation, F_p, the forest, F_f, or through buying firewood, F_b. Households may sell any firewood, F_s, in excess of the minimum consumption. Thus, the model has the following constraints:

$$I_a(t) \ge I_{a,\min}(t), \quad t_0 \le t \le T$$
$$F_p(t) + F_f(t) + F_b(t) - F_s(t) \ge F_{\min}(t), \quad t_0 \le t \le T$$
$$S(t-1) \ge C(t), \quad t_0 \le t \le T$$

In addition to the mentioned constraints, non-negativity constraints are included for income, savings, firewood extraction, land and labour. Geographical variation is introduced through differentiated prices on land, labour, and firewood as well as differentiated yields in agriculture and plantation. With regard to this a major practical constraint is the rather large amounts of data needed for parameter estimation. In the following section we present an approach to estimation of model parameters based on data from Tanzania.

The case of Tanzania

We have compiled data from Tanzania for estimation of parameters. The main reasons for choosing Tanzania were relevance and data availability. With regard to relevance, the government of Tanzania strongly encourages tree planting in rural areas to alleviate problems associated with lack of forest resources. With regard to data, we have the privilege of disposing over a unique set of data on tree planting behaviour covering more than 1,500 households in 32 districts of Tanzania (Aalbæk 2001). Under this implementation strategy, we have sought to estimate parameters to provide for district-level variation in agricultural yields and village-level variation in labour requirements to gather firewood from forests. Table 1 displays the different data sources used to compile the parameter estimates for the model in a Tanzanian context.

Table 1: Approaches and data sources for parameter estimates

Parameter	Estimation approach and data sources
Household demographic typology	Regression of household endowments of adult equivalent units (AEUs) on household head age using detailed data on household composition in terms of age and gender and AEU factors from the literature. *Source:* Cavendish 2002:56, National Bureau of Statistics 2002, Own survey from Iringa District, Tanzania
Agricultural yield and labour requirements	Agricultural yields from three main crops in the season 1998/99 at the district level and prices on agricultural crops from seasons 1992-1999 at regional markets. Agricultural labour requirements from the literature. *Source:* Ministry of Agriculture and Food Security 2000, 2005, Ramadhani *et al.* 2002, Alwang and Siegel 1999:1465.
Forest yield and labour requirements	Village means of households' reported walking distance to area of firewood collection combined with own survey of headload weights and conversion factors from the literature. *Source:* Hofstad 1997:23, Aalbæk 2001, Own survey from Iringa District, Tanzania.
Plantation yield and cash and labour requirements	Plantation yield from an on-farm study of woodlot establishment of *Acacia crassicarpa* from Tabora District. *Source:* Ramadhani *et al.* 2002.
Household minimum agricultural income	Constant across the country based on the household demographic typology and estimates of minimum consumption in the literature. *Source:* Alwang and Siegel 1999:1464, modified.
Household minimum firewood consumption	Constant across the country based on the household demographic typology and estimates of minimum consumption in the literature. *Source:* Luoga *et al.* 2000:248, modified, Matthews 2001:211.
Household labour endowments	Constant across the country based on household composition and estimates of labour equivalents from the literature. *Source:* Byingiro and Reardon 1996:130.
Labour requirement to clear land	Constant value based on a survey by the corresponding author. *Source:* Own survey from Iringa District, Tanzania.
Land and labour prices	Constant across the country based on the corresponding author's own research. *Source:* Own survey from Iringa District, Tanzania.
Interest rate	Based on observations in the literature.

	Source: Patel *et al.* 1995:520 (12,5% Kenya), Ramadhani *et al.* 2002 (20% Tanzania).
Observed tree planting behaviour	Observed tree planting behaviour for more than 1,500 households in 32 districts of Tanzania.
	Source: Aalbæk 2001.

It is seen from Table 1 that most of the parameter estimates are based upon empirical data from Tanzania. We have formed the household typology on the basis of data on household composition from Iringa District, Tanzania. Geographical variation in agricultural yield has been estimated from district-level data on yields for the agricultural season 1998/99. Data to describe the geographical variability of yields in plantations and prices on labour and land have been difficult to obtain. Accordingly, yield in plantations has been estimated from a study in Tabora District, and is thus constant for all areas of Tanzania in the model. Likewise, prices on labour and land have been estimated from own research efforts and are also constant in the model. Most of the other parameters have been estimated from published research.

Discussion

Having presented the model and data issues with regard to implementation in Tanzania we now turn to a discussion of the strengths and weaknesses of the model.

We set out to compile a predictive model to explore the tree planting decision by rural households in developing countries. The resulting model enables us to analyse the impact of factor availability, market failures, and geographical differences of relevance to the tree planting decision. We thus believe that the model has the necessary characteristics and elements to serve the purpose. Having said this, there are numerous weaknesses to the model. First of all, it does not include feedback relations, such as income saturation (we implicitly operate with a linear utility function) and increasing scarcity of factors, e.g. rising/falling prices on land and labour caused by rising/falling population density. Another relevant opportunity for improving the model would be estimates of development in soil productivity over time after clearing. Undoubtedly, this factor influences the choices and practices of farmers with regard to land use. Furthermore, using a fixed household demographic typology is a strong simplification. Variation in family structure between geographical areas and variations between households in household composition will assert great influence on the labour and consumption variables for which the household demographic typology forms the basis. In addition, our typology is formed by a regression using static data, which implies that we assume no changes over time in the conditions influencing household demographics, which, of course, is a rather unrealistic assumption. A third and related aspect is that the model does not include geographical differences in population density and development. In the current model, this aspect must be included indirectly through differences with regard to prices on land and labour. Fourth, our model is strictly deterministic, which precludes us from including the important aspects of risk and portfolio considerations in the choice of land use. Finally, the fact that we have specified a household production function implies that intra-household issues such as gender cannot be analysed in the model framework. Then, of course, there are numerous non-economic factors which cannot easily be incorporated in an economic model, such as land tenure issues, rules regulating livestock movements etc.

A major constraint to the implementation is the scarcity of reliable data. The use of regional statistics on agriculture yields based on only one season necessitated some censoring of the data, but even after this process the reliability remains questionable. Tanzanian districts are rather large units within which there exists considerable variation in biophysical variables of importance for agricultural yields. An alternative approach to stratifying the areas within Tanzania with regard to agricultural yields is to base the stratification upon agro-ecological zones. Such an agro-ecological stratification was done by Aalbæk (2001) based upon, among others, Greenway (1973). Another weakness in the data is the lack of variability in the yields of plantations. Currently, plantations in all areas yield the same volumes that are based on a study from Tabora district (Ramadhani *et al.* 2002). There are, however, a number of other studies on yields in farmers' plantation (Okorio and Maghembe 1994, Karachi *et al.* 1997, Nyadzi *et al.* 2003) in Tanzania, but we have, so far, not been able to find enough studies to model geographical variation within the country.

References

Aalbæk, A. 2001. Access to planting material as a major constraint to farmer tree planting: A national investigation of farmer tree planting and nursery production in Tanzania. Ph.D.-dissertation. The Royal Veterinary and Agricultural University. Copenhagen.

Alwang, J. and P. B. Siegel 1999. Labour Shortages on Small Landholdings in Malawi: Implications for Policy Reforms. World Development 27:1461-1475.

Byingiro, F. and T. Reardon 1996. Farm productivity in Rwanda: effects of farm size, erosion, and soil conservation investments. Agricultural Economics 15:127-136.

Cavendish, W. 2002. Quantitative methods for estimating the economic value of resource use to rural households. pp. 17-66. In: Campbell, B. M. and M. K. Luckert (eds.) 2002. Uncovering the hidden harvest. Valuation methods for woodland & forest resources. Earthscan Publications Ltd. p. 254.

Dewees, P. A. and N. C. Saxena 1995. Tree planting and household land and labour allocation: case studies from Kenya and India. pp. 242-267. In: Arnold, J. E. M. and P. A. Dewees (eds.) 1995. Tree Management in Farmer Strategies: Responses to Agricultural Intensification. Oxford University Press.

Franzel, S. 1999. Socioeconomic factors affecting the adoption potential of improved tree fallows in Africa. Agroforestry Systems 47:305-321.

Gausset, Q., Andersen, S. K., Hansen, H., Lund, J. F., Mugasha, A. G., Nathan, I., Ngaga, Y. Nielsen, S. T. and Theilade, I (in prep). Opportunities and Constraints for Private and Communal Tree Management in Majawanga (Gairo, Tanzania), The Transdisciplinary Journal of Environmental Studies.

Greenway, P.J. 1973. A classification of the vegetation of east Africa. Kirkia 9:1-68.

Hoekstra, D. A. 1994. Factors influencing the economic viability of three agroforestry systems in Eastern and Southern Africa. Forest Ecology and Management 64:265-276.

Hofstad, O. 1997. Woodland Deforestation by Charcoal Supply to Dar Es Salaam. Journal of Environmental Economics and Management 33:17-32.

Karachi, M., D. Shirima and N. Lema 1997. Evaluation of 15 leguminous trees and shrubs and wood production in Tanzania. Agroforestry Systems 37:253–263

Luoga, E. J., E. T. F. Witkowski & K. Balkwill 2000. Economics of charcoal production in miombo woodlands of eastern Tanzania: some hidden costs associated with commercialization of the resources. Ecological Economics 35:243-257.

Matthews, J. D. 2001. Silvicultural systems. Oxford Science Publications. Clarendon Press. Oxford. 284 pp.

Meijerink, G. W. 1997. Incentives for tree growing and managing forests sustainably – more than just carrots and sticks. Werkdocument IKC Naturbeheer nr. W-140. National Reference Centre for Nature Management. Wageningen.

Ministry of Agriculture and Food Security 2000. Integrated District Agricultural Survey 1998/99. Dar es Salaam, Tanzania.

Ministry of Agriculture and Food Security 2005. Basic Data for Agricultural Sector 1995/96 – 2002/03. Mainland Tanzania. Dar es Salaam, Tanzania.

National Bureau of Statistics 2002. 2002 Population and Housing Census. General Report. Government Printer, Dar es Salaam, Tanzania.
Nyadzi, G. I., R. M. Otsyina, F. M. Banzi, S. S. Bakengesa, B. M. Gama, L. Mwambo and D. Asenga. 2003. Rotational woodlot technology in northwestern Tanzania: Tree species and crop performance. Agroforestry Systems 59:253-263.
Okorio, J. and J.A. Maghembe. 1994. The growth and yield of Acacia albida intercropped with maize (Zea mays) and beans (Phaseolus vulgaris) at Morogoro, Tanzania. Forest Ecology and Management 64:183-190
Patel, S. H., T. C. Pinckney and W. K. Jaeger 1995. Smallholder Wood Production and Population Pressure in East Africa: Evidence of an Environmental Kuznets Curve? Land Economics 71:516-530.
Ramadhani, T., R. Otsyina and S. Franzel 2002. Improving household incomes and reducing deforestation using rotational woodlots in Tabora district, Tanzania. Agriculture, Ecosystems and Environment 89:229-239.
Warner, K. 1993. Patterns of Farmer Tree Growing in Eastern Africa: A Socioeconomic Analysis. ICRAF. Nairobi. 270 pp

Performance measurement systems - a promising approach for the management of larger forest organizations?

-A case study of the use of modern Performance Measurement Systems in the context of Evaluation and Performance Measurement Theory

C. Hartebrodt, K. Herbohn, J. Herbohn*

Abstract

Performance Measurement Systems (PMS) have become popular over the past two decades. Especially since the mid 1990s there has been a notable increase of organizations using these kinds of management tools. The benefits of PMS are widely accepted in the industrial sector, but there have been ambiguous experiences in the public sector. One of the first implementations in the European forest sector took place in 2000, with the introduction of a PMS system by the Forest Administration of Baden-Württemberg (Germany; BW). This paper reports experiences from the implementation of the system. A questionnaire was developed, based on previous research in the United States, and used to collect information about implementation experiences. Evaluation theory is used as methodological framework; PMS theory provides relevant criteria for the appraisal of the success of these methods. The paper presents the key results of the survey related to nine criteria. The level of acceptance and use of the systems meet international standards. There is a relevant capability to increase the commitment to the strategy and improve the performance of the whole organization. The operationalisation of targets is one key success factor. On the other hand, it is obvious that the implementation of PMS requires a tremendous input of financial and staff resources. There is a significant risk of failure with the multidimensional use. In addition, the derivation of relevant valid indicators for 'soft factors' outside the financial and physical sphere of a forest organization is crucial. It is concluded that PMS is a feasible approach for forest enterprises and administrations. However, its implementation requires a detailed analysis of the organizational and administrational framework. These factors are discussed and highlighted in the form of seven core findings.

***Keywords*:** performance measurement systems, forest management, multidimensionality, strategy implementation.

Introduction

The management of larger forest organisations have become more and more complex during the past decades. Forest enterprises in Central Europe developed from pure timber producers after World War II towards providers of multipurpose benefits for urbanizing societies. Oesten (2004) designates forest enterprises today as 'quasi public' institutions. The change in focus to multiple benefits has meant that much greater importance has been placed on the management of performance in the social and ecological dimensions over the last two decades.

For several reasons, such as the Rio Conference and the dissatisfaction with different management systems focussing only on the monetary dimension, a set of new, multidimensional performance management tools was developed during the early 1990s. A number of Performance Management Systems have been developed, and applied in the industrial sector over the past 15 years. The Balanced Scorecard system has been the most popular (Gleich, 2001). By the late 1990s a number of forest organisations started to adopt these management tools. Up to now there has been only limited knowledge available whether PMS actually fit with the peculiarities of forest enterprises.

In 2000, the State Forest Administration of Baden-Württemberg (Germany) was one of the first forest organisations to implement such a management system. Valuable experiences were gained in the implementation of the system over the following four years. The current study seeks to document those experiences though a survey of those involved in the implementation process. A questionnaire originally developed by Cavalluzzo and Ittner (C&I, 2004) and used in the largest analysis of public sector administrations in the US was modified and then distributed to members of the State Forest Administration.

Performance Measurement Systems inside and outside the forest sector

Background and history of PMS

The implementation of PMS has been part of a number of administrative reforms in the public sector during recent years (Ritz, 2003). There is a wide consensus that two deficits of traditional management systems have promoted the adoption of these new management tools. On the one hand, the limited success of strategy implementation is important. Only 10 to 30% of these processes are considered to be successful (comp. Kiechel; 1982, Ernest & Young, 1998; Horváth, 2001). On the other hand, a number of authors criticize the traditional management systems as being one-dimensional, in terms of focussing only on the monetary dimension (Gleich, 2001).

During the 1990s a number of different approaches were introduced which led to an almost non-manageable number of PMS tools. Hartebrodt, Herbohn & Herbohn (2006) give a systematisation and overview of the different types and subtypes. Despite the fact that there are a large number of these management tools, four key characteristics, which are principal components of all PMS, can be identified.

Tools for strategy visualisation and implementation;

Procedural approach: including development of corporate vision, strategy and objectives, and internal communication and training policy;

Multidimensionality; and Operationalisation of annual and/or midterm goals.

Use and perception of PMS in industry and administrations

The nature of PMS has changed since they gained popularity over the past 15 years. They were initially designed as retrospective monitoring systems but are currently predominantly used as proactive management instruments (Kaplan & Norton, 2001). Even though enormous distinctions exist between the individual branches, they are widely used in the industrial sector. About 40 % of the enterprises of the leading German stock index (DAX) are using PMS. In the industrial sector most of the enterprises see relevant benefits when using this type of management system. (Horváth & Partner, 2004).

The implementation of PMS in the public sector lagged behind the implementation in the private sector by about 5 to 10 years. The implementation in the public sector was in response to a recognition of the importance of non-financial dimensions of an administration’s activities. In the US a law was introduced that obliged public administrations to use PMS (US Senate, 1992). Despite the fact that the experiences in the public sector have been ambiguous (comp. Kuhlmann, 2005; Wollmann, 2004), most authors expect an increasing significance in public administrations (*ibid.).*

Use of PMS in the forest sector

The implementation of PMS in the forest sector started in the US, Australia and New Zealand and shows considerable overlap with the industrial sector. First attempts can be characterized as multidimensional monitoring systems (e.g. Report of the [US] Forest Service, Financial Year 2001 (US Forest Service, 2002)). However, the development constantly moved towards focussing strategic management systems. Coillte introduced one of the first management-oriented PMS in Europe (Coillte, 2002).

In the German-speaking area the adoption of PMS started at the beginning of the new millennium. The State Forest Administration of BW started using PMS in 2000 (Hartebrodt, 2003) while the 'Österreichische Bundesforste AG (ÖBF)' presented a 'Sustainability Balanced Scorecard' in 2002 (ÖBF, 2002). Several larger forest institutions/administrations are planning the implementation of PMS (*e.g.* Hessen-Forst, State Forest Administration Brandenburg) in 2006.

Evaluation Theory and evaluation of PMS

The evaluation of PMS started in the industrial sector, which is not discussed in this paper. C&I (2004) undertook the first extensive scientific evaluation for the administration sector which provided evidence that the experiences with PMS are mixed in the public sector. Ritz (2003) analysed the use of PMS in public organisations in Switzerland and reported on various opportunities as well as considerable threats.

The evaluation of PMS can be seen in the context of 'process-evaluation', because the success of the implementation is analysed in terms of functionality, processes, namely performance, achievement of administrative objectives and satisfaction of the users (Rossi *et al*., 2004). Scriven (1991) provided a systematic approach for evaluation, which is used in the present case study. Table 1 gives an overview of the assignment of the case study Baden-Württemberg to the theory of evaluation research.

Table 1: Assignment of the case study BW to the theory of evaluation research

Summary of the systematic evaluation approach (Scriven, 1991, in Ritz 2003)	Case study State Forest Administration Baden-Württemberg
Selection of study object: Selection of objects, objectives and dimensions.	State forest administration BW used as a case study. The objecttives were developed from C&I (2004).
Definition of criteria: Selection of the set of criteria.	Criteria have been deduced from PMS theory. Most important are the specific targets related to the implementation of PMS, opportunities and threats of new management tools.
Comparison standards: Definition of comparison standards, which allow an appraisal of the present performance in the study object.	Study was designed as a full comparative analysis to the underlying study of (C&I, 2004). The results of this study are used as comparative standards for the case study.
Methods: Definition of research questions, and survey methodology.	Survey of members of middle and upper management.
Evaluation: Statistical depiction of the study results and management summary.	Statistical analysis using univariate and multivariate statistics. Report with concluding comments in terms of recommendations for the further implementation process. General recommendations for the implementation of PMS in forest enterprises.

Material and Methods

In this survey the questionnaire developed by C&I (2004) was used wherever possible. Adaptations were confined to terminology and the legislative and organisational framework. Some specific questions, especially in terms of the role PMS can play in organisations with extremely wide management spans (1:80), were added.

Questionnaires were distributed by post to the 185 members of the upper and middle management of the State Forest Administration. Two reminders were sent out and a response rate of 48% was obtained. The questionnaire did not contain identifying information, and a further measure to ensure confidentiality, the questionnaires were analysed by the two researchers based at the University of Queensland. The last questionnaires were used as an approximate collective for non-respondents (Oppenheim, 1966). Hartebrodt, Herbohn & Herbohn (2006) provide more detailed information on material and methodology.

This paper provides a preliminary assessment of the implementation of the PMS in the State Forest Service. The individual questions were grouped using the nine criteria deduced from PMS theory. Hartebrodt, Herbohn & Herbohn (2006) provide a more detailed description of the theoretical background of PMS and an overview of the deduction of the individual criteria.

Results

Table 1 gives an overview of the criteria-related results of the survey. On the one hand, it shows that the PMS provided benefits in terms of an improved understanding of strategies while, on the other hand, it is clear that the multidimensional use is not yet adopted by the users of PMS in BW. The results in the US can be interpreted as a sign that a longer use may lead to a more intensive use of non-financial dimensions. The validity of the indicators was neither unbridgeable nor solved. The internal system in BW showed a heavier use of operational targets compared with the more or less external systems in the US. The results indicated that the evaluation of performance of business units and managers is widely accepted in the US, whereas this function was of lower importance in BW.

The high share of positive evaluations with regard to process and performance improvement indicated that these systems are capable of integrating working processes into the management focus. In BW the State Forest Administration widely failed to integrate more external effects and indicators. The situation in the US was better, but 100% of neutral evaluations indicated that the integration of external effects is problematic. The effectiveness of the implementation was low in BW, and better but not sufficient in US administrations. All interviewees made neutral evaluations concerning data-availability. This indicated that problems still exist, especially outside the traditional dimensions, but these obstacles were obviously not serious enough to prevent a further use of these systems.

Table 1: Comparative, criteria* related description of the results

		Baden-Württemberg			**USA**		
	N**	+	=	-	+	=	-
	(%)						
Criteria 1: Support of Strategy implementation	**10**	**60**	**40**	**0**	**80**	**20**	**0**
Criteria 2: Multidimensionality	**20**	**5**	**25**	**70**	**20**	**80**	**0**
Criteria 3: Validity of indicators	3	0	100	0	33	67	0
Criteria 4: Operationalisation	**12**	**42**	**58**	**0**	**20**	**80**	**0**
Criteria 5: Use for performance evaluation	11	27	73	0	71	29	0
Criteria 6: Process and performance improvement	5	60	40	0	100	0	0
Criteria 7: Integration of external effects and indicators	10	0	30	70	0	100	0
Criteria 8: Effectiveness of the implementation process	**10**	**10**	**60**	**30**	**25**	**75**	**0**
Criteria 9: Data-availability (contents and technical accessibility	4	0	100	0	0	100	0
Share (related to evaluation criteria)	9	23	62	19	39	61	0
Share (related to individual questions)	85	22	49	28	42	57	0

* core criteria in bold face type ** Number of related questions in the survey in BW; + Acceptance / heavier use, = neutral evaluation / medium use; - Refusal / low use.

Discussion and conclusion

In general, the results indicate that the implementation of a PMS in BW was successful and meets with the results of the study of C&I (2004). For five out of the nine criteria (two out of the four core criteria), a positive evaluation was found. The basic pattern of the evaluation in the US and in the case study shows a considerable overlap (Figure 1)

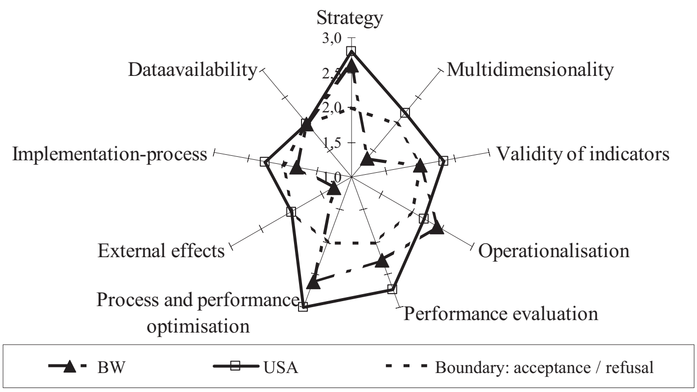


Figure 1: Appraisal of PMS related to the individual evaluation criteria

PMS have the capability to improve the implementation of corporate strategies in the forest sector. There is a wide consensus that this is strongly related to the ability of the forest organisation to define at least a mid-term strategy. This might be a crucial aspect for public institutions, which quite often suffer under a more or less intensive, short term political influence (comp. Ritz, 2003; Frei, Leimbacher & Liebe, 2001).

The implementation of PMS as multidimensional and therefore holistic management instruments is a mammoth task, despite the fact that all these systems seem to be very ‘simple and pictorial’. A strong ‘halo effect’ of the former financial and one-dimensional – management systems was noted. However, there is no evidence that it is not possible to manage the financial sphere with PMS. These difficulties with the multidimensional use are also encountered in the industrial, non-forest sector (Horvath & Partner, 2004; Küng & Krahn, 2000). This is also related to the problems with integrating external effects and key data into the PMS. Managers are not familiar with dealing with mostly non-monetary and external information. A strong relationship to the implementation process and the efforts made with regard to training and communication in the State forest administration in BW is evident. The interviewees stated that they did not receive enough information *e.g.* in terms of the use of these new indicators and how to connect these indicators to the definition of new goals. One major impediment was the fact that the PMS of the State Forest Administration had to be introduced after a sever storm event and therefore training was restricted.

The operationalisation of targets, especially whether targets should be binding on managers and whether indicators used in their performance evaluation are key issues. Addtionally it can be stated that PMS are able to make substantial contributions to the improvement of work and management processes.

The low ratings that many managers gave to the validity of the indicators and data availability while concerning, are however not serious enough to prevent the implementation of PMS in the forest sector. In accordance with other research findings and the vast amount of information provided by the controlling practitioners it can be stated that the implementation of such PMS is a long-term process, operating not in term of business re-engineering but in terms of the transculturation of an organisation.

Implementation of PMS in the forest sector – seven core findings

PMS needs to be developed as part of a mid-term organisational strategy. PMS are not suitable vehicles to trigger short term changes and do not lead to an immediate improvement of the overall performance. This includes that they are not able to promote frequent (often political) shifts in strategy of public forest institutions.

PMS can be used in selected business units or related to a subset of the corporate strategy, but this will increasingly reduce the strategic use and its multidimensionality.

Only internal developed PMS will meet with acceptance and later on with relevance for the business management.

Communication and training of the managers and all other members of the institution is crucial. At least 50% of the input (or preferably 60-70%) is needed after the productive launch of the system.

Multidimensionality requires a tremendous input and leads to new indicators. This implicitly supposes the need to reduce the set of traditional indicators and key data. Otherwise PMS will be perceived more as additional effort than as support.

PMS are not as pictorial and simple as they appear at first sight. The implementation needs a lot of effort and participation and they should not be implanted together with other severe reforms.

The influence of the software used to run PMS systems is comparably low. There is no evidence that sophisticated edp-systems are a key driver for the implementation.

Acknowledgments

We thank the State Forest Administration of Baden-Württemberg for their excellent cooperation.

References

Cavalluzzo, K.S., Ittner, C.D. 2004. Implementing performance measurement innovations: Evidence from government. *Accounting, Organizations and Society*, 29, 243-267.

Coillte 2002. *East Donegal forest Management Plan 2000-2004*; ed. by Coillte, 2002.

Ernest & Young 1998. *Measures That Matter*, Boston 1998, 9.

Frei J., Leimbacher U. , Liebe, L. 2001. *Anwendung des Management-Konzepts 'Balanced Scorecard' im Rahmen des New Public Management: Untersucht am Beispiel des Sportamts der Stadt Zürich*. Diploma-thesis, Universität St. Gallen. 84 pp.

Gleich, R, 2001. *Das System des Performance Measurement: Theoretisches Grundkonzept, Entwicklungs- und Anwendungsstand*, Vahlen, München. 264 pp.

Hartebrodt, C. 2003. Forstliches Controlling – Ein Blick in eine andere Controllingwelt am Beispiel der Landesforstverwaltung Baden-Württemberg. *Controlling: Zeitschrift für erfolgsorientierte Unternehmensführung*, 15. Jg. (11) 2003: 607-614.

Hartebrodt, C., Herbohn, K., Herbohn, J. 2006 (submitted). Mehrdimensionale Steuerungsverfahren - ein erfolgversprechender Ansatz für die Verwaltungs- und Unternehmenssteuerung im Forstsektor? Eine Fallstudie zum Einsatz moderner Managementmethoden im Spiegel von Evaluations- und Performance Measurementtheorie. *Allgemeine Forst und Jagdzeitschrift*.

Horváth, P. 2001. *Strategien erfolgreich umsetzen*. Tagungsband zum 15. Stuttgarter Controller-Forum. Péter Horváth (Hrsg.). Schaeffer-Poeschel, Stuttgart. 431 pp.

Horvath & Partner 2004. *100 x Balanced Scorecard 2003 – Ergebnisbericht*. Studie der Horváth und Partners Management Consultants. 31 pp.

Kaplan, R. S., Norton, D. P. 2001. *Die Strategiefokussierte Organisation – Führen mit der Balanced Scorecard* (Übersetzung der amerikanischen Originalausgabe von Péter Horváth und Damir Kralj). Schaeffer-Poeschel, Stuttgart. 350 pp.

Kiechel, W. 1982. Corporate Strategists under Fire. *Fortune* 27.12.1982, 38.

Kueng, P., Krahn A. 2000. *Performance Measurement Systeme - State of practice und Weiterentwicklung,* Working paper des Instituts für Informatik der Universität Fribourg 00 (12) 2000. 16 pp.

Kuhlmann, S. 2005. Leistungsmessung in Politik und Verwaltung: Reformchance oder Sackgasse. *Cosinex newsletter* 05 (10), 8-11.

ÖBF (Österreichische Bundesforste AG) 2005. *Nachhaltigkeitsbericht zum Geschäftsjahr 2004*, ÖBF, Purkersdorf. 112 pp.

Oesten, G. (2004). Über Perspektiven zukunftsorientierter Waldwirtschaft - Betriebspolitisches Handeln in gesellschaftlichen Spannungsfeldern. *Schweizerische Zeitschrift für Forstwesen* 155/2004, 13-20.

Oppenheim, A.N. 1966. *Questionnaire design and attitude measurement*, Basic Books Inc: New York. 125 pp.

Ritz, A. 2003. *Evaluation von new public management – Grundlagen und empirische Ergebnisse der Bewertung von Verwaltungsreformen in der schweizerischen Bundesverwaltung*. Verlag Haupt, Bern, Stuttgart, Wien. 570 pp.

Rossi, P. H., Lipsey, M. W., Freemann H. E., Howard, E. 2004. *Evaluation: A systematic approach*. 7th ed. B&T; Sage. 470 pp.

Scriven, M. 1991. *Evaluation Thesaurus*. 4. Aufl., Newbury Park/London/New Delhi 1991. 408 pp.

US Forest Service 2002. *Report of the Forest Service, Fiscal Year 2001 – Incorporation Financial and Performance Accountability*. United States Department of Agriculture. 251 pp.

US Senate 1992. *Government Performance and Results Act*. Washington Dc. Committee of Governmental affairs Report, 102-429.

Wollmann, H. 2004. Leistungsmessung (‘performance measurement’) in Politik und Verwaltung. – Phasen Ansätze und Praxis im internationalen Überblick. In: Kuhlmann, S. Bogumil, J. Wollmann, H. (ed.). *Leistungsmessung in Politik und Verwaltung*. Wiesbaden, 21-46.

Collective initiatives on improving work environment in Swedish mechanised forestry – A case of institutional entrepreneurship and change

Oscar Hultåker

Abstract
In 1992 the Swedish Work Environment Authority (SWEA) considered actions limiting the permitted working hours in forest machine operation. As the forest harvesting industry collectively took initiatives aiming at improving the work environment, SWEA agreed to postpone their actions during two years. The forest industry corporations, the forest machine contractors' association, the trade unions, SWEA, and researchers acted together to manage improving activities. After the two years respite, the Work Environment Authority only issued recommendations. The industry actors did not agree on how to continue; hence the initiatives were closed down. Evaluations have shown that several problems still remain. No more comprehensive collective action has been taken against the work environment and occupational health problems in the industry. However, when discussing issues of work environment and occupational health with mechanised forest harvesting contractors and forest machine operators, they still often refer to the initiatives in the middle of the 90'ies. At least the initiatives were successful in raising the awareness among contractors and operators. My aim in this paper is to discuss why the collective initiatives succeeded in raising the awareness among mechanised forest harvesting contractors and machine operators. I do that by analysing documents on the initiatives together with new qualitative interviews with the most central actors who worked on them.
I show how the threat of working time regulation caused a shock in the organisational field which made opportunities for collective action aiming at institutional change. The shock caused by the governmental authorities de-stabilised the organisational field and opened it up for changed norms and rules. Once new norms and rules had been established, the field was stabilised and re-institutionalised. The results show how the acting of institutional entrepreneurs may have long term and unforeseen impact in changing the norms and perceptions of other actors in the field as well as for policy.

***Keywords**:* ergonomics, forest machine operators, innovation system, musculo-skeletal over-load syndromes, organisation theory

Background

Although the mechanisation of forestry work has been a success in reducing the previous high accident rates among motor-manual forest workers, musculo-skeletal overload syndromes has been a severe problem among forest machine operators (Bostrand, 1984; Erikson, 1995; Axelsson, 1998). The over-load problems result from the monotonous and repetitive work operating the machines (Erikson, 1995; Attebrant, Mathiassen, & Winkel, 1998). According to ergonomic research the greatest risks occur when the muscles are exposed to long lasting, monotonous, low intensive work (Johansson *et al.*, 2003). This is also reflected in the Swedish provision on prevention of occupational musculo-skeletal disorders (AFS 1998:1).

In 1992 the Swedish Work Environment Authority (SWEA) prescribed a mechanised forest harvesting contractor to limit the working hours in harvesting machine work to a maximum of four hours non-stop without interrupting break or other work tasks and a maximum of six hours altogether each day. The prescription was appealed. In 1994 an agreement was made between SWEA and the forest harvesting industry including the forest industry corporations, the forest machine contractors' association, and the trade unions. SWEA should postpone further legal actions if the forest industry took active initiatives to solve the over-load problems (Hagberg & Ronström, 1996; *see also* Persson *et al.*, 2003; Synwoldt & Gellerstedt, 2003).

The initiative from the forest industry was organised as a two year project organised and governed by the vocational board of the Swedish forest industry. The vocational board includes representatives of the forest industry corporations, the forest machine contractors' association, and the trade unions. Also SWEA take part of the work in the vocational board. The project emanated from a call within the industry for a project aiming at the development of work environment and production in forestry. In abbreviation the project was called the AND project (*sw.* OCH-projektet). The project was run during 1995 and 1996. The operative work was carried thorough by a small project group of people working with research and development within the forest harvesting industry. The project group was supposed not to carry through their own developmental projects but to initiate and support projects within the forest industry companies and among their forest harvesting contractors (Hagberg & Ronström, 1996).

The project was evaluated by the vocational board of the Swedish forestry industry who stressed improvements especially regarding the number of operators categorised as having high risk or low risk of over-load problems (Hagberg & Ronström, 1996). SWEA was not fully satisfied with the results of the project. They made a decision on a mild recommendation that machine work has to be joined with other work tasks or breaks for at least two hours each working day. This decision was appealed to the Swedish government which confirmed SWEA decision with some minor changes (*see* Persson *et al.*, 2003; Synwoldt & Gellerstedt, 2003). Both the vocational board in their evaluation (Hagberg & Ronström, 1996) and SWEA stressed the need for future actions after the two year project period. The different industry actors could however not agree how to continue the initiative.

During 1997 to 2001 SWEA made two follow-up studies of the effects of the AND project. These evaluations have pointed at a high awareness at different levels in the industry organisations regarding the health problems of forest machine operators, *i.e.* musculo-skeletal overload syndromes. They have also pointed at a high awareness of possible solutions, *i.e.* work rotation. However, despite the high awareness of the problems and possible solutions, they have found that the different possibilities are seldom used. In fact, the later evaluations suggest that there are difficulties finding alternative tasks for the machine operators, thus making it difficult organising work rotation. The evaluations also show that mechanised forest harvesting teams having changed to healthier shift systems show an increased productivity but also that teams later having changed back to previously used shift systems show a further increased productivity (Andersson, 1999; Andersson *et al.*, 1999; Persson *et al.*, 2003; *see also* Synwoldt & Gellerstedt, 2003).

I came to work with the issue of organising the forest harvesting activity in Swedish forestry in 2002. I have been working on the issues of the development of business activities in mechanised forest harvesting contractor companies and the development of work environment in forest machine work. Since 2002 I have met several mechanised forest harvesting contractors and machine operators in my data collecting activities as well as in other discussions, *e.g.* when having presented results of my research. I soon realised that very often when talking about occupational health problems and organising of work contractors and machine operators referred to and still refer to the AND-project.

Perrow (1983) presents two established paradigms when discussing ergonomics of systems of man and machine. Within the design paradigm the central theme is technological efficiency. The operator is a passive actor expected to give correct responses to given stimuli.

Within the human factor paradigm the central theme is biological and psychological limitations of man. However, the operator task still is to give correct responses to given stimuli. Perrow offers a third alternative broadening the human factor paradigm to include also organisational factors. The operator task then changes to be to interact with other humans and the technology in the working system. Perrow put my attention to the challenges of organisation theory for re-interpreting what happened in the AND project. I was strengthened in my conviction as I considered the similarities between the astonishment in the previous ergonomic evaluations of the AND project and the Hawthorne effects in the classical work studies at Western Electric in Chicago described by Mayo (1945).

Aim

This work in progress aim at re-interpreting the AND project by using parts of organisation theory. The previous evaluations of the AND project has to a great extent focused on the lack of success in changing the ways of organising forest harvesting work and the seemingly paradox of a high awareness not giving rise to a change in behaviour. I would like to change the focus. My focus will be the apparent success in implementing the AND project, *i.e.* still ten years after the project was carried through. My focus will be the collective action of institutional actors in changing the attitudes within the industry.

Innovation systems and institutional entrepreneurship

My efforts to re-interpret the AND project start out from innovation systems theory. Rametsteiner, Weiss & Kubeczko (2005) discuss the possibilities to create new employment and business opportunities from forestry in Europe. A central theme for them is how different actors within the forestry sector innovation system together contribute to innovations. This system view of actors in a sector together contributing to innovations stem from Breschi & Malerba's (1997) concept of sectoral innovation systems. The innovation system perspective has also been used within Scandinavian working life research (*e.g.* Gustavsen, Finne & Oscarsson, 2001; Hansson, 2003). They discuss how the different actors in society can create changes in working life, including *e.g.* business actors, trade unions, researchers, and governmental actors.

My efforts to re-interpret the AND project also start out from the new institutionalism of organisation theory. The definition what an institution is diverges between different authors. For the current purpose I use the definition by Meyer & Rowan (1977) that institutions are rule-like norms which are either taken for granted, supported by public opinion, or forced by law and the definition by Jepperson (1991) that institutions are organised and established procedures. Jepperson further discusses how institutions change. He identifies four phases of institutional development: The creation of institutions, institutional development, de-institutionalisation, and re-institutionalisation. The concept of organisational fields has been proved useful to describe how organisations or actors and institutions influence each other and how attitudes and patterns of behaviour are spread through the fields (DiMaggio & Powell, 1991).

Within organisation theory the concept of institutional entrepreneurship has began evolving during the last ten years. According to Fligstein (1997) institutional entrepreneurship is the acting of people who have social skills to motivate co-operation of other actors by providing them with common meaning and identities. Colomy (1998) suggests the study of institutional entrepreneurship in order to correct macro sociological theories on institutional change with the micro perspective of human agency. Colomy identifies institutional entrepreneurs as agents advancing their own particular ideal and material interests when structures become institutionalised.

Method

The central background documents of the AND project all seem to be included as appendices in the previous evaluations of the project. My re-interpretation of the AND project will build on these documents, *i.e.* Hagberg & Ronström (1996), Andersson (1999), Andersson *et al.* (1999), Persson *et al* (2003), and Synwoldt & Gellerstedt (2003). Andersson *et al.* (1999) is a compilation of several reports from SWEA districts. I do not analyse the separate district reports. Besides studying those previous evaluations I build my re-interpretation on qualitative non-standardised interviews with key actors in the project. To date I have gone through the previous evaluations for a first preliminary analysis. Of a planned number of six interviews two have been carried through while three still remain. The sixth interviewee died a few years ago, which will reduce the total number of interviews to five. This will include the persons in the project group, the most central actors in the reference group, and a key actor of SWEA.

The results in this paper build on the document analysis and the analysis of the material from two interviews with key actors. The interviews were guided by a short interview guide. During the interviews I have taken notes. The notes from the interviews has been analysed with special focus on the parts were my respondents diverge from the previous evaluations and on those parts of the interviews targeting matters not covered by the previous evaluations. Through the combined analysis of the previous evaluations and my interview material I write my own story of the AND project as a case of institutional change within a system of actors in the Swedish forest harvesting sector. I also try to find out in what way the institutional change has resulted in innovations within the practices of the actors.

My re-interpretation of the AND project

Before 1992 there were established forms of co-operation between the actors. This co-operation comprised of trust and distrust. Especially between the representatives of the forest industry corporations and the trade unions in the vocational board of Swedish forestry distrust seem to have been established. In the forest harvesting industry there was at least some awareness of the over-load problems although there was a strong resistance to change. The industry situation could be characterised as a strongly institutionalised context.

The project period from the planning of the project in 1994 until the end in 1996 could be characterised as a time of de-institutionalisation and institutional development. The prescription of SWEA caused a shock in the industry. The shock temporarily resulted in trust and mutual interests among the key actors of the industry. The representatives of the forest industry corporations had a primary interest in not getting regulations on the shift schedules in forest machine work. The major way to reduce the risk of regulation was to take active initiatives for promoting a better work environment. This co-incided with the interest of the trade union representatives to take actions for a better work environment. Through the vocational board the actors utilised established organisational structures to handle the shock by organising the AND project. The key actors turned into institutional entrepreneurs who collectively showed an ability to change established attitudes within the industry, which is showed when machine operators and contractors still refer to the AND project and how it contributed to a good organising of work. However, as the key actors succeeded to handle the initial shock the previous, now latent, distrust took over again and impeded further collective action. Distrust again grew between the representatives of the forest industry corporations and the trade union representatives in the vocational board. They were not able to agree on further activities.

The time after the project period could be described as a period of re-institutionalisation. Despite common goals of the key actors, the distrust was so strong that no more collective action was possible. It seems as if the distrust between the forest industry corporation and the trade union representatives has grown even stronger than before the project. Furthermore, no one of the key actors had the ability to act as an institutional entrepreneur on their own. This becomes apparent as the industry had to accept a recommendation of SWEA that neither the forest industry corporations nor the trade union favoured. The organisational field was re-institutionalised at a stage where a new attitude had been established but not a changed behaviour. There is now a regulation recommending work rotation. This is in accordance with the attitudes within the industry. However, not many actors succeed in acting in accordance with the regulation.

The system of actors acting together in the AND project could be described as the forestry work sectoral innovation system. The key actors in this innovation system are the forest industry corporations representatives, the trade unions representatives, the forestry contractors representatives, and SWEA representatives in the forestry vocational board. Behind the key actors are the different forest industry corporations, forest workers, contractors, and SWEA officers. Every one of them is a part of the innovation system centred round the vocational board. However, I have not succeeded in finding any concrete examples of innovations resulting from the AND project solving the difficulties of organising work rotation. It is probably easy to explain, as the organisational field was re-institutionalised without the behaviour having changed. I will anyway continue my efforts searching for innovations through the remaining interviews.

Lessons learned

The fact that one of the interviewees died a few years ago is an illustration of a difficulty with trying in retrospect to re-interpret the AND project. Another difficulty arises from relying on the respondents memories of what happened ten years ago. However, as not all the actors has co-operated very much since the time of the AND project the choice of interviewees offers a way of triangulate between the memories of different actors, although it would have been more effective getting the data from the actors closer to their acting in the project.

My re-interpretation of the AND project shows that it is possible to get long term changes in the attitudes within an industry. The AND project show an example how change processes could favour from strong institutional actors given that trust is established between them. I would also say that my analysis of the AND project from an organisational theory perspective could be helpful giving answers to the paradox of the previous ergonomic analyses that the change in attitudes do not realises in changed behaviour.

Acknowledgment

The work in progress behind this paper has been funded by Land- och sjöfonden of Svenska försäkringsföreningen (SFF) and by The Royal Swedish Academy of Agriculture and Forestry (KSLA). The work has benefited from being a part of the INNOFORCE project centre of the European Forest Institute (EFI).

References

AFS 1998:1. Ergonomics for the prevention of musculoskeletal disorders: Provisions of the Swedish National Board of Occupational Safety and Health on ergonomics for the prevention of musculoskeletal disorders, together with the board's general recommendations on the implementation of the provisions. Arbetarskyddsstyrelsen. Solna (S). 52 pp.

Andersson, W. 1999. Yrkesinspektionens uppföljning av "OCH-projektet": "Skogsbruket är på rätt väg – men arbetet mot belastningsskadorna måste fortsätta". Resultat 1999:10. Skogforsk. Uppsala (S). 4 pp. (Labour inspectorate follow-up of the OCH project: The

Swedish forestry industry is headed in the right direction – but the fight against repetitive strain injuries will continue. Summary in English)

Andersson, W., Ekengren, M., Lindbäck, L., Lundmark, L., Olsson, A., Persson, G., & Synwoldt, U. 1999. Uppföljning av skogsbrukets projekt ”Utveckling av arbetsmiljö och produktion”. Rapport 1999:2. Arbetarskyddsstyrelsen. Solna (S). 32 pp.

Attebrant, M., Mathiassen, S. E., & Winkel, J. 1998. Belastningsergonomi och rationalisering. in: J. Winkel, M. Attebrant & B.-O. Wikström (eds.): Konsensusrapporter rörande kunskapsläget om arbetsmiljön i skogsmaskiner, 1-4. Arbete och hälsa 1998:10. Arbetslivsinstitutet. Solna (S).

Axelsson, S.-Å. 1998. The mechanization of logging operations in Sweden and its effect on occupational safety and health. International journal of forest engineering 9(2), 25-31.

Bostrand, L. 1984. Produktionsteknik och arbetsmiljö: En studie av skogsmaskinförares arbetsförhållanden 1969-81. Rapport 159. Sveriges lantbruksuniversitet, Institutionen för skogsteknik. Garpenberg (S). 133 pp. (Production techniques and work environment: A study on forest machine operator’s work conditions 1969-81. Summary in English)

Breschi, S., & Malerba, F. 1997. Sectoral innovation systems: Technological regimes, Schumpeterian dynamics, and spatial boundaries. in: C. Edquist (ed.) Systems of innovation: Technologies, institutions and organizations, 130-156. Pinter. London (UK).

Colomy, P. 1998. Neofunctionalism and neoinstitutionalism: Human agency and interest in institutional change. Sociological forum 13, 265-300.

DiMaggio, P. J., & Powell, W. P. 1991. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. in: W. W. Powell & P. J. DiMaggio (eds.) The new institutionalism in organizational analysis. 7th impr., 63-82. The University of Chicago Press. Chicago (IL, USA).

Erikson, G. 1995. Belastningsskador bland skogsmaskinförare i Norden: Fakta och åtgärder. Redogörelse 1995:4. Skogforsk. Uppsala (S). 28 pp. (RSI in forest-machine operators in Scandinavia. Summary in English)

Fligstein, N. 1997. Social skill and institutional theory. American behavioral scientist 40, 397-405.

Gustavsen, B., Finne, H., & Oscarsson, B. 2001. Creating connectedness: The role of social research in innovation policy. John Benjamin’s Publishing Company. Amsterdam (NL). 281 pp.

Hagberg, J., & Ronström, J.-Å. 1996. Slutrapport från OCH-projektet. Skogforsk. Uppsala (S). 20 pp. (unpubl.)

Hansson, A. 2003. Praktiskt taget: Aktionsforskning som teori och praktik: I spåren efter LOM. Göteborg Studies in Sociology 14. Göteborgs universitet. Göteborg (S). 308 pp. (Summary in English. Diss.)

Jepperson, R. L. 1991. Institutions, institutional effects, and institutionalism. in: W. W. Powell & P. J. DiMaggio (eds.) The new institutionalism in organizational analysis. 7th impr. 143-163. The University of Chicago Press. Chicago (IL, USA).

Johansson, H., Arendt-Nilsson, L., Bergenheim, M., Blair, S., van Dieen, J., Djupsjöbacka, M., Fallentin, N., Gold, J. E., Hägg, G., Kalezic, N., Larsson, S.-E., Ljubisavljevic, M., Lyskov, E., Mano, T., Magnusson, M., Passatore, M., Pedrosa-Domellöf, F., Punnett, L., Roatta, S., Thornell, L.-E., Windhorst, U., & Zukowska, Z. 2003. Epilogue: An integrated model for chronic work-related myalgia: “Brussels model”. in: H. Johansson, U. Windhorst, M. Djupsjöbacka & M. Passatore (eds.) Chronic work-related myalgia: Neuromuscular mechanisms behind work-related chronic muscle pain syndromes, 291-300. Gävle University Press. Gävle (S).

Mayo, E. 1945. The social problems of an industrial civilization. Harvard University, Graduate School of Business Administration. Boston (MA, USA). 150 pp.

Meyer, J. W., & Rowan, B. 1977. Institutionalized organizations: Formal structure as myth and ceremony. American journal of sociology 83, 340-363.

Perrow, C. 1983. The organizational context of human factors engineering. Administrative science quarterly 28, 521-541.

Persson, G., Olsson, A., Ekengren, M., Andersson, W., & Lindbäck, L. 2003. Utvecklingen av arbetsmiljö och produktion i skogsbruket går vidare. Rapport 2003:3. Arbetsmiljöverket, Solna (S). 13 pp.

Rametsteiner, E., Weiss, G., & Kubeczko, K. 2005. Innovation and entrepreneurship in forestry in central Europe. Research report 19. European Forest Institute & Brill. Joensuu (SF) & Leiden (NL). 179 pp.

Synwoldt, U., & Gellerstedt, S. 2003. Ergonomic initiatives for machine operators by the Swedish logging industry. Applied ergonomics 34, 149-156.

Forest owners' divestment and investment strategies

*Kari Hyytiäinen and Markku Penttinen**

Abstract
Forest owners' optimal harvesting and investment strategies are studied at the forest holding level by including individual forest stands in an asset class portfolio. The forest owner has an option either to clearcut the mature stands and to invest the capital in financial or real asset classes (bank deposits, government bonds, stocks, apartments) or to postpone clearcutting and retain capital in standing trees. Forest inventory data, simulation-optimisation programme Mela and statistics of timber prices are utilised to compute the return series for forest stands. Numerical results show that the optimum level of clearcutting decreases markedly with initial non-forest wealth, particular at low risk-free rates of interest. This suggests that it is rational for non-industrial private forest owners to employ shorter rotations than institutional investors that possess diversified portfolios. Increasing the variety of stand structures by planting different species is not likely to bring substantial benefits due to the correlation between returns from forest stands. The value growth of forest stands can be used to estimate annual returns only for those stands that are soon to be mature. An alternative method for computing the returns for stands at any development phase is proposed based on the net present value of the stand adjusted with fluctuations in forest land prices. This method applies to cases where selling forest stands in the forest land market is considered as an option. Even if selling is not an option, the ratio of maximised net present value to value at immediate harvest can be used as a 'maturity index' for ranking the stands for portfolio optimisation.

***Keywords**:* clearcutting, efficient frontier, forest management planning, portfolio optimisation, risk-neutral

The temporal aspect of the counselling for small-scale forest owners after the storm in Sweden 2005

Fredrik Ingemarson and Mårten Hugoson*

Abstract
The organisations affected by the severe storm in southern Sweden 2005 have gained much experience useful for future forest management. The aim of this study was to describe the temporal aspect of counselling for small-scale forest owners after the storm. How well organised were the affected organisations, concerning this type of catastrophic incident? The results showed that the organisations were not prepared for such large damages and the extra amount of work. Qualitative methodology was used to describe the counselling for small-scale forest owners as assessed by professional foresters. Sixteen semi-structured open-ended interviews with professional foresters from different organisations in the affected region of Götaland were conducted and analysed. From the foresters acting and described course of events, the temporal acting of the organisations were divided into three phases of planning: the emergency phase, the reprocessing phase, and finally, the reflection phase. The emergency phase consisted of the time closest to the storm and the next three months. During this period, the actors worked hard to keep up existing business contacts networks and developing new business relationships. During the second phase, the storm organisations were put up and the amount of personnel engaged reached the highest level. The reflection phase started nine months after the storm and was characterised by a decrease in emergency cases and personnel. The results indicated that normal instructions were not enough to solve a crises situation such as this. There were temporal similarities in how the affected organisations solved the situation. The actions of the organisations after the storm followed a natural pattern from earlier experiences of solving catastrophic incidents. It was suggested that instructions for catastrophic incidents should follow the suggested three temporal phases. Thus, the time for each phase is shortened and the possibilities of adapting counselling to the needs of the small-scale forest owners‘ increases as much as possible under prevailing situations.

Key words: farm forestry, NIPF owner, organisation theory, professional foresters.

1. Introduction

1.1. Background

The destruction by the storm Gudrun could not be imagined by most people before the storm hit the area of southern Sweden on the night between the 8th and 9th of January 2005. During that Sunday morning, people woke up in a landscape struck by the largest storm damages in the modern history of Sweden. The landscape was totally transformed by the hurricane. Trees were laying all over roads, railways, electric cables and houses. Many households were isolated and about 50 000 suffered power failure. The storm damage deeply affected conditions for forestry, the economy and the emotions of the forest owners. It was clear that the Swedish forest sector faced its largest logistic challenge ever. Approximately 75 million cubic metres were wind thrown or damaged, corresponding to nearly an entire years cutting for the whole of Sweden. Of the trees damaged, approximately 80% were Norway spruce, 15% were Scots pine and the remainder deciduous trees. A crisis such as this places extreme demands on the forestry organisation’s resources, particularly managerial time and attention. During this process, the professional foresters played a decisive roll.

In Sweden, there is a long forestry tradition among professional foresters. The forest industry has been of great importance for both the Swedish economy and for employment. The forest owners of Sweden are usually divided into four groups: private forests, state-owned forests, community forests and company forests. Some of the private properties are owned by several people. With about 400 000 owners and an average estate size of about 45 hectares, private holdings encompass approximately 50 percent of the total area of forest, or 10.7 million hectares (Enström 1997). The area of Götaland, where the main part of the storm damages was situated, is dominated by private small-scale forest owners with a mean forested area of about 35 hectares. The mean annual increment is larger in this part of the country compared to the North. Many forest owners are partly dependent upon their forests for their living and the forest owners association is a strong political factor in Götaland.

In many sectors, large organisations have highly developed crises and management plans. This means that they are prepared in the event of a crisis (Spillam 2003). However, some of the organisations believe that the issue of crisis management is unimportant. This article concerns crisis management among the forestry organisations affected by the storm in southern Sweden in 2005. These organisations have gained useful experiences for future crises. If an organisation considers storms as inevitable, they can plan for crisis and thereby shorten the time needed to deal with the crisis, and find new market opportunities presented by the new situation. Crisis management also prepares for public relations, stress and unrest among the employees. The way the organisations responded after the storm stemmed from earlier experiences of solving catastrophic incidents: they did not have a crisis management plan, although some of them had documents with earlier experiences from storms.

1.2. Aim

The aim of the article was to:

1. Distinguish between different temporal phases during the work after the storm
2. Describe the contents of these phases
3. Identify potential support procedures for the different phases

1.3. Theoretical framework

The ability to cope with extreme conditions has probably always been seen as a mark for good organisational management and leadership. In the last three decades, this implicit emphasis has formalized into a large amount of literature on crises management and contingency planning within organisation theory (eg: Barton 2001, Camponigro 1998, Booth 1993, Mitroff et al 1989); i.e. combined with an increased practitioners interest for the subject. The enhanced interest is seen as due to increased complexity in organisational environments combined with a mental shift to realise that crises are not isolated events primarily affecting large commercially oriented organisations, but can strike at organisations of all kinds.

Accordingly, there is a clear tendency towards the establishment of formal crises management procedures within organisations, although some organisations believe that planning for tomorrows uncertainties is too time consuming and expensive (Caponigro 2000) and, alternatively, that crises can be meet by insurance policies (Simbo 1993). However, it is not possible to insure against losses of “soft values” in the commercial organisation, nor it is possible for a non-commercial organisations to take insurances against not fulfilling overarching organisational goals including e.g. responsibilities towards organisational members or citizens in general if that is required by standards or rules etc.

The aim of crises management is thus to minimize the impact of an unexpected event and to help an organisation to gain control of an alarming situation. This ability improves with the establishment of crises management plans. Without a crises management plan, between 50 to 90% of organisations are expected to suffer irreversibly (Pedone 1997, Fink 2000).

An organisation that lacks information about the "content" of a type of crises cannot develop a plan to address it (Spillan 2003). Accordingly, it is important, to learn about typical crises developments in order to increase crises management capacity for future events (Elsubbaugh et al 2004).

Crises preparation studies have recently been conducted and the most influential one - Pearson & Mitroff 1993 - argued that five general phases of crises management can be recognized: (i) signal detection, (ii) preparation/prevention, (iii) containment/damage limitation, (iv) recovery and (v) learning. Reilly (1993) suggests that crises readiness should include crises prevention, including technology and organisational processes to reduce vulnerability, and crises management components concerning the actual response in crisis.

The model has been slightly altered by Elsubbaugh et al (2004) who argue that the central part of the model, the crises management stage (corresponding to Reilly's management component and Mitroff's containment/damage limitation phase) must be individually formed for each type organisation and crises context.

2. Qualitative methodology

A qualitative method was used to explore the professional foresters situation after the storm. Qualitative data, emphasising a persons experiences, are suited to identifying attitudes towards events, processes and structures in their lives (Miles and Huberman 1994). The method is generally explorative, and the researcher has only preconceived ideas about the topics to be discussed, thus the interviews are open-ended (Patton 1990, Kvale 1996, Denzin and Lincoln 2000). There has not been a shared tradition of qualitative analytical techniques, but more researchers have shifted towards a qualitative approach (Miles and Huberman 1994).

The qualitative interviews were tape-recorded and lasted on average one and a half hours. They were semi-structured and open-ended, i.e. they followed an interview guide with proposals on questions. The interviews were allowed to pursue a natural course, but all questions from the initial guide were discussed. At the end of each interview, the researcher verified his understanding of the statements and asked for amendments in accordance with the method used by Kvale (1996).

Professional foresters working on a daily basis with forest owners were interviewed. These respondents were chosen primarily for their wide-ranging experience of small-scale forest owners and forest management. The interview guide was built on seven themes, where the foresters interviewed were asked to describe the temporal development after the storm, the crisis management, the past, changed views upon forestry after the storm, the objectives of the forest owners, insurances, and finally future development.

Seven forestry service organisations working with counselling to small-scale forest owners in the affected region of Götaland were represented (SVO-Växjö, SVO-Tingsryd, Södra Skog, Sydved AB, Skogssällskapet, Weda Skog and Vida AB). The selected respondents worked with management services such as felling operations, forest conservation, forest administration, forest management plans, timber trading, forest policy and economic counselling. Sixteen individual interviews with professional foresters were conducted during autumn and winter 2005. The professional foresters were men and aged between 35 and 60 years, they had between 10 to 35 years of experience of working with counselling of small-scale forest owners.

In accordance with the method used by Miles and Huberman (1994), data reduction was used for focusing, sharpening and organising data that appeared in the transcriptions. Transcriptions were made and the discourse written down. A coding scheme was devised to differentiate and combine the data. Codes are tags used to identify specific themes in a text. The mode of data display was transcribed field notes with attached codes. From the foresters' actions and described course of events the temporal actions of the organisations were analysed. A list of code definitions was created from analysis of the temporal aspects mentioned during the interviews. The codes were clustered, relabelled and revised during the analysis, in accordance with the method used by Miles and Huberman (1994). Finally, the temporal phases were defined and empirical examples confirming the results were chosen from the data.

3. Result

3.1. The story of the emergency phase

The first twenty-four hours is best illustrated by the professional foresters own account of the ravages by the storm.

"It was crashing and cracking. At ten o'clock I could see the light from the city/…/ Now I understood what it was all about! Went to bed at about eleven, took a sleeping pill and went numbed."

No organisation was prepared to handle this type of situation. There was a state of shock during the first weeks and few decisions were taken about how the situation should be solved! Established activities were at a standstill and a new situation had arisen. The forest sector needed at least a couple of weeks to collect information and acquainted the different parties with the situation. Södra had a storm folder to follow, but it was not enough for this size of storm. The actors handled the situation by forming \`storm groups\`. Many professional foresters were forest owners themselves and therefore their own forest could be a suitable starting point for discussions during the consultations.

Collaboration was crucial to handling the situation. The actors in the area consulted about the situation in general and estimated the wind thrown volumes per hectares. The professional foresters in the storm area knew the locality well, and thereby already during Monday had formed an opinion about how much had blown down.

At the beginning, the focus was on cutting as much as possible. No one knew how much had blown down and the processing was carried out rapidly, because of insect attacks and the possibility of finding a market for the timber. Accessibility and carrying capacity guided the choice of cutting areas and suitable sites were chosen along passable roads, which also provided more time for planning. The time just after the storm was a difficult time of the year with few daylight hours. The cuttings were not always done properly because of the large pressure on the teams and the snow layer. New contractors were given large sites where simple (straightforward) methods could be used that made it possible for them to run in the routines. Timber were transported to large temporary log yards and irrigated, pulpwood was stored along the roadside.

Information about the ravages by the storm spread through internal and external channels on a local, regional and national level. Shocking reports about 100 hectares of clearings were reported. The professional foresters personally discussed with the forest owners during the counselling in the office, over the phone or through "storm gatherings". Other sources used for counselling were information containing references to contact persons sent out locally and from information departments, and media contact with radio, television and newspapers. The offices had open doors for many weeks after the storm and lines were lengthy even from the day after the storm, with

“25-30 persons queued up outside each room at the office! The forest owners overstated (the volumes) and excited each other.”

The owners estimated volumes and areas were noted by the foresters on lists. Little time was available for visiting properties and the accessibility was bounded. Some foresters also found it depressing to visit the field.

One of the most important tasks for the professional foresters during the first weeks was to act as welfare officers for the forest owners: most time was spent on the phone providing information and counselling.

”Everything let loose on the Monday with 14 days on the phone. We wrote name, volumes and used the storm folder. You would have needed to be a psychologist to handle the situation! On the way to Växjö I contracted for as much as a whole year.”

Many forest owners were sad and depressed. Absence of current and school transport was a strain on both forest owners‘ and foresters‘ nerves. Many of them had to put all their energy into their work, because of all the pressure at work. Thereby the reflection on their private situation was postponed. Below a forester describes how it was to reach the office during the first Monday after the storm.

”First on the Monday it was possible to reach the office. For six weeks, I had no phone and had to wash myself at work. It was hard! The work took all my energy and it took a couple of months before I could familiarize myself with my private situation.”

Counselling in the field did not start until the reflection phase. The small-scale forest owners cared about their forests and felt it was necessary to do something about the situation. The self-activity was considerable with many accidents in the forest during the first months. One owner expressed the importance of the forest in her life to one forester in the following way:

“We have one son, one daughter and then we have the forest.”

This quotation expresses very clearly what type of pressure the professional foresters worked under with impatient owners.

3.2. The story of the processing phase

The processing phase started a couple of months after the storm. Initially, the focus was on cutting as much as possible. Afterwards, the cutting was adjusted to the market. During this phase, some actors saw that contact with the forest owners lessen, the first signals arose that the forest sector would clear off the situation and the organisations started to prepare with the storm organisations. Much work during this phase concerned logistics and labour management of the contractors. Often the newly employed professional foresters took care of the contractors, and the permanent staff managed the counselling to the forest owners. Many forest owners were worried that their timber could be destroyed during the spring and organisations such as Södra and the Regional boards of forestry that were affected were kept busy with counselling.

Borders, suitable places for storage and communication between neighbours concerning borders were discussed during the contacts with the forest owners. The state of the forest roads was checked, but presented no problem. The professional foresters agreed that the owners had been accommodating and understanding, although it was difficult to inform the owner that precedence was to the felling objects.

The foresters described a stifling atmosphere in many districts before the summer, but it became better during the autumn. All parties had an immense workload during the processing phase. One forester described the workload in the following way:

”During April the work really got started. I lived outside a normal life until week 29. My family was requested not to discuss my tasks during the days to come. I arrived home at ten o’clock every day and there were lots of emotions. The tears felled, but I was not angry or sad.”

The professional foresters were put under huge pressure with a powerful increase of labour forces; at the same time, the forest owners wanted counselling and fast results. In general, the storm area was divided into different areas where the permanent foresters took care of the co-ordination of different tasks. Labour management was a heavy burden for many foresters during this phase. The daily routine had to work at the same time as new members of staff were trained. There are examples where staff broke down from the stain. During the processing phase, much time was invested in labour management, but the professional foresters still believe it did work well.

During the summer, the assembly of machinery was as largest. Such a powerful increase in the number of staff implied that practical arrangements concerning for example accommodation needed to be taken care of.

”We had 29 groups and 65 machines, normally it is four groups! Now we needed to arrange accommodation for 150 persons.”

The local organisations that did not have any activities in other areas in the country had to send for external machine groups. There was little time to assess the skilfulness of the contractors and foreign drivers needed complete instructions that had to be followed up to for correct possible mistakes. The problems often originated in confusion of languages, different type of equipment, but in some cases also different working cultures. The tradition in for example Estonia was that the teams of workers are lead by the works managers out in the field and knowledge about Swedish conditions was limited among the foreign teams of workers.

3.3. The story of the reflection phase

During the reflection phase, after slightly more than half a year, the work came into a calmer phase with lower volumes to handle, less phone calls and thereby a reduced burden of work. Several actors were ready with most of the processing during this phase and could reduce the number of staff. The pulpwood was sold by this time, but it still lay along the roadside, because of large stocks at the industries. During the reflection phase, it was important that the organisations took care of the staff and evaluated the situation. A reaction on the heavy workload could very well appear at this stage. One forester expressed the change of the working situation in the following way:

”A vacant space appears when the working load goes down. What were we doing before this happened?”

Even so, much work was still needed. The tempo had been too high, resulting in loss of quality. The amount of emergency cases had decreased, but the administrative work and other errands that had been put aside for six months still constituted a heavy workload. During the work, the foresters felt their assignments were of great importance for the forest owners. The forest sector would not have been able to handle the situation if the forest owner themselves had not tried to do their best in finding solutions to the problems. The following empirical example verified that the forest owners were grateful and helpful when the harvesters arrived on their properties.

”Forest owners react differently on stress, but 95 percent were very satisfied and the contractors were welcomed as heroes”

During this phase, an important counselling period took place with questions regarding regeneration, soil scarification, insect damages, and remains of stands and reproduction of plans. A large and time-consuming challenge was to activate those forest owners that had not cleared the trees taken down by the wind, who were often passive owners with no relation to forest owners associations or forest companies.

4. Discussion

4.1. Lesson learned

After the event, it was evident that the cutting should have been better adapted for the sale and that the capacity among the machines was enough to handle the processing.

”Everyone was in too much of a hurry! It would have been better to sit down during some days and think about what had happened! Everyone should have gained on that procedure. Some days had a terrible workload!”

The counselling must become more active to prepare the forest owners. One danger with a storm such as this is that interest for forestry decreases. Thus, the counselling must guide the owners towards “the light in the tunnel” against achieving the motivation for a forestry adapted to their objectives.

The professional foresters know their district well and often have their own forest. They have developed long-term contacts and found a trust among many forest owners. One challenge is to provide information to the forest owners that do not attend information meetings and are passive in their actions.

Well functioning geographical information systems are decisive for efficient labour management. The systems used should be convertible, not only inside the country, but also outside the country. Standard forms for overseas contractors should be found at all organisations and with instructions in their own languages.

4.2. The future of the counselling in the area

The standing volume in large parts of the storm area was reduced to half the normal volume. The demand for counselling for regeneration will be great, whereas the cutting intensity will be less than normal. Below is an example of the tasks that the counselling has to resolve:

1. Insects damage
2. Regeneration
3. Scarification
4. High stumps
5. Drainage
6. Group of trees
7. Remains of trees
8. Soil damage
9. Forest management plans

The contact surface against the forest owners has increased after the storm, creating fine conditions for counselling in the area in the future. The forest owners are now having a clear reference as to what will happen if activity is to low. The foresters agree that nothing stands up against the storm in the heart, but silvicultural practices matter on the fringes.

4.3. The professional foresters changed view upon forestry

The time after the storm has been hard. Many foresters became depressed by what they saw in the forest. Some felt they had lost the drive and many still felt tired during the reflection phase. Most foresters have afterwards nuanced their view about forestry and created new challenges.

The effects of the storm will be apparent for many years to come. The professional foresters agree that it is not possible to totally cover oneself against a heavy storm like Gudrun. Now, there are possibilities for creative forest owners to adapt the silviculture to the site and the objectives of the forest owners. The foresters' views have changed, because the forest cannot be used as a liquidity reserve to such a high degree as before. Shorter rotation periods, a higher share of natural regeneration, thinning on time and a variety of trees for spreading risks are examples that the forester now recommends to the forest owners.

”In the early stage, my view upon forestry had changed. The extent of the damages partly depends upon the management of the forest, but in the heart, it did not have any influence. Everything over 35 years has blown down. Life goes on and the spruce falls! Today I believe in intensive cultivated land in some areas and a more extensive management in other areas.”

4.4. Crisis management

The actions of the organisations after the storm followed a pattern from previous experiences for solving catastrophic incidents. Leadership and team building are crucial elements in the effective handling of crisis. The organisations appear to have handled this well, but the lack of preparation among employees has lead to conflict of moral issues and tension among them.

The organisations were not prepared for such extensive damage and the amount of extra work: the current instructions among the organisations were not sufficient to cope with a situation such as this. The organisations followed a reactive model; the decisions on planning occurred during and after the event. A proactive model is preferable, in which the organisations have already completed a vulnerability analysis that has helped them to develop a plan. The manager has to account for the difference between investments in time for planning for a crisis against the losses from failing to plan for a crisis. Eventually, most organisations will be confronted with some type of crisis. Preparation and planning are crucial for successful crisis management. Sufficient information is crucial for developing a plan. Risk assessment of potential problems and crisis management practices assist in reducing tension and moral issues that emanate from crises (Spillan 2003).

Operative storm management teams were formed, but not till after the storm event had occurred. The storm event would provoke or/and motivate the organisations to create crisis management teams or planning mechanism to prepare for subsequent crisis events. The establishment of a crisis management culture supporting the importance of crisis management practices is the best way to prepare for a crisis (Caponigro 2000). The creation of crisis managements team and adapting crisis management as a part of the strategic planning process are the right ways for such a development to take place (Pauchant et al. 1992, Mitroff et al. 1989). When employees are aware that such a crisis can take place, they can help managers assess the vulnerabilities and prepare for any crisis that may occur (Spillan 2003).

The temporal phases of the organisations after the storm were similar. It was suggested that a crisis management plan should follow the suggested three temporal phases presented in the result chapter. The emergency and the processing phases from the empirical result should be included in the containment/damage limitation phase of the crisis management plan, in accordance with Mitroff 1993. The reflection phase should correspond to the recovery and learning phase.

References

Booth, S.A. 1993. Crisis Management Strategy: Competition and Change in Modern Enterprises, Routledge, London.

Barton, L. 2001. Crisis in organisations II. South Western Publishing Co, Cincinatti.

Camponigro, J. 1998. The crisis counsellor: The executive´s guide to avoiding, managing, and thriving on crisis that occur in all businesses, Barker Business Books, inc, Soutfiled, MI.

Cmponigrom J.R, 2000. The Crisis Councellor: A Step-By-Step Guide to Managing a Business Crisis. Contemporary Books, Chicago.

Denzin, N.K. & Lincoln, Y.S. 2000. Handbook of Qualitative Research. SAGE Publications, London-New Delhi. 1065 p.

Elsubbaugh, S, Fildes, R and Rose, M.B. 2004. Preparation for Crisis Management: A proposed Model and Empirical Evidence. Journal of Contingencies and Crisis Management, 12 (3): 112-127.

Enström, J. 1997. Grundbok för skogsbrukare. Skogsstyrelsen. Jönköping. 189 p.

Fink, S. 2000. Crisis Management Planning for the Inevitable. AMAOCM, New York.

Kvale, S. 1996. InterWiews: An Introduction to qualitative research interviewing. Thousand Oaks, CA, Sage Publications. 326 p.

Miles, M.B. & Huberman, M.A. 1994. Qualitative Data Analysis. Sage Publications, Thousand Oaks, London, New Delhi. 338 p.

Mitroff, I., Pauchant, T. and Shrivastava, P. 1989. Crisis, disasters, catastrophe: Are you ready? Security management 33 (2): 101-108.

Patton, M.Q. 1990. Qualitative Evaluation and Research Methods. Sage, Newbury Park, Calif., London. 532 p.

Pauchant, T., Mitroff, I. and Ventolo, G. 1992. The dial tone does not come from god! How a crisis can challenge dangerous strategic assumptions made about high technologies: The case of the Hinsdale telecommunication outrage, Academy of management executive 6(3): 66-79.

Pearson, C and Mitroff, I. 1993. From Crisis-Prone to Crisis-Prepared: A Framework for Crisis Management. Academy of Management Executive, 7 (1): 59-76.

Pedone, R. 1997. Disaster Recovery – Are You Prepared for Business Disruption? Long Island Business News, Novemeber: 23-24.

Reilly, A.H. 1993. Preparing for the Worst: the Process of Effective Crisis Management. Industrial and Environmental Crisis Quarterly, 7 (2): 115-143.

Simbo, A.K. 1993. Catastrophe Planning and Crisis Management, Risk Management 40(4): 64-66.

Spillan, J.E. 2003. An exploratory model for evaluating crisis events and managers concerns in non-profit organisations. Journal of Contingencies and Crisis Management. 11 (4): 160-168.

The scramble for cash: access and access mechanisms to income from a commercial NTFP

Anders Jensen

Abstract
Based on a case study on agarwood and Aquilaria spp. in Lao P.D.R., NTFP commercialisation is analyzed through its effect on income distribution, and with a specific objective to trace out mechanisms by which different economic agents along the commodity chain, that is in harvesting, trade, wholesalers and export, get access to income flows, and mechanisms by which they control and maintain their access. Various de jure and de facto mechanisms are identified, of which technical skills, market access, relations and credentials with state officials, political and administrative networks, social and family relations and carte blanche harvesting permits stand out.

***Key words*: Eaglewood, commodity chain, income distribution, South-east Asia**

Introduction
Non-timber forest products (NTFPs) entering the global commodity chain become captivating in a development frame of reference. NTFP commercialisation figures prominently in discussions over the faith of tropical forests and is hedged in by a call to increase economic value of the resource and significantly contributing to rural livelihoods and serving as an augmented incentive for conservation. It builds on the recognition of NTFPs contributing to the livelihoods and welfare of forest dependent people (Arnold & Peres 2001, Gram 2001, Belcher 2005) and local people's incentive in preserving the resource (Salafsky & Wollenberg 2000).

Poor people rely on NTFP resources as means of subsistence while rich people are in a better position to exploit NTFPs commercially (Cavendish 2000, Warner 2000, Arnold & Perez 2001, Belcher and Kusters 2004). It seems almost to be a generic aspect of NTFP commercialization that poor people have little or no access to skills, technology or capital necessary to be able to fully benefit from opportunities presented by markets (Arnold & Perez 2001, Angelsen & Wunder 2003). Other factors may also explain why poor people may not be the winners of commercialisation, and importantly the observation of markets and market relations being embedded in a wider context of social rules, values and systems of power and authority (Granovetter 1992; Harriss-White 1996; Platteau 1994, Stuart & Johnson 2004)

The overall objective of the study is to analyze income distribution aspects of NTFP commercialisation and the market and non-market mechanisms by which income differentiations are shaped. The conceptual and analytical framework rests on Ribot's (1998) concept of 'access' and his study on the charcoal commodity chain in Senegal and the concept of 'bundles of power' by Ribot & Peluso (2003) as a contrast to 'bundles of rights' by (Schager & Ostrom 1992) and further inspired by He's (2004) study of the matsutake mushroom commercialization in Southern China.

Central to the analysis is access by economic agents to benefits in the commodity chain, i.e. income from agarwood. There are two types 1) access to resources, which is the classical notion of property, and 2) access to benefit, which is the ability to benefit from things, and may encompass market access, labour access, access to capital, access to social relations, access to knowledge and access to resources, i.e. agarwood. The analysis is thus directed towards mapping of differentiated agents' access along the commodity chain to key points of economic power, and to analyze who benefits and how, and to eventually determine the dynamic aspects of access, access control and maintenance.

The analysis is based on the agarwood commodity chain in Lao P.D.R. (hereafter Laos), one of the poorest yet natural resource rich countries in Asia, and a socialist, one-party regime. Agarwood is regarded as one of the world's most valuable NTFPs, and develops in some trees of Aquilaria spp. as a chemical barrier to wounding, normally only one tree out of ten forms agarwood. The wood is fragrant and highly resinous with brown and black colours, and is either traded as 'mai dii' (good wood) or agarwood oil extracted from 'mai khilai' (bad wood) or 'mai phaktoo' (wood from stumps) with a price range started at 0.3 USD/kg for the cheapest 'mai phaktoo' to over 5,000 USD/kg for the best qualities of 'mai dii'. Agarwood trade was introduced in Laos at the end of the Second Indochina War in 1975 by Vietnamese war veterans and Thai merchants. In 2004, the estimated total export value is 14 mill. USD.

An unique data platform was built up from February 2003 to March 2005 by open-ended interviews and standardized and semi-structured questionnaire. It includes national harvest and trade survey with 103 harvesting group leaders, 73 agents and traders and all 45 wholesalers as respondents, an international market survey in Bangkok, Singapore and Dubai and interviews with key-informants: national-level traders and govt. officials, and a survey in all 18 provinces and visits to 22 districts and 50 villages, and discussions with state officials at national level. Data collection has benefited greatly from the author's knowledge of the Lao language and culture and working experience within the forestry sector in Laos. Most important to the observations and findings presented in this article, have been made during casual and informal discussions, often after interviews.

1. Harvesters

Detection of trees requires both intimate ecological knowledge and vast experience. Local use of *Aquilaria* spp. is limited, and no common pool of knowledge has been built up to draw upon by local people, and has to be acquired by cumulative trial-and-error learning. Many of the populations now harvested, have previously been searched by non-local, experienced harvesters. Many of the commercially valuable trees have already been removed and local people are disadvantaged both in terms of being able to acquire knowledge and experience and in income opportunities, and hence harvesting is characterized by a marked income differentiation.

Villagers who harvest in forests within village boundary or in adjacent forests, notably conservation forests, are by far the largest group (approx. 10,000 people in 2004), and have the lowest annual income among the three groups of harvesters, which further includes professional harvesters from Lao and harvesters from Vietnam. Villagers are not in the position and lack resources to effectively monitor and control often large areas of natural forests in which the exact location of agarwood forming trees is not known. Exclusion of outsiders is limited to harvesting of bulk products: 'mai phaktoo' and wildlings, and some kind of collective action exists for the harvest of these products and initiated by the village headman. Not involved in the process of annual quota setting, economic benefit is confined to these products and to nominal village fees, a kind of entrance fee to village forests and gives right to harvest commercial NTFPs in general, and official fees paid by traders and agents when buying wood, though the volumes and qualities are routinely understated.

Though secured under the present Forest Law, customary rights to commercial NTFPs do not operate *per-se*. Harvesting rights are granted to villagers contingent on licenses, permits, quotas, etc. obtained by a processing industry (a wholesaler) and any harvesting without a processing industry is in principle illegal. Villagers are therefore by a de jure mechanism tied to a wholesaler, who will try to purchase all wood within the area under his license, and at prices much below market prices. However, this monopsony is rarely effective, at least not to experienced harvesters with better market access than villagers. Villagers realize and acknowledge that they lack both market access and technical skills but object to exclusion from lucrative production and trade.

Professional harvesters from Laos (approx. 1,000 – 2,500), dignified for their technical skills as ‘visakaans’ (technicians), gain access and withdrawal rights on a de jure basis through harvesting permits to National Production Forests. These permits are legally under a wholesaler’s license and professional harvesters are thus in a mutual state of dependence. However, the loyalty of visakaans goes with the cash, and the monopsonic condition prevails only in part.

Harvesting habitually takes place outside of NPFs, i.e. in conservation forests. Restrictions on length of harvesting trips (normally 30 days) and season (no harvesting in the rainy season), are observed as they are easier controlled than harvesters whereabouts. Contact to villagers is frequent as professional harvesters often go back to forest areas which they searched incompletely, and are dependent on a good rapport with village chiefs for guidance and purchase of food stuffs. Contrary to Vietnamese harvesters, professional harvesters do pay village fees, and nurture good relations with village headmen, often along ethnic and linguistic lines. For these reasons, professional harvesters will limit themselves to a few provinces whereas Vietnamese harvesters are mobile throughout the country.

Ethnic Vietnamese harvesters (approx. 500) have no de facto entry barriers and are furthermore renowned for their abilities and shrewdness, and high income from agarwood. Their access and withdrawal rights are sheltered under extra-legal de facto mechanisms not only to agarwood resources but also to other commercial NTFPs and understandable only by the special relationship between Laos and Vietnam. Attempts by provincial and district authorities to restrict access are not effective, and Vietnamese harvesters possess a carte blanche permit with no restrictions on length of harvesting trips, season and location.

Vietnamese harvesters avoid contact with villages except for purchase of rice and other consumables and when hiring local guides, who only are paid in case of detection of trees. With no ties to wholesalers in Laos and with international market access to Vietnam, most of their harvest is channelled out of Laos. However, prices for ‘mai dii’, the sole product of interest to Vietnamese, are higher in Laos than in Vietnam but Lao traders, agents and wholesalers avoid trading because earlier encounters involving dishonest tricks and cheating.

2. Traders and agents

Traders and agents (in total 500 – 1,000) are positioned as intermediares between harvesting and wholesale and with main functions in trade of all products and processing of ‘mai dii’. By far the largest profit margins potential lies in the trade and processing of ‘mai dii’ whereas ‘mai khilai’ and ‘mai phaktoo’ require bulk and transport. Trading in ‘mai dii’ is delicate and demanding skills in grading of wood and a substantial capital facility, and many traders and agents have experienced grand losses.

Locations for trading are at factory gates, trading offices in district capitals, in villages when traders/agents go on purchase trips and sometimes stay for prolonged periods to wait for harvesters coming back from the forest, often the case of newly opened areas for harvesting. At all these locations, good rapport with village headman, district governors, state officials, etc. is of decisive importance, as any unresolved conflict, voiced mistune and unfavourable comments will inflict negatively on the status of traders and agents. In this respect, traders/agents with ethnic and linguistic affinities have a distinct advantage. Unofficial payments to officials are seen but payments are often towards charity and traditional ways of doing business. For instance, any wood purchase is sealed with a small hospitable party paid by traders/agents, something that Indian agents because of their Muslim faith find difficult.

Agents' activities are sheltered under a wholesaler's license - either they are employed by a wholesaler, which is the case for Indian wholesalers or attached to one wholesaler to which most of the traded wood goes to, not necessarily the most valuable. Traders work independently, and are either general NTFP traders with a portion of their business in agarwood or agarwood traders with no ties to one wholesaler and often with access to international markets, i.e. Vietnamese agents with status as carte blanche economic agents, similar to that of Vietnamese harvesters. NTFP traders mainly make income through transport provision. A large group of traders exist at local level, village traders, and not included in this analysis. The only function is to store 'mai khilai' and 'mai phaktoo' from villagers harvesting in own areas, an activity that will only last for 2 – 3 years.

Trade in agarwood is largely an unregulated domain in that few policies directly touch on this part of the commodity chain. Regulations applicable are part of the wholesalers license and include trade permits and transfer fee payable for transport of wood between provinces, and fees to villages for buying wood. Unsanctioned, random checks by police and forest officials are common except for Vietnamese agents, and those without patronage from wholesalers and state officials risk losing income to pay-offs – even if they are working perfectly within the bonds of the law. Most of the agents and wholesalers come from Pakkading District (see further in section on wholesalers) and here these pay-offs are paid routinely standardized to an amount equivalent to the amount requested for minor traffic offences. Viewed as negligible and therefore paid routinely to wind off further questions.

3. Wholesale

Wholesalers are the 'Lords of the Scent' and have dominant position in agarwood business. Wholesaler is an umbrella term used for other terms which could be used interchangeably: merchants, factory owners and national-level traders. They gain control over access to agarwood resources, processing and distribution by various de jure and de facto mechanisms and maintain and control their position by technical skills and expanded market access as well as management of cash flow. There are two groups: in numbers dominate approx. 40 Lao wholesalers where as 4 Indian wholesalers work through joint ventures largely along the same mechanisms as Lao wholesalers. Indian companies are branches of the largest companies in Dubai, the global agarwood centre.

By far the largest number of Lao wholesalers, >20, is located in Pakkading District, Bolikhamsai Province, and most of the other wholesalers in other provinces are somehow related to these wholesalers through family and social relations. Often these wholesalers are women whose husbands or other close relatives work in the government and/or are influential party members. New factories are started by already established wholesalers, family members or by former employees, who maintain close business connections with their former bosses and receive loans and advances and supply wood in interlocking arrangements. Outsiders to the Pakkading clans need to gradually build up social ties with state officials, and in general, have to shell out higher unofficial payments.

Two other groups also exist: 3 to 4 Vietnamese traders getting a quota with no processing units and access under an aforementioned carte blanche permit, and illegal factories along the Myanmese border (approx. 10) run by Lao wholesalers with no legal permits. Their access is through cover from forestry officials based on credentials and relations and political and administrative network established during times with legal papers. It shows that these networks and relations exist and an investment in these may be of value to other business ventures too.

To legally operate as wholesaler requires an array of licenses, permits are required and in principle, also an annual quota, though this is not a strict requirement. These papers are obtained through administrative procedure, and has a time horizon of 8 to 10 months, and give the right to trade in and processing agarwood, and furthermore, to buy firewood and to employ people. Little or no profit is actually made from agarwood oil. Distillation continues to keep business going and to gain legal access to 'mai dii' on which profits can be made.

Only one company has the right to export unprocessed wood, i.e. 'mai dii', other companies are forced to export 'mai dii' illegally or not to export at all, what most Lao wholesalers do. This was gained not by unofficial and official payments but by political tom-toming and reasoning of rural development, so rational arguments do occasionally gain weight.

Investment licenses are issued for a 5 to 10 year period and under controlled by the province governor. Quotas are negotiated on an annual basis and are not based on inventory data and local people have no vote. Quotas are, if availed, only a measure to determine payments to the government, not reflection of resource status and management objectives. While the official payments for investment license and quota is a scant reflection of economic potential resource, the handsome, unofficial payments are, often jumped up by secretive bidding between competing wholesalers.

Trade between wholesalers is striking and a few wholesalers have gained a significant position for volume of oil and wood traded. Within the tightly knit network of Lao wholesalers, any adulteration of oils and other malpractices are frowned upon. Since pure oil is a rarity on international markets and most of the oil is bought by Indian wholesalers for export, a competitive advantage is actually handed out free of charge. Surprisingly, there seems to be no price collusion among Indian wholesalers, which would have added to their advantages, and in contrast to Lao wholesalers, there is no network among the Indians.

Conclusion

This study has provided material evidence to a theory on access and access mechanisms of commodity chains based on framework provided by Ribot (1998) and Peluso and Ribot (2003). Much of agarwood commodity chain in Laos is left in a legal limbo as key points of economic power, notably trade, are unregulated and state officials conspicuously fail to monitor and assess the status of harvesting, trade, processing and export and to provide adequate measures. On the other hand, state officials do accept routine and discretionary payment to fulfil private objectives of agents, traders and wholesalers. Circumvention of laws and policies and allocation of permits, licenses, quotas, etc. and exemption from legal inflictions, are thus not at all random but run along specific lines. Not all favours are honoured by cash payments, however, and many non-market exchanges do operate. These access mechanisms occur based on socio-geographic identity (linguistic and ethnic similarities), relations and credentials with state officials through kinship and social ties, establishment and investment in political and administrative networks and mediating roles and functions that especially wholesalers take on. Vietnamese harvesters and traders have a special status in Laos and a carte blanche permit to their activities. Of the market based mechanisms, technical skills in processing and grading are prominent and a distinct entry barrier, and furthermore provision of financial facilities and international market access are furthermore explaining income differentiation in both vertical and horizontal directions.

References

Angelsen, A. and Wunder, S. (2001) Exploring the forest-poverty link: key concepts, issues and research implications. CIFOR Occasional Paper No. 40. Center for International Forestry Research, Jakarta, Indonesia.

Arnold, J.E.M. and Perez, M.R. (2001) Analysis: can non-timber forest products match tropical forest conservation and development objectives? Ecological Economics (39): 437-447.

Belcher, B.M. (2005) Forest Products markets, forestry and poverty reduction. International Forestry Review (7): 82-89

Belcher, B.M. and Kusters, K. (2004) Non-timber forest products commercialisation: development and conservation lessons. In: K. Kusters and B.M. Belcher (eds.): Forest Products, Livelihoods and Conservation: case studies of non-timber forest product systems. Center for International Forestry Research, Jakarta, Indonesia. 1-22.

Cavendish, W. (2000) Empirical regularities in the poverty-environment relationship of rural households: evidence from Zimbabwe. World Development (28):1979-2003

Gram, S. (2001) Economic valuation of special forest products: an assessment of methodological shortcomings. Ecological Economics (36): 109-117

Granovetter, M. (1992) Economic action and social structure: the problem of embeddedness. In: Granovetter and Swedberg (eds.): The Sociology of EconomicLife. Boulder: Westview Press.

Harriss-White, B. (1996) Free market romanticism in an era of deregulation. Oxford Development Studies (24) 1:27-45

He, Jun (2004) Globalized Forest-Products: Commodification of Matsutake Mushroom in Tibetan Villages Yunnan Province, Southwest China. Presented at "The Commons in an Age of Global Transition: Challenges, Risks and Opportunities," the Tenth Conference of the International Association for the Study of Common Property, Oaxaca, Mexico, August 9-13.

Platteau, J.-P. (1994) Behind the market stage where real societies exist – part I: the role of public and private order institutions. Journal of Development Studies 30 (3):533-77.

Ribot, J.C. (1998) Theorizing access: forest profits along Senegal’s charcoal commodity chain. Development and Change (29): 307-341

Ribot, J.C. and Peluso, N. (2003) A theory of access. Rural Sociology (68): 153-181.

Salafsky, N. and Wollenberg, E. (2000) Linking livelihoods and conservation: a conceptual framework and scale for assessing the integration of human needs and biodiversity. World Development (28) 8 pp.1421-1438

Schlager, E. and Ostrom, E. (1992), Property-Rights Regimes and Natural Resources: A Conceptual Analysis, Land Economics, 68: 249-262.

Start, D. and Johnson, C. (2004) Livelihood options? The political economy of access, opportunity and diversification. Working Paper 223, Overseas Development Institute, London, UK.

Warner, K. (2000) Forestry and sustainable livelihoods. Unasylva (51): 3-12

The good, the bad and the ugly: income determinants and a typology of commercial agarwood harvesters in Lao PDR

Anders Jensen and Henrik Meilby*

Abstract
Based on interviews with 103 leaders of groups harvesting agarwood in various parts of Lao PDR we identify income determinants and prepare a typology of harvesters. There are three main groups of harvesters: [a] highly professional, migrant harvesters from Vietnam; [b] non-local, professional harvesters and [c] local harvesters. From interpretation of auxiliary information it emerges that groups [b] and [c] can be further subdivided based on experience and harvesting strategy and in the final typology we therefore distinguish five categories of harvesters. Income determinants are mainly related to product and market variables, structural characteristics of harvesting groups, opportunistic harvesting and knowlegde and experience.

Key-words: stratification, commercial NTFP, Aquilaria, eaglewood

1. Introduction

It is evidenced through research and in implementation of rural development projects that non-timber forest products (NTFPs) play a significant role in local economies in developing countries, e.g. Arnold & Ruiz Perez (1998). Income from sales of NTFPs is often the only source of cash for forest dependent people. In many rural communities in Lao PDR (henceforth Laos), a country rich in natural resources yet one of the poorest in South-east Asia, it is a development imperative to increase the forestry sectors' contribution to socio-economic development, not least from NTFPs (Gansberghe 2005; MAF 2004), a goal which can be reached by means of commercialisation (Foppes 2005). One commercial NTFP is agarwood or 'mai khedsana' extracted from *Aquilaria* species, which may contribute from 10% to 70% of total cash income in rural areas (Alton & Rattanavong 2004; Brahmin & Phoumphone 2004), and ranks as one of the most commercially important NTFPs in the country (Foppes & Khetphanh 1997). Based on a nation-wide survey on harvest and trade (unpublished data) the total export value of agarwood is estimated at approximately 14 million USD in 2004. Harvesters receive a large fraction of the final sales price (export value) and based on an analysis of their harvest costs it appears that they get a relatively large share of the resource rent (unpublished data), approx. 2.8 mill. USD, or 20 % of the final sales price. This figure is comparatively high. For instance, in a study from Nepal on medicinal and aromatic plants Olsen (1998) finds harvester's share to be only 0.3%, and in a study on rattan in Vietnam Belcher (1998) finds a figure of 0.8%. Clearly, the incomes earned from agarwood extraction are tremendous compared to other NTFPs.

The income distribution among agarwood harvesters is highly skewed. Income disparities are commonly up to three- or four-fold and there are strong indications that Vietnamese and professional Lao harvesters earn considerably more than, and largely appropriate agarwood resources from, local people (unpublished data). This seems to be an example of elite capture (Dove, 1994). The inevitable question arises, whether commercialization of NTFPs inevitably leads to stratification of harvesters and signals a situation where outsiders reap the better part of the economic benefits?

In the literature on NTFPs, the sensitive area of income differentials appears to be overlooked. To the best of our knowledge there are no studies that specifically analyse income differentials from NTFP extraction and inequalities between groups involved and hence seek to explain why some harvesters earn more income. Olsen (2005) provides useful terminology and some kind of typology of harvesters as economic agents but no insight on income determinants.

Therefore this paper is devoted to an analysis of income differentials and attempts to identify income determinants and suggest a framework typology of commercial agarwood harvesting. The hypothesis is that commercial NTFP harvesting, *in casu* agarwood harvesting, is a pure economic activity where income is determined by a set of strongly correlated variables describing harvester groups and their strategies.

The analysis is based on estimates of mean income per day, i.e. returns to labour. If estimates of annual income were used, other causal phenomena would come in play. Chiefly, number of days spent in agarwood harvesting and consequently issues related to livelihood strategies would become important. This would divert attention from income determinants.

2. Materials

The basis for the study is quantitative data from 103 complete standardized, semi-structured interviews conducted in 2004. Interviews with local harvesters were carried out in villages in three provinces of Laos with relatively intact agarwood resources and ongoing harvesting: Phongsali, Saysomboun Special Zone and Sayabouri. Interviews with Vietnamese and professional harvesters took place en-route or at factory gates in these or other provinces, especially in Pakkading District of Bolikhamsai Province, a free-zone with harvesters going to all parts of the country.

Respondents were leaders of agarwood harvesting groups. Members of groups are often from the same village, tribe and social group, and refer to each other as 'friends'. Individual interviews were time-consuming and did not add to accuracy, and group leaders are generally knowledgeable and enjoy a certain status. Due to difficult transportation and absence of group leaders, on average less than one interview was achieved per two days in the field, so a total of 250 days was spent in interviews with harvesters.

The accuracy of the data depends largely on the reliability of the respondents. Most were open and friendly but a few were non-communicative and participated with casual disdain, and especially Vietnamese harvesters were reluctant to share information. Where possible, data were crosschecked to verify the accuracy of responses.

Supplementary information was gathered through interviews with key informants, participatory and direct observation of agarwood harvesting, scrutiny of legal documents, open-ended interviews with national, provincial and district authorities and visits to more than 50 villages representing all parts of the country.

3. Methods

Dependent variable

Initially, it was planned to provide estimates of 'Average income per collection trip' as 'Revenues' minus 'Direct and indirect costs'. However, in pre-testing it proved exceptionally difficult to get reliable estimates of costs, i.e. capital, personal and product transport, processing and marketing, and it was decided to ask for estimates of 'Average income per collection trip' and 'Average costs' separately. 'Income per day' is calculated by dividing 'Average income per collection trip' by 'Average days spent in harvesting' and is the harvesters' own estimate of daily income.

Independent variables

The entry point to the analysis of independent variables was the initial grouping of harvesters in ethnic Vietnamese, Professionals and Local people. While these categories had no interpretation *per se*, they necessarily had to be included because of correlation with other variables and because this grouping figured prominently in all interviews. Furthermore, if a typology could be suggested with three entries, descriptive sub-groups could be suggested and hence enhance overall understanding of the typology.

Closely linked to the initial grouping is the notion of access and withdrawal rights to agarwood resources. These can either be based on customary rights to forests within village boundaries, on an authorized permit to National Production Forests, or extended to include all legal categories, hence semi-legal, and no rights at all, termed extra-legal.

In one tree there can be many different types of agarwood products and these products are characterised by huge price differences. 'Mai dii', literally good wood, the most valuable wood which is used as incense and medicine catches a price over 500 Thai Baht (approx. 12 USD); 'Mai khi khuan', 'residue from using axe', is used for extraction of essential oil by distillation and prices range from 80 Thai Baht/kg to 500 Thai Baht/kg (approx. 12 USD to approx. 2 USD); 'Mai phaktoo', meaning 'wood from stumps', is used for extraction of agarwood oil and has a market price of less than 80 Thai Baht/kg (approx. 2 USD). Especially in 'Mai dii' and 'Mai khi khuan' there are many products and it is estimated that the total number of traded and graded agarwood products is greater than 100.

Agarwood is traded between individuals, i.e. sellers and buyers, and with no bidding. There are no fixed quality criteria and no objective grading systems so pricing of a piece or lot of wood depends largely on the knowledge and experience of buyers and sellers. Furthermore, larger quantities generally yield higher prices. Hence, it is advantageous for harvesters to stock and trade in agarwood, i.e. buying from other harvesters.

Harvesters benefit from being able to sell to a range of different buyers, who openly compete on prices. Most products are traded along one particular route: harvester → agent or trader → wholesaler, yet there is also a substantial trade along many other routes. While 'Mai phaktoo' has high transportation cost compared to unit value and is mainly traded by harvesters selling directly to wholesalers or larger agents and distinctly within the administrative delineation of the wholesalers license, 'Mai khi khuan' is traded along the route from harvesters to agents and then to wholesalers but also directly to wholesalers and often across areas with different licenses. 'Mai dii' is sold along all trade routes and also abroad, notably to Vietnam.

Markets are defined by their distance to transit markets in Bangkok, Singapore and Dubai, by number of actors and their level of competition, and do not refer to location or geographic coverage. With all buyers purchasing in districts and provinces and often residing in villages adjacent to newly opened harvesting areas, markets occur at all sites.

On harvesting trips, harvesters frequently do not detect any harvestable trees and divert to opportunistic harvesting: commercial hunting of larger mammals and birds, extraction of other commercial NTFPs and collection of *Aquilaria* wildlings. Opportunistic harvesting can be interpreted as a sign of declining agarwood resources and is likely to influence income negatively.

Socio-economic characteristics are included to unravel livelihood aspects of harvesting yet without any in-depth investigation at household level and encompass subjective assessments of wealth status and purpose of harvesting and whether advances are routinely received from agents, traders or wholesalers.

Harvesting groups differ with respect to number of harvesters, duration of harvesting trips and quantity harvested. Furthermore, the dataset includes information on number of trips and collection days in 2004 and whether harvesting is a full-time or part-time occupation.

Investment in harvesting as measured by average direct variable costs, mainly on transport and consumables, is likely to be positively correlated with income.

Knowledge and experience is important when it comes to identifying trees with agarwood in the forest. Since only 1 out of 10 trees forms agarwood it is important to check trees for indices of agarwood formation. The indices *inter-alia* include stem form, presence of bore holes and bark structure. If indices are not known, trees will be cut indiscriminately. The estimated number of trees with agarwood formation per 10 trees with DBH >10 cm (FREQ10) was used as a check on knowledge and experience, lower estimates indicating profound knowledge. A proxy for experience is number of trips and days spent on harvesting during the preceding five years, i.e. 1999-2003.

Statistical analysis
Using the initial grouping of harvesters, ethnic Vietnamese, Professionals and Local people, as point of departure for the typology, sets of independent variables were explored for patterns, relationships and correspondence through analysis of correlation matrices and frequency tables. The next stage of the analysis aimed at developing the typology and included dimensional simplification using principal component analysis and graphical analysis. Initial groups were compared with alternative sets of groups created through cluster analysis. Graphical representation was used to analyze similarities between members of the various clusters and differences between clusters as regards income were tested by analysis of variance. Having decided how to group harvesters we proceeded with the modelling stage, aiming to identify income determinants other than the harvester category. First, all possible models with 1-10 independent variables were tested, and for selected models parameter estimates, i.e. signs and values, and residuals were analysed. It turned out that residuals were generally characterised by considerable heteroscedasticity. This problem was eliminated by logarithmic transformation of the dependent variable (average daily income) and selected models with 3-7 variables were examined in more detail. Parameter estimates were examined and collinearity problems were sought diagnosed. Finally, the structure of the residuals was examined graphically, tests of normality were made and a final model was selected, which was characterised by acceptable parameter estimates, good explanatory power and well-behaved residuals.

This model was interpreted and the typology further developed by application of qualitative data from interviews. The option of adding sub-groups and a more descriptive approach was hereby left open.

4. Results

Table 1 summarises the independent variables considered. The mean of INCODAY across all groups is 73,000 Kip (approx. 7 USD), which compares to a daily wage for unskilled work of 25,000-40,000 Kip (approx. 2.5-4.0 USD) and thus indicates how lucrative agarwood harvesting is. However, the risk of not detecting a single *Aquilaria* tree with agarwood is high, especially for local people, and INCOMIN is therefore 0 and minimum of INCODAY is positive but below the wage rate. INCOMAX and maximum of the other variables are high and should be treated as extremes.

In Table 2, a total of 40 independent variables are presented. Along with mean and standard deviation, minimum and maximum values are included to indicate the observed range of values.

Table 1 Summary of dependent variables

Dependent variables	Description	Mean	Std.dev.	Min.	Max.
INCOMIN	Minimum income from harvesting trip (in Kip)	567,403	1,105,387	0	6,000,000
INCOAVG	Average income from harvesting trip (in Kip)	1,765,000	2,681,829	10,000	12,000,000
INCOMAX	Maximum income from harvesting trip (in Kip)	6,123,835	8,888,390	25,000	40,000,000
INCODAY	Average income per day (in Kip) †	73,735	40,178	10,000	200,000

† INCOAVG/DAYSAVG

Table 2 Summary of independent variables

Variable		Mean	St.dev	Min.	Max.
Dummy variables (1/0):					
VIET	1 for Vietnamese citizens, 0 otherwise	0.16	0.36	0	1
PROF	1 for non-local Lao citizens	0.34	0.48	0	1
LOCAL	1 for local people, 0 otherwise	0.51	0.50	0	1
EXLEGAL	1 for extralegal harvesting, 0 otherwise	0.21	0.41	0	1
SEMILEG	1 if harvesting with permit, 0 otherwise	0.29	0.46	0	1
LEGAL	1 if harvesting under customary rights	0.50	0.50	0	1
POOR	1 for poor harvesters, 0 otherwise	0.49	0.50	0	1
RICH	1 for rich harvesters, 0 otherwise	0.01	0.10	0	1
LIVELIH	1 if harvest for livelihood purposes only	0.47	0.50	0	1
DISCRETI	1 if harvest for discretionary purposes	0.15	0.35	0	1
ADVANCE	1 if advance received, 0 otherwise	0.10	0.30	0	1
DII†	1 if price > 500 Baht/kg, 0 otherwise	0.81	0.40	0	1
KHILAI	1 if price 80-500 Baht/kg, 0 otherwise	0.78	0.42	0	1
PHAKTOO	1 if price < 80 Baht/kg, 0 otherwise	0.28	0.45	0	1
LOCMAR‡	1 if agarwood sold to local market	0.42	0.50	0	1
REGMAR	1 if agarwood sold to regional market	0.53	0.50	0	1
NATMAR	1 if agarwood sold to national market	0.36	0.48	0	1
INTMAR	1 if agarwood sold internationally	0.16	0.36	0	1
TRADER	1 if harvesters are trading in agarwood	0.47	0.50	0	1
STOCK	1 if harvesters keep stock, 0 otherwise	0.47	0.50	0	1
FULLTIME	1 if harvesting agarwood all year round	0.26	0.44	0	1
NTFP	1 if harvesting other commercial NTFPs	0.26	0.44	0	1
SEEDLI	1 if harvesting seedlings, 0 otherwise	0.34	0.48	0	1
HUNTING	1 if commercial hunting during trips	0.14	0.34	0	1
INDICES	1 if indices of agarwood are well known	0.79	0.41	0	1
Continuous-scale variables:					
KGMIN	Min. harvest quantity, kg fresh weight	6.25	5.65	0	20.0
KGAVG	Avg. harvest quantity, kg fresh weight	16.09	5.01	7.5	27.5
KGMAX	Max. harvest quantity, kg fresh weight	28.86	14.78	12.5	80.0
DAYSMN	Min. duration of harvesting trips, days	10.03	15.49	1	90.0
DAYSAVG	Avg. duration of harvesting trips, days	16.84	19.53	1	90.0
DAYSMX	Max. duration of harvesting trips, days	28.07	27.82	1	100.0
SIZEMIN	Min. number of harvesters in group	5.91	8.08	1	30.0

SIZEAVG	Average number of harvesters in group	9.81	12.03	1.5	60.0
SIZEMAX	Max. number of harvesters in group	17.54	23.48	2.0	100.0
TRIPS04	Number of harvesting trips in 2004	8.77	5.39	1.0	30.0
COLLD04	Average collection days in 2004	92.25	83.73	1.0	300.0
COSTAVG	Average cost per trip in 2004, 1000 Kip	265	378	0	2,000
FREQ10	No. of trees with agarwood out of 10	3.98	3.11	0.5	10
TRIPS5Y	Avg. number of harv. trips 1998-2003	40.45	35.91	1.0	300.0
COLLD5Y	Avg. annual collection days, 1999-2003	110.6	102.5	0.4	378.0

† DII, KHILAI and PHAKTOO are not mutually exclusive

‡ LOCMAR, REGMAR, NATMAR and INTMAR are not mutually exclusive

An extract of the correlation matrix is shown in Table 3. Only variables with coefficients of correlation exceeding 0.70 are included in the table and the number of variables is therefore only 20. Most noticeable is the absence of socio-economic variables, yielding the impression that socio-economic aspects are less important. This could be explained by the very high prices of some grades of agarwood and potential high income from harvesting so that it is an attractive activity not only for the poor. It is less obvious why FREQ10 and INDICES do not appear but it turned out that they reappear in the regression models. VIET correlates with a range of variables, clearly suggesting that Vietnamese stand out from other groups. PROF and LOCAL bond with access and withdrawal rights, and grouping based on legal aspects seems to be synonymous with the initial grouping. LOCAL correlates with LOCMAR since locals often sell to agents and traders who operate locally and an effect of product is probably present. The TRADER-STOCK relation is easily explained as trading is contingent upon stocking of wood. The fact that FULLTIME is strongly related to COLLD04 is a consequence of COLLD04 being derived as TRIPS04 × DAYSAVG and full-time harvesters will have more trips in a year *ceteris paribus*. The FULLTIME-LOCMAR link appears spurious but may result from a confounding effect of KHILAI and the need to cover costs in less successful harvesting trips by selling products that normally would be left behind.

Table 3. Variables with coefficients of correlation numerically greater than 0.70

Variable	Correlated with
VIET	EXLEGAL, INTMAR, DAYSMAX, DAYSAVG, DAYSMIN, SIZEMAX, SIZEAVG, SIZEMIN, COSTAVG, HUNTING
PROF	SEMILEG
LOCAL	LEGAL, LOCMAR
FULLTIME	COLLD04, LOCMAR
TRADER	STOCK

Following a series of analytic steps outlined earlier, the selected regression model with five independent variables is shown in Table 4. The dependent variable is the logarithm of INCODAY. LOCAL is the reference category and therefore not included in the model.

Table 4. Multiple regression result with ln(INCODAY) as dependent variable. Currency: Kip. LOCAL is the reference category. N = 103, RMSE = 0.3284, $R^2 = 0.7177$

	Intercept	VIET	PROF	PHAKTOO	HUNTING	FREQ10
Estimate	11.25	0.8565	0.1997	-0.5169	-0.3432	-0.05324
Std.error	0.086	0.183	0.089	0.109	0.178	0.0152
Pr>|t|	<0.0001	<0.0001	0.027	<0.0001	0.057	0.0007

The parameter estimates in Table 4 are generally in line with expectations. They follow patterns from the analysis of correlation and the rather high coefficient of determination (R^2), statistical significance of all five variables and signs of coefficients confirm the validity of the model. Addition of more variables in any of the tested models increased R^2 slightly but the maximum observed for any model was 0.75, i.e. only 0.03 greater than for the selected model. As shown in the table, FREQ10 re-emerged as a statistically significant factor, indicating that knowledge and experience plays an important role. In this model and, for that matter, all other models that were tested socio-economic variables (RICH, POOR, LIVELIH, DISCRETI, ADVANCE) turned out to have no significant effect. Market and product relations are represented in the model by PHAKTOO and even more so through the strong relationship with VIET. Opportunistic harvesting is represented by HUNTING.

5. Discussion

While the relevance of statistical modelling of this kind is undisputed, it must be kept in mind that the preceding analyses are advances based solely on empirical data and variables that vary together. It is not possible to establish causal relationships and reach irretractable conclusions based on these methods alone. To this effect, contributions from qualitative approaches and findings from interviews are taken into account. Other actors in the trade, agents, traders and wholesalers hold a bird's eye view on stratification of harvesters and the distribution of income between them, and suggest a more detailed model in which PROF and LOCAL be divided in 'PROF full-time', 'PROF part-time', 'LOCAL strictly', and 'LOCAL broadly'. For LOCAL, INDICES act as proxy marker between LOCAL harvesting strictly within village boundaries (INDICES=0) and LOCAL harvesting in village forests and other nearby forests, especially protected forests (INDICES=1).

In Figure 1, these categories are presented with INCODAY as dependent variable. As will appear from the confidence intervals the income level of Vietnamese harvesters (VIET) is again distinctly different from that of other groups. The remaining four groups are pair-wise PROF full-time/PROF part-time and LOCAL strictly/LOCAL broadly not significantly different. However, means are at different levels and PROF full-time is significantly different from LOCAL broadly and PROF part-time is from LOCAL strictly. For this reason, the model 1) VIET 2) PROF full-time 3) PROF part-time 4) LOCAL broadly 5) LOCAL strictly is kept as final result.

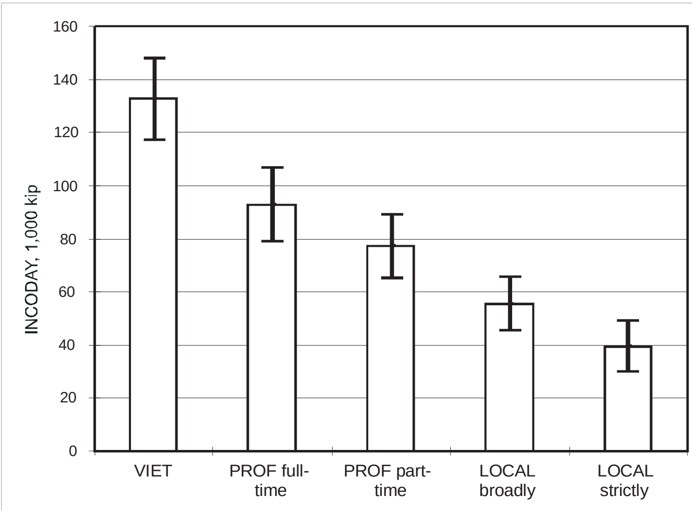


Figure 1. Typology with five groups and 95% confidence intervals for mean income per day (INCODAY, 1000 kip)

6. Conclusion

The final typology includes five groups of agarwood harvesters. The groups can be described as follows:

Highly professional, migrant harvesters

In this group, which is represented by harvesters coming from Vietnam, are found skilful, efficient and thievish harvesters with international market access. They are quality seekers as they primarily deal with valuable high-quality products and are able to recover high transportation costs. They harvest in large groups and over many days.

Full-time professional, mobile harvesters

These harvesters share characteristics with Vietnamese harvesters but generally operate in smaller groups and spend shorter time on harvesting. They harvest a wider range of products and have good market access but only within Laos.

Part-time, semi-professional, mobile harvesters

Like the full-time professional harvesters, harvesters in this group have an authorized harvest permit and are both quality and quantity seekers. They only harvest during the dry season.

Local harvesters

Local harvesters harvest under customary rights and are primarily quantity seekers. They mainly go for ‘mai khi khuan’ and ‘mai phaktoo’ and sell their products to local agents and traders. Some local harvesters may become professionals later if they manage to move up the learning curve.

Restricted local harvesters

This sub-group under local harvesters has generally scant knowledge and experience and only harvest within village boundaries and for quantity. Their income level is similar to wage labour.

References

Alton, C. & Rattanavong, H. 2004. Service delivery and resettlement: Options for development Planning. Final Report Livelihoods Study, Lao/03/A01, UNDP/ECHO, Vientiane, Lao P.D.R.

Arnold, J.E.M. & Ruiz Perez, M. 1998. The role of non-timber forest products in conservation and development. In: Wollenberg, E. and Ingles, A. (eds.) Incomes from the forest: methods for the development and conservation of forest products for local communities., pp. 17 – 42. CIFOR/IUCN. Bogor, Indonesia.

Belcher, B.M. 1998. A production-to-consumption systems approach: lessons from the bamboo and rattan sectors in Asia. In: Incomes from the forest: methods for the development and conservation of forest products for local communities. CIFOR, Bogor, Indonesia.

Brahmin, A. & Phoumphone, K. 2003. Study on local coping mechanisms in disaster management: case studies from the Lao P.D.R. Concern. Vientiane, Lao P.D.R.

Dove, M.R. (1994) Marketing the Rainforest: 'Green' panacea or red herring? Analysis from the East-West Center 13, 1-7

Foppes, J. (ed.) 2005. Draft Summary Report: Workshop on Marketing Information Systems (MIS) for Agriculture and Forestry Products. NAFRI, Vientiane, Lao P.D.R.

Foppes, J. & Ketphanh, S. 2005. Non-timber forest products for poverty reduction and shifting cultivation stabilisation in the uplands of the Lao P.D.R. In: Poverty reduction and shifting cultivation stabilization in the uplands of Lao PDR: Technologies, approaches and methods for improving upland livelihoods - Proceedings of a workshop held in Luang Prabang, Laos PDR, January 27-30, 2004. NAFRI, Vientiane, Lao PDR.

Foppes, J. & Khetpanh, S. 1997. The use of non-timber forest products in Lao P.D.R. Paper presented at the Workshop on Sustainable Management of Non-Wood Forest Products at IDEAL, UPM. Serdang, Selangor, Malaysia, 14-17 October, 1997. IUCN/DoF, Vientiane, Lao P.D.R.

Gansberghe, D. 2005. Agriculture and Forestry in the National Growth and Poverty Eradication Strategy. In: Improving Livelihoods in the Uplands of Lao PDR. NAFES/NAFRI/NUOL, Vientiane, Lao P.D.R.

MAF 2004. Forestry Strategy to the year 2020 (FS2020) of the Lao PDR. Ministry of Agriculture and Forestry, Vientiane, Lao P.D.R.

Olsen, C.S. & Bhattarai, N.K. 2005. A typology of economic agents in Himalayan plant trade. Mountain Research and Development 25(1), 37-43.

Olsen, C.S. 1998. The trade in medicinal and aromatic plants from central Nepal to northern India. Economic Botany 52(3), 279-292.

Promoting reforestation in Estonia

Paavo Kaimre, Risto Sirgmets & Tarmo Vahter*

Abstract
Reforestation of clear-cut areas has been considered one of the most critical topics of forest management in Estonia during the last 15 years. Experts have given alarming assessments especially about the situation in private forests.

In the paper the use of different tools, implemented by forest authorities for the sake of reforestation has been analyzed. The results of National Forest Inventory and inventories made by the Centre Forest Protection and Silviculture have been used to describe the preliminary results in the forest.

The intervention of government into forest management confined to legislation during the 1990ies but since the end of the century, financial instruments have also been used. It has been planned by the Ministry of Environment to implement a guarantee fund related to forest regeneration. Costs and benefits of creating such a guarantee fund were analyzed. Preliminary calculations indicated that long-term revenues and short-term costs were almost equal when taking into account all private forests. Authors suggest to link guarantee payments with financial incentives.

Key words: reforestation, forest policy, financial incentives

Introduction

Remarkable changes have been taken place in Estonian forestry since regained independence in 1991 and some of the changes have been favoured *ex post* , some have been criticised. Smooth transition from planned economy to market economy, re-establishment of private property, institutional changes in state forest management are considered successful achievements. One of the topics which makes stakeholders worry, is reforestation in privately owned forests.

Socio-economic changes in the end of 1980-ies led to the implementation of important changes in forestry. The biggest transformation took place in financing and organisational institutions, also in forest management. In the first project of Estonian Forestry concept, compiled by Malev Margus in autumn 1988, the question of reforestation was mentioned: *to influence the relationship between conifers and deciduous trees via forest management so, that the amount of conifers should be 50-75% and to enlarge the area of spruce stands in fertile forest types and lessen the area of deciduous trees* (Etverk, 2005).

In 1990-ies the ideas of close-to-nature forestry spread in Estonia, which in turn resulted in natural regeneration and hence the growth of deciduous stands more than coniferous. At the beginning of the new century the situation could be faced where in state forests 68% of felling area was artificially regenerated by planting and sowing, in private forests the per cent was only 13 between 1999-2003 (Centre of Forest Protection and Silviculture, 2006). The possible reasons of low rate of reforestation besides general attitude were also unwillingness of forest owners to make extremely long-time investments.

The article gives an overview of the problems concerning regeneration, describes legislative means in guaranteeing regeneration and analyses the costs and benefits of implementing the guarantee fund.

Material and method

The most important documents and publications since 1988 when reforms started in forestry were used to get a background for the decisions influencing reforestation. Two Forest Acts and a new draft act were analysed from the point of view of forest regeneration.

The data is gained from the National Forest Inventory and inventory carried out by the Centre of Forest Protection and Silviculture, in which the results of regeneration of clear-cut areas between 1995-1999 were assessed (Centre of Forest Protection and Silviculture, 2004; 2005).

To estimate the cost and benefits of implementing the guarantee fund, the additional revenue gained from managing economically valuable stands instead of low value stands were calculated. Managers of three County Environmental Departments were interviewed in order to estimate the administrative costs. In making calculations, it was presumed that guarantee payments is implemented for all private forest owners in all reforestation areas.

Situation in reforestation

As mentioned above, the most problematic issue in Estonian forestry after transition period concerned reforestation in private forests. Critical statements considering both environmental and economic aspects have been published.

The inventory carried out in 2003 about the clear cut areas between 1995-1999 revealed that the problem is not a quantity of regeneration, but its character. According to the requirements set in Forest Act, the regeneration is sufficient in 80.8-89.1% of the clear cut areas. The distribution of tree species is troublesome because a big share of economically valuable stands are naturally replaced by less valuable tree species. Figures presented in the table 1 describe the harvesting of timber by tree species in Estonian forests. Figure 2 illustrates the prevailing trend - clear-cut areas are regenerating with deciduous tree species.

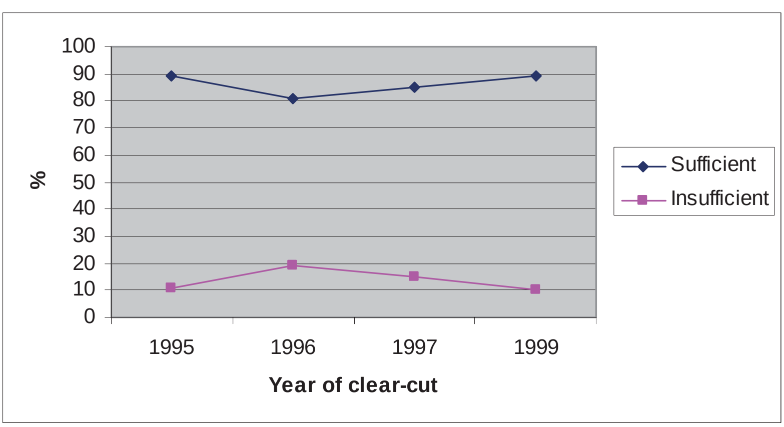


Figure 1. Results of reforestation by inventory made in 2003 (Centre of Forest Protection and Silviculture, 2004)

Table 1. Comparison of suggested and actual harvesting volume by tree species.

Tree species	Suggested annual harvesting volume 2001-2010, million m^3	Actual annual harvesting volume 1999-2003, million m^3
Scots pine	2.1	2.5
Norway spruce	3.2	5.0
Birch sp.	2.6	2.0
Aspen	1.8	1.2
Black alder	0.5	0.4
Grey alder	2.3	0.5
Other species		0.2
Total	12.6	11.8

Comparison of data indicates that Norway spruce and Scots pine give a biggest share of cutting volume – 42% and 21% respectively. At the same time, the area where spruce and pine grow in young stands, is 37% only. It means that the share of coniferous stands is decreasing in Estonia at present. As a consequence of natural processes and silvicultural measures, the composition of stands probably changes in favour of coniferous species during the decades. But still the 28% share of "other tree species", which are non-forest trees (mainly Bird Cherry (*Padus rascemora)*, Common Rowan (*Sorbus aucuparia)* etc.) is alarming. Forest officers and policy makers are trying to find and implement relevant instruments to improve the situation.

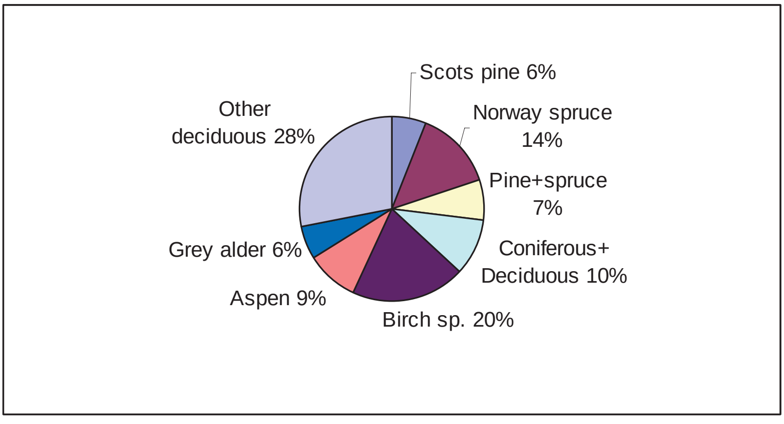


Figure 2. Distribution of reforested areas (1995-1997 and 1999) by tree species.

The inventory of clear-cut areas shows that the most critical from the regeneration point of view are spruce stands on Hepatica, Oxalis and Oxalis-Myrtillus site types (Centre of Forest Protection and Silviculture, 2005).

Legislation and reforestation

One of the most important tasks of the Forest Act approved by the Parliament in October 1993, was to create an environment and conditions for the private forest ownership in Estonia. Society which until this time acted in the command economy, believed that market economy, based on the private property, guarantees wise decisions and sustainable development. The ideology of Forest Act was based on the idea that forest owner itself makes the best decisions, therefore quite less regulations were written into the Act.

Concerning the reforestation, it was stated in the Forest Act that forest owner has to reforest clear-cut areas within five years and use genetically high quality breeding material.

The next Forest Act which was approved by the Parliament in 9.12.1998, tackled the reforestation more profoundly. The main principles are the following: it is required to reforest all clear cut areas and perished parts of protection and commercial forests with an area of more than 1 ha within three years after the cutting or perishing thereof. If an area has not regenerated within seven years after the cutting or perishing, the Ministry of the Environment shall organize its reforestation at the owner's expense.

In the draft of the new Forest Act which is already sent by the Government to the Parliament, strong efforts have been made to activate forest owners to reforest clear-cut areas. A new instrument for the Estonian forestry is a guarantee fund (the forest owner has to transfer a certain sum of money to the special account before he/she could start the clear-cut).

The implementing of guarantee fund is compulsory in certain forest types and in areas bigger than 2 hectares. The question of guarantee fund has caused numerous discussions amongst stakeholders – private forest owners are generally against it, but environmental organisations support the idea. Norwegian experience – the Forest Fund was taken as a model while elaborating the guarantee fund as a forest policy tool.

Economic incentives

Financial incentives have been widely used as an instrument of economic policy. The study "Evaluating Financing of Forestry in Europe" revealed that in 1990-ies the share of direct and indirect financial support for private forestry compared to other countries was the lowest in Estonia (European Forest Institute, 2005). At the beginning of 1990-ies the government paid subsidies were marginal according to the general economic policy.

In year 2000 when through the Private Forestry Centre private forest owners started to receive support for soil preparation, the volume of reforestation in privately owned forests was 1987 hectares. In year 2004 the planting and sowing area covered more than 3600 hectares (Centre of Forest Protection and Silviculture, 2006). The remarkable growth of forest cultivation is due to the increase of planting which gives better results compared to the sowing but it is also more expensive.

Table 2. Subsidies and reforestation in private forests in 2000-2005

Year	Financial support, EUR	Area of soil preparation, ha	Area of reforestation, ha
2000	11800	179	1987
2001	11900	173	2770
2001	38600	588	2765
2003	42850	626	3699
2004	51100	924	3604
2005	91400	1300	Data not available

Results and discussion

The tree species and age composition of Estonian forests enable to harvest a big share of coniferous stands. High timber prices as a consequence of demand also increase the harvest volume of spruce and pine stands. At the same time, the regeneration of cutting areas takes place mainly with deciduous species. Natural processes and silvicultural measures influence the tree species composition in young stands within the next decades, probably in favour of coniferous species. Still the 28% share of "other tree species", which are non-forest trees (mainly Bird Cherry (*Padus rascemora)*, Common Rowan (*Sorbus aucuparia)* etc.) on reforestation areas is alarming. Forest officers and policy makers try to find and implement relevant instruments to improve the situation.

Legislation, especially the Forest Act, has been considered to be the most important tool of forest policy. The rules concerning reforestation have been become more strict and detailed in the legislation. The key-elements of reforestation and their treatment in Forest Act are presented in the table 3.

Table 3. The treatment of reforestation in Forest Act

	Fores Act 1993	Forest Act 1998	Draft 2006
Maximum interval between clear-cut and reforestation	5 years	3 years	2 years
Maximum period of regeneration	5 years	7 years	5 years
Minimum number of trees per hectare	Not determined	1200	To be determined by Forest Management Instructions

Poorly regenerated clear-cut areas have negative impact on economy and environment. Non-regenerated areas suffer from decreasing area of forest habitats, the threat of erosion increases and the defending function against wind decreases. Furthermore, non-regenerated areas do not enable to harvest neighbouring stands. Efficient land usage could not take place, resulting in a loss of future revenues for the whole economy.

According to the calculations, hundreds of millions of *kroons* extra income can be obtained by forest owners during the rotation period when less valuable species in regenerated areas will be substituted by economically more valuable ones. Extra income per year is about 3 million *kroons* (by optimistic scenario it is 6-7 millios *kroons* per year).

Expenses in public sector will increase when implementing the guarantee fund. The growth in administrative expenses per 15 County Environmental Departments is at minimum 1.05 million *kroons*. Employing additional officers for the administration (incl. control and monitoring) of the guarantee fund, the total annual costs are 4…5 million *kroons* which means that the extra benefits and costs are almost equal.

It is extremely important to find out and implement policy tools which favour and support the reforestation in privately owned forests. In addition to the guarantee payments the existing means already included into legislation (sanctions, reforestation by authorities at owner's expense etc.) have to be used by the governmental departments.

To increase the reforestation with coniferous species, the combining of guarantee fund and financial incentives would be an opportunity. It is important to the forest sector and economy to keep the share of coniferous forests at the same level and therefore tax concessions could be applied for young cultivated stands.

As Estonian economy is moving from liberal, "invisible hand" ruled model to the economy using more and more financial and regulatory tools, then the same tendency is characteristic in the forestry. Forest economists can participate in the process, providing relevant analyses and making knowledge based suggestions.

References:

European Forest Institute**,** 2005. Evaluating financing of forestry in Europe. Executive summary. http://www.efi.fi/projects/effe/Deliverables/

Centre of Forest Protection and Silviculture, 2004. Lageraiealade inventeerimine metsauuendamise vajaduse väljaselgitamiseks.[The inventory of clear cut areas for the investigation of reforestation needs]. Tartu. 28 lk. In Estonian.

Centre of Forest Protection and Silviculture, 2005. Lageraiealade inventeerimine metsauuendamise vajaduse väljaselgitamiseks. [The inventory of clear cut areas for the investigation of reforestation needs].Tartu. 27p. In Estonian.Centre of Forest Protection and Silviculture, 2006. Yearbook Forest 2005. Tartu. 175p.

Etverk, I. 2005. Taasiseseisvunud Eesti metsapoliitika ja –seadusandluse kujunemine (aastani 2005) [The forest policy and forest legislation of Estonia (until 2005)]. Tartu. 363 p. In Estonian.

Profitability of pre-clearance in first-thinning Scots pine stands

Kalle Kärhä

Abstract
The impact of undergrowth and its pre-clearance methods on the productivity, costs, and silvicultural result of the winter and summer harvesting of first-thinning Scots pine (*Pinus sylvestris*) stands, and as well as the profitability of pre-clearance were analysed. The density and average height of the Norway spruce (*Picea abies*) undergrowth were found to have a significant impact on cutting productivity. Spruce undergrowth density also affected forwarding productivity. Undergrowth density, height, or pre-clearance method had no effect on the silvicultural result. The density and average height of the spruce undergrowth, the size of the trees to be harvested, the roundwood removal, and the costs for harvesting machinery used affected the calculated pre-clearance limits. The pre-clearance limit refers to the spruce undergrowth level, above which pre-clearance became economically profitable. Based on the findings of this study, when the spruce undergrowth density in a marked pine stand exceeds the pre-clearance limit, the most effective pre-clearance result is achieved when a one-metre radius is cleared around each merchantable stem together with any other spruce undergrowth over 1.5–2.0 m high that may hinder cutting.

***Keywords*:** undergrowth, pre-clearance, profitability, first thinnings, Scots pine, Finland

1. Introduction

According to the National Forest Programme, the estimated need for first thinnings is 250,000 hectares per year in Finland (Anon. 1999). However, during the past five years only 170,000–180,000 hectares per year was carried out (Västilä and Herrala-Ylinen 2001–2005). Moreover, first thinnings are late on a total area of 400,000 hectares (Valkonen 1999). High harvesting costs, particularly cutting costs are the main problems in first-thinning stands. Small stem size, low roundwood removal per hectare, the high number of remaining trees and dense undergrowth mean low productivity and high cutting costs (Kärhä et al. 2004). In 2005, the average harvesting costs in mechanised first thinnings carried out by the forest industries and Metsähallitus were 15.5 €/m^3 (cutting 11.0 €/m^3; forest haulage 4.5 €/m^3) when the average stem size was 86 dm^3 and the average roundwood removal 42 m^3/ha (Kariniemi 2006). In Finland, first-thinnings yielded 3.6 million m^3 in 2005. Two thirds of the first-thinning wood harvested came from Scots pine (*Pinus sylvestris* L.) stands (Kariniemi 2006).

Nevertheless, high cutting costs can be reduced by improving the harvesting conditions, e.g. by means of pre-clearance. There are usually large amounts of non-marketable undergrowth in many early thinning stands. Dense undergrowth restricts the visibility of harvester operator, hinders cutting work, and reduces the productivity of cutting. At the beginning of the 21st century, the current guidelines for undergrowth pre-clearance were made by Metsäteho Oy in Finland (Anon. 2001). When undergrowth is dense and restricts visibility, the directions recommend that a one-metre radius is cleared around each merchantable stem together with any other undergrowth that may hinder visibility (Anon. 2001). It is suggested that good cultivatable undergrowth trees will be left outside clearance. When undergrowth is low, it is recommended that only a one-metre radius is cleared around each merchantable stem (Anon. 2001).

The guidelines present no density or size limits on undergrowth, whenever or whatever clearing method is used (cf. Anon. 2001). Similarly, when pre-clearance is left completely undone. The recommendations of the guide have spread to the field, but still, unfortunately too often all undergrowth trees have been cleared from a stand. On the other hand, there are plenty of first-thinning sites where no pre-clearance has been carried out, even if there would have been a need for it.

In Finland, unfortunately there is a lack of accurate information about the profitability of pre-clearance in first-thinning stand, e.g.

- what is the effect of undergrowth height on harvesting productivity and costs,
- what is the effect of undergrowth tree species on harvesting productivity and costs,
- when the pre-clearance has to be conducted, and
- what kind of pre-clearance methods have to be used.

Metsäteho Oy analysed the impact of undergrowth and its pre-clearance methods on the productivity, costs, and silvicultural result of the winter and summer harvesting of first-thinning Scots pine stands, as well as the profitability of pre-clearance. The aim was to research when and how pre-clearance has to be conducted in different first-thinning Scots pine stands.

2. Material and methods

The research defined undergrowth as trees under 7.0 cm in breast-height-diameter ($d_{1.3}$), and over 1.1 cm in stump diameter (d_0). Four different pre-clearance methods were tested in the research:

i) one metre radius cleared around trees of merchantable wood,
ii) one metre radius cleared around trees of merchantable wood and other undergrowth that hinders cutting cleared, while leaving the cultivatable spruce undergrowth,
iii) one metre radius cleared around trees of merchantable wood and undergrowth taller than one metre cleared, and
iv) all undergrowth cleared (total pre-clearance).

In addition, first-thinning wood was harvested from uncleared research plots. There were in all 85 sample plots in the study. The size of the research plots was 20 m × 50–60 m. The research plots were established in Scots pine dominated first-thinning stands which were 30–50 years old. The research plots were cleared and measured in autumn 2004.

The time studies were carried out on cutting and forest haulage in winter and summer 2005. In all 70 sample plots were included in the harvesting time studies. The silvicultural result was measured after harvesting operations using the inventory method developed by Sirén (1998). The growth and quality losses for remaining merchantable trees in a first-thinning stand were determined by the model of Kovalama (Kokko and Sirén 1996). In total, 678 m^3 roundwood (total 5,695 first-thinning trees) was cut. The material of forest haulage was 461 m^3. Mainly harvesters for thinnings (weight 13–15 tons) and medium-duty harvesters (15–17 tons) were used in cutting, and medium-duty forwarders (weight 12–15 tons; max. load rating 10–11 tons) in forest haulage.

Harvesting costs were calculated for a harvesting chain including a medium weight harvester (e.g. John Deere 1270D, Ponsse Ergo, Valmet 911.3) (operating hour (E_{15}, including delay times shorter than 15 minutes) cost 78 €/h) and a forwarder (e.g. John Deere 1070D, Ponsse Wisent, Valmet 840.2) (53 €/h). In addition, the cutting costs were calculated for a small harvester (e.g. John Deere 770D, Sampo-Rosenlew 1066) (68 €/h) and for a harvester for thinnings (e.g. John Deere 1070D, Ponsse Beaver, Valmet 901.3) (74 €/h). Additional cubic metre based (€/m^3) harvesting costs caused by Norway spruce (*Picea abies* L. Karst.) undergrowth were calculated by comparing harvesting costs with harvesting conditions with no spruce undergrowth. Additional hectare based (€/ha) harvesting costs caused by spruce undergrowth were calculated by multiplying additional cubic metre based costs with cut/hauled wood volume.

In defining the profitability limits of pre-clearance i.e. the pre-clearance limits, the additional hectare based costs caused by spruce undergrowth in cutting and forest haulage were summarized and compared with the pre-clearance costs. Clearance costs were considered as those costs incurred when clearing a one metre radius around merchantable stems and other undergrowth that might hinder cutting (Treatment option 3). Pre-clearance costs were calculated per research plot using Metsäteho's clearance-thinning pricing function. The value of growth and quality losses for remaining trees was not included within the pre-clearance limit calculation because the undergrowth density or size were not connected to growth and quality losses.

3. Results

3.1 Impacts of pre-clearance of undergrowth

When only a one metre radius was cleared around trees of merchantable wood (Treatment method 2), the removal of undergrowth was around half of the initial density (Fig. 1). When using selective pre-clearance methods (clearance of a one metre radius around trees of merchantable wood and other undergrowth that hinders cutting, or clearance of a one metre radius around trees of merchantable wood and undergrowth taller than one metre) (Treatment methods 3 and 4), the undergrowth removal was approximately 80%. The removal of undergrowth was, on average, 97% in total pre-clearance (Treatment method 5).

The clearance method which cleared a one metre radius around trees of merchantable wood and undergrowth taller than one metre (Treatment option 4), affected size distribution the most (Fig. 2). Over half of the undergrowth cleared was 2–4 m high. The average height of standing undergrowth was 2.1 m. When clearing a one metre radius around trees of merchantable wood and other undergrowth that hinders cutting (Treatment option 3), the average height of standing undergrowth was 2.5 m. Uncleared plots, and plots which only had a metre radius cleared around merchantable trees, had an average undergrowth height of 3 m.

The costs were highest in the plots where all undergrowth was cleared – an average of 202 €/ha. The smallest average clearing costs (125 €/ha) were when only a one metre radius was cleared around the merchantable trees. The average clearing costs were higher when removing over one metre tall undergrowth (178 €/ha) than for clearing other undergrowth in addition to the one metre radius (168 €/ha).

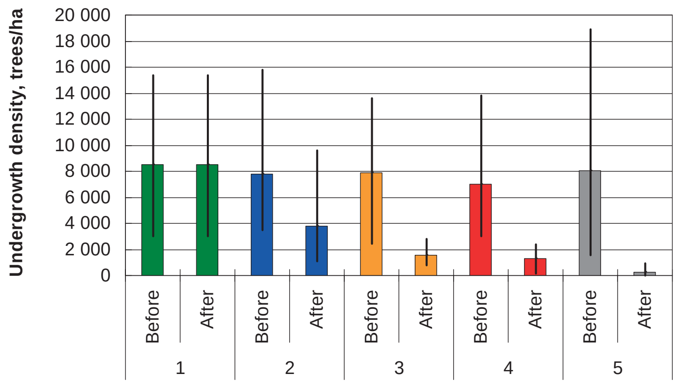


Figure 1. Impact of undergrowth pre-clearance on the density of the undergrowth for each treatment method. The average undergrowth before and after clearance (columns), as well as the variation range of density for each treatment method.

Treatment methods:

1 = not cleared

2 = one metre radius cleared around trees of merchantable wood

3 = one metre radius cleared around trees of merchantable wood and other undergrowth that hinders cutting cleared, while leaving cultivatable spruce undergrowth

4 = one metre radius cleared around trees of merchantable wood and undergrowth taller than one metre cleared

5 = all undergrowth cleared.

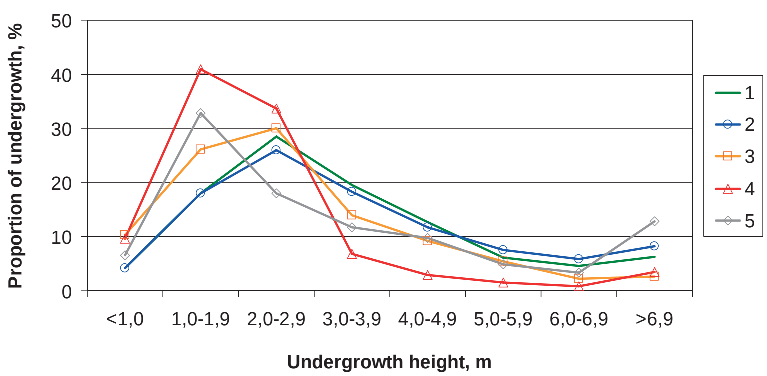


Figure 2. Impact of pre-clearance on the undergrowth height distribution for each treatment method. Undergrowth height distribution after clearance. See treatment methods 1–5 in the Fig. 1.

3.2 Impacts of undergrowth on productivity

The density and average height of the Norway spruce undergrowth were found to have a significant impact on cutting productivity (Figs. 3 and 4). When the density of spruce undergrowth increased, the time consumption increased for moving the harvester head to the butt of removable tree, felling and bringing the stem to the processing point. The time consumption for undergrowth clearance and stacking carried out by the harvester head increased along with the density and average height of the spruce undergrowth. The effect of the average height of spruce undergrowth in cutting productivity was less than with the density of the spruce undergrowth (Figs. 3 and 4).

When the spruce undergrowth density was 2,000 stems per hectare and the average height was 2 m, cutting productivity was 12–14% less than for harvesting conditions where there was no spruce undergrowth. When the density of spruce undergrowth was 10,000 stems per hectare and the average height was 2 m, cutting productivity was 30–34% less. The smaller the merchantable stems harvested, the more cutting productivity decreased along with an increase in spruce undergrowth density and average height (Figs. 3 and 4).

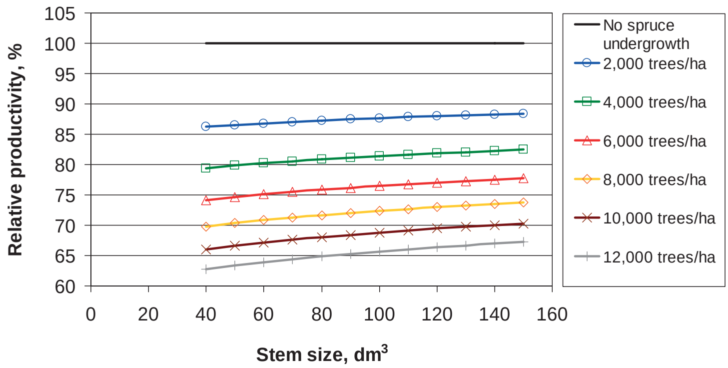


Figure 3. Relative impact of spruce undergrowth density on cutting productivity as a function of stem size harvested in a first-thinning pine stand. The average height of the spruce undergrowth was 2.0 m. The commercial roundwood removal increased from 33 m^3/ha (stem size 40 dm^3) to 64 m^3/ha (150 dm^3).

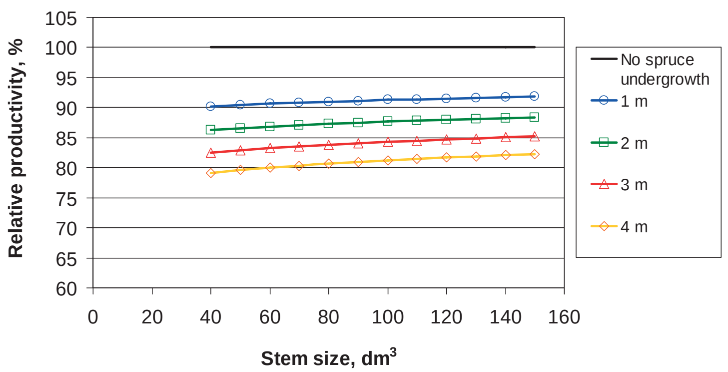


Figure 4. Relative impact of spruce undergrowth height on cutting productivity as a function of stem size harvested in a first-thinning pine stand. Spruce undergrowth density 2,000 trees/ha. The commercial roundwood removal increased from 33 m^3/ha (stem size 40 dm^3) to 64 m^3/ha (150 dm^3).

Spruce undergrowth density also affected forwarding productivity. Spruce undergrowth density had a lower impact on productivity in forwarding than in cutting. When the spruce undergrowth was 2,000 stems per hectare, forwarding productivity was only 1–2% less than for harvesting conditions with no spruce undergrowth. When spruce undergrowth density was 10,000 stems per hectare, forwarding productivity was 5–7% less.

The pre-clearance method used affected harvesting productivity through the spruce undergrowth left behind to grow. Broadleaved undergrowth had no significant impact on harvesting productivity either in summer or winter.

3.3 Impacts of undergrowth on silvicultural result

Undergrowth density, height, or pre-clearance method had no significant effect on the silvicultural result. The silvicultural result at the majority of the study sites was good. The average damage percentage (percentage of damaged merchantable trees from the number of remaining merchantable trees) was 4.2%. The average strip road width was 4.4 m.

The current discounted value of growth and quality losses for remaining merchantable trees in the first-thinning stand was an average 77 €/ha. Growth and quality losses in summer (99 €/ha) were clearly higher than for growth and quality losses incurred in winter (63 €/ha). The density or size of undergrowth and the pre-clearance method used had no significant impact on the value of growth and quality losses for remaining trees.

3.4 Profitability of pre-clearance

The density and average height of the spruce undergrowth, the size of the trees to be harvested, the roundwood removed, and the costs for harvesting machinery used affected the calculated pre-clearance limits. The pre-clearance limit refers to the spruce undergrowth level, above which pre-clearance became economically profitable. Pre-clearance was economically profitable when the additional harvesting costs curve exceeded the pre-clearance costs curve.

When the density and average height of the spruce undergrowth or the volume of roundwood removed increased, it was economically profitable to do pre-clearance in first-thinning stands which had a quite low density of spruce undergrowth. Correspondingly, when the size of the trees to be harvested increased, the pre-clearance limits rose. Likewise when using harvesters for thinnings (weight 13–15 tons) or small harvesters (weight under 13 tons) instead of medium-duty harvesters in cutting.

When harvesting of first thinnings was carried out under typical harvesting conditions (average stem size 50–100 dm^3; roundwood removal 30–60 m^3/ha), the pre-clearance limits ranged from 400 spruce undergrowth trees per hectare to over 10,000 (Table 1). When the roundwood removal was small (20–30 m^3/ha) and the clearance was carried out as salary work, pre-clearance was not economically profitable with any spruce undergrowth density with several stem sizes.

Table 1. Pre-clearance limits (number of spruce undergrowth trees per hectare) for first-thinning pine stands, with an average spruce undergrowth height of 1–4 m. Harvesting is carried out using medium-duty forest machines at an operating hour (E_{15}) cost of 78 €/h for the harvester and 53 €/h for the forwarder.
Pre-clearance is not economically profitable when the spruce undergrowth density of the marked stand is lower than that presented in the table. Pre-clearance is economically profitable when the spruce undergrowth density is higher than that presented in the table.

	Pre-clearance limit was not determined because roundwood removal from the marked first-thinning stand was either very low (≤ 200 trees/ha) or very high (≥ 1,500 trees/ha).
	Pre-clearance was not economically profitable in any harvesting conditions (the additional harvesting costs curve and pre-clearance costs curve did not intersect).

Average spruce undergrowth height 1 m

Stem size, dm^3	Roundwood removal, m^3/ha								
	20	30	40	50	60	70	80	90	100
40		5,200	2,200	1,400					
50			4,000	2,200	1,600	1,200			
60			8,200	3,400	2,200	1,600	1,200		
70				5,600	3,200	2,200	1,600	1,200	1,000
80				10,800	4,600	2,800	2,200	1,600	1,400
90					7,000	4,000	2,800	2,000	1,600
100					13,000	5,400	3,400	2,600	2,000
110						7,800	4,600	3,200	2,400
120						12,600	6,000	4,000	3,000
130							8,400	5,000	3,600
140							13,200	6,600	4,400

Average spruce undergrowth height 2 m

Stem size, dm^3	Roundwood removal, m^3/ha								
	20	30	40	50	60	70	80	90	100
40		1,800	1,000	600					
50		3,600	1,600	1,000	600	600			
60			2,400	1,400	1,000	800	600		
70			4,200	2,000	1,200	1,000	800	600	600
80			10,000	2,800	1,800	1,200	1,000	800	600
90				4,400	2,400	1,600	1,200	1,000	800
100				8,200	3,200	2,000	1,400	1,200	1,000
110					4,400	2,600	1,800	1,400	1,000
120					7,200	3,400	2,200	1,600	1,200
130						4,400	2,800	2,000	1,600
140						6,400	3,400	2,400	1,800

Average spruce undergrowth height 3 m

Stem size, dm^3	Roundwood removal, m^3/ha								
	20	30	40	50	60	70	80	90	100
40	2,800	1,000	600	400					
50		1,600	800	600	400	400			
60		2,600	1,200	800	600	400	400		
70		6,000	1,800	1,000	600	600	400	400	400
80			2,600	1,400	800	600	600	400	400
90			4,200	1,800	1,200	800	600	600	400
100				2,400	1,400	1,000	800	600	600
110				3,600	1,800	1,200	1,000	800	600
120				5,800	2,400	1,600	1,200	800	800
130					3,200	1,800	1,400	1,000	800
140					4,400	2,400	1,600	1,200	1,000

Average spruce undergrowth height 4 m

Stem size, dm^3	Roundwood removal, m^3/ha								
	20	30	40	50	60	70	80	90	100
40	1,400	600	400	200					
50	3,000	800	600	400	200	200			
60		1,400	800	400	400	200	200		
70		2,200	1,000	600	400	400	200	200	200
80		3,800	1,400	800	600	400	400	200	200
90			1,800	1,000	600	600	400	400	400
100			2,600	1,400	800	600	400	400	400
110			4,400	1,600	1,000	800	600	400	400
120				2,200	1,200	1,000	600	600	400
130				3,000	1,600	1,000	800	600	600
140				4,400	2,000	1,200	1,000	800	600

4. Discussion and conclusions

The results of the research were in line with earlier research results on the pre-clearance of undergrowth (e.g. Lilleberg 1990, 1991, Sirén 1990, Gunnarsson and Hellström 1991, Kuitto et al. 1994, Mäki 2000, Tahvanainen 2001a, 2001b). The research also highlighted the effect of undergrowth height on cutting productivity. The impact of undergrowth on forwarding productivity was also a new finding in this research. The relationship between undergrowth and forwarding productivity has not been previously researched (cf. Gunnarsson and Hellström 1991, Tahvanainen 2001a, 2001b).

Research by Tahvanainen (2001a, 2001b) could not unequivocally state the impact of undergrowth tree species on cutting productivity. This research showed that irrespective of harvesting season (summer/winter), spruce undergrowth has the most significant effect on both cutting and forwarding productivity. The overall density of undergrowth also impacted on cutting and forwarding productivity, but its effect was smaller than that of spruce undergrowth. Broadleaved undergrowth had no significant impact on harvesting productivity either in summer or winter.

In this research, the density and size of the undergrowth or the pre-clearance method used had no effect on the silvicultural result. The silvicultural result in the majority of research sample plots was good: the damage percentage was less than 5% and the strip road width was less than 4.5 m. The main reason that the silvicultural result remained good even in sample plots with very dense undergrowth is most likely due to the operators removing dense undergrowth with the harvester head. Unless the operators did not do so, the number of damaged trees would likely have been greater than it was. The good level of silvicultural result can also be partly explained by the level of harvester operator experience (7–20 years) in first thinnings of those who participated in the research.

Tahvanainen (2001a) calculated the pre-clearance profitability limits for small harvesters (Nokka Profi and Sampo-Rosenlew 1046X) to be a stem size of 50 dm^3 and a roundwood removal of 48 m^3/ha. Tahvanainen (2001b) confirmed that pre-clearance in winter was profitable when the density of conifer undergrowth was more than 1,600 trees per hectare. Correspondingly, pre-clearance in summer was profitable when the overall density of undergrowth was more than 6,000 trees per hectare (Tahvanainen 2001a). The results of this study indicated that one or two pre-clearance limits for first-thinning stands cannot be determined when the pre-clearance of undergrowth is economically profitable. The harvesting conditions – the density and average height of the spruce undergrowth, the size of the trees to be harvested, and the roundwood volume removed – and the costs of harvesting machinery used affected the calculated pre-clearance limits in this research.

Based on the findings of this study, when the spruce undergrowth density in the marked pine stand exceeds the pre-clearance limit, the most effective pre-clearance result is achieved when a one-metre radius is cleared around each merchantable stem together with any other spruce undergrowth over 1.5–2.0 m high that may hinder cutting. Pre-clearance work should be carried out ideally a full year in advance of harvesting operations so that the cleared undergrowth stems can settle on the ground. A one-metre radius around each merchantable stem to be cleared should be cut low down, about 10 cm from the stump. Otherwise the stumps can be left longer. Elsewhere it is recommended only to clear the taller (higher than 1.5–2.0 m) spruce undergrowth.

If the spruce undergrowth is predominantly about one metre high, the need to carry out clearance is minimal. The taller the spruce undergrowth, the greater the need to do the clearance. It is important to keep in mind not to pointlessly clear. Part of the spruce undergrowth can be left to fill in patchy or open forest stands. However, it should be remembered that a spruce undergrowth density of 200–500 trees per hectare already weakens cutting productivity so much, that it is worthwhile doing pre-clearance in certain harvesting conditions (cf. Table 1). In addition, it should be noted that undergrowth is also important for forest biodiversity and game habitat.

When the roundwood removal was small (20–30 m^3/ha) and the clearance was carried out as salary work, pre-clearance was not economically profitable with any spruce undergrowth density with several stem sizes. In this case, the options from a wood procurement organisation point of view are:

1) Leave the stand out of the scope of timber sales,
2) Carry out unprofitable pre-clearance and roundwood harvesting,
3) Leave pre-clearance undone and carry out roundwood harvesting, and
4) Leave pre-clearance undone and carry out energy wood harvesting.

When the roundwood removal is small (about 20 m^3/ha), the stand is left out of the scope of timber sales. A second option is to carry out energy wood harvesting. When the roundwood removal is greater, commercial roundwood harvesting with or without pre-clearance become more feasible.

References

Anon. 1999. Finland’s National Forest Programme 2010. Ministry of Agriculture and Forestry, Publications 2/1999. 40 pp.

Anon. 2001. Hakkuukonetyömaan ennakkoraivaus. (Pre-clearance of mechanised harvesting site.) Metsäteho’s Guidebook. 7 pp.

Gunnarsson, P. and Hellström, C. 1991. Maskinell gallring i bestånd med underväxt – Hur kan problemen undanröjas? (Mechanized thinning in stand with undergrowth – How can this problem be eliminated?) Skogsarbeten, Resultat 17/1991. 4 pp.

Kärhä, K., Rönkkö, E. & Gumse, S-I. 2004. Productivity and Cutting Costs of Thinning Harvesters. International Journal of Forest Engineering 15(2): 43–56.

Kariniemi, A. 2006. Timber harvesting costs, harvesting conditions and volumes in 2005. Metsäteho, Unpublished statistics.

Kokko, P. & Sirén, M. 1996. Harvennuspuun korjuujälki, korjuujäljen seurausvaikutukset ja niiden arviointi. (Silvicultural result of thinnings: consequences and evaluation.) Finnish Forest Research Institute, Research Papers 592. 70 pp.

Kuitto, P-J., Keskinen, S., Lindroos, J., Oijala, T., Rajamäki, J., Räsänen, T. And Terävä, J. 1994. Mechanized cutting and forest haulage. Metsäteho, Report 410. 38 pp.

Lilleberg, R. 1990. Kuormainharvesteri avo- ja harvennushakkuissa. Maksuperustetutkimus. (One-grip harvester in clearcuts and thinnings. Research on the basics of payment.) Metsäteho, Monisteita 28.3.1990. 21 pp.

Lilleberg, R. 1991. The thinning method and multi-tree handling in mechanized first thinning of pine stands. An NSR-Project. Metsäteho, Report 406. 11 pp.

Mäki, J-P. 2000. Frame-steered tractor-based harvesters in thinning. TTS Institute, Forestry Bulletin 616. 4 pp.

Sirén, M. 1990. Small multi-function machines in early thinning operations. A joint Nordic NSR-study. Folia Forestalia 743. 29 pp.

Sirén, M. 1998. One-grip harvester operation, it's silvicultural result and possibilities to predict tree damage. Finnish Forest Research Institute, Research Papers 694. 179 pp.

Tahvanainen, M. 2001a. Alikasvoksen ennakkoraivauksen vaikutukset kesäaikaisessa koneellisessa ensiharvennushakkuussa. (Effects of undergrowth pre-clearance on mechanised first-thinning cutting in summer.) Työtehoseura, Monisteita 84. 87 pp.

Tahvanainen, M. 2001b. On the effects of advance clearing of undergrowth when applying mechanised thinning. TTS Institute, Forestry Bulletin 638. 4 pp.

Valkonen, S. 1999. Ensiharvennus. (First thinning.) In: Reunala, A., Halko, L. and Marila, M. (eds.). Kansallinen metsäohjelma 2010 – Taustaraportti. (Finland's National Forest Programme 2010 – Background Report.) Ministry of Agriculture and Forestry, Publications 6/1999: 84–85.

Västilä, S. And Herrala-Ylinen, H. (Eds.). 2001. Metsänhoito- ja perusparannustyöt vuosi 2000. (Silvicultural and forest-improvement works, year 2000.) Finnish Forest Research Institute, Forest Statistical Bulletin 596. 30 pp.

Västilä, S. And Herrala-Ylinen, H. (EDS.). 2002. Metsänhoito- ja perusparannustyöt vuosi 2001. (Silvicultural and forest-improvement works, year 2001.) Finnish Forest Research Institute, Forest Statistical Bulletin 646. 36 pp.

Västilä, S. And Herrala-Ylinen, H. (EDS.). 2003. Metsänhoito- ja perusparannustyöt vuosi 2002. (Silvicultural and forest-improvement works, year 2002.) Finnish Forest Research Institute, Forest Statistical Bulletin 697. 24 pp.

Västilä, S. And Herrala-Ylinen, H. (EDS.). 2004. Metsänhoito- ja perusparannustyöt 2003. Metsänhoito- ja perusparannustöiden kustannukset 2002. (Silvicultural and forest-improvement works 2003. Costs of silvicultural and forest-improvement works 2002.) Finnish Forest Research Institute, Forest Statistical Bulletin 742. 48 pp.

Västilä, S. And Herrala-Ylinen, H. (EDS.). 2005. Metsänhoito- ja perusparannustyöt 2004. (Silvicultural and forest-improvement works 2004.) Finnish ForestResearch Institute, Forest Statistical Bulletin 778. 36 pp.

Results and implications from a comparative study of Swedish and Finnish forest sectors

Jussi Leppänen and Paul Nouro*

Abstract
Sweden and Finland as two neighbouring forestry countries are compared. Despite the widely similar features of forestry sectors, some interesting differences are found. In Finland, the economic dependence on and the people's involvement in the forestry sector are wider than in Sweden. For instance, there are almost double as many family forest owners in Finland as in Sweden. Decision making is more centrally organised in Finland than in Sweden. On the other hand, more normative control and general enhancement of rural entrepreneurship is employed in Sweden, whereas Finland relies more on direct financial support for rural sectors. The structural change in forest industry has progressed further in Finland than in Sweden and the dependence on imported wood is greater in Finland. The financing of nature conservation increased during the 1990's strongly in both countries and was on average at a slightly higher level in Finland than in Sweden. Since 1999, however, the conservation financing level has increased remarkably in Sweden. Eight out of ten of the general public in both Finland and Sweden see that forests are very or rather well managed. The impression is that forestry is practised slightly more intensive in Finland than in Sweden. Also the forestry net revenues have been since the end of 1990's higher in Finland.

Keywords: *comparative study, forest policy, forestry, forest industries, nature conservation*

1. Introduction

Sweden and Finland are two neighbouring Nordic countries, which have similar competitive advantages in the global economy. One of these is the forest resources, which have played an essential role in the industrialisation process and in the development of the welfare state in both countries.

Although Sweden and Finland are in many forms similar countries, there are also differences. The objective of this article is to compare the Finnish and Swedish forest sectors in order to find out the factors, which can be argued to affect the relative forest sector competitiveness of the respective country. The aim of the study is to assist ongoing forest policy processes in both Sweden and Finland.

The article is organised as follows. In chapter "Materials and the working group" the main sources of information, certain conversion methods and the responsible working group as a "think tank" for the results are described. This is followed by the "Results of the comparative analysis", which is written in a rather brief straight-forward style according to topics chosen by the working group. The final chapter of the article is "Summary, conclusions and implications", which discusses on the selected differences between countries.

2. Materials and the working group

The materials of the study have been based mostly on the secondary information i.e. existing data and research results, which have been made as comparable as possible between the countries. The precise references are impossible to include in this article, but will be available in the final report. Therefore, the sources for information are described in a more general way in this chapter.

The most important sources of the forest resource and forest utilisation data have been the Statistical Yearbooks of Forestry of the both countries. These have been supplemented with other statistics from both countries. Conversions have been carried out e.g. in felling volume statistics, which differ between countries with regard to over and under bark practises and the extent of removal definition. In case of the financial terms, inflation unadjusted monetary conversion 1 euro = 9 SEK has been employed in all other subjects and times series except for in annual revenues and costs of forestry, where annual exchange rates, unadjusted to inflation, were used.

The primary data sources of participating organisations have also been essential. These organisations have been described with the working group. National legislations have been in an important role, when comparing normative control, public organisations, financial support and taxation. National budget propositions and reports have provided that state financial data, which have not been included to forest statistics. In addition, published and internal reports of organisations have been employed. For instance, data for financing nature conservation has been received from reports and datasheets of the Ministry of the Environment in Finland and the Swedish Environmental Protection Agency. Threatened species have been compared according to national red-listed reports. Forest certification data has been received from the national representatives of the certification systems.

The responsible working group as a "think tank" and as a responsible body for the results presented in this article has had representatives from four organisations. The Forestry Research Institute of Sweden (SKOGFORSK) has been the initiator and the coordinator of the project. The private METSÄTEHO research and development service company, the Finnish Forest Research Institute (METLA) and the Ministry of Agriculture and Forestry in Finland have been collaborating with Skogforsk from the Finnish side. The responsible working group has been as follows.

Jarmo Hämäläinen, Metsäteho, Finland
Jussi Leppänen, Metla, Finland
Pentti Lähteenoja, Ministry of Agriculture and Forestry, Finland
Paul Nouro, Metla, Finland
Lennart Rådström, Skogforsk, Sweden (project coordinator)
Åke Thorsén, Skogforsk, Sweden

In addition, there have been several researchers from the organisations involved during the project, when comparable data and respective calculations have been made. Curt Almqvist, Torbjörn Brunberg, Staffan Jacobson, Magnus Larsson, Sten-Gunnar Skutin and Johan Sonesson from Skogforsk and Jouko Örn and Kalle Kärhä from Metsäteho have been responsible of essential parts of the results.

3. Results of the comparative analysis

3.1 Forest land, production and harvesting

The productive forest land, i.e. land producing more than 1 m^3o.b. wood during the rotation, is in Finland 20 million ha. In Sweden forest land covers 23 million ha, i.e. 12% more than in Finland. In Finland, the growing stock remained rather stabile at 1.5 milliard m^3o.b. since 1920's until the middle of 1970's. Since then, during the past three decades, the growing stock has been increasing up to over 2.0 milliard m^3o.b. In Sweden, the growing stock has been increasing steadily during the century, from ca 1.7 milliard m^3o.b. in 1925 up to today's 3.0 milliard m^3o.b.

The annual growth on forest land in the shift of millennium was 95 million m^3o.b. (4.7. m^3/ha) in Finland and 106 million m^3o.b. (4.6 m^3/ha) in Sweden. Scots pine (Pinus sylvestris) is the dominating species (50%) in Finland, whereas Norway spruce (Picea abies [L.] Karst.) is the most common species in Sweden (42%). The share of birch (Betula pendula and B. pubescens) is greater in Finland (16%) than in Sweden (11%).

Felling volumes have during the past 50 years increased by 25% in Finland and by 65% in Sweden. The annual fellings have been on the average during first years of 21st century 53 million m^3u.b. in Finland and 66 million m^3u.b. in Sweden. In Finland, saw logs have comprised 45% and pulpwood 43% of the total felling volume. The respective proportions in Sweden have been 52% for saw logs and 38% for pulpwood. Relatively, relative felling of the growing stock has been little higher in Finland (3.3%) than in Sweden (2.7%).

Since 1970 until the 21st century the annual final felling areas have varied in Finland between 100,000 and 150,000 ha with a tendency to increased areas. In Sweden, the final felling areas have decreased from 300,000 ha down to 175,000 ha during the same period. Annual thinning areas have increased in Finland since 1975 until 21st century from 100,000 ha up to 300,000 ha. During the same period, in Sweden the annual thinning areas have varied between 200,000 ha and 300,000 ha, with a tendency to increase during the past two decades.

The extent of the harvesting is constrained partly by the age-class distribution of forests. The impression is that in Finland harvesting can be carried out slightly more intensively than in Sweden, and the production capacity of the forest land has been utilised little better. However, this impression cannot be scientifically confirmed, because of the insufficient data. For, instance, the site type classification systems are different in both countries. However, both Finland and Sweden have a great potential for increased roundwood production.

3.2 Silviculture and forest tree breeding

Methods for forest regeneration are similar in Finland and Sweden. In Finland ca 55% of the forest regeneration areas are artificially planted compared to ca 60% in Sweden. Seeding is carried out on ca 20% of the regeneration areas in Finland, but insignificantly in Sweden. Further, natural regeneration is employed on 24% in Finland and on 37% in Sweden. During the period of 1990-2003 planting areas have been rather constant in Finland, 80,000-100,000 ha annually, whereas in Sweden they have been decreasing from annual ca 190,000 ha down to 140,000 ha. During the same period, soil preparations have stayed in both countries at relatively constant levels, ca 130,000 ha in Finland and 150,000 ha in Sweden.

Tending of young stands has varied between 150,000 ha and 250,000 ha annually in Finland. In Sweden, tending of young stands collapsed from ca 360,000 in 1990 down to

200,000 in the middle of 1990's. Since then, tending of young stands has gradually increased in Sweden, and was 340,000 ha in 2003.

The extent and development of forest fertilisation has been over time relatively similar in both countries. In both cases the growth of fertilisation activities culminated at the end of 1970's. The decrease of fertilisation has been since then dramatical. The extent of fertilisation in Finland is nowadays ca 50% of the amount carried out in 1990. In Sweden, the respective extent is ca 20%. Today, the annual fertilisation area is ca 20,000 ha in both countries. In Finland, peatlands constitute about half of the all fertilised forest lands. In Sweden, the share of fertilised peatlands is insignificant. In Sweden, fertilisation has been carried out mainly by the large-scale forestry and in the family forestry fertilisation has had only marginal importance (ca 1 % of the total fertilisation). In Finland, the family forest owners have had a very high fertilisation activity (ca 60% of the total fertilisation).

Forest ditching has overall been carried out more extensively in Finland, and the intensive use of the peatlands in Finland depicts for its own part the differences in the intensity of the timber production. Cleaning of existing forest ditches has been carried out in Finland on average 75,000 ha annually. The ambition of today is to increase the annual area. In Sweden, cleaning of forest ditches has had a very small extent, only 500-1,000 ha annually, although from the wood production point of view the need for this activity would be probably greater.

The elk damages with serious consequences for the roundwood production and economy are principally located in pine-dominated young forests. Such damages are found more than double as much in Sweden (28.2% of the young pine stands) as in Finland (13.1%). The major reason is that elk population is significantly greater in Sweden than in Finland.

The responsibility of forest tree breeding is in both countries given to a single organisation. In Finland, the responsible organisation is the state-financed Finnish Forest Research Institute Metla and in Sweden, the privately financed Forestry Research Institute of Sweden Skogforsk. In Finland, forest tree breeding is by 100% financed by the state. In Sweden, 1/3 of the total financing of forest tree breeding is indirectly from the state budget for forestry.

Forest tree breeding is carried out in both countries according to similar breeding strategies and the major tree species are Scots pine and Norway spruce. In Sweden, also breeding of Contorta pine is in the programme, but not in Finland, where a part of the resources are allocated to the breeding of Silver birch.

In Finland, state support up to 85% of the costs for establishing and management of forest seed tree orchards is available during the establishment process. In Sweden, no state financing is available for orchards. Since the 1950's Finland has established significantly greater areas of Scots pine seed tree orchards than Sweden. In Finland, there are plans to establish significantly greater area (3.8 times more) of Scots pine seed tree orchards than in Sweden. The use of qualified seed from orchards in nurseries is increasing in both countries, especially in Finland. In Finland, the proportion of the qualified seed for Norway spruce plants is greater and for Scots pine plants less compared to Sweden.

During the 1990's the plant production has been decreasing in both countries. In Finland, the production volume of forest plants is half of that in Sweden. The share of plants produced in pot plant systems is high. For Norway spruce the share of pot plants is less in Sweden than in Finland.

3.3 Forest owner groups, employment and size of sector

The non-industrial private family forest owners have ca 60% of the forest land in Finland, compared to ca 50% in Sweden. State has ca 25% in Finland and ca 20% in Sweden, and companies ca 10% and ca 25%, respectively. The remaining forest land is in Finland in ownership of "other owners" and in Sweden of "other private and public forest owners". The number of private forest holdings in Finland is ca 445,000 (ca 300,000 over 5 ha). In Sweden the respective number of private forest holdings is ca 240,000 (ca 200,000 over 5 ha). The average area of a forest holding in Finland is 24 ha compared to 48 ha in Sweden. During the past three decades, the average area of a holding has decreased in Finland but increased in Sweden. The ownership structure and development can be assumed to effect both to the activity in forestry as well as to the wood supply to processing industries.

The forest sector is an important employer both in Finland and Sweden, but the relative importance of the sector has decreased in both countries. In 2003 ca 4% of the employees in Finland were working in the forest sector compared to ca 3% in Sweden. In the same year, the share of the forest sector of the GDP was ca 6% in Finland compared to ca 3 % in Sweden.

3.4 Industry and markets

Finland and Sweden are both significant forestry countries in the world. In the list of top export countries of forest industrial products, Sweden possesses the second and Finland the third place. However, there are clear differences in the forest industry structures between the countries. In Finland, forest industry is characterised by few big companies, which have a wide horizontal range of production in pulp, paper and sawmilling industries. In Sweden, forest industry companies are on average smaller. Pulp and paper industry and sawmills have also mostly separate owners. In addition, vertical integration in value chain is greater in Finnish than in Swedish forest industries. In Finland, the major line in pulp and paper production is high-quality printing papers, but also fine paper and paperboard are significant. In Sweden, instead, paperboard and different packaging papers are dominating products. Also newsprint has a great share in production in Sweden. The most important export markets are in both cases in Western Europe, but the significance of Asia, Japan and USA is increasing.

Annual investments in forest industries have increased up to ca 1 milliard euros during the period of 1990-2004 and the production has grown successively both in Finland and Sweden. This expansion of production has been to great extent built on the imports of roundwood. The net imports of roundwood in Finland are greater than in Sweden, and the imports have increased practically during the full period since 1970 until today. The net imports of roundwood to Sweden developed similarly until 2000, when the growth culminated. The Finnish forest industry is, to a greater extent than the Swedish, basing its production on imported wood. This applies especially to that part of the industry, which is focused on the high-quality printing papers.

3.5 Forestry organisations

In Finland, the Ministry of Agriculture and Forestry (MAF) is responsible for planning and implementation of the forest policy. The Ministry of Environment is responsible for biodiversity, nature conservation and environmental management. The fields of the MAF are extension in forestry, state forestry, forest research and international forestry. The National Forest Council is working as an advisory organ for MAF. There are 13 regional Forestry Centres (FC), which have extension and public authority tasks in forestry. The FCs supervises the Local Forest Management Associations (LMFA). The Regional Forest Councils are working as advisory organs for the FCs, which are juridical private organisations with public authority tasks. Forestry Development Centre TAPIO is nowadays a separate organisation, which sells services to FCs, MAF etc.

In Sweden, the Ministry of Industry is responsible for the business issues of forestry and the implementation of forest policy, whereas the Ministry of Agriculture is responsible for forest research. Ministry for Sustainable Development has the responsibility over biodiversity as well as nature conservation and environmental management. The Swedish Forest Agency (SFA, formed through the merge of National Board and Regional Boards of Forestry) is organised under the Ministry of Industry. The SFA supervises that the forestry is developed according to forest policy set by the government and parliament. The SFA consist of five regions.

The Finnish Forest Research Institute METLA is a state organisation under the administrative sector of MAF with responsibility over forest research and statistics. In Sweden there is no comparable single organisation.

The Finnish Forest and Park Service METSÄHALLITUS is a state business enterprise under the administrative sector of MAF. In nature conservation issues Metsähallitus is administered by the Ministry of Environment. Metsähallitus manages state forests and nature conservation areas, and has certain public authority tasks. Business and societal activities are separated in the organisation. The Swedish SVEASKOG is a limited company in 100% state ownership. Its main task is to manage state forests in accordance to the objectives given by the state; one included task is also to develop the values of forests concerning nature experiences and recreation.

With regard to organisations of family forest owners there are great differences between Finland and Sweden. In Finland, the forest policy part is under the Union of Agricultural Producers and Forest Owners (MTK, which is the counterpart for the Swedish LRF), whereas the forest industrial part is in a countrywide co-operative company METSÄLIITTO Group. In Sweden, both of these parts are in regional Forest Owners' Associations, additionally to the forest policy activities by the Federation of Swedish Farmers (LRF). In Finland, the Unions of Forest Management Organisations (UFMOs) are unifying and supporting the activities of the Local Forest Management Associations (LFMAs). UFMOs are directly connected to the MTK, which results into an indirect connection of LFMAs to the MTK. Certain tasks of the LFMAs are financed through the legally stipulated membership and forest management fee of family forest owners, collected by the tax authority.

The Finnish roundwood markets are dominated by three big forest industry companies, of which one, as mentioned, is owned by the family forest owners. The co-operation between family forest owners has two separated roles with regard to a single forest owner. The officer of a LFMA is working as a consult for the roundwood seller (forest owner) and the officer of the Metsäliitto is working as a business partner (buyer). In Sweden, an officer of a Forest Owners' Association has the both roles as a consult and business partner.

In Sweden, there are six big forest industry companies, of which one is a part of a business concern owned by the family forest owners. In addition, there are three Forest Owners' Associations, which are both buyers and sellers of roundwood. Moreover, both in Sweden and Finland there is a number of independent sawmill companies.

The two central organisations of the forest industries, the Finnish and the Swedish Forest Industries Federations, have analogous tasks and objectives. The organisations include all the forest industrial branches. Their contribution is to improve the competitiveness of the member companies and to increase the use of the forest based products. The activities cover business life issues in a wide sense. The orientation is highly international.

3.6 Laws and norms for forestry

Normative framework for forestry is described not only in the forest laws, but in both countries also in the Constitution, especially concerning the ownership rights and in the general legislation, e.g. in the Land use and Construction Act in Finland and in Planning and

Construction Act in Sweden. In addition, forestry is regulated by Nature Conservation Acts, the Act on Land Purchase in Sweden, Real Estate Formation Acts as well as by provisions for the negotiation obligations in issues related to Sami people.

The forest policy objectives in the forest code are very well comparable in Finland and Sweden. Forests shall be managed and used in a sustainable way so that they will provide a good yield in the long term. The biological diversity of forests shall be safeguarded and the general social interests shall be taken into consideration. When considering the other forestry related legislation, the differences are related to fragmentation prevention control of a forest holding and to preference position of a local resident in forest real estate purchase, which are applied in Sweden, and to financing of sustainable forestry, which is applied in Finland.

Due to the historical background as a single country before 1809, the structure of the legislation is the same in Finland and Sweden. For instance, some sections of the Law of 1734 are still in force in Finland. Similarities exist also in the modern legislation. This applies e.g. to the provisions on the forest protection to reduce insect damage risks, which are almost identical in both countries.

Table 1. The most important provisions in the Finnish Forest Act (FFA) and in the Swedish Forestry Act (SFA)

Provision	FFA	SFA
Obligation to afforest	after regeneration felling	on unemployed land and when condition of forest is clearly unsatisfactory
Time limit for forest regeneration measures	3-5 years	3-4 years
Conditions for regeneration harvest	minimum age or minimum diameter or specific reason	minimum age or obligation to reforest
Max. proportion of forest area to be regenerated	no limits	limitations when forest area is over 50 ha
Fellings in protection forests	permission needed	permission needed
Harvesting on year-around pasture forests for reindeers	negotiation obligation on state lands	negotiations required with Sami hamlets
Noble hardwood trees (e.g. oak)	no provisions in forest law	provisions
Protection against insects	provisions (a separate law)	provisions
Harvesting on scrub and waste land	Allowed	principally prohibited
Habitats of special care	comprehensive list in Forest law	a list of examples as a general advise
Avoiding damage as a result of forestry activity	shall be avoided on stands and terrain	shall be avoided on terrain and waters
Building of forest roads	constraints for especially important habitats	constraints
Time limit for forest use declaration	2 weeks (all fellings)	6 weeks (only final fellings)
Settlement of forest and environment	no provisions	obligatory for forest holdings over 10 ha
Prejudgement on the legality of felling	can be applied for habitats of special importance	can be applied
Imposition and prohibition	also with fine	also with fine
Security for forest regeneration	may be required if earlier omissions	may be required in case of expensive measures of larger scale
Penalty	max 2 years sentence to prison	max 6 months sentence to prison

3.7 Taxation laws

In Finland, since the income year 2006 family forestry incomes are principally taxed as capital incomes with a fixed tax rate of 28%. Two out of three family forest holdings selected in 1993 to be taxed according to wood sales profits, whereas the rest chose to keep the area-based site-productivity taxation system (the old tax system) during the transitional period 1993 - 2005.

In Sweden, forestry incomes are principally regarded as business incomes, taxed with progressive rates. This includes, that certain allocation possibilities can be employed when calculating the annual taxable net income. In addition, a part of the business incomes can be taxed also in Sweden as capital incomes with a rate (30%), subject to a net property calculation.

For other forest owners than individuals, the company income tax rate is in Finland 26% and in Sweden 28%. In Finland, the excise duty for the diesel oil is applied for road transport, whereas forest machines are allowed to use lower duty fuel. In Sweden, also forest machines are obliged to use the higher taxed diesel oil.

The taxation levied in the ownership change of a forest holding is generally lower in Sweden. However, close family relationship combined with over 10-year ownership period and continued agricultural entrepreneurship can reduce substantially the tax burden levied in the ownership change in Finland.

Table 2. Important forest taxes in Finland and Sweden.

	Finland	**Sweden**
Company income taxation	Corporate income tax 26 % (since 2005, previously 29 %)	Corporate income tax 28 %
Individuals: Capital income taxation (proportional) of forest incomes	1. Yes, since 1993 2. No, until 2005 Capital income tax rate 28 % (since 2005, previously 29 %)	Yes, according to a calculation based on net property of business properties since 1994. Capital income tax rate 30 %
Individuals: Earned income taxation (progressive) of forest incomes	Partially, progressive taxation with marginal tax effects: 1. Yes, but only the value of self-employment in delivery sales 2. Yes, until 2005	Yes, progressive taxation with marginal tax effects
Social payments of entrepreneur	1. No, since 1993 2. Partially, until 2005 1. & 2. Yes, a separate obligatory social payment system for farm forest owners and ca 3000 non-farm forest owners.	Yes, calculated from the earned income
Excise duties (the most important)	– Light fuel oil (forest machines) – Diesel oil (road transport) – Petrol (chain saws etc.) – Vehicle tax (road transport)	– Diesel oil (forest machines and road transport) – Petrol (chain saws etc.) – Vehicle tax and road tax (road transport)
Inheritance and donation, forest holding	3. Yes, fair values, progressive 4. Yes, 40% of the tax values (100% of the tax values before 2004)	Cancelled since the income year 2005 (based on the tax values until 2004)
Property tax on the forest holdings	Cancelled since 2006, tax values until 2005	Forest holding: No Private house with its site: Yes
Real estate tax	Yes, but only applied to the forestry buildings and their sites	Forest holding: No Private house with its site: Yes
Value added tax (VAT)	Yes, since 1995 (22 %)	Yes (25 %)
Profit from assignment when selling the forest holding	Yes, capital income tax 28 % No, in case of closest relatives, if possession time exceeds 10 years	Yes, capital income tax 30 % applied to 90 % of the profit
Stamp tax when purchasing a forest holding	4 % of the value	1,5 % (individuals) 3,0 % (companies etc)
Possibilities for regulating the net income for forest taxation (delayed or decreased tax)	– Forest deduction – Depreciations – Expense and damage cost reserves – Pension insurance	– Capital taxation according to net property – Forest deduction – Forest deduction in rationalising holding structure – Periodisation reserve – Expansion reserve – Depreciations – Forest account – Payment schedule – Silvicultural expense reserve – Replacement reserve – Pension insurance
Special regulations	1. Capital income taxation – Net taxation of all capital incomes and interest costs including the interest costs	– Single income source, i.e. net taxation of all business activities of an individual (e.g.

	from own house. – In case of deficit, maximally a 10-year allocation period if a set-off against the earned income is not earlier possible. – Separate net taxation of profits and losses from assignments with a 3-year allocation possibility of losses from future profits. 2. Area taxation In case of deficit, allocation to next year without restriction, but only until 2005	forestry and agriculture) – In case of deficit, this can be allocated to next year and so on without any time restrictions. – Possibility for the deficit set-off against the earned income during the 5 first years of the new business activity

Symbols in Finnish column:
1. Wood sales profit taxation, 2. Area taxation, 3. Without active agriculture, 4. With active agriculture.

3.8 Opinions of the general public on forestry

In Finland, the Finnish Forestry Association has during 1993-2003 regularly surveyed the forestry opinions of the general public. In Sweden, the Federation of Forest Industries has since 1985 every second year surveyed how the general public sees the forestry and forest industries. The survey covers ca 1,000 persons in both countries. The questionnaire settings are not similar in both countries, but there are some questions which are comparable. One of these surveys how forests are managed. In Finland 85% of the general public sees that forests are managed very well or rather well. Also in Sweden a positive opinion on the forest management is dominating: 80% sees that forests are managed very well or rather well. These results have stayed quite well at the same levels during the period 1997-2003. The part of the general public, who see that forests are managed very badly is marginal, only some percents. In both countries a similar question is set on the reliability rank of the information providers. In Finland, the forestry professionals have the greatest reliability. This group of information providers does not exist in the Swedish survey. Of the comparable information providers, the environmental organisations have the greatest reliability, followed by representatives of the forest industries and journalists. In both countries the reliability difference between different environmental organisations is great. WWF has the highest reliability and Greenpeace the lowest, which in Finland is ranked after the representatives of the forest industries. The politicians both in Finland and Sweden have the lowest reliability as forest information providers. In wide sense, the general public relies similarly on the different information sources in both countries, both with regard to ranks and levels.

3.9 Public support

The public financing for the forestry is essentially greater in Finland than in Sweden. The Finnish forestry budget for 2005 was 162 million euros. The biggest inputs were financing for sustainable forestry 63 million euros, Forestry Centres and Tapio 44 million euros and Finnish Forest Research Institute Metla 39 million euros. Financing for sustainable forestry was allocated mostly to tending of young stands, and to some extent to regenerations. Financial support is allocated also to forest improvement works, including cleaning of forest ditches and construction and basic improvement of forest roads. In Sweden, the forestry budget for 2005 was 60 million euros. The Swedish Forestry Agency had 35 million euros and inputs for nature and cultural habitats protection and management in forests were 24 million euros. Forest research in Sweden was financed via an other budget section than forestry budget of Ministry of Industry. The most essential difference between Finland and Sweden was, therefore, that in Finland a great part of the forestry budget was allocated to wood production increasing measures, whereas in Sweden the weight point was on the nature and cultural habitats. The financing of silviculture and forest improvement was in 2005 ca 1.2 euros per harvested cubic metre in Finland. Another important difference is that in Finland there has been a tradition for processing the National Forest Programme. This is carried out in co-operation between the state and forestry and the processing work is characterised by consensus.

3.10 R&D structure and education

Financial inputs for forest research are somewhat lesser in Finland than in Sweden. The most important research units are the Finnish Forest Research Institute Metla and the Swedish University of Agricultural Sciences (SLU). The state financing for forest research is, however, ca 20% higher in Finland. In Sweden, the private financing is ca four times greater than in Finland. The total financing has been increasing both in Finland and Sweden during the period 1995-2000, but since then the level has been rather stable. In 2004 the forest research investments were in Finland ca 62 million euros and in Sweden ca 70 million euros. The number of forest researchers is by 50% higher in Finland than in Sweden. The difference between financial inputs and number of man-years in research can partly be explained through the differences in research and wage costs. During the recent 15 years the number of researchers has increased in both countries, principally through the increased number of post graduate students, whereas the other non-researcher personnel has decreased essentially in number. The fields of research are relatively similar in both countries, but there is little more technological and economic research in Finland than in Sweden, and little more plant physiology, genetics and pathology research in Sweden than in Finland. The annual number of graduated from forest education is about double as great in Finland as in Sweden.

3.11 Forestry revenues and costs

The calculated forestry revenues and costs cover the period 1992–2003 and are based on the annual prices and costs. Total revenues from delivery and stumpage sales have increased more in Finland than in Sweden. In 1992 the revenues, calculated per under bark cubic metre, were 3.5 euros lower and in 2003 5.1 euros higher in Finland than in Sweden, respectively. The roundwood prices were at the end of the period higher in all roundwood assortments in Finland than in Sweden. The differences were greatest in saw logs and spruce pulpwood. On average, the wood sales revenues at roadside per under bark cubic metre were 45 euros in Finland and 40 euros in Sweden. Forestry costs have decreased in Sweden more than in Finland. Since the year 2000 the level of costs was equal in the both countries, ca 17.5 euros per under bark cubic metre harvested. In 2003 the logging and terrain transport costs were higher, but the costs for silviculture and other works were lower in Sweden than in Finland. Transport costs were also lower in Sweden. The difference between forestry revenues and costs at roadside was during the whole period, with an exception in 1997, greater in Finland than in Sweden. Since 1997 the net of the revenues and costs per under bark cubic metre harvested has stayed at the same level in Finland, but decreased by ca 5 euros in Sweden.

3.12 Forest fuels

In Finland, the national energy strategy is based on continuous introduction of renewable energy types. The target is to increase the share of renewable energy by 25% until 2015 and by 40% until 2025. In the National Forest Programme the target is to increase the annual use of forest fuels from 2.7 million m^3 (2004) to 5 million m^3 (2010).

In Sweden, the national energy strategy is not as concrete as in Finland with regard to the use of the forest fuels. The overall goal is "... an energy system, which is based on sustainable, preferably domestic and renewable energy sources...".

In Finland, financial support is available for harvesting of the forest fuels, in forms of supporting the collection of small-sized wood from young stands and extraction of stumps. The state support for harvesting the small-sized wood is given within the financing of sustainable forestry. The support is 7.0 euros per solid cubic metre for felling and terrain transport and 4.25 euros for chipping. An area support for tending of young stand, varying between 100-300 euros per hectare, is independent from the forest fuel collection support. The state support for extraction of stumps is 0.44 euros per solid cubic metre.

In Sweden, state support is not employed as an instrument for harvesting of the forest fuels. Instead, general economic instruments, like CO_2 tax, emission allowance trade and green certificate for electricity, are used. In addition, Swedish Energy Agency (STEM) has R&D efforts to develop the use of forest fuels.

In Finland, the energy consumption was 411 TWh in 2004. The share of wood fuels was 84 Two or ca 1/5. Of that the forest fuels were 23% and, further, the share of large-scale energy production of that 40%. In Sweden, the energy consumption was 493 TWh in 2003. The share of wood fuels was 92 TWh or ca 1/5, i.e. precisely the same share as in Finland. Of that the forest fuels were 25% and, further, the share of large-scale energy production of that ca 50%.

In Finland, the collection and processing of the wood residues after final harvest was carried out so that ca 50% of the residues were chipped at roadside in 2004, ca 30% were delivered in bundled form as "slash logs" and ca 20% in non-processed form. The respective collection and processing picture in Sweden is that today ca 85% of the wood residues are chipped at roadside and ca 10% on the logging area. Systems and methods for collecting and processing the wood residues after final harvest have not changed regardless of the great foundative investments on developing baler/bundler or other large-scale technology in Sweden.

In Finland, small-sized wood is collected for forest fuel in tending of young stands and from early thinnings. This is carried out mechanically and in a relatively large scale. In Sweden, this is not carried out in any practical scale. In Finland, also stumps are extracted for energy, but in Sweden this is only carried out at an experimental level.

Despite not regarded as a forest fuel, one related and a very significant domestic energy resource is peat. Peat is often also mixed with forest fuels in order to improve the burning process. In Finland, peat is used in large-scale energy production and regarded as the most important domestic energy resource. In Sweden, the consumption of energy peat is rather limited compared to Finland.

Both Finland and Sweden have a significant potential for increased removals of forest fuels. To come true, the forest fuel reserves should be made economically harvestable. This could be reached by a better integration of forest fuels in other raw material flows of forestry, as well as also by the activities of energy producers. For this, a new technological thinking is needed, development of the new information and decision systems as well as better utilisation of the production resources and the raw materials.

3.13 Environmental care and nature conservation

In Finland and Sweden, a significant set-aside of nature conservation areas has been carried out during the 20th century, especially in the northern parts of the countries. The share of protected forest land has been relatively low especially in the southern and middle parts of the countries. Both countries have since the beginning of 1990's invested significantly in increased nature conservation. Since 1990, the state financing of the new conserved areas, consisting of compulsory purchase of land, compensations and support, has been on average little higher in Finland than in Sweden. Since 1999, however, the financing level has been increasing strongly in Sweden (especially in 2005), whereas in Finland the level has been decreasing. This has been due to the implementation of the environmental goals in Sweden and the nature conservation programmes in Finland, respectively.

Financing for the management of the conservation areas has been for a long time at rather constant level in Finland, but increased little since 2003. In Sweden, the financing has been increased remarkably since 2001. Financial allocations for forest habitat protection (e.g. agreements for nature conservation) were introduced earlier in Sweden than in Finland. The financing has also been significantly greater in Sweden than in Finland. In Finland, the financing was until 2003 greater for the inventory and management of the forest habitats than for the compensations to the forest owners. Since 2004 increasingly more financing has been allocated to the compensations than to habitat inventory and management. In Sweden, this breakpoint was already in 1997-1998. Liming of waters and water systems has been since a long carried out in a large scale in Sweden, but insignificantly in Finland.

Concerning the forest certification there is a significant difference between the countries. In Sweden, the FSC has been all the time the dominating system for forest certification, even if PEFC has received an increased extent during the last years. If all certified forest lands in Sweden were summed, would the total of these two systems be 17.1 million ha. However, 3.8 million ha is double certified, which results into 13.3 million ha of the total certified forest land area in Sweden. Of the total forest land 22.7 million ha in Sweden ca 60% has a forest certificate.

In Finland, the FSC has not received any established position. Until recent, only 93 ha of forest land had the FSC certificate. In Finland, the PEFC system is extensively dominating. 22.4 million ha or 97% of the total forest and scrub land has the PEFC-certificate in Finland (scrub land means forest land with potential growth between 0.1-1.0 cubic metres per ha).

Relatively to the number of evaluated species, the share of threatened species in 2000 was equal in both countries (10%). Of the all red-listed species a number of species were found in forests even if these were not their primary habitats. The share of red-listed species, which in 2000 were found in forests, was almost the same in both countries, 47.8 in Sweden and 46.9% in Finland. This means that the picture of threatened species is similar in both countries.

4. Summary, conclusions and implications

The standing timber volume and the annual increment are higher in Sweden. However, the ambitions and level of activity in silviculture is higher in Finland. Relative harvesting volumes of the total growing stock are little greater in Finland than in Sweden, which indicates more intensive forestry in Finland than in Sweden. Also with regard to the regeneration methods, natural regeneration is more common in Sweden than in Finland, where seeding replaces a part of more uncertain natural regeneration. Elk damages in young forests are double as high in Sweden as in Finland.

The forest and environmental policies play a very important role in both countries. There are more regulations in the Swedish forest code than in the Finnish one. Forestry income taxation and diesel oil tax situation is more favourable in Finland than in Sweden, but the other taxes are mostly more favourable in Sweden. In Finland, there are special laws on the public financing of forestry, which are lacking in Sweden. One can well argue that in Finland, the society puts more financial efforts than in Sweden for developing the forestry. However, in Finland and Sweden the investments in forest research are relatively equal, ca one euro per harvested cubic metre, but in Finland there are essentially more forest researchers.

In Finland both family forestry and state forestry have more important roles in the country's economy than in Sweden. Even the net revenues from forestry have grown stronger since the end of 1990's in Finland than in Sweden. One of the important differences between Finnish and Swedish forestry organisations is also the institutional contact surface towards family forest owners and the strong position of Finnish family forest owners. However, the family forestry holdings are larger in Sweden. Another organisational difference is the division of the forest decision making in Sweden into more ministries than in Finland. The coordination of forest policy is more centrally organised in Finland due to the National Forest Programme.

The forest sector has a more important role in the Finnish economy. The GDP share of total forest sector is in Finland double as high as in Sweden. The structural change in the forest industry has progressed further in Finland than in Sweden and the dependence on imported wood is greater in Finland. The general public values forestry practises high in both countries.

Eight out of ten of the general public in both Finland and Sweden see that forests are very or rather well managed.

The relative share of threatened species was in 2000 similar in both countries. Financing of nature conservation increased during the 1990's strongly in both countries and was on average at little higher level in Finland than in Sweden. Since 1999, however, the financing level has increased remarkably in Sweden. In Finland, almost all of the forest area has an environmental certificate (comes under the PEFC system) compared to 60% in Sweden (mostly coming under the FSC system).

The final conclusions could be as follows. The forestry sector and the wood market seems to be more market oriented in Sweden. This includes more simplifications in order to enhance rural entrepreneurship. On the other hand, in Finland, where the size of forest industrial enterprises are on average bigger than in Sweden, globalisation has affected domestic investments of forest industry more in than in Sweden.

The final implications could be that in Finland, more normative support and financial simplifications for rural entrepreneurship could be developed in order to open more markets for new private forestry enterprises. In Sweden on the other hand, the coordination of forest policy processes and the position of family forest owners therein could be strengthened and the role of forest policy and economic research increased.

Acknowledgements

Research financing from the METSÄMIESTEN SÄÄTIÖ Foundation and Ministry of Agriculture and Forestry are gratefully acknowledged by METLA.

Modelling forest stock effects of forest investments in Finland 1960-2004

Mikael Linden

Abstract
The national forest growth process and forest policy experienced in Finland in past 50 years are analyzed in terms of modern dynamic investment theory. Optimal forest investments and forest stock are derived in dynamic optimization framework. The private investments are subsidized by the government to stimulate forest growth. The optimal level of investments and growth effects depend on harvesting rate, on marginal productivity of forest stock, and on marginal benefits of investments. Under reasonable conditions government investment aid induces forest growth and supports less rigid adjustment path to higher optimal level of forest stock than without aid. Some regression results with Finnish regional data promote considered positive investment effects on forest stock.

Keywords: Forest policy in Finland, forest stock volume, forest investments, public aid, dynamic analysis

I. Introduction

In Finland, the framework of public intervention in non-industrial private forestry was created during the 20th century, initially with legislation, and since 1928 with extension and funding for selected forestry activities. In the 1950s, cuttings were exceeding annual growth, and the sustainable cutting budget was of increasing concern to public decision makers. A major change in forestry policy took place during the 1960s with increased public intervention in forest management and financing. This was carried out via several large-scale forestry programmes and additional budget expenditures. The aim was to increase the long-term cutting potential of the forests (Uusitalo 1978, Palosuo 1979). The target of the new forest policy was to increase forest investments and, consequently, growing forest stock, and commercial fellings. Increasing investments into forestry were also seen as a growth factor for Finnish economy (Juurola et al. 1999).

Figure 1 shows the volume of Finnish growing forest stock based on extrapolation of Nation Forest Inventories (NFI) during years 1955 – 2004. The stock was not increasing before year 1972 but after it a steady growth process has taken place. The underlying process behind the Figure 1 is also seen in Figure 2 where forest stock increment, drain and removals (in million m^3) in Finland 1955-2004 are shown. After the beginning of 1970s the stock increment has been in every year larger than total drain, i.e. natural drain added with cuttings.

Forestry intensification was achieved especially in Northern Finland by increasing the share of clear cuttings in final fellings in 1950s and 1960s. This led to an expansion of artificial regeneration and consequent need for tending seedling and young stands. In addition, many peat lands were drained, fertilization was increased and a dense network of forest roads was built. All these (silvicultural) investment measures were made feasible by directions and substantial financial assistance from government. The change in forest policy was implemented by the Forest Financing Programmes (MERA) during the period 1965-1975, and these forestry programmes had successors well into the 1980s. In all these programmes the basic target was increase the extension of wood production in

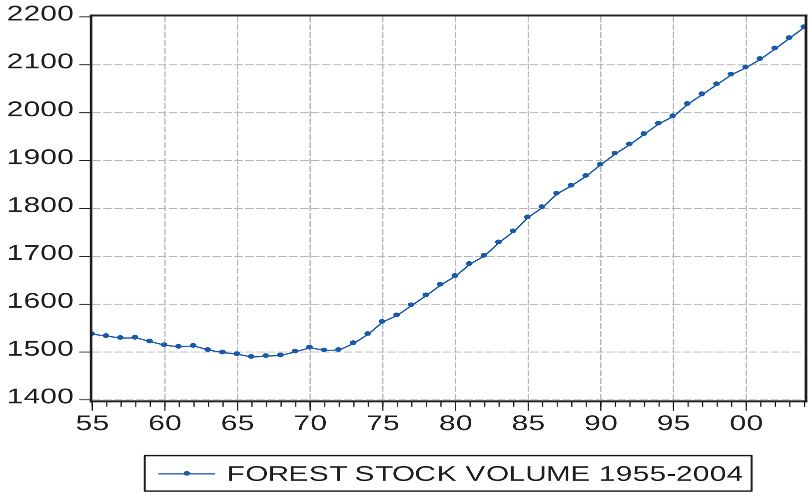


Figure1. Forest stock volume (in million m^3) in Finland 1955 - 2004

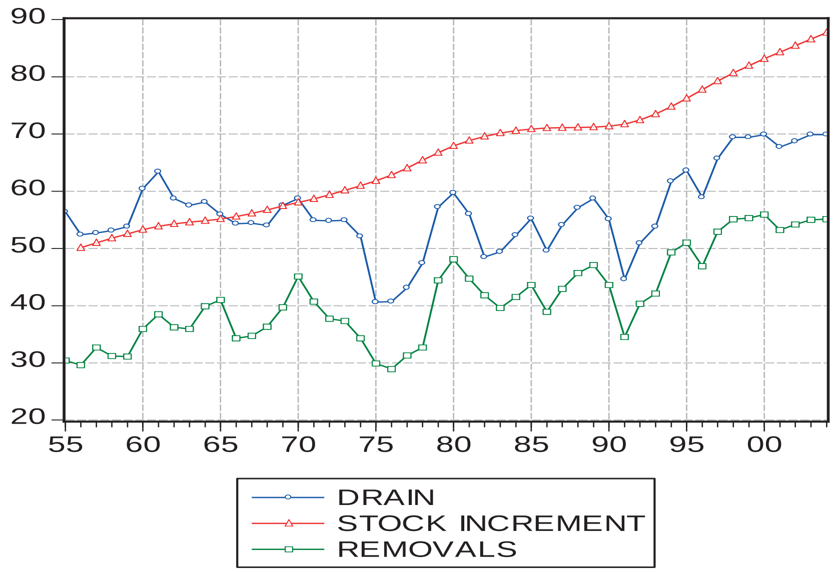


Figure 2. Forest stock increment, drain and removals (in million m^3) in Finland 1955-2004

both measures of areas and wood volume per hectare. The forest investment outlays and their effects can be measured in many ways. Figure 3 shows the affected hectares by different types of investments (drainage, fertilization, regeneration, and tending). For all cases a major increase took place during the years of 1965 -1978 starting with drainage and artificial regeneration.

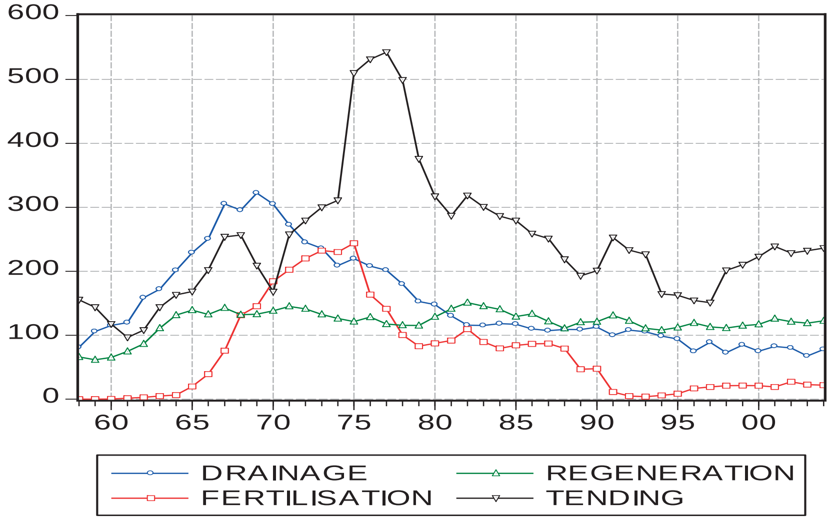


Figure 3. Forest investments (in 1000 hectares) in Finland
1958-2004

Figure 4 summarizes the forest investments in monetary terms. In years 1963 – 1978 both private and government aid to forest investments increased in real terms to maximum levels.

The question of forest investment effect on growing forest stock is seldom directly analyzed theoretically or empirically in forest economic papers. Typically the stock growth analysis is conducted with forest production function or with rotation models

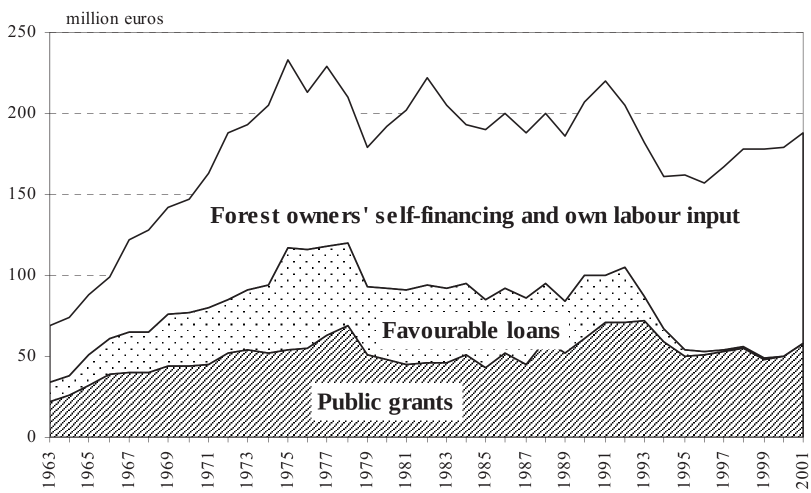


Figure 4. Real forest investments (in million euros, 2001 prices) in Finland 1963-2001

without any explicit investment function (e.g. Chang 1981, Nautiyal & Couto 1983, Williams & Nautiyal 1990). Dynamic analyses are few. Lyon & Sedjo (1983) developed an economic maximizing optimal control model of long term timber supply potential. However the main focus in their paper is in optimal harvest of different types of forest. Vehkamäki (1986) derives a target forest stock for government's forest policy in aggregate neo-classical growth and consumption model with biological stock production function. Optimal conditions of allocation of capital (investments) between forest stock and non-forest capital in gross national product depending linearly on the supply of raw wood are derived. However he uses linear target investment functions without any adjustment cost process. A more general approach that uses neo-classical investment theory directly added with biological production function for forest stocks are few (Anderson 1976, Omwani 1988). Note however that any papers connecting renewable resources in general and investments are also relevant in his context (e.g. Clarke et al. 1979, Clarke 1990, Nyarko & Olson 1991, Jorgenson & Kort 1997).

Empirical papers relating factors to timber harvesting and forest investments are many but only few connect forest stocks and investment to each other. In their review paper on forest investments and harvesting Beach et al. (2005) do not document any papers on forest stock effects of investments. Some papers analyze effects of plot and resource conditions on investments (see Beach et al. 2005, Linden & Leppänen 2006 and 2003b). The results confirm the positive relation between stock measures and investments but the proposed causality runs from stock variables to investments, not vice versa which is the focus of this study.

The lack of interest in dynamic investment models of renewable resources like forest can be understood easily. In theory renewable resources are self-sustaining processes where investments to keep (forest) capital level at desired level are not necessary needed. As long as harvesting is sustainable investments are redundant. Investments are only considered if a higher level of forest capital must be obtained. This was the relevant case in Finland in mid 1960s when the extensive forest investment policy started. On the empirical side lack of detailed measurements of aggregate forest stock and very slowly maturing forest investment effects have hindered the empirical analyses.

Next we build an optimal control model of forest investments targeted to maximize the value of forest stock. Model incorporates together convex adjustment cost of investments, stock dynamics depending on stock level, investments and parametric harvesting rate, and government investment subsidy. It is shown that optimal control levels of forest investments and stock exist and they can be obtained with investment subsidies speeding up the stiff adjustment process. Some forest growth regression results with aggregate data from Finnish forestry board districts in years 1965-2003 are also presented to complete the analysis.

II. Optimal investments and forest stock

The theoretical standpoint for deriving optimal forest investments is based on the neo-classical capital theory (see Precious 1987, Heijdra & van der Ploeg 2002, Ch. 4). Assume that net value of forest capital of the representative private forest owner is given by what is left over of stock value after the investment outlays have been paid

(1) $$V(t) = P_1(t)S(t) - P_2(t)[1 - s_I(t)]\Phi(I(t))$$

where $V(t)$ is net value of the forest in period t,
$S(t)$ is the forest stock in m^3,
$P_1(t)$ is the (stumpage) price of forest unit,
$P_2(t)$ is the price of investment goods unit,

s_I is the government investment subsidy, and
$\Phi(I(t))$ is the stock adjustment cost function, with $\Phi' > 0$ and $\Phi'' > 0$.

The real net value is obtained with dividing Eq. 1) by $P_1(t)$

$$v(t) = S(t) - p_2(t)[1 - s_I(t)]\Phi(I(t))$$

where $p_2(t) = P_2(t)/P_1(t)$ is the relative price of investment goods.

Assume that $p_2(t)$ is constant over time (i.e. we can assume that $p_2(t) = 1$).

The forest stock accumulation is given by

(2) $$\dot{S}(t) = F(S(t)) + I(t) - hS(t),$$

where $F(S(t))$ is the "forest" production function with $F'(S(t)) > 0$, i.e. forest stock effects on growth of forest, and h is the constant share of stock harvested every period .

Under these assumptions the net present value of forest is

(3) $$v(0) = \int_0^\infty v(t)e^{-rt}dt = \int_0^\infty e^{-rt}[S(t) - (1 - s_I(t))\Phi(I(t))]dt.$$

The forest owner maximizes the value of forest (3) under the restriction (2). The current value Hamiltonian can be written as

(4) $$H(t) = e^{-rt}[S(t) - (1 - s_I(t))\Phi(I((t)) + q(t)[F(S(t)) + I(t) - hS(t)]].$$

$q(t)$ is the Lagrange multiplier for forest stock accumulation restriction, e.g. the shadow price of existing forest stock. It measures how much the value of forest stock would change ($dv(t)$) if initial forest capital stock were slightly increased $(dS(t))$, that is $q(t)) = dv(t)/dS(t)$.

The first order conditions of optimization of Eq. 4) are

5a) $$\frac{\partial H(t)}{\partial I(t)} = e^{-rt}[q(t) - (1 - s_I(t))\Phi'(I(t))] = 0$$

5b) $$-\frac{\partial H(t)}{\partial S(t)} = e^{-rt}[\dot{q}(t) - rq(t)] = -e^{-rt}[1 + q(t)(F'(S(t)) - h)].$$

Eq. 5a) implies investment function (see Appendix I) like

$$q(t) = (1 - s_I(t))\Phi'(I(t)) \quad \Rightarrow$$

$$I(t) = I(q(t), s_I(t)), \quad \text{with } I_q > 0 \text{ and } I_{s_I} > 0.$$

6)

The interpretation of optimality condition 5a) for investment is simple: the shadow price of forest stock, i.e. the marginal benefit of investment $q(t)$, is equal to marginal cost of investment $(1 - s_I(t))\Phi'(I(t))$. Lower is the marginal cost due the high investment subsidy less the marginal benefit of investment is allowed (i.e. higher is the level of investments).

Eq. 5b) gives the intertemporal efficiency condition. It implies that

$$\dot{q}(t) = q(t)[r - F'(S(t) + h] - 1$$

or

$$\frac{\dot{q}(t)}{q(t)} = [r - F'(S(t))] - \frac{1}{q(t)} + h \quad .$$

The shadow capital gain rate $\dot{q}(t)/q(t)$ is increasing when (subjective) interest rate, harvesting rate, and level of shadow price are large but stock yield, $F'(S)$, is small. If the forest owner is impatient the shadow value of his (lost) forest capital is increasing. Now the shadow or the opportunity value of forest investment is high. If the forest yield must equal the market rate of return on other (financial) assets, $r - F'(S(t)) = 0$, then capital gain rate is still positive when harvesting rate is high $\dot{q}(t)/q(t) = h - 1/q(t) > 0$ (i.e. the foregone gains of investments are high as they are harvested away).

For constant shadow value $\frac{\dot{q}(t)}{q(t)} = 0: \quad F'(S(t)) = r + h - \frac{1}{q(t)}$. The forest yield is larger than interest rate but the small shadow value (gains from forest stock investments) depresses it. Thus marginal gain of investments is positively related to stock yield: forest marginal productivity (i.e. forest yield) has to cover both interest and harvesting rates minus the inverse of shadow value of forest capital. Note, if $r = 1/q(t)$ then $F'(S(t)) = h$, corresponding to MSY harvesting rule.

Finally, $\frac{\dot{q}(t)}{q(t)} = [r - F'(S(t))] - \frac{1}{q(t)} + h < 0$, can happen for a positive, albeit low, shadow value of forest capital and high forest yield. Thus if forest yield is already high (i.e. young forest) then the capital gain rate can decrease in time. Investments are less useful in this case.

Differential system of our model consists of

$$\begin{cases} \dot{S} = F(S) + I(q, s_I) - hS \\ \dot{q} = q[r - (F'(S) - h)] - 1 \end{cases} \qquad 7)$$

State phase results depend on properties of

8) $$d\dot{S} = (F'(S) - h)dS + I_q dq + I_{s_I} ds_I - Sdh$$

9) $$d\dot{q} = dq[r - (F'(S) - h)] + qdr - qF''(S)dS + qdh.$$

The slopes of $\dot{S} = 0$ and $\dot{q} = 0$ curves in (q, S)-space are determined by

$$(\frac{dq}{dS})_{|\dot{S}=0} = -\frac{F'(S) - h}{I_q} \quad (F'(S) > 0,\ I_q > 0)$$

$$(\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{[r - (F'(S) - h)]} \quad (F''(S) < 0)$$

leading to three cases of variable forest stock yield with given harvesting rate and interest rate:

	I	II	III
	$F'-h>0,\ r-(F'-h)>0$	$F'-h>0,\ r-(F'-h)<0$	$F'-h<0,\ r-(F'-h)>0$
$(\frac{dq}{dS})_{\vert\dot{S}=0}$	$-$	$-$	$+$
$(\frac{dq}{dS})_{\vert\dot{q}=0}$	$-$	$+$	$-$

Case I: $F'(S) - h > 0,\ r - (F'(S) - h) > 0$ corresponds to high forest yield compared to harvesting rate. This is called an almost mature forest case, where

$$(\frac{dq}{dS})_{|\dot{S}=0} = -\frac{F'(S) - h}{I_q} < 0,$$

$$\frac{\partial \dot{S}}{\partial S} = F'(S) - h > 0 \quad \text{and} \quad \dot{S} = 0: \quad \mathrm{S} = \frac{1}{h}[F(S) + I(q, s_I)],$$

$$(\frac{dq}{dh})_{|\dot{S}=0} = \frac{S}{I_q} > 0, \quad \text{and} \quad (\frac{dS}{dh})_{|\dot{S}=0} = \frac{S}{F'(S) - h} > 0.$$

$\dot{S} = 0$ curve is decreasing in (q, S)-space and $\dot{S} > 0$ with larger S. Increased harvesting rate shifts $\dot{S} = 0$ curve outwards since larger harvest does not mean less forest stock (in long run) since stock yield is bigger than harvesting rate. Marginal investments are now more valuable than earlier $(\frac{dq}{dh})_{|\dot{S}=0} > 0$.

$$(\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{[r-(F'(S)-h)]} < 0,$$

$$\frac{\partial \dot{q}}{\partial q} = [r-(F'(S)-h)] > 0, \text{ and } \quad \dot{q}=0: \quad q = \frac{1}{[r-(F'(S)-h)]} > 0,$$

$$(\frac{dq}{dr})_{|\dot{q}=0} = -\frac{q}{[r-(F'(S)-h)]} < 0, \text{ and } \quad (\frac{dq}{dh})_{|\dot{q}=0} = -\frac{q}{[r-(F'(S)-h)]} < 0.$$

$\dot{q}=0$ curve is decreasing in (q,S)-space and $\dot{q}>0$ with larger q. Increasing interest rate and harvesting rate shift $\dot{q}=0$ curve inwards as future gains investment reduce.

As both $\dot{S}=0$ and $\dot{q}=0$ curves are decreasing in (q,S)-space their relative steepness can be solved with following arguments:

$$(\frac{dq}{dS})_{|\dot{S}=0} = -\frac{F'(S)-h}{I_q} \to 0^-, \text{ when } [F'(S)-h]^+ \to 0, \text{ and}$$

$$(\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{[r-(F'(S)-h)]} \to -\infty, \text{ when } [r-(F'(S)-h)]^+ \to 0.$$

Thus a point $S^* = S$ (or alternatively $h^* = h$) with $F'(S)-h=0$ exists where

$$(\frac{dq}{dS})_{|\dot{S}=0} = 0 \quad \text{but} \quad (\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{r} < 0$$

showing that $\dot{S}=0$ is less steeper than $\dot{q}=0$ (see Figure 5, next page).

Case II: $F'(S)-h>0,\ r-(F'(S)-h)<0$ corresponds to case where forest yield is very high compared to given harvesting rate. This called an young forest case, where (like in Case I)

$$(\frac{dq}{dS})_{|\dot{S}=0} = -\frac{F'(S)-h}{I_q} < 0,$$

$$\frac{\partial \dot{S}}{\partial S} = F'(S)-h > 0 \text{ and } \quad \dot{S}=0: \quad S = \frac{1}{h}[F(S)+I(q,s_I)],$$

$$(\frac{dq}{dh})_{|\dot{S}=0} = \frac{S}{I_q} > 0, \quad \text{and} \quad (\frac{dS}{dh})_{|\dot{S}=0} = \frac{S}{F'(s)-h} > 0,$$

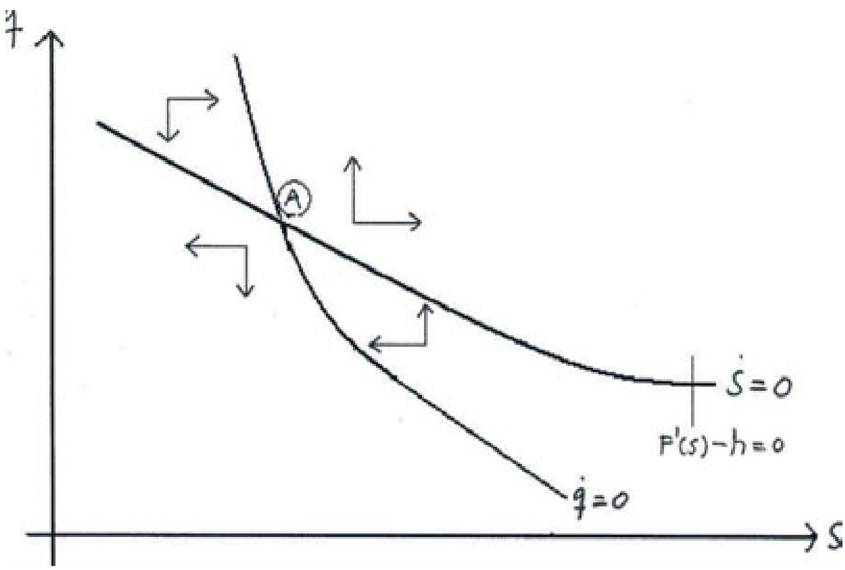


FIGURE 5. Saddle point stable almost mature forest stock and investment equilibrium (A).

but

$$(\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{[r-(F'(S)-h)]} > 0,$$

$$\frac{\partial \dot{q}}{\partial q} = [r-(F'(S)-h)] < 0, \quad \text{and} \quad \dot{q}=0: \quad q = \frac{1}{[r-(F'(S)-h)]} < 0,$$

$$(\frac{dq}{dr})_{|\dot{q}=0} = -\frac{q}{[r-(F'(S)-h)]} > 0,$$

$$(\frac{dq}{dh})_{|\dot{q}=0} = -\frac{q}{[r-(F'(S)-h)]} > 0.$$

Now $\dot{q}=0$ curve is increasing in (q,S)-space and $\dot{q}<0$ with larger but negative q. Thus investment gains for forest stock are harmful. Waste of capital takes place. The case is not relevant. Actually $\dot{S}=0$ and $\dot{q}=0$ curves do not intersect in positive (q,S) quadrant.

Case III: $F'(S)-h<0,\ r-(F'(S)-h)>0$ corresponds to case with low forest yield compared to given harvesting rate. This called a mature forest case, where

$$(\frac{dq}{dS})_{|\dot{S}=0}=-\frac{F'(S)-h}{I_q}>0,$$

$$\frac{\partial \dot{S}}{\partial S}=F'(S)-h<0 \quad \text{and} \quad \dot{S}=0: \quad S=\frac{1}{h}[F(S)+I(q,s_I)],$$

$$(\frac{dq}{dh})_{|\dot{S}=0}=\frac{S}{I_q}>0, \quad \text{and} \quad (\frac{dS}{dh})_{|\dot{S}=0}=\frac{S}{F'(S)-h}<0.$$

$\dot{S}=0$ curve is increasing in (q,S)-space but $\dot{S}<0$ with larger S due the low stock yield effects. Increased harvesting rate shifts $\dot{S}=0$ curve inwards since larger harvest means less forest stock, $(\frac{dS}{dh})_{|\dot{S}=0}<0$, making the marginal investments more valuable than earlier, $(\frac{dq}{dh})_{|\dot{S}=0}>0$.

$$(\frac{dq}{dS})_{|\dot{q}=0}=\frac{qF''(S)}{[r-(F'(S)-h)]}<0,$$

$$\frac{\partial \dot{q}}{\partial q}=[r-(F'(S)-h)]>0, \quad \text{and} \quad \dot{q}=0: \quad q=\frac{1}{[r-(F'(S)-h)]}>0,$$

$$(\frac{dq}{dr})_{|\dot{q}=0}=-\frac{q}{[r-(F'(S)-h)]}<0, \quad \text{and} \quad (\frac{dq}{dh})_{|\dot{q}=0}=-\frac{q}{[r-(F'(S)-h)]}<0.$$

$\dot{q}=0$ curve is decreasing in (q,S)-space and $\dot{q}>0$ with larger q. Increasing interest rate and harvesting rate shift $\dot{q}=0$ curve inwards as future gains investment reduce.

As $\dot{S}=0$ curve increases and $\dot{q}=0$ curve decreases in (q,S)-space (see Figure 6) we notice that :

$$(\frac{dq}{dS})_{|\dot{S}=0}=-\frac{F'(S)-h}{I_q}\rightarrow 0^+, \text{ when } [F'(S)-h]^-\rightarrow 0 \quad \text{and}$$

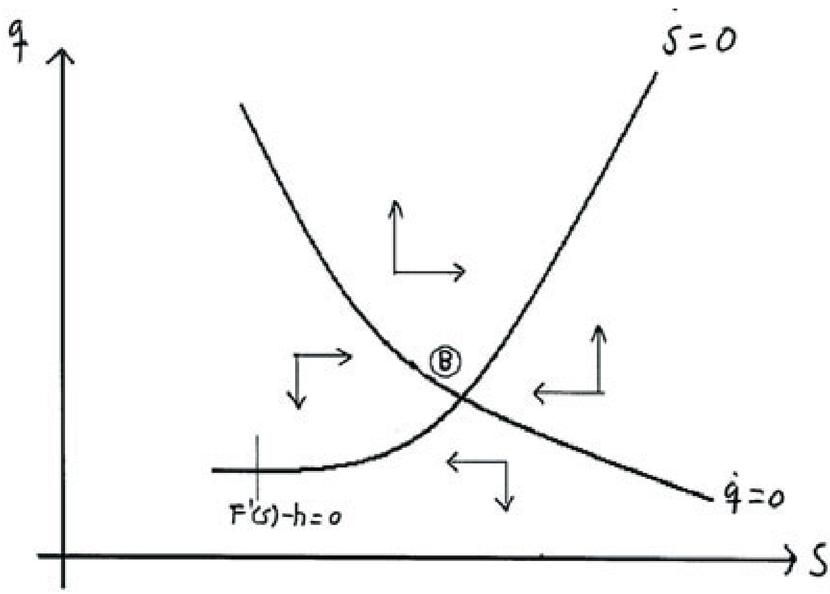


FIGURE 6. Saddle point stable mature forest stock and investment equilibrium (B).

$$(\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{[r-(F'(S)-h)]} \to \infty, \text{ when } [r - (F'(S) - h)]^{+} \to 0.$$

Thus for point $S^{*}=S$ (or $h^{*}=h$) with $F'(S)-h \leq 0$ we have

$$(\frac{dq}{dS})_{|\dot{S}=0} \geq 0 \quad \text{but} \quad (\frac{dq}{dS})_{|\dot{q}=0} = \frac{qF''(S)}{r-(F'(S)-h))} < 0 .$$

The analysis so far implies that cases I and III are relevant. The $\dot{S}=0$ curve is U-shaped in (q,S) space, but $\dot{q}=0$ curve is decreasing having slope of $-\infty$ when $(\frac{dq}{dS})_{|\dot{S}=0} < 0$ and $r-(F'(S)-h) \approx 0$. For big values of S $\dot{S}=0$ curve is above $\dot{q}=0$ curve with positive slope, $(\frac{dq}{dS})_{|\dot{S}=0} > 0.$ The condition $F'(S)-h=0$ divides the (q,S)-space in two sectors where dynamics are quite different. However in both sectors we have saddle point stability cases, i.e. cases I and III support equilibrium points, (A) and (B) for which optimal investment and forest stock level exist.

However the information concerning the case I can not rule out multiple intersection points in (q,S) space. $\dot{S}=0$ and $\dot{q}=0$ curves intersect three times if the slope of $\dot{S}=0$ curve decreases steeper than slope of $\dot{q}=0$ for some part in (q,S) space when $F'(S)-h>0$. A condition for $|(\frac{dq}{dS})_{|\dot{S}=0}| \; > \; |\frac{dq}{dS})_{|\dot{q}=0}|$ is

$$\frac{F'(S)-h}{I_q} > \frac{q\,|F''(S)|}{[r-(F'(S)-h)]}.$$

This takes easily place if $I_q = \frac{1}{(1-s_I)\Phi''} \approx 0$ i.e. Φ'' is big: the adjustment costs are large. The result allows for Figure 7 where we have one unstable solution C), and two saddle point solutions A) and B).

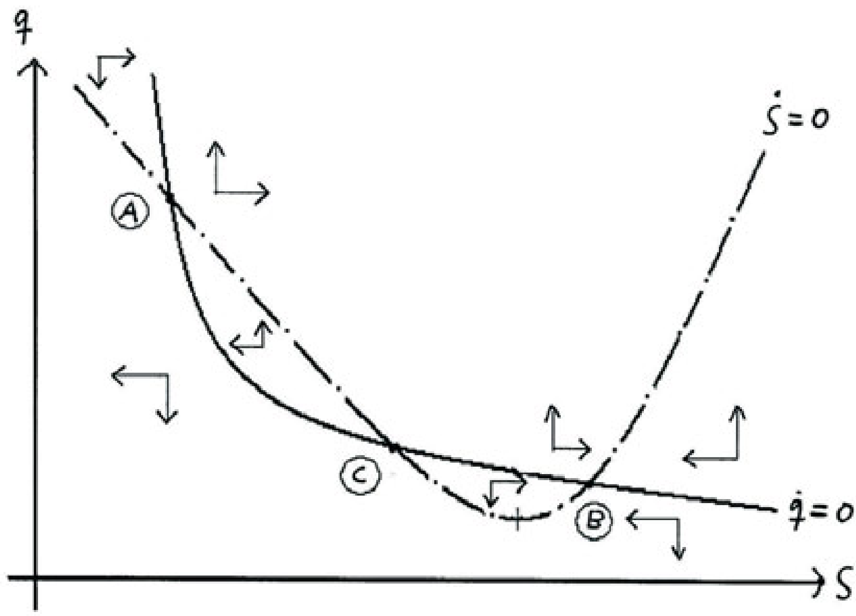


FIGURE 7. Multiple equilibrium points in (q,S) space

Thus, in long run, if we start with young forest where investment gains are high but forest stock is low (equilibrium point A) the optimal investment policy with given (low) harvesting rate sustains a low steady state level of forest stock. A larger and more mature forest stock that allows also for higher harvesting rate is obtained at steady state point B. Between these points an unstable equilibrium point C may exist where from dynamics drive either toward point A or B. If equilibrium point B with large forest stock is considered to be socially more desirable than point A, then government investment subsidy program can help to obtain it effectively.

III. Public subsidy effects

The analysis above indicated that Case III is relevant for active investment forest policy supporting optimal control and stable path to a equilibrium solution. We analyze next the effects of increase in public investment subsidy $(ds_I > 0)$. The change in s_I affects only the location of $\dot{S}=0$ curve but have effects on shadow value forest stock since

$$d\dot{S} = (F'(S) - h)dS + I_q dq + I_{s_I} ds_I - Sdh$$

and

$$(\frac{dq}{ds_I})_{|\dot{S}=0} = -\frac{I_{s_I}}{I_q} < 0 \quad , \text{ and } \quad (\frac{dS}{ds_I})_{|\dot{S}=0} = -\frac{I_{s_I}}{F'(S) - h} > 0 \quad .$$

Increasing public subsidy shifts $\dot{S}=0$ curve down and right (Figure 8) since investment cost reduces and firms are willing to invest the same amount at lower value of q, $(\frac{dq}{ds_I})_{|\dot{S}=0} < 0$, i.e. larger investment subsidy increases forest stock, $(\frac{dS}{ds_I})_{|\dot{S}=0} > 0$.

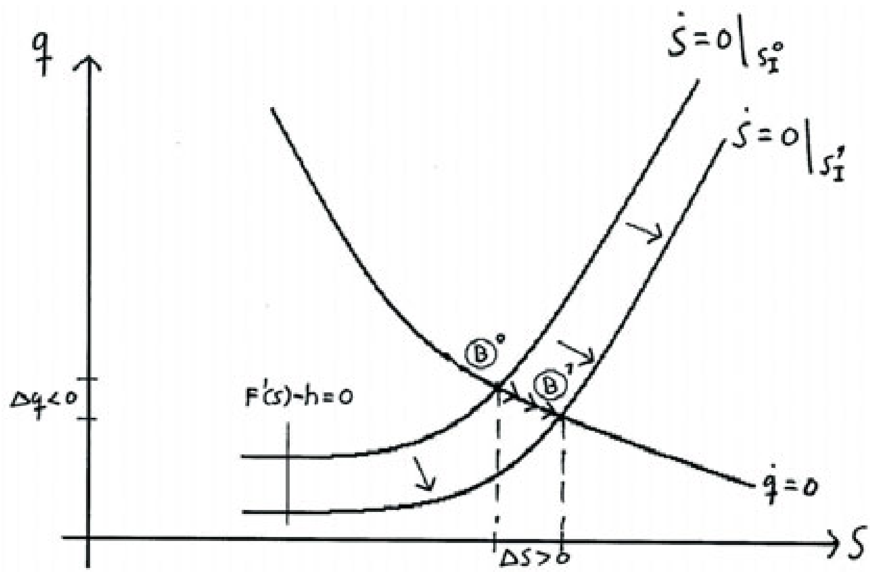


FIGURE 8. Increase in public investment aid: Optimum level forest stock is larger than without aid.

Note that if subsidy increase is large enough points A and C will come closer to each other and finally join and disappear in Figure 7. Similarly in Figure 5 the point A will change to point B in Figure 6. Thus active state aided investment policy will in long run destroy the low forest stock equilibrium points. This means that state aided investments will help to find optimal equilibrium point B sooner and with less friction compared to pure private adjustment process to it.

Harvesting rate has also an interesting role in the determination of steady states. If the given harvest rate h is always larger than forest yield $F'(S)$ then we operate only with equilibrium point B (Case III: $F'(S)-h<0$). Note that the level of steady state forest stock can be also quite small now as the increased harvesting rate shifts $\dot{S}=0$ curve inwards (an opposite case to Figure 8 presentation). Anyway the gains of forest investments and public subsidy are always large as forest yield and marginal benefit of investments are positively related to each other at steady state level of marginal benefits (i.e. when $\dot{q}=0$).

From practical and empirical point of view the equilibrium point B loses part of its relevance since under the extensive public forest investment subsidy program experienced in Finland since 1965 forest yield or forest stock increment has been larger than total drain (see Figure 2). Thus forest stock equilibrium points like A or C above has not only theoretical curiosity. Alternative we can argue that forest stock dynamics in Finland has not yet obtained any kind of steady state and the adjustment process is still going on. Some estimates concerning the process of national forest stock dynamics may help here. Thus next we present some regression results on Finnish forest stock dynamics.

IV. Empirical model

IV.1. Modeling forest growth

Assume that we have local (e.g. county or forest district based) observations of forest stocks in two, not necessarily successive, time periods S_{i,T_1} and S_{i,T_2} ($T_1<T_2$) with $i=1,2,...,N$. The growth increment of stocks between these two periods in region i is defined as

$$\Delta S_{i,T_2-T_1}=S_{i,t=2}-S_{i,t=1}=F_i(S_{i,t\in(T_1,T_2)})-\sum_{t=T_1}^{t=T_2}DRAIN_{i,t}\,,$$

where $F_i(S_{i,t\in(T_1,T_2)})$ gives the local stock effect on growth during the time period (T_1,T_2), and $\sum_{t=T_1}^{t=T_2}DRAIN_{i,t}$ is the local total drain consisting of fellings, felling waste and natural drain during (T_1,T_2).

This specification is problematic since $S_{i,t\in(T_1,T_2)})$ and $\sum_{t=T_1}^{t=T_2}DRAIN_{i,t}$ are dependent. The latter determines partly the level of the former. To avoid this dependency we consecrate on start level or first period stock effects on growth increment in a regression model setting in a following way

$$\Delta S_{i,T_2-T_1}=a_0+a_1S_{i,T_1}-a_2(\sum_{t=T_1}^{t=T_2}DRAIN_{i,t})+\varepsilon_{i,T_2-T_1}\,. \quad 1)$$

Next we introduce the forest investment effects in the model like

$$\Delta S_{i,T_2-T_1}=\alpha_0+\alpha_1S_{i,T_1}-\alpha_2(\sum_{t=T_1}^{t=T_2}DRAIN_{i,t})+\alpha_3INV_{i,T_1-D}+\varepsilon_{i,T_2-T_1}\,,$$

1) Note that we could estimate $G_i(S_{i,T_1})$ non-parametrically giving an interesting functional relationship between $\Delta S_{i,T_1-T_2}$ and $G_i(S_{i,t\in(T_1,T_2)})$ based on different local startup stock effects on local growth increment. This gives possibility to test if startup stock has scale or age effects on stock increment.

where INV_{i,T_1-D} are forest investments done D-period ago before period T_1 in local forests having delayed effects, say after 15-20 years later, on forest stock in period T_2-T_1.

Naturally we could use in the model variables for other delayed periods since local forest investment programs last for many years. Alternative a cumulative measurement of delayed investments can be constructed. Thus we have

$$\Delta S_{i,T_2-T_1} = \alpha_0 + \alpha_1 S_{i,T_1} - \alpha_2 (\sum_{t=T_1}^{t=T_2} DRAIN_{i,t}) + \sum_{j=0}^{p} \alpha_{3,i} INV_{i,T_1-D-j} + \varepsilon_{i,T_2-T_1}$$

or

$$S_{i,T_2} = \alpha_0 + (1+\alpha_1) S_{i,T_1} - \alpha_2 (\sum_{t=T_1}^{t=T_2} DRAIN_{i,t}) + \alpha_3 (\sum_{j=0}^{p} INV_{i,T_1-D-j}) + \varepsilon_{i,T_2-T_1}$$

Finally, for testing government investment aid effects on stock growth, we can divide investment in two parts, to private and public investments, i.e. $\sum_{j=0}^{p} INV_{i,T_1-D-j}^{PRIV}$ and $\sum_{j=0}^{p} INV_{i,T_1-D-j}^{PUB}$,

$$S_{i,T_2} = \alpha_0 + (1+\alpha_1) S_{i,T_1} - \alpha_2 (\sum_{t=T_1}^{t=T_2} DRAIN_{i,t})$$

$$+ \alpha_3 (\sum_{j=0}^{p} INV_{i,T_1-D-j}^{PRIV}) + \alpha_4 (\sum_{j=0}^{p} INV_{i,T_1-D-j}^{PUB}) + \varepsilon_{i,T_2-T_1}$$

From viewpoint of practical regression model estimation the model is well defined but if the investment variable is not specified in same units as stocks and drains (m^3) the interpretation of coefficients α_3 and α_4 is difficult. Naturally we have to develop some measure of extension of investments that is convertible to m^3, e.g. if know the area affected by investments (in hectares) and know what is the volume of stand per hectares in different regions we can calculate a proper investment measure.

IV.2 Data

Our data consist of observation of forest stock, drain, and forest investments in 19 Finnish forestry board districts during years 1965-2001. The observations of following variables in different regions were obtained from Finnish Statistical Yearbook of Forestry:

$STOCK_{NFI9}$ = Stock volume (in m^3) of forest according to national forest inventory 1996-2003

$STOCK_{NFI8}$ = Stock volume (in m^3) of forest according to national forest inventory 1986-1994

$DRAIN_{1986-2001}$ = sum of yearly fellings, fellings waste, and natural drain (in m^3) in years 1986 – 2001 adjusted to regional years of NFI's.

$REGEN_{1965-1978}$ = sum of yearly hectares affected by artificial regeneration (seeding and planting) in years 1965-1978

$TEND_{1965-1978}$ = sum of hectares affected by tending of seeding stands and improvement of young stands (cleaning and thinning inc. pruning) in years 1965-1978

$FERTIL_{1965-1978}$ = sum of hectares affected by forest fertilization in years 1965-1978

$DRAINAGE_{1965-1978}$ = sum of hectares affected by forest drainage in years 1965-1978

$PRIVc_{1965-1978}$ = sum of real private investment costs (in euros) in years 1965-1978

$PUBAIDc_{1965-1978}$ = sum of real financial aid and subsidy to private investments (in euros) in years 1965-1978

Figure 9. depicts the distribution of stock growth between the forestry board districts during the NFI's in 1986-1994 and in 1996-2003. In all regions, except in one (region 14), the forest stock has increased. In the northern part of Finland (regions with numbers of 17, 18, and 19) the forest growth has been unexpected fast during the past 15 years.

At this moment any proper solutions were not found to transform unit of investment observations (hectares or euros) to units of m^3. Thus some regression coefficient estimates lack direct physical interpretation. Thus the results are only indicative and qualitative in some parts. However we assume that used delayed investment effects stemming from years 1965-1978 are motivated and detect the growth effects of investment. Some preliminary analysis showed that results with model on change of forest stocks $\Delta STOCK_{NFI9-NFI8} = STOCK_{NFI9} - STOCK_{NFI8}$ were less satisfactory compared to model on level variable $STOCK_{NFI9}$.

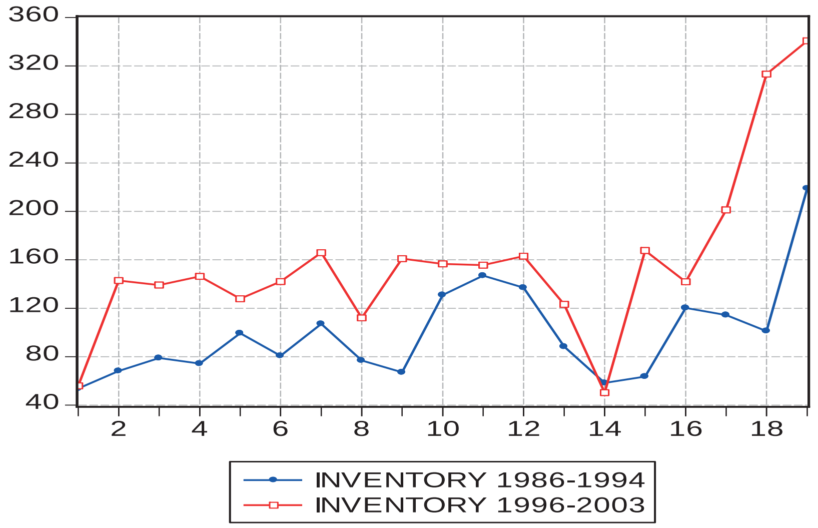


Figure 9. Forest stock (in million m^3) in 19 Finnish forestry board districts according national forest inventories (NFI's) in 1986-1994 and 1996-2003

IV.3. Results

We first analyze the stock effects of forest investment measured in hectares (i.e. variables REGEN, TEND, FERTIL and DRAINAGE). Note that variable TEND includes investment actions (cleaning and thinning) that actually reduce the forest stock in short run. However the variable was included in regressions as it correlated strongly with other investment variables and preliminary results were poor without it. Typically all investment forms are closely connected to each other in forest management.

Table 1 gives the results of regression model on stock measurements from NFI9 in different regions. Exogenous variable includes different delayed investment actions measured in hectares and stock dynamic variables ($STOCK_{NFI8}$ and $DRAIN_{1986\text{-}2001}$). The results are expected but lack robustness in some parts. Stock effects on stock growth or increment span from 0.18 to 0.50 with average value of 0.35 corresponding to 3.5% yearly stock growth. Drain effects lack robustness over different specifications but effects are negative as expected. Stock effects from investments are all positive except for TEND that has surprisingly large negative effects on forest stock. However summing up all investment effects indicates strong positive stock growth effects. Results for tending, fertilization and drainage are robust but regeneration coefficient estimates are disperse. Model diagnostics support statistically significant results.

Table 1. OLS –regression model results of forest stock effects of forest investment in 19 Finnish forestry board districts during years 1965-2001. Investments measured in hectares. Endogenous variable: $STOCK_{NFI9}$ (N=19, HC t-values in parenthesis)

Constant	40.76 (1.23)	71.38 (2.17)*	35.05 (1.49)	90.02 (2.83)*	87.02 (3.85)*	16.68 (0.51)
$STOCK_{NFI8}$	1.18 (3.82*)	1.32 (4.69)*	1.40 (3.28)*			1.51 (3.34)*
$DRAIN_{1986-2001}$		–2.40 (–2.20)*		–0.26 (–0.13)*		1.25 (0.82)
$REGEN_{1965-1978}$			1.12 (1.79)*	2.15 (2.95)*	2.14 (3.60)*	0.99 (1.53)
$TEND_{1965-1978}$			–1.25 (–4.73)*	–1.05 (–2.13)*	–1.12 (–3.16)*	–1.49 (–3.76)*
$FERTIL_{1965-1978}$			0.83 (2.04)*	0.84 (1.35)	0.88 (1.66)	1.02 (2.16)*
$DRAINAGE_{1965-1978}$			0.84 (3.88)*	0.86 (2.04)*	0.98 (3.27)*	1.03 (3.20)*
R^2 *Normality*[1]	0.462 9.48*	0.587 3.05	0.812 3.31	0.656 0.531	0.654 3.84	0.822 5.52

*) statistically significant from zero at 10% level
[1)] B&J -test for model residual normality. H_0: residuals are normal

Table 2 gives corresponding results with monetary investments in two parts: private funding to forest investments and public financial investment aid and subsidy to private forest owners in years 1965-1978. The results are less satisfactory than in Table 1. Stock and drain effects are close to earlier ones but monetary investment effects are only in few cases statistically significant. The sign of private investment effects depend on the model specification. The negative private investment effects in most cases cast some doubts on earlier results concerning the non-substitution between private investments and public investment aid (see Linden & Leppänen 2006, 2003a). Regression results with excluding public aid produce a positive and significant estimate for the coefficient of private investment cost (last column in Table 2). As the correlation between PUBc and PRIVc is very high (0.89) we perhaps face here the problem of multicollinearity. Anyway, the public aid to private investments increases the forest stock clearly and supports our theoretical results.

Table 2. OLS –regression model results of forest stock effects of forest investment in 19 Finnish forestry board districts during years 1965-2001. Investments measured in euros. Endogenous variable: $STOCK_{NFI9}$ (N=19, HC t-values in parenthesis)

Constant	52.69 (1.76)*	117.96 (3.42)*	101.87 (2.84)*	62.25 (3.82)*	117.95 (3.53)*
$STOCK_{INV8}$	1.63 (3.71)*			1.47 (2.87)*	
$DRAIN_{1965-1978}$		−3.55 (−1.88)*		−1.09 (−0.62)	−3.53 (−2.48)*
$PRIVc_{1965-1978}$	−1.86 (−2.45)*	1.17 (1.03)	−0.29 (−0.39)	−1.26 (−1.77)	1.24 (3.23)*
$PUBAIDc_{1965-1978}$	2.77 (2.37)*	0.13 (0.07)	2.15 (1.39)	2.09 (1.88)*	
R^2 *Normality*	0.624 8.67*	0.417 0.337	0.279 6.25*	0.634 5.45	0.41 0.28

*) statistically significant from zero at 10% level
[1)] B&J -test for model residual normality. H_0: residuals are normal

V. Conclusions

An optimal control model where proposed to understand the forest policy actions made in Finland in years 1965-1978 to boost national wood production. The target of the new forest policy was to increase forest investments with public aid and to obtain larger national forest stock, faster forest growth, and larger potential commercial cuttings. The model results show that actions made in years 1965-1978 correspond to the model implications. As investment process in forestry is time demanding and rigid, implying large convex adjustment costs, the financial aid to private forest owners is cost reducing and incentive creating leading to less rigid investment adjustment process. Larger wood production is made possible with given marginal gain of investment when investment subsidies are distributed to private investors. Substantial public aid destroys the possible (unstable) equilibrium points stemming from large adjustment costs and make stable path to increased forest stock levels more feasible.

The optimal control level of forest stock is characterized by forest yield (marginal productivity of forest stock) that equals to the sum of interest and harvesting rates minus the inverse of gain of forest capital investments. This means that harvesting rate can be also larger than forest yield if interest rate is low and investment gains are low. The case corresponds to the mature or even to the old forest case.

Elementary empirical record of Finnish national forest dynamics since 1965 does not support steady state behaviour. Positive growth rate of forest stock has lately even been increasing. However these facts do not reject the possible path towards some steady state. Some supplementary empirical results were obtained with regression models which approximate the forest stock process analyzed theoretically. The data consisted of forest stock, drain, and investment observations from nineteen Finnish forestry board districts during years 1965-2001. The regression results confirmed generally the model predictions with economic and statistical significance. However some non-robustness of estimated coefficients was also obtained. A more detailed empirical study with more observation in needed next to reveal all relevant aspects of growth process of forest stocks in Finland in past 50 years.

Appendix I Derivation of investment function

Diffentiating the optimum condition 5a) gives

$$dq = (1 - s_I)\Phi'' dI - ds_I \Phi'$$

$$\Rightarrow$$

$$dI = \frac{dq}{(1 - s_I)\Phi''} + \frac{ds_I \Phi'}{(1 - s_I)\Phi''}$$

and $I(t) = I(q(t), s_I(t)),$ where

$$I_q = \frac{1}{(1 - s_I)\Phi''} > 0 \quad \text{and} \quad I_s = \frac{\Phi'}{(1 - s_I)\Phi''} > 0.$$

With the quadratic investment function $\Phi(I(t)) = I(t) + b[I(t)]^2$ with $b > 0$ investments takes a form

$$I(t) = \frac{1}{2b}[\frac{q(t)}{1 - s_I(t)} - 1].$$

References

Anderson, F.J (1976) "Control Theory and the Optimum Timber Rotation", Forest Science 22, 242-246.

Beach, R.H., Pattanayk, S.K., Yang, J.-C. , Murray, B.C. and Abt, R.C. (2005) "Econometric Studies of Non-industrial Private Forest Management: A Review and Synthesis", Forest Policy and Economics 7, 261-281.

Chang, S.J. (1981) "Determination of the Optimal Growing Stock and Cutting Cycle for an Uneven Aged Stand", Forest Science 27, 739-744.

Clark, C.W., Clarke, F.H. & Munro, G.R. (1979) "The Optimal Exploitation of Renewable Resource Stocks: Problems of Irreversible Investment", Econometrica 47, 25-47.

Clark, C. W. (1990) Mathematical Bioeconomics. The Optimal Management of Renewable Resources. 2nd ed. Wiley.

Heijdra, B.J & van der Ploeg, F. (2002), Foundations of Modern Macroeconomics, OUP.

Jorgenson, S. & Kort, P.M. (1997) "Optimal Investment and Finance in Renewable Resource Harvesting", Journal of Economic Dynamics and Control 21, 603-630.

Juurola, M., Ollonqvist, P., Pajuoja, H. & Toropainen, M. (1999) "Outcomes of Forest Improvement Work in Finland", Silva Fennica 33: 217-224.

Linden, M. & Leppänen, J. (2006) "Public Cost-Sharing in Private Forest Investments in Finland 1983-2000", European Journal of Forest Research (forthcoming). (2003a) "Effects of Public Financed Aid on Private Forest Investments: Some Evidence from Finland, 1963-2000", Scandinavian Journal of

Forest Research 18, 560-567. (2003b) "The Impact of Government Investment Assistance on Forest Investment and Timber Supply: A Theoretical and Empirical Analysis" in F.Helles, N. Strange & L. Wichman (eds.), Recent Accomplishments in Applied Forest Economics Research, 167-180, 2003. Kluwer Academic Pub. Dordrect

Lyon, K.S. & Sedjo, R.A. (1983) “An Optimal Control Theory Model to Estimate the Regional Long-Term Supply of Timber”, Forest Science 29, 798-812.

Nautiyal, J.C. & Couto, L. (1984) “The Nature and Uses of the Timber Production Function; Eucalyptus grandis in Brazil”, Forest Science 30, 761-773.

Nyarko, Y. & Olson, L.J. (1991) “Stochastic Dynamic Models with Stock-Dependent Rewards”, Journal of Economic Theory 55, 161-168.

Omwami, R.K. (1988) An Economic Model Underlying the Choice of Capital Intensity in Timber Production. Acta Forestalia Fennica 204.

Precious, M. (1987), Rational Expectations: Non-Market Clearing and Investment Theory, OUP.

Palosuo, V.J. 1979. MERA-programme in Finnish forestry. Acta Forestalia Fennica 165. (In Finnish with English abstract).

Uusitalo, M. 1978. Finnish Forestry During the MERA-Programme Period 1965-1975. A Review Based on Statistics. Folio Forestalia 367. (in Finnish with English abstract).

Vehkamäki S. (1986) The Economic Basis of Forest Policy: A Study on the Goals and Means of Forest Policy. Acta Forestalia Fennica 194.

Williams, J.S. & Nautiyal, J.C. (1990) “The Long-Run Timber Supply Function”, Forest Science 36, 77-86.

Grants for advisory services in the private Danish forestry sector – a principal-agent approach

Dorthe H. Lund, Suzanne E. Vedel, Jette B. Jacobsen and Finn Helles*

Accepted of: *Journal of Forest Economics*

Abstract
National strategies concerning sustainable forest management are not implemented in private forest management if owners without an education in forestry are not given advice and applicable guidelines. Therefore the Danish government gives a grant to consultant companies offering advisory services to private forest owners. The Danish Forest and Nature Agency, who administers the grant, the consultant companies and the forest owners constitute a multi-layer principal-agent system. The government can benefit from using differentiated contracts because the consultant companies have private information on their costs, which may lead to adverse selection. In a market situation where the consultant companies can be divided into two agent groups with high or low costs, it will be Pareto-efficient for the government to use the group with low costs, and this type of agent will receive an informational rent through the grant. The difference in the agent-specific utility that the forest owner gains determines the maximum informational rent, which can be obtained by the consultant company group with low costs.

Key words: Principal-agent theory, adverse selection, advisory services, private forest owners.

The effects of value-added creation and cost efficiency strategies on the financial performance of finnish medium-sized and large sawmills

Katja Lähtinen & Anne Toppinen*

Abstract
Since 1990s the business environment of sawmill industry has changed notably due to the increase in competition both between European and non-European enterprises, as well as within the EU following its enlargement and the relocation of production to the new member countries. The changes in the business environment are posing further challenges for maintaining competitiveness and acceptable financial performance of the Scandinavian sawmills. However, for the sawmills located in the higher cost-level areas, the possibilities to use cost competition strategy are limited. For them, counterbalancing the higher production costs by manufacturing higher-priced value-added timber products has been pointed out as a main option for aspiring sustainable financial performance. The outcome of this strategic orientation is nevertheless not studied.

In this research, the effects of efficiency and value creation strategy on the business success of Finnish sawmills are studied. Financially measured, efficiency is assessed with production costs and value creation capability with prices paid for products. The data of the study comprises official financial statement information of 27 Finnish, other than large international forest industry corporations owned medium-sized and large sawmills for the period of 2000–2004. The effect of cost- and value-added components on the firm-level financial performance is evaluated using regression analysis. Costs are assessed with the proportion of material- and salary expenses of turnover, and value-added with the share of value-added and investments of turnover. Preliminary results indicate that cost-efficiency strategy was explaining financial performance better than value-added model irrespective of indicators used.

Keywords: Value-added, cost-efficiency, strategy, sawmills, medium-sized, financial performance

Introduction
Scandinavian sawmills are posing demanding challenges induced by slowing growth of consumption of timber in the main markets, Western Europe and Japan, rapidly increasing competition in those areas caused by growth of supply, especially, from Eastern-European countries and Russia, and coexistent increase in sawlog prices. At the same time, due to oversupply and the emergence of production from low-cost countries of Eastern Europe, development of lumber prices in Europe has been less than favourable during the 2000s. In addition, the enlargement of the EU in 2004 has brought out investment opportunities in the 10 new member countries tightening even more the competitive pattern of Scandinavian timber manufacturers.

In current global competitive environment, standard product manufacturing and raw material oriented strategies are unfavourable for the competitiveness of producers located in high-cost countries. Investments into value-added production and using intangible resources to create services and commodities, of which customers are prepared to pay higher prices, have been emphasized as crucial for acquiring business success (e.g. Bush & Sinclair, 1991; Korhonen & Niemelä, 2005). However, there are many factors affecting the success of strategic management decisions made within an industry. Size of the company, either measured by annual turnover or number of employees, is one of these for lumber industry comprising companies from large stock exchange firms to privately owned medium and small sized enterprises. These ownership and size differences lead to certain diversity in the firm goal setting and data involved, which in order to avoid receiving unequivocal or biased results should be taken into account in the empirical analysis.

Since 1990s, there have been several studies made concerning sawmill marketing and production strategies (e.g. Bush & Sinclair, 1991; Bush, Sinclair & Araman, 1991; Niemelä & Smith, 1996), representing a wide variety of solutions made from cost leadership, differentiation and focus strategies into their diverse combinations. However, even if specialization has been emphasized especially important for the business success for smaller enterprises, in the real world, large enterprises have been more active in implementing strategies based on value-added production (e.g., Smith, Dasmohapatra & Luppold, 2004). According to Niemelä & Smith (1997), sawmills have limited possibilities to bound themselves into one competitive strategy type, since the heterogeneity of the raw material causes the production process of a sawmill to provide a wide variety of products suitable for several markets, by nature. However, according to Hansen, Seppälä & Juslin (2002), especially in smaller sized sawmills with scarce resources this multi-faceted approach is less likely to lead into business success.

Most of the empirical studies linked to the sawmilling business have focused either on the marketing strategies or production efficiency issues (e.g., Nyrud & Bergseng. 2002; Nyrud & Baardsen, 2003; Salehirad & Sowlati, 2005), while the evidence of the effects of value-added and efficiency seeking strategies on the financial performance of the sawmills is very limited. Only Roos *et al*. (2001) have, using data for the Swedish sawmill inventory in 1995, found value-added production to increase the profit margins, while the proof of the effects of cost reduction and higher efficiency on profits was not so clear.

The aim of this study is to fill the gap in the empirical literature of sawmill business economics. In particular, we will examine the statistical significance of value-added and efficiency seeking strategies on alternative financial performance measures by acknowledging the effects of firm size and the ownership structure. Data consist of a sample of 27 medium and large-sized sawmills in Finland that are not owned by large international forest industry corporations. However, since timber is globally traded commodity, the results of this study may be indicative also for the lumber industries with similar technologies and societal conditions in competing countries, especially in Scandinavia.

Empirical Background

Strategic Choices and Competitiveness of Sawmill Industry

Industry-level competitiveness is a combination of its structure and the strategic decisions made by firms within the industry (Porter, 1985), while at the firm-level, financial performance is a result of the strategic choices made and a firm's organizational structure (Caves, 1980). Both resources and industrial structures have been found to be important for company success (e.g., Mauri & Michaels, 1998; Hawawini, *et al*. 2003). In enterprise strategy, the means for ensuring competitiveness, sustainable financial performance, and positive future development are supposed to be defined. According to Porter's generic strategies (1980), superior performance within industry is based either on cost leadership, differentiation or focus.

Regardless of the generic strategy chosen, quality, customer services, and product prices have been considered as the most important elements of competition for sawmills (e.g. Idassi *et al.* 1994). Due to the changes occurred in the business environment of sawmill industry since the beginning of 1990s, capability to create and deliver value for selected customer segments by specializing has been considered as the cornerstone of competitiveness (e.g., Bush & Sinclair, 1991; Juslin & Hansen, 2002; Toivonen, *et al*. 2005). Even if creating value-added has been seen as an option especially for smaller sawmills for surviving in the modern competitive arena (e.g., Bush & Sinclair, 1991), evidence exists that very large sawmills are more active producing value-added products than their smaller counterparts (e.g, Smith, *et al*., 2004).

So far research of the effects of the different sawmill strategies on their financial performance is limited. However, the few studies made on the area, have shown positive relationship between specialization and business success. Roos *et al*. (2001), compared the economic performance of Swedish sawmills with the main strategic dimensions of adding value to products with advanced production, decreasing fixed costs by pooling the production into larger units, and increasing efficiency by investing in modern technology. Value-added production was found to increase profit margins, while the effects of reduce costs and higher efficiency on profits were not so clear. Similar results were also obtained in a study concerning the most common value-adding combinations of Swedish sawmills (Roos *et al*., 2002), where the linkages between further processing of customer-oriented and higher value products were associated with higher profit margins.

Assessment of financial performance

The traditions of analysing business success by evaluating financial statement information, dates long back in history (e.g., Hardy & Meech, 1925). The aim of the financial accounting is to provide information for managers, investors, and financial analysts of the economic behaviour resulting from firm's activities within its environment (see, e.g., Riahi-Belkaoui, 2000). The methods of gathering and analyzing financial statement information are defined, e.g., in International Accounting Standards (IAS) (see, e.g., Epstein & Mirza, 2004).

The variety of financial performance measures commonly derived form financial statement information is substantial (see e.g., Committee for Corporate Analysis, 2000). The choice of the ratios to be employed for a specific purpose is affected both by the information needs and the data accessible for analyses. In this study, financial performance of the Finnish medium-sized and large sawmills is evaluated from the perspective of liquidity (Quick and Current Ratio), solvency (Equity Ratio, % and Debt to Net Sales Ratio, %), profitability (ROI, %), and growth (Growth, %). Information used in calculations originates from income statement (Growth, %), financial statement (Current Ratio and Equity Ratio, %), or both of these (Debt to Net Sales, %, and ROI, %). The benchmark values for the financial performance measures of in this study are presented in the endnote of this paper[1]. Detailed description of the ratios can be found, e.g., in Committee for Corporate Analysis (2000).

Liquidity describes corporate financial position in regard to its financial adequacy, while solvency ratios comprise longer time-scale by assessing the company's capital structure. Profitability ratios illustrate the return received on the capital invested in the company, while growth measures give indications of the company's ability to generate revenues in the future. Growth, as such, is not a measure for success: continuous unsustainable growth weakens the financial position of a company and jeopardizes its long-term existence. However, a positive trend in revenue growth with contemporaneous good financial performance indicates positive future business success and vice versa. Simplified,

[1] Committee for Corporate Analysis (2000) has defined benchmark values for Quick Ratio (above 1 = good, 0.5–1 = satisfactory, below 0.5 = poor), Current Ratio (above 2 = good, 1–2 = satisfactory, below 1 = poor), Equity Ratio, % (above 40 % = good, 20–40 % = satisfactory, below 20 % = poor), Net Debt to Sales, % (below 40 % = good, 40–80 % = satisfactory, above 80 % = poor). The reference values for ROI, %, and Growth, % are to a large extent specific not only to industry but also to individual firms.

e.g. Laitinen (2002) has described the relationship as follows: change in growth of revenues → change in profitability → change in liquidity → change in solvency.

Materials and methods

The data used are based on official financial statements of 27 Finnish medium-sized and large sawmills, not in the ownership of large forest industry conglomerates, for the years of 2000–2004. The financial statement information comprising 135 observations (5 fiscal periods of 27 sawmills), is collected by Balance Consulting (2005). Financial statement analyses and the financial performance measures derived are adjusted and calculated according to the recommendations of the Finnish Committee for Corporate Analysis (Balance Consulting, 2005; Committee for Corporate Analysis, 2000).

The effects of cost- and value-added components on the firm-level financial performance were evaluated using panel regression analysis. The observations for each year were treated as deriving from different population by including time dummies in fixed effects regression models. This was done for taking into account annual business cycles in the analyses.

Most of the financial performance ratios used as dependent variables in the panel regression analyses are non-normally distributed by nature, due to the characteristics of formulas used in calculations (e.g., Trigueiros, 1995), and changes in underlying economic conditions (e.g, Wood & Piesse, 1987). Yet, the assumptions necessary for regression analysis are normality, homoscedasticity, and independence of error (e.g., Bereson et al.,). Since the amount of annual observations was too low for standard normality tests to be reliable, the data characteristics were detected with Q-Q plots of model residuals. As a result of this, transformations were applied for Current Ratio (ln Current Ratio) and Debt to Net Sales, % (sqrt Debt to Net Sales, %). In addition, for turnover growth, % (Growth, %), only the values between +50 % and -50 % were included in the data (n=130).

The impacts of value-added and cost-efficiency seeking on each of financial performance measures were tested with two separate panel regression models. In value-added strategy models Production value added/Turnover, %, and Investments/Turnover, %, were used as independent variables. In cost-efficiency strategy models Material expenses/Turnover, %, and Salary expenses/Turnover, %, were employed as independent variables. Simplified, making investment decisions and preparing for increasing production value-added require longer time-scale actions than affecting material and salary expenses by, e.g., making adjustments in production. Thus, also the independent variables describing value-added strategy (information both from income statement and financial statement) and cost-efficiency strategy (information from income statement) represent different time-spans, by nature. Production value-added was assumed to have a positive effect on financial performance measures, while material and salary costs were expected to have negative impacts on the financial performance measures. The effect of investment activity on performance measures can be either positive or negative, depending on the time scale.

Results

As a background for further analyses, key figures of the 27 sawmills in the data were compared to the whole Finnish sawmill industry in 2000–2004. The results show, that large and medium-sized sawmills in the data represent a considerable part of the Finnish sawmill industry both in terms of production, turnover and employment (table 1). In 2000, the production of the dataset sawmills comprised 17.2 % of the total Finnish sawmill industry timber production (Finnish Forest Industry Federation, 2001; Finnish Forest Research Institute, 2001). In 2000–2004, the proportion of the dataset sawmills was 19–26 % of the total industry turnover, and 17–22 % of the total industry employment, annually.

Compared to the whole Finnish sawmill industry, on the average, the dataset companies had almost tenfold company-wise turnover, and threefold employment, respectively (table 1). This is due to the large proportion of very small companies within Finnish sawmill industry. As an example, in 2000, the total timber production in Finland was 13.4 million m^3 (Finnish Forest Research Institute, 2001). Of this, the proportion of the dataset sawmills was 2.3 million m^3 (appr. 85 000 m^3 *per* company), and large Finnish forestry companies (UPM-Timber Ltd, Stora Enso Timber Ltd, Finnforest Ltd, and Vapo Timber Ltd) 7.3 million m^3, respectively (Finnish Forest Industries Federation, 2001). Thus, in 2000, the remaining 3.8 million m^3 was produced by the rest of the sawmills, indicating company-wise annual production of 3 000 m^3, approximately.

Table 1. The dataset sawmills and Finnish sawmill industry in 2000–2004 (StatFin, 2006; Balance Consulting, 2005).

	2000	2001	2002	2003	2004
DATASET SAWMILLS					
Number of Companies	27	27	27	27	27
Turnover (mill. €)	601	614	664	724	713
Employment	1 893	1 828	1 804	1 840	1 843
Turnover / Company (mill. €)	22.2	22.7	24.6	26.8	26.4
Employment / Company	70.1	67.7	66.8	68.1	68.3
FINNISH SAWMILLING INDUSTRY					
Number of Companies	1 242	1 175	1 162	1 123	1 096
Turnover (mill. €)	3 203	3 007	3 147	2 820	2 857
Employment (1 000)	11 198	10 416	10 212	8 766	8 553
Turnover / Company (mill. €)	2.6	2.6	2.7	2.5	2.6
Employment / Company	9.0	8.9	8.8	7.8	7.8

Like the information provided by Balance Consulting Ltd (2005), also the financial ratios provided by StatFin (2006) are adjusted and calculated according to the recommendations of the Committee for Corporate Analysis (2000). Thus, the financial ratios of the two data sources presented in figures 1–5 are comparable with each other. Aside from Quick Ratio (fig. 1), differences can be seen in the mean financial performance ratios between the dataset sawmills and the ones of the whole industry. Information of the Quick Ratio was available only for 17 dataset sawmills in 2000. Thus, Current Ratio was employed as a liquidity measure in the further regression analyses of this study.

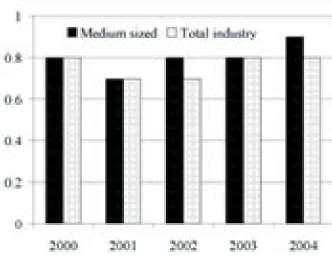


Fig. 1 Quick ratio of the dataset sawmills and Finnish sawmill industry in 2000–2004 (StatFin, 2006; Balance Consulting, 2005).

The solvency of the large and medium-sized sawmills seems to have developed more positively than the capital structure of the whole industry. Incurring of a debt (Debt to Net Sales Ratio, %) increased at industry-level in 2000–2004 (fig. 2), while in the large and medium-sized sawmills the development was quite opposite. In addition, although in each of the year in 2000–2004, another solvency measure (Equity Ratio, %) was higher at industry-level than the sawmills in the data, within industry the trend was declining unlike in the dataset sawmills (fig. 3).

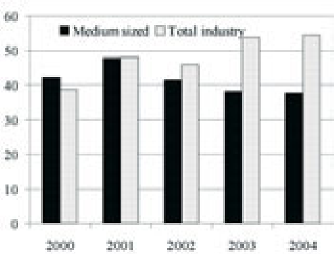


Figure. 2. Debt to Net Sales, % of the dataset sawmills and Finnish

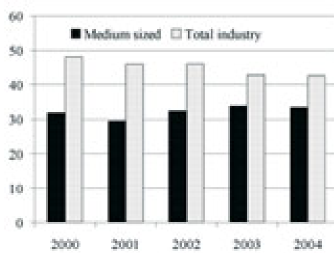


Figure. 3. Equity Ratio, % ratio of the dataset sawmills and Finnish

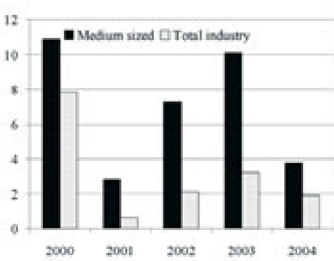


Figure. 4. ROI, % of the dataset sawmills and Finnish sawmill industry in 2000–2004 (StatFin, 2006; Balance Consulting, 2005).

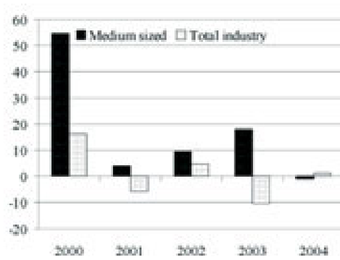
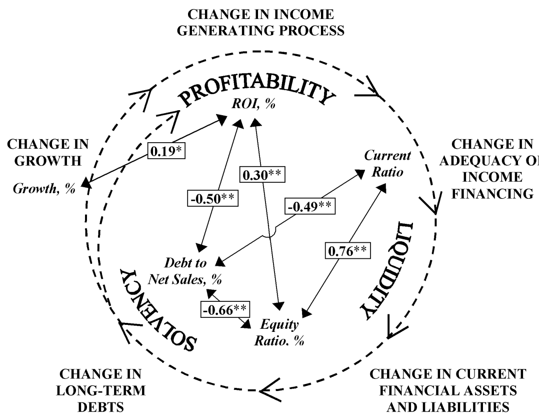


Figure. 5. Turnover Growth, % of the dataset sawmills and Finnish sawmill industry in 2000–2004 (StatFin, 2006; Balance Consulting, 2005).

The liquidity, solvency, profitability and growth ratios (dependent variables) were scrutinized with two-tailed Pearson correlations (fig. 6). The results indicate, that in the dataset there are statistically significant indications of cyclic interdependences between the short- and long-term financial ratios describing different aspects of business success, defined, e.g. by Laitinen (2002). In terms of interrelationships between the financial ratios, the only missing link without statistical significance within the cycle was between ROI, %, and Current Ratio. Also the signs of the correlations were logical: e.g., there was a positive relationship between the short- and long-term financial ratios describing different aspects of business success, defined, e.g. by Laitinen (2002). In terms of interrelationships between the financial ratios, the only missing link without statistical significance within the cycle was between ROI, %, and Current Ratio. Also the signs of the correlations were logical: e.g., there was a positive relationship between Current Ratio and Equity Ratio, % while the correlation between Current Ratio and Debt to Net Sales, % was negative.



** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).

Figure. 6. 2-tailed Pearson correlations between the dependent variables.

In order to take into account the annual business cycles in the panel regression analyses, different years were modelled as fixed effects. Company size in terms of turnover and number of employees was used in the early phases as a control variable in regression models, but since it was found to be statistically insignificant, it was left out from the results further reported. In the results (tables 2, 3 and 4) at 10 %, 5 %, and 1 % level significant coefficients are denoted with *, **, and ***, respectively (n=27). Standard errors are in brackets aside with regression coefficients. Intercept term equals effect for year 2004, VALUE=Value-added/Turnover, %, INVESTMENT= Investments/Turnover, %, MATERIAL= Material expenses/Turnover, %, SALARY = Salaries/Turnover, %. AIC is Akaike's Information Criterion for model and the coefficient of determination (R^2) measures fit of the model.

The results for liquidity measured with Current Ratio are in table 2. Statistically significant impact on liquidity was found for INVESTMENT (significant at 10 % level), MATERIAL and SALARY (significant at 1 % and 10 % level, respectively). The coefficients of all of those variables were negative. Thus, according to models, both decrease in investments (value-added strategy), and decrease in material and salary costs (cost-efficiency strategy) increase liquidity. Statistical proof of the effect of production value added (VALUE) on the liquidity measure was not found. However, the explanatory power of both of the models is rather low. Especially, for value-added strategy model the coefficient of determination (R^2) is close to zero.

Solvency was modelled both in regard to Equity Ratio, %, and Debt to Net Sales, %, (table 3). All independent variables had statistically significant impact on Equity Ratio, %. VALUE and INVESTMENT had positive and negative coefficients, respectively, both significant at 5 % level. MATERIAL and SALARY had negative coefficients, both significant at 1 % level. Thus, measured by Equity Ratio, %, solvency is increased either by increase in production value and decrease in investments (value-added strategy model), or decrease in material and salary expenses (cost-efficiency strategy model).

Table 2. Estimation results for testing the effects of value-added and efficiency of production for liquidity (ln Current Ratio) of sawmills (n=27).

(n=135)	Value-Added Strategy ln Current Ratio			Cost-Efficiency Strategy ln Current Ratio		
Intercept	0.306	**	(0.147)	1.389	***	(0.359)
2000	-0.142	*	(0.082)	-0.071		(0.075)
2001	-0.205	**	(0.083)	-0.180	**	(0.082)
2002	-0.056		(0.065)	-0.031		(0.056)
2003	-0.049		(0.056)	-0.015		(0.050)
2004	--------		--------	--------		--------
VALUE	0.005		(0.008)	--------		--------
INVESTMENT	-0.009	*	(0.005)	--------		--------
MATERIAL	--------		--------	-0.012	***	(0.004)
SALARY	--------		--------	-0.027	*	(0.014)
AIC	111.2		--------	100.9		--------
R^2	0.03		--------	0.13		--------

In Debt to Net Sales, %, solvency model, INVESTMENT and SALARY had statistically significant, positive and at 1 % level significant coefficients. Therefore, assessed by Debt to Net sales, %, decrease in solvency is affected by increase in investments (value-added strategy model) or increase in salary costs (cost-efficiency strategy model). Both coefficients of determination for value-added strategy models for solvency were close to zero, while the explanatory power of cost-efficiency strategy models was somewhat higher.

Table 3. Estimation results for testing the effects of value-added of production for solvency in terms of Equity Ratio, % (table 2) and sqrt Debt to net Sales, % (table 3) of sawmills (n=27).

(n=135)	Value-Added Strategy Equity Ratio, %			sqrt Debt to Net Sales, %			Cost-Efficiency Strategy Equity Ratio, %			sqrt Debt to Net Sales, %		
Intercept	27.504	***	(4.962)	5.872	***	(0.383)	68.284	***	(10.804)	3.788	***	(0.835)
2000	-3.464		(2.877)	0.454		(0.270)	-1.504		(2.690)	0.263		(0.191)
2001	-3.523		(2.715)	0.587	**	(0.278)	-2.531		(2.307)	0.473	*	(0.246)
2002	-1.900		(2.243)	0.238		(0.260)	-0.298		(1.993)	0.129		(0.236)
2003	-0.912		(1.916)	0.015		(0.165)	1.036		(1.526)	-0.042		(0.138)
2004	--------		--------	--------		--------	--------		--------	--------		--------
VALUE	0.544	**	(0.220)	-0.001		(0.020)	--------		--------	--------		--------
INVESTMENT	-0.262	**	(0.113)	0.034	***	(0.010)	--------		--------	--------		--------
MATERIAL	--------		--------	--------		--------	-0.350	***	(0.129)	0.007		(0.009)
SALARY	--------		--------	--------		--------	-1.340	***	(0.432)	0.210	***	(0.036)
AIC	903.96		--------	354.93		--------	970.29			354.48		--------
R^2	0.01		--------	0.08		--------	0.16			0.20		--------

The results of the value-added and efficiency seeking on profitability (ROI, %) and turnover growth (Growth, %) are in table 4. VALUE, MATERIAL, and SALARY were found to have statistically significant impact on ROI, %. The VALUE coefficient was positive and significant at 1 % level. MATERIAL and SALARY had both negative coefficients, and they were significant at 5 % and 1 % level, respectively. Thus, according to models, increase in production value (value-added strategy) or decrease in material and salary expenses (cost-efficiency strategy) increase profitability. In value-added strategy model the coefficient of determination for ROI, %, was 0.17 and in cost-efficiency strategy model 0.21, respectively.

Table 4. Estimation results for testing the effects of value-added of production for profitability (ROI, %) and turnover growth (Growth, %) of sawmills (n=27). Annual turnover growths >+50 % and < -50 % have been removed from the observations (n=130).

	Value-Added Strategy						Cost-Efficiency Strategy					
	ROI, % n=135			Growth, % n=130			ROI, % n=135			Growth, % n=130		
Intercept	-13.521	***	(2.410)	-2.020		(3.742)	30.114	***	(8.834)	-27.621	**	(11.273)
2000	0.766		(1.990)	9.886	**	(4.249)	6.751	***	(1.944)	11.775	***	(2.673)
2001	-0.182		(1.346)	9.011	***	(2.793)	0.168		(2.083)	7.172	**	(3.080)
2002	1.298		(1.371)	10.481	***	(2.912)	3.968	**	(1.831)	10.751	***	(3.032)
2003	3.183	**	(1.279)	10.154	***	(3.478)	6.793	***	(1.561)	10.669	***	(3.480)
2004	--------		--------	--------		--------	--------		--------	--------		--------
VALUE	1.394	***	(0.132)	0.215		(0.227)	--------		--------	--------		--------
INVESTMENT	-0.060		(0.091)	-0.550	**	(0.240)	--------		--------	--------		--------
MATERIAL	--------		--------	--------		--------	-0.266	**	(0.102)	0.379	***	(0.133)
SALARY	--------		--------	--------		--------	-0.994	***	(0.340)	0.056		(0.400)
AIC	801.36		--------	942.5		--------	913.61		--------	1029.55		--------
R^2	0.17		--------	0.09		--------	0.21		--------	0.09		--------

In Growth, %, assessments, indications of statistically significant impact of INVESTMENT and MATERIAL on turnover growth was found. Investment activity coefficient was negative and significant at 5 % level, while material expenses had positive coefficient, significant at 1 % level. Unlike in other analyses, for value-added strategy the intercept in the Growth, %, model was not statistically significant. The result of Growth, % in value-added strategy, is controversial, since according to it, decrease of investments increases turnover growth. The coefficient of determination was 0.09 for both value-added strategy and cost-efficiency strategy model.

Discussion

The purpose of the study was to examine the effects of value-added and cost-efficiency strategies on the financial performance of Finnish privately owned small and medium-sized sawmills. In order to include different time scales and aspects of business success in the assessments, financial performance was measured with various ratios calculated by using income statement information, financial statement information, or both of these.

Cost-efficiency strategy models were found to explain better financial performance than value-added strategy models. Both material and salary expenses were found to have statistically significant effects on liquidity, solvency (in terms of Equity Ratio, %), and profitability. In value-added strategy models, only solvency (Equity Ratio, %) was affected both by production value-added and investment activities. Compared to earlier research findings, the signs of the cost-efficiency strategy coefficients were congruent in contrast to the value-added strategy coefficients. In all models, where investment activity (INVESTMENT) coefficient had statistical significance, it was found to have negative impact on the financial performance. Especially, the negative impact of investments on Growth, %, can be considered as arguable. In addition, production value-added showed at 1 % statistically significant impact only on ROI, %. However, the sign of the coefficient was positive and therefore in line with the empirical literature.

Two complementary explanations may be found both for the better statistical significance of material and salary expense variables in explaining the development of financial performance, as well as for the better congruency of cost-efficiency strategy models with earlier empirical findings. Firstly, the five-year span of the study was rather short in proportion to the time-scale of firm-level strategic decision-making. Increasing value-added and investments are future-oriented actions, which may not generate immediate positive effects on the financial performance, but require time to boost the business success. Simplified, except from depreciations, future-oriented investments in value-added creation by specialization may not be seen in the figures of income statement within a short period at all. On the other hand, material and salary expenses may be decreased also within a short time span by adjustments of production, which within a financial period have immediate effects on the annual cost structure. Secondly, cost-efficiency and value-added creation are not exclusionary to each other but interlinked parts of firm economics. In sawmilling, satisfactory level of cost efficiency in regard to materials and labour may be considered as the prerequisite for sustainability of the business, which can be supported in the course of time with the capability to create value-added. Yet, in regard to scale-effects commonly linked to cost-efficiency seeking, no statistical evidence of their existence was found in panel regression analyses since company size was found to be insignificant in all the models

Finally, the results of this study should be considered as preliminary ones giving an overview of the cost- and value-added factors affecting sawmilling financial performance. In the future, in order to increase the explanatory power of the models and to widen the scope of analysis, value-added and cost-efficiency strategy variables should be combined in regression analyses. Later, together with acquiring data of additional accounting periods, managers of medium sized sawmills will also be interviewed for getting better qualitative information of their strategic decision-making processes.

References

Balance Consulting. 2005. *Financial statement analyses for Finnish medium-sized and large privately owned sawmills in 2000–2004*. Unpublished documents. Ordering from http://www.balanceconsulting.fi/esittely/english.shtml. Retrieved 24 March, 2006.

Berenson, M. L., Levine, D. M., and Krehbiel, T. C. 2001. *Basic Business Statistics: Concepts and Applications*. 8th Edition. Prentice-Hall International Editions. 843 pp.

Bush, R. J. and Sinclair, S. A. 1991. A Multivariate Model and Analysis of Competitive Strategy in the U.S. Hardwood Lumber Industry. *Forest Science*, 37(2), 481–499.

Bush, R. J., Sinclair, S. A., and Araman, P. A. (1991). A qualitative investigation of competition in the U.S. hardwood lumber industry. *Forest Products Journal*, 41(11/12), 43–49.

Caves, R. E. (1980). Industrial Organization, Corporate Strategy and Structure. *Journal of Economic Literature*, XVIII (March 1980), 64–92.

Committee for Corporate Analysis. 2000. *A Guide to the Analysis of Financial Statements of Finnish Companies*. Gaudeamus, Helsinki. 85 pp.

Epstein, B. J. and Mirza A. A. 2004. IAS 2004 *Interpretation and Application of International Accounting and Financial Reporting Standards*. Wiley & Sons, Inc. 960 pp.

Finnish Forest Industries Federation. 2001. Ympäristönsuojelun vuosikirja. Saha- ja levyteollisuus. Vuoden 2000 tilastot. (*Annual environmental report*, 2001) http://www.forestindustries.fi/files/julkaisut/pdf/saha_ja_levy2000.pdf. Retrieved, 24 March, 2006. 56 pp. (In Finnish)

Finnish Forest Research Institute. 2001. *Yearbook of Forest Statistics 2001*. 372 pp. (In Finnish, English summary).

Hardy, C. O., Meech, S. P. 1925. Analysis of financial statements. *The University Journal of Business*, 3(4):378–396.

Idassi, J. O., Young, T. M., Winistorfer, P. M., Ostermeier, and D. M. Woodruff, R. B. 1994. A customer-oriented marketing method for hardwood lumber companies. *Forest Products Journal*, 44(7/8), 67–73.

Juslin, H. and Hansen, E. (2002). *Strategic Marketing in the Global Forest Industries*. Authors Academic Press, Corvallis, OR. 607 pp.

Hansen, E., Seppälä, J., and Juslin, H. 2002. Marketing strategies of softwood sawmills in Western North America. *Forest Products Journal*, 52(10):19–25.
Hawawini, G., Subramanian, V. & Verdin, P. 2003. Is performance driven by industry- or firm-specific factors? A new look at the evidence. *Strategic Management Journal*, 24(1): 1–16.
Laitinen, E. K. 2002. *Strateginen tilinpäätösanalyysi.* Strategic Financial Statement Analysis. Gummerus Kirjapaino Oy, Jyväskylä. 234 p. (In Finnish).
Mauri, A. J. & Michaels, M. P. 1998. Firm and industry effects within strategic management: An empirical examination. *Strategic Management Journal*, 19(3), 211–219.
Niemelä, J. S. and Smith, P. M. 1996. A Cross-National Investigation of Softwood Sawmill Marketing Strategies. *Forest Science*, 42(3), 290–299
Niemelä, J. S. and Smith, P. M. 1997. A Multinational Analysis of Competitive Strategies of Softwood Sawmills. *Scandinavian Journal of Forest Research*, 12, 297–301.
Nyrud, A. Q. & Baardsen, S. 2003. Production efficiency and productivity growth in Norwegian sawmilling. *Forest Science*, 49(1): 89–97.
Nyrud, A. Q. & Bergseng, E. R. Efficiency and size in Norwegian sawmilling. *Scandinavian Journal of Forest Research*, 17(6): 566–575.
Porter, M. E. 1980. *Competitive Strategy, Techniques for Analyzing Industries and Competitors*. The Free Press, New York. 396 pp.
Porter, M. E. 1985. *Competitive Advantage – Creating and Sustaining Superior Performance*. The Free Press, New York. 557 pp.
Riahi-Belkaoui, A. 2000. *Accounting Theory*. 4th Edition. Thomson Learning, London. 516 pp.
Roos, A., Flinkman, M., Jäppinen, A., Lönner, G. and Warensjö, M. 2001. Production strategies in the Swedish softwood sawmilling industry. *Forest Policy and Economics*, 3, 189–197.
Roos, A., Flinkman, M., Jäppinen, A., Lönner, G. and Warensjö, M. 2002. Identification of Value-adding Strategies in the Swedish Sawn Wood Industry. *Scandinavian Journal of Forest Research*, 17, 90–96.
Salehirad, N. & Sowlati, T. Perfomance analysis of primary wood producers in British Columbia using data envelopment analysis. *Canadian Journal of Forest Research*, 35(2): 285–294.
Smith, P.M., Dasmohapatra, S., Luppold, W. G. 2004. A profile of Pennsylvania's hardwood sawmill industry. *Forest Products Journal*, 54(5):43–49.
StatFin. 2006. Statistics Finland. http://www.stat.fi/meta/til/ata.html. *Internet database of Statistics Finland*. Retrieved March 24, 2006.
Toivonen, R., Hansen, E., Järvinen, E. and Enroth, R-R. 2005. The Competitive Position of the Nordic Wood Industry in Germany – Intangible quality dimensions. *Silva Fennica*, 39(2), 277–287.
Trigueiros, D. 1995. Accounting indentities and the distributions of ratios. British Accounting Review, 27 (2): 109–126.
Wood, D. & Piesse, J. 1987. The information value of MDA based financial indicators. *Journal of Business Finance and Accounting,* 14(1): 27–38.

Optimal conversion of European beech – models and preliminary results

Henrik Meilby and Peter Tarp*

Abstract
In this study we analyse economic aspects of conversion of even-aged beech (*Fagus sylvatica* L.) stands to near-natural, uneven-aged forests. Growth is modelled using a matrix approach based on a new distance-independent individual tree growth model developed for beech in Denmark. The analyses include characteristics of optimal conversion strategies and their consequences for cash flow, liquidation value, steady-state diameter distributions and long-term harvest policies. We also examine effects of factors such as discount rate, cost structure, prices, site quality, recruitment, and initial state of the stand on optimal conversion strategy and long-term development of the forest. Here we present the applied models and a few preliminary results.

Key words: continuous cover, economic optimisation, Fagus sylvatica L., matrix model, near-natural forestry

Introduction
In recent years, near-natural, continuous-cover management systems have attracted increasing attention. In part this is due to the ecological advantages of only harvesting smaller patches of trees, or even single trees, at a time; in part it is a consequence of the potential economic advantages of avoiding large investments in regeneration and tending. A range of studies have focused on the silvicultural aspects of the conversion process, e.g. Hanewinkel & Pretz (2000), Kenk & Guehne (2001), and Sterba & Zingg (2001). Gradually, economic aspects have also atracted attention, e.g. Tarp et al. (2000), Buongiorno (2001), Hanewinkel (2001), Price (2003), Tarp et al. (2005), and Price & Price (2006).
Among harvest regimes mentioned as possible paths towards uneven-aged stand structures the most common is undoubtedly ‘target diameter harvesting’, i.e. a range of harvest regimes characterised by putting emphasis on the largest trees of the stand. Normally the concept includes, however, also thinning of medium-sized or even small trees that have reached ‘their target’ due to other characteristics than size alone. It is assumed to depend on species and site conditions how harvesting of the largest trees should be combined with thinning and how the overall harvest strategy should depend on initial state of the stand, ecological goals, prices, etc.

The ultimate goal of this study is to thoroughly examine the economics of conversion to uneven-aged beech stands by: (i) identifying optimal conversion strategies; (ii) examining how such strategies depend on initial state of the forest, price functions, discount rate, fixed costs, growth and recruitment; (iii) comparing results with continued even-aged management. The presentation here is limited to description of the applied models and some preliminary results.

Models and methods
Describing the growth of even-aged stands and future uneven-aged forest properly within the same model framework is demanding. Using an individual-tree model provides maximum flexibility with respect to simulation of thinning practices and patterns, but in a study that emphasises optimal conversion and associated harvest policies this approach is unnecessarily time consuming and requires complicated thinning rules. Consequently this study applies a

diameter-class approach where an individual-tree growth model is used to create, and dynamically update, the transformation matrices needed to forecast future states of the stand. The basic growth model is the diameter growth model of Nord-Larsen (2006):

$$\Delta d(d_{i,t},\alpha_0,G_t,G_{L,t}) = \exp\big(\alpha_0 + \alpha_1 \ln(d_{i,t}+\alpha_5) + \alpha_2\, d_{i,t} + \alpha_3\, G_t + \alpha_4\, G_{L,t} \big/ \ln(d_{i,t}+\alpha_6)\big)$$

where Δd is diameter increment from time t to time t+1, $d_{i,t}$ is the breast height diameter of tree i at time t, G_t is the basal area of the stand, $G_{L,t}$ is the basal area of trees with breast height diameters exceeding that of tree i, $h_{i,t}$ is the height of tree i, and $\alpha_0 \ldots \alpha_6$ are model parameters (Table 1). The parameter α_0 is site specific. Here it was estimated using $\alpha_0 = \beta_0 + \beta_1 \ln(H_{50})$, where H_{50} is a site index expressed as dominant height at age 50; β_0 and β_1 are model parameters (Table 1).

Mortality was described using Nord-Larsen's (2006) mortality model:

$$M_{i,t} = M(d_{i,t},G_{L,t}) = \big(1+\exp\big[\eta_0 + \eta_1 / d_{i,t} + \eta_2\, G_{L,t}\big]\big)^{-1},$$

where M is the probability that the subject tree dies within the next year and $\eta_0 \ldots \eta_2$ are model parameters.

Height was estimated using the following regression of height on diameter:

$$h_{i,t} = 1.3 + \frac{H_{50}}{22} \times 41\big(d_{i,t}/(d_{i,t}+6.46)\big)^3$$

The parameters of this model were estimated by Emborg et al. (1996) for beech in Suserup Forest, a semi-natural forest on the island of Zealand. However, the coefficient $H_{50}/22$ is not part of the original model and was introduced here to enable using the model at sites with site indices (H_{50}) differing from 22 m. Total and commercial volume were estimated using the volume functions developed by Madsen (1987).

Recruitment was estimated using a model type inspired by Morsing (2001, p. 55-56). The model is expressed as:

$$R_t = R(V_t) = \delta_0 - \delta_1 V_t$$

In Morsing's work the model was used to express the number of trees in the first diameter class but here R_t denotes the number of trees entering the first diameter class within a five-year period, V_t is the total standing volume per hectare and δ_0 and δ_1 are model parameters. In practice, recruitment varies a lot between sites and over time so, while the general pattern of decreasing recruitment with increasing standing volume is likely to be correct, at least for a wide range of volumes, the precision of predictions are likely to be low, even for locally estimated parameters.

At a given point in time (t) the state of the stand is described as a vector $N_t = [n_{1,t} \ldots n_{m,t}]^T$ of stem numbers in each of j=1…m fixed-width (w) diameter classes. The harvest at time t, $F_t = [f_{1,t} \ldots f_{m,t}]^T$ is calculated using a policy vector $Q_t = [q_{1,t} \ldots q_{m,t}]^T$. All elements of Q_t, $0 \le q_{j,t} \le 1$, and $f_{j,t} = n_{j,t} \cdot q_{j,t}$. The state of the stand at time t is projected to time $t+\Delta t$ using:

$$N_{t+\Delta t} = A\,(N_t - F_t) + R$$

$$= \begin{bmatrix} n_{1,t+\Delta t} \\ n_{2,t+\Delta t} \\ n_{3,t+\Delta t} \\ n_{4,t+\Delta t} \\ \vdots \\ n_{m,t+\Delta t} \end{bmatrix} = \begin{bmatrix} a_1 & 0 & 0 & \cdots & 0 \\ b_1 & a_2 & 0 & \cdots & 0 \\ 0 & b_2 & a_3 & \cdots & 0 \\ 0 & 0 & b_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & 0 \\ 0 & 0 & 0 & b_{m-1} & a_m \end{bmatrix} \begin{bmatrix} n_{1,t}(1-q_{1,t}) \\ n_{2,t}(1-q_{2,t}) \\ n_{3,t}(1-q_{3,t}) \\ n_{4,t}(1-q_{4,t}) \\ \vdots \\ n_{m,t}(1-q_{m,t}) \end{bmatrix} + \begin{bmatrix} R_t \\ 0 \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix},$$

where R_t is the recruitment, A is the transition probability matrix, $a_1 \ldots a_m$ are probabilities that a tree will remain in the diameter class and $b_1 \ldots b_{m-1}$ are probabilities of moving to the next higher class within the period Δt. At each time step the probabilities a_j and b_j are estimated as:

$$b_j = \left(\Delta t\, \Delta d(w[j-0.5], H_{50}, G_t, G_{L,jt})/w\right) \times \left(1 - M(w[j-0.5], G_{L,jt})\right)^{\Delta t}$$

$$a_j = \begin{cases} \left(1 - \Delta t\, \Delta d(w[j-0.5], H_{50}, G_t, G_{L,jt})/w\right) & \\ \quad \times\ \left(1 - M(w[j-0.5], G_{L,jt})\right)^{\Delta t} & for\ j < m \\ \left(1 - M(w[j-0.5], G_{L,jt})\right)^{\Delta t} & for\ j = m \end{cases} .$$

Growth and mortality within each class are assumed to correspond to those of a tree with diameter equal to the mid diameter of the class, $d_j = w[j-0.5]$. In addition, mortality is assumed to be homogeneously distributed within the class.

The stumpage value of the harvest (S_t) is calculated by application of the volume function of Madsen (1987) for merchantable volume >10 cm, $v()$, and a stumpage price function $P()$:

$$S_t = \sum_{j=1}^{m} n_{j,t}\, q_{j,t}\, \left[P(d_{j,t})\, v(d_{j,t}, h(d_{j,t})) - C_a\right] ,$$

where C_a is a fixed access cost and the price function $P()$ is the polynomial:

$$P(d_{j,t}) = \phi_0 + \phi_1\, d_{j,t} + \phi_2\, d_{j,t}^2 + \phi_3\, d_{j,t}^3 + \phi_4\, d_{j,t}^4 + \phi_5\, d_{j,t}^5$$

with parameters $\phi_0 \ldots \phi_5$. C_a is mainly of interest for small trees with zero merchantable volume and is introduced here to make sure that the option of cutting lots of non-commercial trees does not become unrealistically attractive.

At the initial stage (t = 0) we assume that an even-aged stand exists. In practice we describe this stand by its diameter corresponding to mean basal area, D_g, standard deviation of diameter, $s(d)$, skewness of the diameter distribution, $\gamma_1(d)$, and stand basal area, G. Based on these the parameters of a three-parameter Weibull distribution were computed. Finally, this distribution was used to predict the number of trees in each diameter class at t = 0.

Table 1 Applied parameters of models describing growth, site quality, mortality, recruitment and stumpage price. The parameters of the stumpage price function are valid for prices as of 2003.

	Model				
Par. No.	$\Delta d()^{\dagger}$	$\alpha_0(H_{50})$	$M()^{\dagger}$	$R()$	$P()^{\ddagger}$
0	-	-3.4642	7.4157	230.8	2.3021
1	0.7281	0.7938	-36.2820	0.255	423.61
2	-0.0021	-	-0.0875	-	-2991.5
3	-0.0164	-	-	-	9987.5
4	-0.2109	-	-	-	-13907
5	22.5321	-	-	-	6844.4
6	1.0000	-	-	-	-

† Diameter and diameter increment in millimetres, G and G_L in m^2ha^{-1}.
‡ Price in € m^{-3}, diameter in metres.

Assuming that the initial state of the stand is given, our goal is to maximise the discounted value of the future net cash flow. Consequently, the objective function to be maximised is the expectation value:

$$W^* = \max_{Q} \left\{ \sum_{t=0}^{\infty} S_t\ (1+r)^{-t} \right\}$$ where r is the discount rate.

Since it is impractical to operate with an infinite sequence of policies (Q = Q_0, Q_1, …), since we are focusing on conversion and are therefore mainly interested in the first roughly 100 years, and as we assume that conversion leads to a long-term equilibrium forest that will be treated in the same way indefinitely, we restricted the number of different policies to 7. Each of the first six policies was applied three times and the seventh policy was applied for the rest of the future. Moreover, as in practice the time horizon of simulations must be limited the objective function was approximated as:

$$W^* = \max_{Q_0 \ldots Q_6} \left\{ \sum_{\tau=0}^{\mathrm{T}} S_{\tau\,\Delta t}\ (1+r)^{-\tau\,\Delta t} + \frac{(1+r)^{-(\mathrm{T}+1)\,\Delta t}}{3\,\Delta t\ r} \sum_{\tau=\mathrm{T}-2}^{\mathrm{T}} S_{\tau\,\Delta t} \right\} .$$

Obviously, the use of an annuity based on the last three periods ($\tau = \mathrm{T}-2 \ldots \mathrm{T}$) reduces precision but for commonly used discount rates of 0.01-0.04 and a time horizon of 500 years ($\mathrm{T} = 100$; $\Delta t = 5$ years) it emerges that the proportion of the total expectation value contributed by the discounted value of this annuity is in the order of 10^{-3}-10^{-9}. We therefore consider the approximation acceptable.

Due to the fact that future stand states are, in part, determined by the present harvest policy the optimisation problem is characterised by strong inseparability of policy vectors. Consequently, the objective function has a large number of local maxima and it is necessary to use a robust global optimisation procedure to search for the optimal harvest policy. We used a simulated annealing algorithm (Cerny 1985; Kirkpatrick et al. 1983) and tuned its parameters to provide stable results for discount rates from 0.01 to 0.04. With the applied price function it emerged that optimal solutions always implied that all trees were felled before 60 cm and we therefore used m = 12 diameter classes with a width of w = 5 cm. Consequently the total number of policy variables to be optimised was 84. In most cases the optimisation algorithm managed to do this within 200,000 iterations. To further improve the results a greedy coordinate search was used to identify the maximum objective value of the basin of attraction pointed out by the simulated annealing algorithm. Finally, elements of the harvest policies in the optimal solution that had no effect on the objective value were zeroed and it was checked that, for all policy elements, the partial derivatives with respect to the objective function were negative, i.e. $\forall j,t : \partial W / \partial q_{j,t} < 0$.

Results

Most optimisation runs were done for a stand with the following initial characteristics: D_g = 25 cm, G = 30 m^{2}ha^{-1}, $s(d)$ = 5 cm, $\gamma_1(d)$ = 0.05, H_{50} = 22 m. The corresponding parameters of the Weibull distribution function are: location: 13.31; scale: 12.37; shape: 2.172. With respect to stumpage prices we used functions expressing the relationship between diameter and price in 2003 (parameters in Table 1). These were based on data from Dansk Skovforening et al. (2003). Real prices were calculated using a consumer price index (Statistics Denmark 2005) and the exchange rate was 7.4601 DKK/€ (Anon. 2005). An access cost of C_a = € 0.1 was applied for each tree harvested.

Replicated optimisation runs showed that the results were remarkably stable and policy elements that were either 0 or 1 generally did not vary between runs. For policy elements that were somewhere between 0 and 1, standard deviations between individual runs remained small for common discount rates of 0.02-0.04. However, for discount rates of 0.06-0.08 solutions ended up in 2-3 slightly different basins of attraction. Expectation values of the resulting policies were very stable and for discount rates of 0.02-0.08 between-run coefficients of variation were in the order of 10^{-4} or less.

Optimisation was done for discount rates ranging from 10^{-6} to 10^{-1}. The dynamics characterising the optimal solutions are shown in Figure 1 for discount rates from 0.01 to 0.07. The optimal path is illustrated by the development of remaining volume and liquidation value after cutting and the optimal policy is illustrated by the volume and value of the harvest. The graphs clearly show that the first roughly 100 years are characterised by very strong dynamics. This is the period where the harvest policy changes every 15 years and the period where the remaining part of the original stand is harvested. When the seventh harvest policy is introduced the stand has been put on the track and is allowed to converge towards its long-term steady state. Since stand basal area and the maximum diameter of trees left in the forest decrease with increasing discount rate, high discount rates lead to fast growth and short expected life-time of trees. Consequently, for high discount rates the time needed for the forest to converge towards the final state is relatively short and the fluctuations are dampened very fast compared to the dynamics observed for lower discount rates. An important consequence of the lower maximum diameter resulting for high discount rates is that, although the annual harvest does not vary much between discount rates and is in fact greatest for a discount rate of 6%, the value of the harvest decreases considerably with increasing discount rate.

The way that the long-term equilibrium diameter distribution is approached in the optimal solution depends on initial state of the stand, discount rate and access cost. Figure 2 shows an example for a discount rate of 2%. The initial state of the stand corresponds to the base case described above. The graphs show that initially (t = 0) the stand is harvested from below. Later, at t = 15, when the next policy is activated thinning is discontinued for some time but from t = 30 harvest from above (45-50 cm) is started and at t = 60 the harvest diameter is 50-55 cm. Finally, at t = 120 and t = 500 the last harvest policy is active and trees are harvested in the diameter class 45-50 cm. Closer examination of the patterns reveals that from year 45 to 85 trees are left to grow beyond the size found at the long-term equilibrium where the harvest diameter is 45-50 cm, and from year 0 to 60 the number of trees (after harvest) in the greater-size diameter classes exceed the number of trees found in those classes in the steady-state forest.

The steady-state harvest policy (at t = 500) and the distribution of the steady-state harvest are illustrated in Figure 3 for discount rates from 0.0001% to 10%. With respect to the harvest policies it is noted that, as expected, the size at which all remaining trees are removed ($q_{j,t}$ = 1) is decreasing with increasing discount rate. More interestingly, it is observed that for discount rates of 1-2% felling takes place in the largest diameter classes only but for other discount rates at least one class of smaller-diameter trees is thinned. This can be thought of as a combined tending and commercial felling operation. For high discount rates the two size ranges tend to merge and tending and commercial felling can no longer be distinguished. By running the optimisation with different assumptions regarding access cost and recruitment it was observed that, in agreement with common sense, the use of tending depends on both. If lots of trees are recruited more need to be removed and to the extent that natural mortality leaves too many, implying that diameter growth becomes relatively slow, thinning is introduced. Similarly, if access cost is low it becomes an attractive solution to thin trees before they have reached commercial size.

Steady-state diameter distributions are shown in Figure 4. In agreement with the observations mentioned above the maximum diameter generally decreases with increasing discount rate. In addition, due to the decreasing standing volume and basal area with increasing discount rate (cf. Figure 1) the recruitment increases and the mortality in the smaller diameter classes decreases. Consequently, for discount rates from 0.0001% to 5% the remaining stem number after harvest in the diameter class 0-5 cm is observed to increase with increasing discount rate. For greater discount rates it appears that two alternative strategies are competing: (a) thinning many pole-sized trees and leaving the remaining trees to grow to 35-40 cm, and (b) thinning fewer pole-sized trees and reducing the final target diameter. Strategy (a) tends to win for discount rates of 0.07-0.08 and since it is characterised by slightly greater standing volumes than (b) the stem numbers in the diameter class 0-5 cm are lower than for discount rates of 0.06 and 0.09-0.10.

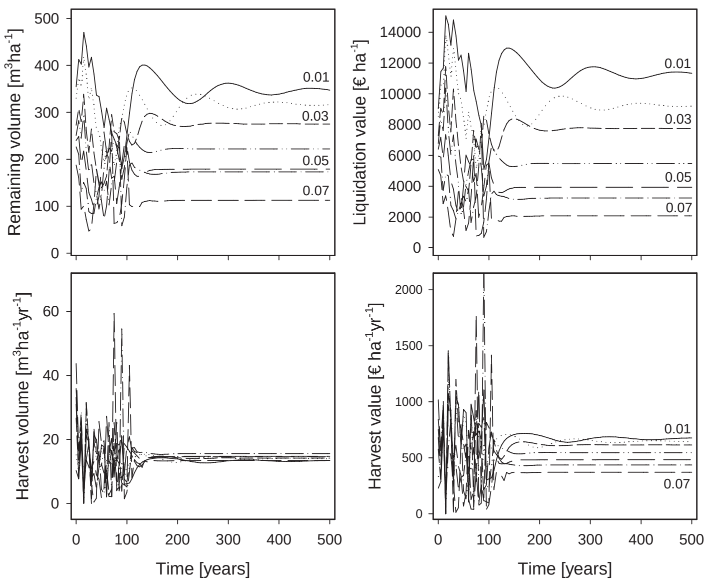


Figure 1. Dynamics of remaining volume, liquidation value after harvest, harvest volume and harvest value. Results for discount rates from 0.01 to 0.07.

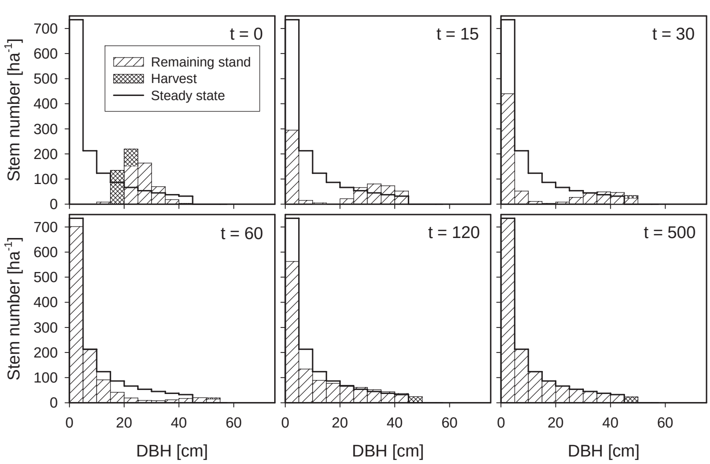


Figure 2.Diameter distributions at t = 0, 15, 30, 60, 120 and 500 years. The long-term diameter distribution (remaining stand after harvest) is shown with thick black lines. A discount rate of 2% and an access cost € 0.1 per tree are assumed.

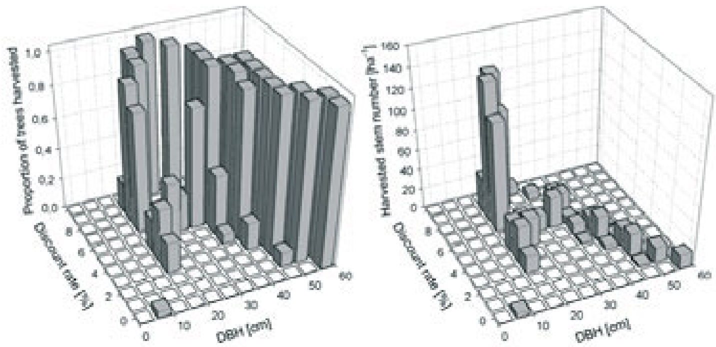


Figure 3.Steady-state harvest policy (left) and harvested stem number (right) in diameter classes 0-5…55-60 cm for discount rates from 0.0001 to 10 per cent. Empty classes are shown in white.

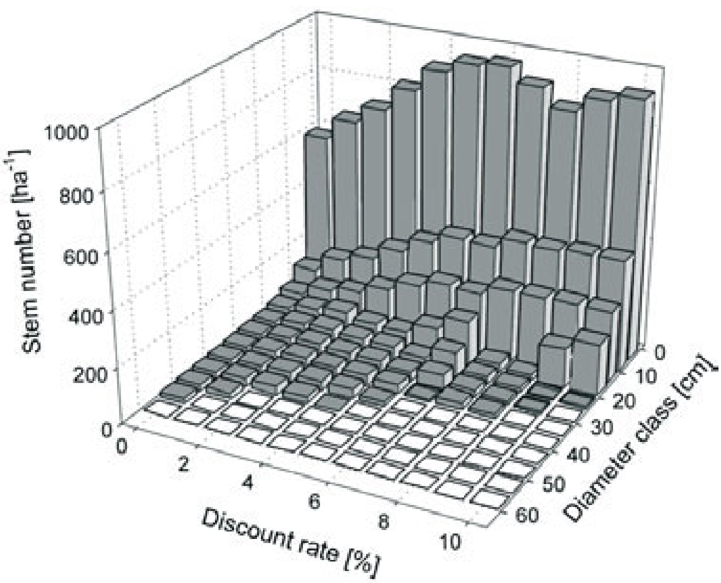


Figure 4. Steady-state diameter distributions after harvest for discount rates from 0.0001 to 10 per cent. Empty classes are shown in white.

Discussion

A major advantage of the applied matrix approach is that, although the model is initialised for, and continues to operate within, a stand covering a certain area the computational effort is not influenced by this area and the associated number of stems. In comparison, an individual-tree approach based on a tree list does not allow operating with very large stands (lists), implying that optimality results would be characterised by random variation caused by the discreteness of the approach.

The applied individual-tree growth model was developed on the basis of a large dataset from even-aged stands. Consequently, the model can be expected to better describe competition within the stand existing at the beginning of the simulations than the uneven-aged stand that gradually develops. However, at present no better model components are available for Danish conditions.

The effect of stand density on recruitment is only supported by data from a single stand (Morsing 2001) but, in reality, recruitment may vary considerably from site to site and over time. In the simulations it is assumed that recruitment can be described as a linear function of volume. This may indeed be true within the range of conditions typically found in forest stands but for very high and, particularly, very low stand densities it is not likely to be an adequate description of reality.

Obviously, the use of a fixed price function constitutes a large simplification of reality. However, in the present context use of the same price function for the initial, even-aged population of trees and for future generations of uneven-aged stands seems even more disputable. Quite likely the initial, even-aged stand is the outcome of an intensive (and costly) regeneration process and, that being the case, the density and quality of the stand may be everywhere nearly the same. However, since future regeneration is assumed to happen spontaneously and will usually be most successful in medium-sized gaps, a more heterogeneous stand can be expected. The average quality of the stand may be better or worse than that of the existing stand but the extent to which this depends on the chosen harvest strategy is not accounted for by the applied model. Fundamentally, it can be expected that the quality of trees left in the stand after active thinning (i.e. target diameter harvesting in small to medium size classes) is higher than that of trees left as a result of natural selection. It is not likely that the natural selection process will favour survival of high quality trees and, therefore, it seems safe to assume that stumpage prices will be lower if no thinning is done than if a quality-oriented thinning programme is introduced. This assumption will be incorporated in future analyses.

The results indicated that always harvesting the largest trees may not in all cases be the most profitable practice. At the start of the conversion the diameter of the largest trees may still be so low and their expected future price increase so great that harvesting these largest trees is not justified from an economic point of view. Instead, to reduce basal area and increase diameter growth in such cases thinning from below may be preferable in the beginning. Similarly, at steady state the recruitment may be so high and the natural mortality so relatively low that it becomes profitable to supplement harvest of the largest trees with thinning among pole-sized trees. As a consequence the overall harvest will include both large and relatively small trees, making the harvest resemble the pattern observed by Sterba & Zingg (2001, Fig. 3).

References

Anon. 2005. Danmarks Nationalbank, Havnegade 5, 1093 Copenhagen K, Denmark. URL: http://www.nationalbanken.dk/dnuk/specialdocuments.nsf, Current rates, Exchange rates. Accessed December 2005.

Buongiorno, J. 2001. Quantifying the implications of transformation from even to uneven-aged forest stands. Forest Ecology and Management 151: 121-132.

Cerny, V. 1985. Thermodynamical approach to the travelling salesman problem: An efficient algorithm. Journal of Optimization Theory and Applications 45: 41-51.

Dansk Skovforening, Hedeselskabet, Skovdyrkerforeningerne & Skov- og Naturstyrelsen 2003. Skovøkonomisk Tabelværk til Windows, Version 1.0. Dansk Skovforening, Frederiksberg.

Emborg, J., Christensen, M. & Heilmann-Clausen, J. 1996. The structure of Suserup skov, a near-natural temperate deciduous forest in Denmark. Forest & Landscape Research 1: 311-333.

Hanewinkel, M. & Pretzsch, H. 2000. Modelling the conversion from even-aged to uneven-aged stands of Norway spruce (Picea abies L. Karst.) with a distance-dependent growth simulator. Forest Ecology and Management 134: 55-70.

Hanewinkel, M. 2001. Economic aspects of the transformation from even-aged pure stands of Norway spruce to uneven-aged mixed stands of Norway spruce and beech. Forest Ecology and Management 151: 181-193.

Kenk, G. & Guehne, S. 2001. Management of transformation in central Europe. Forest Ecology and Management 151: 107-119.

Kirkpatrick, S., Gellat, C.D. & Vecchi, M.P. 1983. Optimization by Simulated Annealing, Science 220, 671-680.

Madsen, S. F. 1987. Vedmassefunktioner ved forskellige aflægningsgrænser og nøjagtighedskrav for nogle vigtige danske skovtræarter [Volume equations for some important Danish tree species. Standard and form class equations. Total and merchantable volumes]. Det forstlige Forsøgsvæsen i Danmark 41: 41-242.

Morsing, M. 2001. Simulating selection system management of European beech (Fagus sylvatica L.). PhD Thesis, The Royal Veterinary and Agricultural University (KVL), Copenhagen, 176 pp.

Nord-Larsen, T. 2006. Modeling Individual-Tree Growth from Data with Highly Irregular Measurement Intervals. Forest Science 52 (2): 198-208.

Price, C. 2003. The economics of transformation from even-aged to uneven-aged forestry. In: Helles, F., Strange, N. and Wichmann, L. (eds). Recent Accomplishments in Applied Forest Economics Research. Kluwer Academic Publishers, Dordrecht, pp. 3-17.

Price, M. & Price, C. 2006. Creaming the best, or creatively transforming? Might felling the biggest trees first be a win-win strategy? Forest Ecology and Management 224: 297-303.

Statistics Denmark 2005. Danmarks Statistik, Sejrøgade 11, DK-2100 København Ø. Consumer price index. URL: http://www.dst.dk/Statistik/seneste/Indkomst/Priser/Forbrugerprisindeks.aspx (Danish version). Accessed December 2005.

Sterba, H. & Zingg, A. 2001. Target diameter harvesting – a strategy to convert even-aged forests. Forest Ecology and Management 151: 95-105.

Tarp, P., Helles, F., Holten-Andersen, P., Larsen, J.B. & Strange, N. 2000. Modelling near-natural silvicultural regimes for beech – an economic sensitivity analysis. Forest Ecology and Management 130: 187-198.

Tarp, P., Buongiorno, J., Helles, F., Larsen, J. B., Meilby, H. & Strange, N. 2005. Economics of converting an even-aged Fagus sylvatica stand to an uneven-aged stand using target diameter harvesting. Scandinavian Journal of Forest Research 20: 63-74.

Locating feasible routes from kvartals to the nearest road in the Novgorod region of Russia

Bruce Michie, Kaija Saramäki & Ari Pussinen*

Abstract
One of the biggest challenges in dealing with the accessibility of forests in the Novgorod Region of Russia is the large numbers of rivers, lakes and bogs. Combined with the long distances from forests to the nearest road these obstacles make it difficult to locate feasible routes and calculate feasible hauling distance from kvartals (management units) to the road. The goal of this study is to develop a method for finding feasible routes to as many kvartals as possible and then to use the length of these feasible routes as a general measure of the accessibility of forest land in the Novgorod Region of Russia.

Keywords: accessibility, gis, Novgorod, forest road

Introduction
The forest resources of the European part of Russia are vast (appr. half of the European forests), and form an important part of the total timber trade in Europe. The Russian Federation's forest resources amount to appr. 883 million hectares of forest land and the North-West Russia's forest land to almost 90 mill. ha (Karvinen et al 2005). The forests in the North-West Russia are in the boreal zone, and the most common tree species are spruce, pine, and birch. Other species include aspen and larch. The forests are categorised into three groups and each group has its own set of management tasks that can be executed (Pisarenko et al 2002).
A majority of the procured wood is exported, mainly as roundwood and sawn logs, but also as chips, plywood and pulp. Poor road conditions, frost damages to the roads, lack of forest roads and large amounts of wetlands have concentrated the forest harvesting to areas which are close to railways, main roads and watercourses. In other words, in easily accessible areas. Having cut the mature forests from the roadsides, the less valuable and young forests dominate in accessible areas and the mature and over mature forests in remote areas are not harvested. With modern technology, harvesting is possible in thick, remote forests as well, if no consideration is given to the costs involved. If/when the costs are considered, it becomes economically infeasible to harvest in these areas. As the industry still needs wood supply, increasing pressure has been put on harvesting those ecologically valuable forests, which are accessible. If there were known economically accessible areas, with mature forests, and no ecological value, it would make the decision of wood harvesting easier.

The forest land area of Novgorod is 3.6 mill ha and its growing stock in 2003 was 614 mill m^3 (Karvinen et al. 2005). Novgorod is seen as a progressive area for foreign investments and in the past decade has seen a few new mills being built by foreign companies. These include UPM Kymmene's Pestovo sawmill (inaugurated in 2004), Chudovo mills (100% shareholder since 2005) and Stora Enso's Nebolchi sawmill (inaugurated in 2004) (UPM-Kymmene 2006, Stora Enso 2006).

The objective of this paper is to describe recent progress with producing methods that are able to objectively estimate the accessibility of forest resources in the Novgorod region of Russia. Previous methods using the shortest (perpendicular) distance from management units to the nearest road have been criticized as being unrealistic due to the large numbers of rivers, lakes and deep bogs that can make the shortest route impossible to follow.

Method and data

Data

As Russia began to expand and open its forest products markets to outside ideas, methods and investments in the 1990's it was decided that the Novgorod region should become a test bed for trying these new ideas or investments before deciding whether to incorporate them on a broader scale. In the spirit of that openness much work was done looking at how the information contained in maps of the Novgorod region could be used to investigate the accessibility of forest resources in that region (Michie et al 2004).

Map data covering the Novgorod region includes the general layers of kvartal, leshoz (24 in the Novgorod region), parks, wildlife reserve boundaries, relief, roads, railroads, urban areas, leshoz centers, forest areas, non-forest area, marshes, lakes and rivers.

The road network of the Novgorod region is rather comprehensive and increases the industrial attractiveness of the region. With an average amount of 17 km of roads per 100 km^2, 1147 km of railroad and more than 300 km of open waterways for navigation, cargo can be carried effectively and with ease to the Baltic states, other regions of the Russian Federation, Scandinavia, and CIS countries. The road network crosses the region leading to major cities such as St. Petersburg, and from there onwards to Finland and the Baltic Sea as well as through Moscow to other areas of eastern Europe. The railroads cross the region in practically all directions and, in addition to main line railroads, there are some narrow guage railroads, which can be used locally. Waterways make it possible to carry cargo in vessels and boats from Lake Illmen, to the Baltic and White seas and then onwards to other regions in Europe and countries outside of Europe, such as Turkey. The forest road network in the Novgorod region forms a less comprehensive network, with an average of 4.5 km of forest roads per 1000 ha, and will, hopefully, be improved within 10 years due to new forest legislation. The current amount of forest roads is only a third of the recommended amount (Michie et al 2004).

Method

The shortest distance from a kvartal center (centroid) to the nearest road (or perpendicular distance) has been used as a benchmark for assessing forest accessibility (Michie et al 2004). The perpendicular distance to the nearest road is the shortest possible route to access the kvartal. Very often when a line is drawn from the centroid of a kvartal to the nearest road it crosses rivers, lakes or deep bogs making the route infeasible. As a result some kvartals have no feasible direct access to the road. Those kvartals for which direct access to the road is feasible (a perpendicular line from the centroid of the kvartal to the nearest road crosses no obstacles) become access points for other kvartals.

Initiating distance to road calculations starting from the kvartal rather than the road (as is done when buffers are used) allows scale changes (grouping of management units) to reduce the number of necessary calculations (as woods workers might also try to use one forest road to access several remote forest management units). This is especially important when dealing with the large numbers of management units that typically occur in Russia. Using perpendicular distance to road segments allows distance to each road segment to be evaluated with just 3 distance checks (two end points plus the intersection of a perpendicular line from the management unit centroid to the line segment). Splitting road segments or adding intermediate points requires that each new point be evaluated increasing the number of necessary calculations.

Locating the shortest path over land (Manifold 2006; MIT OCW 2006) starts by either creating a regular grid of points or by creating a cost surface. All points from the grid which fall on water are then eliminated. The network is a regular grid of paths connecting the remaining points (using the cost surface method no actual paths are determined requiring additional work to determine the shortest path). Standard network calculations are performed to find the path between two chosen points. Locating shortest paths from any point in a forest to an existing road network would require an infinite number points and paths. This procedure was modified to avoid constructing networks covering thousands of regions between hundreds of rivers in order to simplify the problem of finding routes from 21 201 kvartals to the closest of 40 803 road segments.

To find feasible routes to the road from kvartals for which direct access is infeasible it is necessary to find at least one feasible route from the kvartal under consideration to another kvartal from which direct access is feasible (such as route A in Figure 1). Lines from the kvartal under consideration are drawn to all nearby kvartals which have feasible direct road access and this leads to a set of candidate routes. Routes which cross a river or other obstacle or are longer than 10 km are eliminated. A feasible one-bend route (for example, Route B in Figure 1) is the one having the shortest total distance to the road. Feasible two-bend routes (such as route C in Figure 1) are found by drawing lines from remaining kvartals (which have neither direct access nor access through one-bend to the road) to all kvartals accessed by one-bend routes and then choosing the shortest feasible route. The shortest three-bend route would be determined in a similar way by accessing kvartals with two-bend access. Three-bend routes were not investigated in this study.

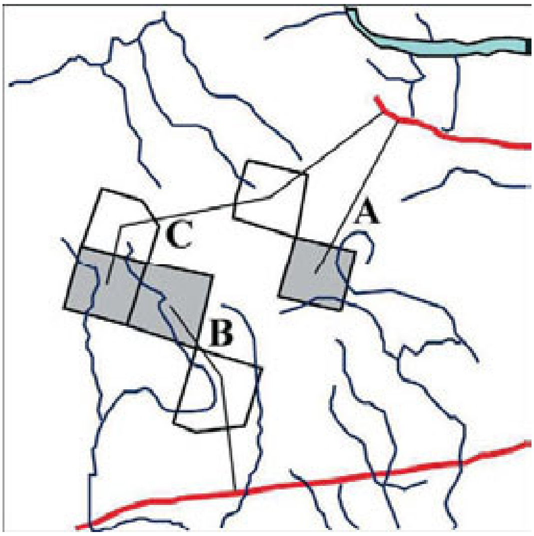


Figure 1. *Kvartals with direct (A), one bend (B) and two bend (C) access to the nearest road.*

The method of determining feasible access to kvartals described above roughly mimics the actions of woods workers who tend to harvest forests closest to the road first and then look for forests that can be accessed from points of known accessibility (recently harvested forests). The advantage of doing this analysis by computer rather than depending on woods workers to find their own routes allows many kvartals to checked before actually trying to access any particular one in the field. Additionally, by looking at large numbers of kvartals at one time analysts might discover groups of kvartals which might be most economically accessed by one woods road.

In order to ensure that enough access points exist near roads we added a grid of regularly spaced points and included those for which direct access routes to the nearest road were feasible. This was done because land near roads is often agricultural land and would not be organised into forest management units. In this case kvartals distant from the road might otherwise have no access points to use as intermediate points on a route to the road.

Results

A comparison between the shortest (max. two bends) distance and the feasible distance for the 17 926 management units for which feasible access has been determined shows that the feasible distance is 1.5 times as large as the shortest distance.

A test of the method for determining feasible routes to kvartals in the Novgorod Region of Russia consisted of 20 201 kvartals with total enclosed area of 2.8 million ha (including areas of non forest). A line connecting the centroid of each kvartal to the closest road segment was drawn and then tested to see if it crossed any rivers, lakes or deep bogs. A feasible direct route from 8174 kvartals 1.1 mill ha to the road was found. Figure 2 shows 302 kvartals along with feasible direct routes to the nearest road.

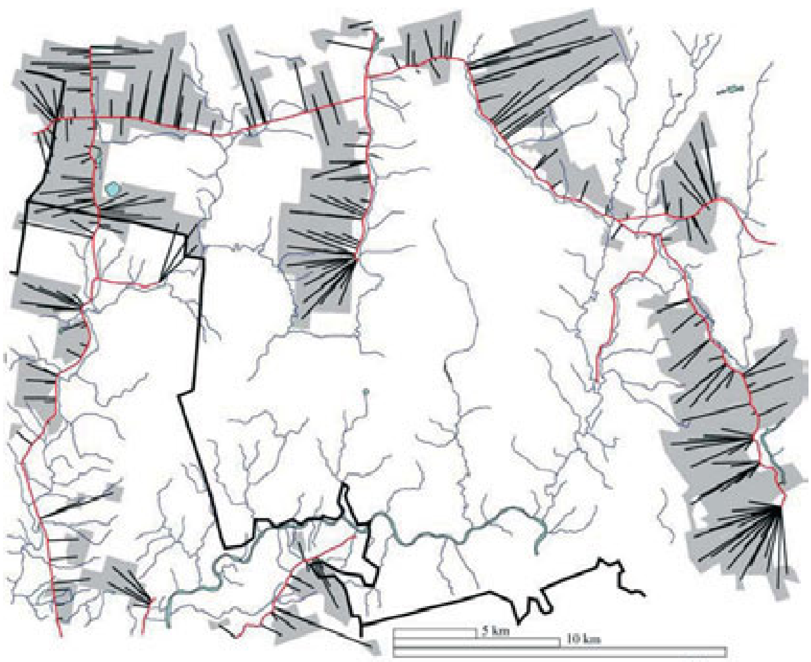


Figure 2. Kvartals which have direct feasible acces to the nearest road (302 kvartals*)*

In order to determine feasible routes for the remaining 12 027 kvartals an attempt to find feasible routes from these remaining kvartals to 21 889 road access points (the centroids of 8174 kvartals that do have feasible direct access to the road plus another 13 715 regularly spaced points that also have feasible direct access to the road).

Using this method 8104 kvartals 1.1 mill ha were found to have feasible one-bend road access. Figure 3 shows 291 kvartals with feasible one-bend road access. By starting from kvartals which have no feasible access lines yet can now be drawn to those kvartals which do have feasible one-bend access and as before the shortest feasible two-bend route is chosen. All together 1648 kvartals (226 768 ha) were found to have two-bend feasible access.

That leaves 2275 kvartals (341 694 ha) with no feasible access. Figure 4 shows 197 kvarals with feasible two-bend access to the road network plus 96 kvartals with no feasible access found so far. While no attempt was made to discover kvartals accessible with routes having three bends, it is clear from Figure 4 that many kvartals with no feasible access along routes allowing no, one or two bends would have access to kvartals having two-bend access so if the process were extended to allow routes with three bends many, if not all, of the remaining kvartals would be found to be accessible.

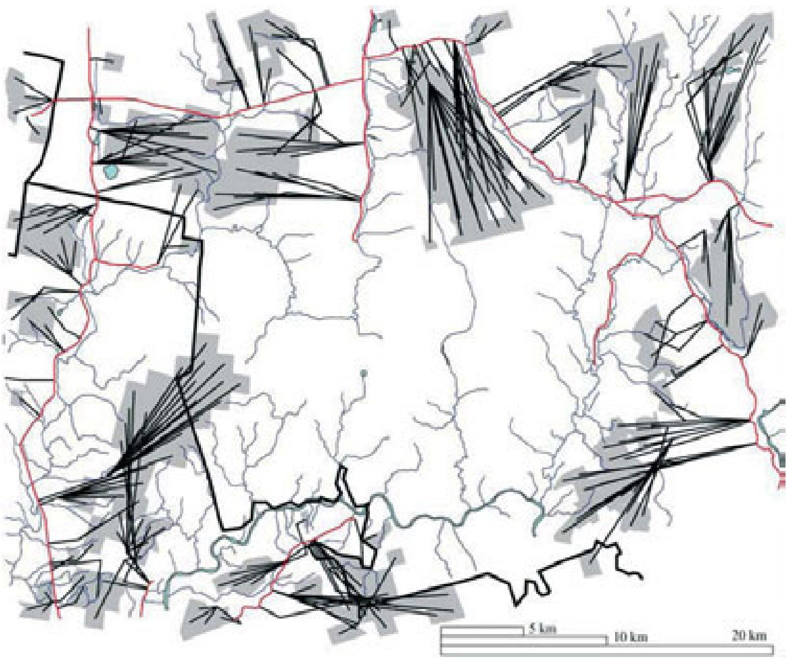


Figure 3. Kvartals with feasible one-bend access to the road network (291 kvartals)

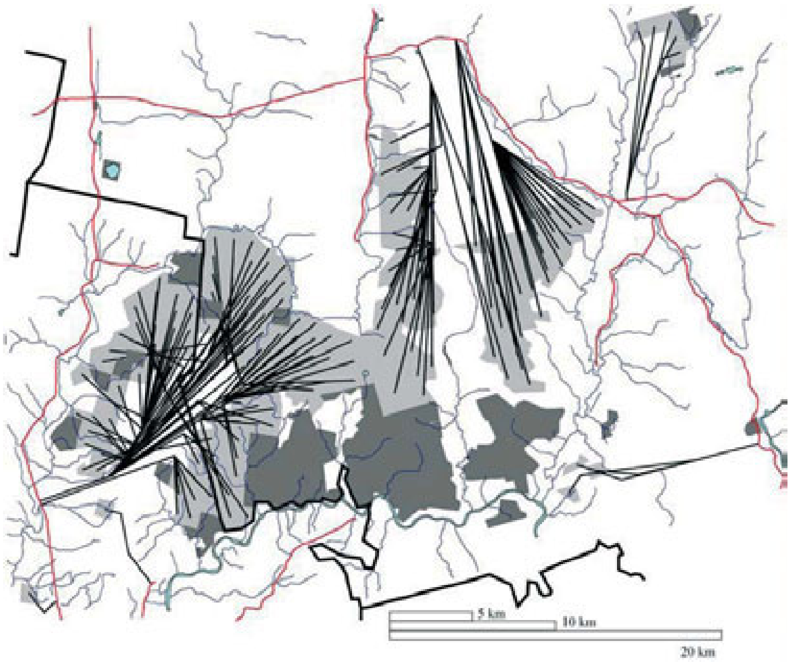


Figure 4. Kvartals with feasible two-bend access to the road network (194 kvartals) plus 96 kvartals with no feasible access yet found

Tables 1 and 2 show that feasible distances are substantially longer than shortest possible routes and that the longer the distance to the road is the more likely that feasible distances are greater than shortest distances. In the first three classes the feasible distance for more than half of the kvartals (measured in both numbers of kvartals and hectares) remains in the save distance class as the shortest distance. In the next five classes the feasible distance to less than half of the kvartals can be found in the same distance class as shortest distance class implying that the farther kvartals are from the nearest road the more likely that obstacles are encountered along the way to the road making feasible distances longer than the shortest distance to the road.)

Table 1 Feasible Distance vs Shortest Distance Matrix for 20 201 Kvartals (numbers of kvartals)

Shortest				Feasible Dist (km)						No feasible	
Distance (km)	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 9	9 to 11	11 to 31	access found	total
1 to 2	2 898	204	79	38	23	27	26	16	34	64	3 409
2 to 3		2 348	365	171	117	78	104	44	95	156	3 478
3 to 4			1 710	428	199	117	164	105	153	233	3 109
4 to 5				1 224	327	178	243	143	225	223	2 563
5 to 6					790	273	285	170	269	199	1 986
6 to 7						499	342	174	267	203	1 485
7 to 9							634	334	536	317	1 821
9 to 11								259	520	264	1 043
11 to 25									691	616	1 307
total	2 898	2 552	2 154	1 861	1 456	1 172	1 798	1 245	2 790	2 275	20 201

Table 2 Feasible Distance vs Shortest Distance Matrix for 20 201 Kvartals (thousands of hectares)

Distance (km)	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 9	9 to 11	11 to 31	access found	total
1 to 2	378	26	12	6	4	4	3	2	4	9	448
2 to 3		308	50	22	18	10	14	5	14	24	465
3 to 4			224	57	25	16	21	15	22	30	410
4 to 5				168	43	26	32	20	30	27	346
5 to 6					112	37	39	24	33	31	276
6 to 7						67	46	25	37	44	219
7 to 9							91	45	74	49	259
9 to 11								35	75	40	150
11 to 25									100	87	187
total	378	334	286	253	202	160	246	171	389	341	2 760

Discussion

Improving access to kvartals that are located far from the nearest road will decrease transportation costs for logs harvested from Novgorod region forests. Additionally, there will be less chance that remote kvartals are avoided due the the high cost of access. This will help to maintain the sustainability of forestry in Novgorod and may increase the availability of larger diameter trees which are often found far from the nearest road. Changes in the demand for bioenergy or other changes in demand may mean that kvartals that have been harvested once for large tress may become attractive for the harvesting other types of trees in a few years making easy access doubly important.

One problem that occurred in the set of kvartals examined in this study was that some of the kvartals were quite large and parts of the same kvartal might fall on opposite sides of a river. In this case our analysis would only determine a feasible route to the part of the kvartal which includes the centroid. A second problem occurred when the nearest feasible access point to the road occurred on the opposite side of the road. The route discovered in this case is still feasible but since it crosses the road and then comes back to it the length of the feasible route is over estimated.

It can also be said that for the one-bend and two-bend routes it may be possible to find shorter feasible routes than those found by the methods outlined above. Sometimes routes from kvartals cross each other. When this happens more than one feasible route becomes available for consideration. The extra work required to find optimal routes is probably not justified since any routes found by this or any other method could not be considered final without visiting the site and walking the routes. Further, woods workers will, most likely, check the condition of previously used routes before settling on any new routes and are likely to prefer suboptimal but proven routes over apparently superior routes. Final routes might also try to intersect the road network at more than one point. This would allow the route to be used even if unanticipated problems develop while the route is being used by heavy trucks.

Conclusion

Together, the shortest distance and feasible distance from kvartals (forest management units) to the road give two measures of the accessibility of forest land in the Novgorod Region of Russia. The shortest distance to the road is a measure of accessibility which is entirely dependent on road infrastructure. Feasible distance, on the other hand, is a measure of accessibility which also includes an attempt to avoid obstacles such as rivers, lakes and deep bogs. In order to reduce the shortest distance to the road network it would be necessary to build more roads. Reduction of the feasible distance to the road (downward toward the shortest distance) could be achieved by building very short roads in combination with bridges. The cost of building roads would have to be compared with the cost of building bridges in order to determine the cheapest way to reduce transport costs along forest roads in the Novgorod Region of Russia. Ideally, the cost of roads and bridges would be completely offset by savings in transportation costs. The techniques described in this paper will help to determine the most cost effective locations for new roads or bridges.

Acknowledgements
The authors would like to thank the funding bodies of the study, the Ministry of Agriculture and Forestry of Finland and the Academy of Finland. We would also like to thank the St. Petersburg Forest Technical Academy for their cooperation as well as various trainees and staff members at EFI, who have contributed to this study.

References

Michie, B., Pussinen, A. & Saramäki, K. 2004. Economic Accessibility of Forest Resrouces in Novgorod Region. Proceedings of The Biennial Meeting of The Scandinavian Society of Forest Economics. Vantaa, Finland. *Scandinavian Forest Economics* Vol 40: 297-306.

Pisarenko, A. I., Strakhov, V. V., Päivinen, R., Kuusela, K., Dyakun, F. A. and Sdobnova, V. V. 2000. Development of Forest Resources in the European Part of the Russian Federation. EFI Research Report 11. Brill. 102 p.

Karvinen, S., Välkky, E. and Torniainen, T. 2005. Luoteis-Venäjän metsätalouden taskutieto. Finnish Forest Research Institute. 116 p.

UPM Kymmene. 2006. http://w3.upm-kymmene.com/upm/internet/cms/upmcms.nsf/$all/92cf8396f49975d2c225701b00417b43?OpenDocument&qm=menu,5,1,0&select=2005. 15.5.2006

Stora Enso. 2006. http://www.storaenso.com/CDAvgn/main/0,,1_-5470-12070-en,00.html. 15.5.2006.

Manifold. 2006. http://www.manifold.net/doc/700/shortest_path_over_land.htm. 3.6.2006. 15.6.2006

MIT OCW (Massachuchettes OpenCourseWare). 2006. http://ocw.mit.edu/NR/rdonlyres/Civil-and-Environmental-Engineering/1-963Fall-2004/453652C6-9190-424B-9912-0D7460D229C5/0/lab8_1.pdf 26.6.2006.

Acceptability of operations, corporate responsibility, sustainability, or what?
- the many faces of responsibility within the global pulp and paper industry

Mirja Mikkilä

Abstract
This work summarises the essential findings of the empirical analysis of responsibility within the Scandinavian-based pulp and paper industry that was studied by quantitative and qualitative methods, employing the acceptability of operations as an indicator. The data were gathered at four mills of the case company, Stora Enso Oyj, located in four countries, China, Finland, Germany and Portugal, by interviewing the internal and external stakeholders.

The interview material gave a number of definitions of the acceptability of operations and allowed a few dominant regional characteristics to be extracted. The main elements of acceptability for the Chinese were loyalty, distribution of welfare and cultural diversity, while the Finnish stakeholders emphasised profitability, sustainability and communication, the Germans socioeconomics, the solid waste problem and global forest operations and the Portuguese case showed the importance of technical competitiveness, quality of the products and land use.

The results showed that the acceptability elements covered issues beyond the traditional dimensions of corporate social responsibility. This demonstrated that the traditional concepts of corporate social responsibility, or corporate responsibility, are not adequate when dealing with the operations of a global company.

Key words: pulp, mills, profitability, sustainability & acceptability

Introduction
The operating methods and techniques of the pulp and paper industries in Europe and North America have been criticised since the 1970's (Halme, 1997, Uimonen, 1998, Hellström, 2001), at the same time as internationalisation has increased the number of stakeholders and enlarged the debate surrounding the industry. Other reasons for the increasing willingness of corporations to behave in an ethically acceptable manner and to carry their share of a wider responsibility than just the economic one can be changing values, building of company images, preparations for future regulations and standards, and globalisation of corporations, societies and politics. The choice of behaviour that is ethically "right" is problematic, as there is no model that defines how to behave in different operational environments. This problem has arisen especially in the natural resource-based industries such as pulp and paper, as their dependence on natural resources binds them intensively and comprehensively to the local societies wherever they operate.

The world's ten largest pulp and paper companies are located in Asia, North America and Scandinavia (http://english.forestindustries.fi/figures/). The operations of those in Europe and North America have been criticised constantly since the 1970's (Halme, 1997, Hellström, 2001, Uimonen, 1998), and recent criticism of the large Scandinavian-based companies has been stronger than that of Asian and North American ones, for example. There are two major reasons for this. First, Scandinavian-based pulp and paper companies have truly globalised to other continents, whereas the Asian and North American companies have expanded mainly within their own continents. Secondly, the Scandinavian companies export the majority of their production, so that the Finnish pulp and paper industry exported 90% of its production in 2005 and around 50% of its production capacity was located outside the country (http://english.forestindustries.fi/figures/), whereas the Asian and North American companies produce mainly for their own continental markets.

The above differences explain why the Scandinavian companies can be considered more international or global than other large pulp and paper producers, and why their operating environment is more challenging. It is thus globalisation that has raised the social role of the pulp and paper industry as a topic of debate in Scandinavia recently and has increased the number of stakeholders involved, while no such pressure exists within the Asian and North American-based industries, or the pressure remains at a reasonable level, at least.

The objective of this paper is to outline empirical corporate responsibility within a globally operating pulp and paper company, Stora Enso Oyj. Next, the theoretical context of stakeholder approach-based corporate responsibility and the operationalisation of the theoretical framework will be summarised in the following, a synthesis of the quantitative and qualitative analyses will be presented and the strengths and challenges of this kind of study will be discussed. Finally, conclusions will be drawn.

Conceptual and theoretical background

Corporate responsibility based on a stakeholder approach

Milton Friedman's (1970) classic statement "the business of business is business" is probably one of the oldest and narrowest references to the responsibility of business enterprises. The concept of responsibility has diversified greatly since then. Carroll (1979) launched the multidimensional construct of corporate social performance, which included an element of responsibility. The theoretical concepts of corporate social responsibility and performance were turned into practical ones in the 1990's. The UNCED summit in Rio in 1992 boosted a general consciousness of environmental, social and cultural issues (UNCED, 1993), since when corporate social responsibility has been connected with sustainable development (Welford, 2002, Korhonen, 2003). Both scholars and business people adopted the concept of "corporate responsibility" in the late 1990's in order to clarify the role of social issues as one dimension of responsibility. In addition, the practical concept of "acceptability of operations" was applied when describing social responsibility and related issues in the Finnish pulp and paper industry in the late 1990's, Donaldson & Preston (1995) emphasised that business enterprises that are considering a strategy of corporate social responsibility have to identify the object of their responsible actions. Their stakeholders are commonly considered to represent this object. The first references to stakeholders in an organisation-related context dated back to the 1960's (Freeman, 1984), since when the stakeholder approach has become a commonly used framework within which to broaden management's vision of its roles and responsibilities beyond the profit maximisation function, to include the interests and claims of non-stockholding groups (Mitchell et al., 1997).

Theoretical framework

The theoretical framework is based on the modification of the acceptability hierarchy (Mikkilä 2003, 2005a, Mikkilä et al., 2005), based on Saaty's (1980) hierarchical decision-making process as presented in the form of the analytic hierarchy process (AHP). The acceptability model describes multi-criteria problems with multiple actors, the latter being defined in terms of the characteristics of two theories related to CSP: the theory of business values and stakeholder theory. The theory of business values refers to judgements, including the process involved in making judgements and the standards and criteria brought to bear in this process (Frederick, 1995). Stakeholder theory (Freeman, 1984) was employed to identify judges for the acceptability model (Figure 1).

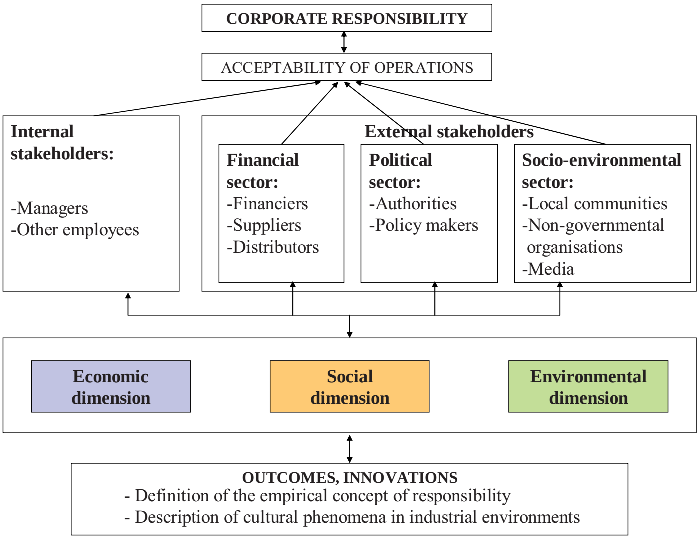


Figure 1. The conceptual framework for the responsibility study

Material and methods

Basic material

The empirical material was gathered from four pulp or paper mills in China, Finland, Germany and Portugal belonging to a Scandinavian-based company, Stora Enso, and their operating environments (Table 1).

Table 1. Technical data on the case mills

Characteristics	Case 1: China	Case 2: Finland	Case 3: (Former East) Germany	Case 4: Portugal
Year of foundation	1995/96	1937	1993/94	1965
Number of employees	690	800	350	420
Raw material	Market pulp	Roundwood from natural forests	Recycled paper	Roundwood from plantations
Product	Fine paper	Fine paper	Newsprint	Market pulp
Production capacity, t/a				
- pulp/de-inking plant		370,000	360,000	300,000
- paper	120,000	814,000	300,000	

The stakeholders interviewed represented the major part of the value chain of the case mills, from the raw material source up to the end-users of the products. A total number of 130 people participated, some 60% of whom represented external stakeholders and the remaining 40% were employees of the company. Thus, the entire material was composed of 130 taped interviews and completed questionnaires (Table 2).

Table 2. Distribution of interviewees

Stakeholders	China	Finland	Germany	Portugal
A. Internal stakeholders				
1. Headquarters		3		
2. Dept. of forest operations		4		6
3. Case mill				
- top and middle managem.	6	8	7	2
- staff	3	2	12	3
Sub-total	9	17	19	13
B. External stakeholders				
1. Customers	2	2	2	-
2. Suppliers	1	4	2	3
3. Authorities	2	2	5	5
4. Policy makers	2	3	5	1
5. Pulp and paper association and research institutes		2	1	1
6. Non-governmental organisations	-	7	3	3
7. Local people	3	4	5	3
Sub-total	10	24	23	16
Total sample	19	41	41	29

Applied methods

The three applied methods are presented profoundly in Mikkilä, 2005a, 2005b and Mikkilä et al., 2005 and summarised below.

The quantitative analysis was based on Saaty's (1980) Analytic Hierarchy Process (AHP), which is a multi-attribute decision analysis method (Mikkilä et al., 2005) that provides a way of quantifying subjective preferences concerning entities or objects (Saaty, 1980). The local weights for the acceptability criteria and their sub-criteria were calculated on the basis of these pairwise comparisons, which were analysed using a recent Mathematica package, AHP.m, developed by Alho and Kolehmainen at the University of Joensuu, Finland. Alho et al. (2001) introduced the method as follows. Let vi be the value of an entity (main criterion in this application) i = 1,…, I and let r(i,j,k) be the ratio vi/vj as perceived by judge k = 1,…,K. As all vi are positive, it can be assumed without loss of generality that vi = exp(μ + αi), where μ is an intercept term. The theoretical values of vi/vj are thus exp(μ + αi), where μ cancels out. Define y(i,j,k) = log[r(i,j,k)]. The regression model for pairwise comparisons of data in the multiple judge case is of the loglinear form

$$r(i,j,k) = \alpha i - \alpha j + \varepsilon(i,j,k), \quad (1)$$

where the error term representing all types of inconsistencies has an expected value E[ε(i,j,k)] = 0. For identifiability, it is assumed that αI = 0, so that αi measures the value of entity i relative to entity I.

The major deficiency affecting the statistical analysis lay in the imperfect coverage of the acceptability criteria. A qualitative analysis was therefore necessary in order to deepen the content of empirical corporate social performance and responsibility (Mikkilä, 2005a). For this purpose, thematic interviews (Eskola & Suoranta, 1998) were conducted in the form of guided conversations according to the recommendations of Yin (2003). The interview data were organised separately for each country for further processing. Qualitative data analysis was carried out using the most recent software package devised for this purpose, QSR NVivo, a product of the Australian company QSR International. The program is useful for coding, searching and modelling qualitative data (Luomanen & Räsänen, 2002). The interview material was transcribed and imported into NVivo, and coded. Next, the passages for each code were counted by cases in order to obtain an idea of the cultural and national characteristics of the acceptability concept on the one hand and the common characteristics on the other. After this the stakeholders' understanding of the acceptability concept within the pulp and paper industries and their opinions on the matter were studied in depth. Finally, themes defining the concept were extracted and combined into typologies in the subsequent analysis. Thus an interpretative explanation of the acceptability phenomenon was given on the basis of the clues produced and hints available.

Triangulation is a method used for confirming findings in qualitative research. It is supposed to support a finding by showing that its independent measures agree with it, or at least do not contradict it (Miles & Huberman, 1994). Two methodologies, quantitative and qualitative, were chosen here in order to pick out triangulation sources that have different biases and different strengths, so that they can complete each other. Although the quantitative analysis yielded three tentative acceptability criteria, financial-technical, environmental and social, the experimental acceptability model was composed of eleven elements: technical, financial, economic, resource-based, environmental, social, societal, cultural, organisational, institutional and ethical. Comparison of these two models would have been very difficult without further processing of the qualitative model for a concept of empirical corporate responsibility having four major elements, economic, environmental, social and organisational responsibility. The similarities and contradictions between the two sets of data were identified and compared by stakeholder groups in order to describe the phenomenon profoundly and increase the validity of the results (Mikkilä, 2005b).

Results

Regional acceptability of the case company

The interview material presented a number of definitions for the acceptability of operations. The dominant regional characteristics are summarised below.

The Chinese case illustrated well the challenge of global acceptability. The results showed that the employees were loyal to the company's targets and policies, but their understanding of the concepts might differ from that existing at headquarters. In addition, the distribution of welfare was regarded as the duty of a large company.

The economic, environmental and social debate in Finland in the 1990's was reflected in the acceptability characteristics. Business management trends associated with quartile thinking and shareholder value was reflected in the emphasis on profitability as an acceptability element. The environmental debate on sustainable natural resource management and the conservation of biological diversity in commercial forest areas brought out the sustainability dimension. The communication element was a consequence of the poor communication skills that existed at the time when the extensive international criticism of the industry began in the early 1990's.

The German case produced a three-level model of local, national and global acceptability of operations. Socioeconomic issues were emphasised at the local level in the region of the former East-Germany, the solid waste problem was crucial at the national level, and finally, German stakeholders were worried about the nature of global-level forest operations and their effects on the global environment.

Technological issues dominated over financial ones when it came to the Portuguese concept of acceptability. The quality of products was generally considered an essential issue in industrial production, and the questions concerning land use that had originated from the environmental discussion at the time of the extensive establishment of eucalyptus plantations in the 1980's were still current, as many smallholders had recently shifted or were planning to shift from agricultural production to the more productive cultivation of eucalyptus trees.

Empirical corporate responsibility

The regional findings were generalised into an empirical corporate responsibility model based on the large empirical material indicating comprehensive corporate responsibility (Figure 2).

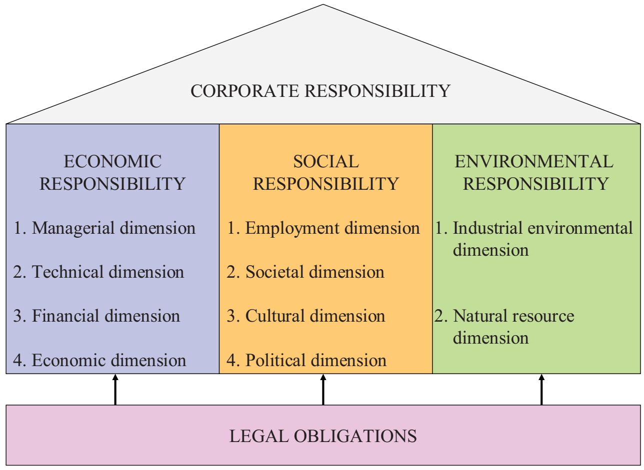


Figure 2. Empirical corporate responsibility model

Corporate responsibility, including economic, social and environmental responsibilities, refers to both the organisational and societal, or internal and external, responsibility of a company. The organisational, or internal part of economic responsibility, for example, includes managerial, technical and financial dimensions, while the economic dimension refers to the economic impacts of the company and thus to societal, or external responsibility. The employment and cultural dimensions are both organisational and societal questions, but the remaining dimensions of social responsibility refer mainly to the company's relations with the surrounding society. Similarly, both dimensions of environmental responsibility include both internal and external elements.

Discussion

A few major challenges related to the research setting, applied methodologies and cultural issues that arose during the field work and analyses are discussed below.

The various cultures were one of the major challenges that arose. The primary focus was on studying the content of the acceptability concept, but this was also a study of the transferability of western-based concepts and methodologies to the industrial Suzhou area of China and to a transitional area in former East Germany.

The objective of employing the quantitative method here was to test its applicability to research problems of this kind. Measurement and comparison can at best facilitate the formation of a quick idea on a phenomenon, but they provide only a narrow explanation, as found here. When only the elements of corporate responsibility corresponding to the acceptability criteria were compared with the tentative criteria, the analysis resulted in fairly similar valuations, and this showed that the tentative acceptability criteria were relatively broadly applicable, not only in Finland, where they had been formulated.

The comparison of the qualitative and quantitative results demonstrated that the Finnish, German and Portuguese interviewees were relatively logical in behaviour between the two methods. The comparison between the quantitative and qualitative analyses resulted in some inconsistencies in the Chinese opinions, however, in that the respondents appreciated financial-technical and social issues in industrial production, while they hardly mentioned environmental issues at all in the open interviews. On the basis of this, it can be concluded that the applicability of western concepts and methodologies is far from self-evident in either a business or research context when a totally different culture is involved.

The challenges were evident, but their total influence on the conclusions could not be estimated concretely. A cross-scientific, cross-methodological and cross-scientific research is always subjective, however. Thus, the cultural and other challenges can scarcely be said to detract from the value of the results.

Conclusions

The operating environments of multinational enterprises are changing and developing rapidly because of the expansion of these enterprises and the economic, social, cultural and environmental developments taking place in the societies concerned. Corporate (social) responsibility has become a popular concept in the strategic management of industries during the last ten to fifteen years. Many business concepts have been launched very rapidly, and it is therefore not surprising that the content of popular theoretical concepts is not always clear in industrial circles.

This study showed on the basis of these four substantially different cases that responsibility through the concept of acceptability is a local and regional phenomenon based on local and regional values. The acceptability of operations describes the current situation, and if the situation is thought to be good enough, this approach produces relatively little information on potential future challenges. One crucial observation was that, although the general acceptability of operations was relatively high in all cases covering issues related to the company's current performance, and also on issues of wider social responsibility, the higher the acceptability was, the more important was the economic and socioeconomic role of the production unit in society.

It can be concluded that the acceptability elements covered issues beyond the traditional dimensions of corporate social responsibility. Thus the acceptability of operations indicated comprehensive corporate responsibility. The application of comprehensive corporate responsibility approach in business context may have some positive implications for sustainability.

Acknowledgments

This paper summarises a few essential findings of my doctoral dissertation "The many faces of responsibility – Acceptability of the global pulp and paper industry in various societies", which is being refereed at the time of writing this paper. I wish to thank Professor Timo Pukkala of the University of Joensuu and Dr. Minna Halme of Helsinki School of Economics and Business Administration for their valuable comments and their support for this work. In addition, the help of Mr. Malcolm Hicks with the language editing has been essential to the finalisation of this paper. The doctoral thesis will be published online: http://www.metla.fi/dissertations.

References

Alasuutari, P. 1996. Researching culture. Qualitative method and cultural studies. Sage Publications. London. 208 p.

Alho, J. M., Kolehmainen, O., Leskinen, P. 2001. Regression methods for pairwise comparison data. In: Schmoldt, D., Kangas, J., Mendoza, G., Pesonen, M. (eds.). The analytic hierarchy process in natural resources and environmental decision making. Kluver Academic Publishers. Dordrect. 235-252.

Carroll, A. B. 1979. A three-dimensional conceptual model of corporate social performance. Academy of Management Review 4, 497-506.

Carroll, A. B. 1995. Stakeholder thinking in three models of management morality: a perspective with strategic implications. In: Näsi, J. (ed.). Understanding stakeholder thinking. Gummerus Kirjapaino Oy. Jyväskylä. 47-74.

Donaldson, T., & Preston, L. E. 1995. The stakeholder theory of the corporation: concepts, evidence, and implications. Academy of Management Review 20(1), 65-91.

Eskola, J. & Suoranta, J. 1998. Johdatus laadulliseen tutkimukseen. (In Finnish: Introduction to the qualitative research). Vastapaino. Tampere. 268 p.

Finnish Forest Industries Federation, Facts and figures,
http://english.forestindustries.fi/figures/ (accessed 23-May-2006).

Frederick, W. C. 1995. Values, nature, and culture in the American corporation. Oxford University Press. New York. 313 p.

Freeman, R. E. 1984. Strategic management. A stakeholder approach. Pitman Publishing Inc. London. 276 p.

Halme, M. 1997. Environmental management paradigm shifts in business enterprises. Doctoral dissertation. Acta Universitas Tamperensis 542. 233 p.

Hellström, E. 2001. Conflict Cultures – Qualitative Comparative Analysis of Environmental Conflicts in Forestry. Doctoral dissertation. Silva Fennica, Monographs 2. 109 p.

Korhonen, J. 2003. On the ethics of corporate social responsibility – considering the paradigm of industrial metabolism. Journal of Business Ethics 48, 301-315.

Luomanen, J. & Räsänen, P. 2002. Tietokoneavusteinen laadullinen analyysi ja QSR NVivo-ohjelmisto. (In Finnish: Computer supported qualitative analysis and QSR NVivo-programme). University of Turku, Department of Sociology, Sociological research A25. Turku. 183 p.

Mikkilä, M. 2003. Acceptability of operations as an indicator of corporate social performance. Business Ethics: A European Review 12(1), 78-87. http://www.blackwell-synergy.com/ (accessed 23-May-2006).

Mikkilä, M. 2005a. Observing corporate social performance empirically through the acceptability concept: a global study. Corporate Social Responsibility and Environmental Management 12, 183-196. http://www.interscience.wiley.com/ (accessed 23-May-2006).

Mikkilä, M. 2005b. Corporate responsibility in various cultural settings: an empirical study of the pulp and paper industry. Conference Proceedings, Business Strategy and Environment 2005 Conference. Leeds, UK, September 4-6, 2005. http://www.bseconference.org/downloads/mikkilae.pdf (accessed 23-May-2006).

Mikkilä, M. Kolehmainen, O. Pukkala, T. 2005. Multi-attribute assessment of acceptability of operations in the pulp and paper industries. Forest Policy and Economics 7, 227-243. http://www.sciencedirect.com/ (accessed 23-May-2006).

Miles, M. B. & Huberman, A. M. 1994. Qualitative data analysis. An expanded sourcebook. Sage Publications: Thousands Oaks-London-New Delhi. 338 p.

Mitchell, R.K., Agle, B.R. & Wood, D.J. 1997. Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. Academy of Management Review 22(4): 853-886.

Saaty, T. L. 1980. The Analytic Hierarchy Process. Planning, priority setting, resource allocation. McGraw-Hill, Inc. United States of America. 287 p.

Uimonen, A.-M. 1998. Nätti-Jussin uudet seikkailut, Suomalainen metsäteollisuus ympäristöpaineissa 1990-luvun Saksassa. In Finnish: Nätti-Jussi's new adventures, Finnish pulp and paper industries in environmental pressure in Germany in the 1990's. Licentiate dissertation. University of Jyväskylä. Publications No. 113/1998. 161 p.

UNCED. 1993. United Nations of Conference on Environment and Development, Rio de Janeiro, 3.-14. June 1992. Ympäristöministeriö, Ulkoministeriö. (Ministries of Environment and Foreign Affairs, Finland). 237 p.

Welford, R. 2002. Globalisation, corporate social responsibility and human rights. Corporate Social Responsibility and Environmental Management 9(1), 1-7.

Yin, R. K. 2003. Case study research. Design and methods. Applied social research methods services. Vol. 5. Sage Publication. London. 179 p.

A game theory approach to the Iranian forest industry raw material market

Soleiman Mohammadi Limaei and Peter Lohmander*

Abstract
Dynamic game theory is applied to analyze the timber market in northern Iran as a duopsony. The Nash equilibrium and the dynamic properties of the system based on marginal adjustments are determined. When timber is sold, the different mills use mixed strategies to give sealed bids. It is found that the decision probability combination of the different mills follow a special form of attractor and that centers should be expected to appear in unconstrained games. Since the probabilities of different strategies are always found in the interval [0,1], the boundaries of the feasible set are sometimes binding constraints. Then, the attractor becomes a constrained probability orbit. In the studied game, the probability that the Nash equilibrium will be reached is almost zero. The dynamic properties of timber prices derived via the duopsony game model are found also in the real empirical price series from the north of Iran.

Keywords: Iranian forest industry, game theory, Nash equilibrium, constrained probability orbit.

1. Introduction:
The forest sector is important to the economy in northern Iran. A rather small number of large mills dominate the industry in the region. The analysis in this paper is made with the ambition to describe the market structure and to analyze the dynamic properties of the market. The study also focuses on the theory of duopsony games. The dynamics of such games, in particular with conditions typical in the region, will be studied and compared to real empirical data series.

Hence, dynamic game theory will be applied to analyze the timber market in northern Iran as a duopsony.

When timber is sold, the different mills use mixed strategies to give sealed bids. The Nash equilibrium and the dynamic properties of the system based on marginal adjustments will be determined.

Game theory is a branch of mathematical analysis developed to study decision making in situations of conflict (and sometimes cooperation). Such situations exist when two or more decision makers (player) have different objectives, act on the same system or share the same resources. Game theory provides a mathematical process for selecting an optimal strategy (that is, an optimum decision or a sequence of decisions) in the face of an opponent who has a strategy of his own. In game theory, these assumptions are usually made:

Each player has two or more strategies or specific choices.

Different possible combinations of strategies available give different payoffs to the different players.

In some games the players have perfect information about the game. This is not always the case. In some games, the information is not perfect and symmetrical.

Game theory has applications in a variety of fields, including, operation research, economics, political sciences, military strategy, psychology and biology. It has close links with economics in that it seeks to find rational strategies in situations where the outcome

depends not only on one's own strategy and "market conditions", but upon the strategies chosen by other players with possibly different or overlapping goals.
Some typical market situations to be handled within this framework in economics are oligopolies and oligopsonies, in particular duopolies and duopsonies.

A game can be classified on the basis of several criteria. Depending on the number of players, we may have two-person, three –person or n-person games.
Depending on the payoff situation a game can be classified as either constant-sum or nonconstant-sum. A constant sum game can be classified as a zero-sum or non-zero-sum games.

In a zero-sum game the sum of payoffs at the end is zero since the amounts won or lost are equal. In such games, each player knows exactly how the other player is affected by different decision combinations as long as he knows how he is affected by the combinations himself. As an economic example of this, we may consider two firms in a duopolistic market that are striving to increase the number of customers. If the total number of customers is constrained, the number of customers won by one firm must be identical to the number of customers lost by the other.

In many real games, the information is incomplete. Player A does not know exactly how player B is affected by different decision combinations without a lot of special information concerning the (economic or maybe physical or biological) environment of player B. Most economic situations are non-zero-sum.
In many cases, it is necessary to calculate the optimal behaviour of each player for each possible position in the physical state space and speed vector and for each possible position, speed vector and decision of the other players. The problem is then solved recursively in the spirit of dynamic programming for every player conditional on the behaviour of all other players. In fact, in a two person difference game, if the decisions of player B or their probability distribution are known by player A and the decisions made by player B are not affected by the decisions made by player A, then player A may regard his optimization problem in the difference game as a common dynamic programming problem. This however, is a very special case where we do not really investigate game anymore. We then have a “game against Nature”. The dimensionality problem in dynamic programming is well known. In difference games, the dimensionality problem is much worse.

Then, what can be done?

If we accept low resolution in the state and time space and a low number of possible decisions (controls), then the difference games can often rapidly be solved. Furthermore we usually have to assume that the game is deterministic: Each player selects a pure position dependent strategy. If we let the players use randomized strategies, make different decisions with different probabilities in different situations, the computation time grows very rapidly.

One observation concerning the deterministic differential or difference game is that the outcome is known when the initial conditions are known.

In a deterministic differential game, each player knows exactly what to do and what the other players will do in every possible situation. There is really no need to play a game. For this reason we may say that we know the outcome of a game.

Of course in reality, the players do not know much enough or have time enough to calculate the optimal decisions in all possible positions. In real world conflicts, the technical properties of the equipment and the exact positions of the army units may not be known by the opponent. In other kinds of conflicts in a complicated society, the options available to the opponent are frequently very difficult to estimate.

In many real world games in economics, the physical and economic environment of the game problems changes rapidly and often unpredictably. One player may own a factory which produces a particular product. If the price of the product is high, this player may be very interested to buy a unit of some input factor. This input factor transaction may be a game in which the factory owner participates among other potential buyers. In this case, the factory owner highly valuates a decision combination which means that he can buy the input factor. One month later, the price of the product decreases dramatically. Again, the factory participates in a similar transaction game. This time he does not valuate a decision combination which makes him buy the input factor as highly as before. Since the economic environment unpredictably changes in this game, we can not expect that the players will select the same strategy for ever. Hence, we can not be sure that a player who estimates the probabilities of the other player's decisions via the frequencies in the complete historical decision observation series, and optimizes his strategy accordingly, will optimize his expected result in the changing environment.

In this paper, dynamic game theory is applied to Iranian forest industry. There are two sawmills firms actively involved in the timber market area of the game. A large number of forest companies and privately planted forests sell timber to these sawmills.

In each transaction, each sawmill (player) gives a sealed bid: A high or a low bid. Here the situation is a noncooperative game. Our first aim is to determine the optimal strategy and Nash equilibrium for each player.

2. Literature review:

Cournot (1838) presents a revolutionary contribution to the theory of non cooperative equilibria in oligopoly situations. von Stackelberg (1934 and 1938) is one of the persons who has contributed to game theory before the concept was established. In particular, he was interested in dynamic duopoly theory.

The mathematical theory of games was described by Neumann and Morgenstern (1944).

Nash (1950 and 1951) gave us the important concept "Nash equilibrium". In Nash equilibrium, no player has an incentive to deviate from the strategy chosen, since no player can choose a better strategy given the choices of the other players.

The Nash equilibrium has been very useful in most developments of game theory.

Brown and von Neumann (1950) discussed how to use differential equations in the solution of games. Robinson (1951) used an iteration method where each player sequentially estimated the probability distributions of the other players decisions and adapted the own decision probabilities optimally. Brown (1951) investigated a problem similar to the problem in Robinson (1951). Bellman (1953) continued the studies of iterative algorithms and so did von Neumann (1954).

Luce and Raffia (1957) studied many important game problems with mathematics and numerical methods.

Schelling (one of the winners of the price in economic sciences in memory of Alfred Nobel 2005) gave a good survey of the field strategy of conflict in 1960. Dresher (1961) stressed the time dimension and optimal decisions over time in connection to several games of conflict. Isaacs (1965) introduced the theory and several applications of differential games.

Selten (1975), Kalai and Smorodinsky (1975) and Rasmusen (1990) present a wide spectrum of game models from economics and related fields. Aumann and Hart (1992 and 1994) wrote a useful handbook of game theory with economic applications. (Aumann was the other winner of the price in economic sciences in memory of Alfred Nobel 2005). They dynamics of Cournot games has been studied by Flåm (1990), Flåm and Moxnes (1991) and Flåm and Zaccour (1991).

Lohmander (1994) studied the dynamics and non cooperative decisions in stochastic markets with pulp industry application. Lohmander (1997) contains a general investigation of the constrained probability orbit of mixed strategy games with marginal adjustment. A general two person non-zero sum game (with zero as a special case) is analyzed. A doupsony application where two sawmills are competing in the timber market is included and the dynamic properties of the system are determined.

Game theory has found new forest sector applications in recent years. Koskela and Ollikainen (1998) described a game-theoretic model of timber prices and the capital stock for the Finnish pulp and paper industry. Carter and Newman (1998) examined the impact of reservation prices on timber revenues from federal timber sale auctions in North Carolina from a game-theoretic perspective by recognizing the effect of competition on optimal bid strategies.

3. Cooperation or conflict in the timber market: A doupsony discussion.

Two sawmills buy timber from a large number of independent forest owners in an area. Every time a unit of timber is available, the forest owner receives sell bids from the potential buyers. Clearly, this is a case where the buyers as a group may benefit from cooperation and low bids. The extra profit obtained via the low timber price may then be distributed between the buyers in some way.

In some cases, the strongest sawmill (in the sense of ability to survive high timber prices), may prefer not to cooperate and to destroy the input market of other sawmill via high bids). This way, both sawmills loose profits during some time period and the strongest sawmill has the option to use his monopsony power and to increase his profits even more than before via low timber prices. The sawmill example contains two kinds of solutions:

In the cooperation case, way may expect the sawmills to calculate the timber price which maximizes the profit of the two sawmills as a group. Then they distribute the extra profit somehow within the group. Sometimes we may expect that the sawmills decide not only the timber price but also the distribution of the timber. The forest owners may not notice this cooperation directly. They may notice that all bids are low or that only one of the saw mills gives a bid on each unit of timber, or finally, that one sawmill gives a low bid and the other sawmill gives a very low bid on each timber unit. In the latest case, the very low bid is there just to hide the cooperation from the sellers. It does not affect the plan of buyers anyway.

In timber price fight case, the timber price bids are high until one of the buyers leaves the market. Then the bids instantly fall and the low price level remains until increased competition appears.

In a third case the buyers do not cooperate because they do not believe that other buyers will keep an agreement. Maybe they are also aware that the government will discover market cooperation and punish cartels. Hence, the buyers act according to the law and sometimes deliver sealed bids. (Some countries have such laws.)

When they decide to give a bid, they first have to inform themselves about the quality of the timber and other practical details. This activity is not costless. Then, they have to decide the level of the bid.

Of course, they can give a low bid and hope that the other sawmill will not give a higher bid. In that case they will buy the timber cheaply. If they have bad luck, the other sawmill buys the timber with a higher bid and the only economics consequence of the activity is the cost of the investigation.

On the other hand, they may give a high bid and hope that the other sawmill will give a lower bid. The probability of obtaining the timber is of course higher in this case, but the price is also higher.

This last version of the game is interesting in several ways and the methodology to be used in the analysis is not obvious. Each player has in the example two different possible decisions: A high (H) or a low (L) bid. The players are denoted A and B.

If the sum of the total profit made by the two players is zero (or a constant), it is obvious that no cooperation will appear. If the players know all the economic consequences for both players of all decision combinations exactly, then we can use the two person zero sum game theory.

The optimal strategies may turn out to be pure (only one decision) or mixed for each player where a mixed strategy means that different decision should be made with different probabilities.

In the sense that one sawmill has no (or very limited) information concerning the economic consequences in the other sawmill of different decision combinations, the obvious way for player A to deal with the problem is to observe and estimate the frequencies of the different decision taken by player B.

4. Timber price (Numerical data analysis):

Numerical data were collected from two forest companies in the north of Iran (Fig. 1). These companies are called Shafarod and Neka Chub.

They buy more than 70 percent of the timber in the region. We may call this a duopsony situation.

These companies rent some forests from the government. They harvest and manage these rented forests but they also buy the timber from other sources such as privately planted forests and forest companies. These companies produce different products in their own sawmills such as sawnwood, veneer, plywood, pulpwood, firewood and charcoal.

Now, we denote sawmills Shafarod and Neka Chub, A and B, respectively.

Figure. 1. The distribution of Iranian northern forests and two sawmills.

The real timber price series from the year 1990 until 2004 were collected from the two sawmills. Appendix A and Fig. 2 show these series. The differences of the real timber prices are shown in Fig. 3.

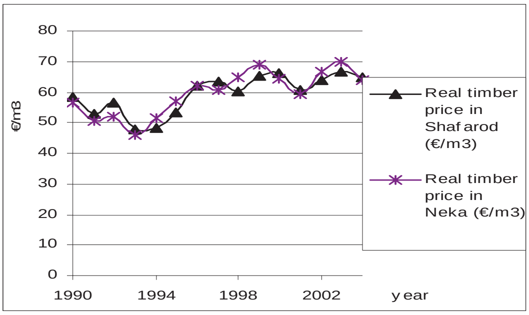


Figure. 2. Real timber prices in two sawmills in the north of Iran.

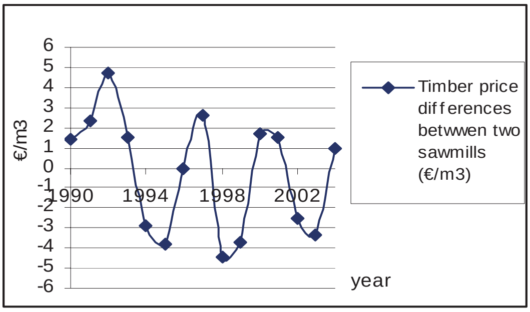


Figure. 3. The differences between real timber prices between two sawmills in the north of Iran.

As a start, we investigate the prices using autoregressive (AR) time series analysis. Timber prices are treated as stochastic and assumed to follow a first order Markov process. A Markov price expectation structure refers to any stochastic model in which price is conditional on previous prices. Current prices are known, but the future prices are uncertain. Fifteen years of timber price data were used to estimate the following model:

$P_{t+1} = \alpha + \beta P_t + \varepsilon_t$, where P_{t+1} is the expected price in period t+1, P_t is price in the current period and ε_t is the error term. ε_t is assumed to be independent identical distribution and Gaussian, with expected value 0 and standard deviation σ_{ε_t}.

The estimated parameters α, β are found below: (t statistics in parentheses).

Sawmill A:

$$P_{t+1} = 23.394 + 0.678 P_t + \varepsilon_t \qquad (1)$$

(1.727) (3.496) $\sigma_{\varepsilon_t} = 8.880.$

Sawmill B:

$$P_{t+1} = 23.915 + 0.667 P_t + \varepsilon_t \qquad (2)$$

(1.808) (3.518) $\sigma_{\varepsilon_t} = 8.422.$

The parameter estimates of the two first order AR price processes above indicate that prices are stationary. Nonstationary Martingale prices, on the other hand, have the property $P_{t+1} = P_t + \varepsilon_t$.

Detailed inspections of the results however show that the t-values of the constants are too low to give a statistically significant indication of stationarity at the 95% level.

Furthermore, the estimated first order AR processes do not give any information concerning possible dependence between the prices in the two sawmills. Hence, some alternative models would be interesting. As a start, we investigate the price difference.

The first order AR model for the timber price differences between the two sawmills, $\bar{P}_t = P_{t,A} - P_{t,B}$ is:

$$\overline{P}_{t+1} = 0.368 + 0.084\overline{P} + \varepsilon_t \tag{3}$$

(0.325) (0.273) $\sigma_{\varepsilon_t} = 4.231.$

Also the second order AR process for timber price differences was estimated:

$$\overline{P}_t = \alpha + \beta\overline{P}_{t-1} + \delta\overline{P}_{t-2} + \varepsilon_t \tag{4}$$

$$\overline{P}_t = -0.22369 - 0.01548\overline{P}_{t-1} - 0.30816\overline{P}_{t-2} + \varepsilon_t$$

(-0.1759) (-0.04678) (-0.93313) $\sigma_{\varepsilon_t} = 4.386796.$

We observe that the first and second order AR models of the price differences give very low t-values. Such models do not seem to capture the properties and possible dependencies of the prices very well. The price difference equilibrium of the price differences according the second order AR model can be calculated:

$\overline{P}_{eq} = \alpha + \beta\overline{P}_{eq} + \delta\overline{P}_{eq}$ or $(1-\beta-\delta)\overline{P}_{eq} = \alpha$

and $\overline{P}_{eq} = \dfrac{\alpha}{(1-\beta-\delta)}.$ (5)

Using the estimated parameter values, we get the equilibrium price $\overline{P}_{eq} = -0.1690€.$

So, if we use the second order process, even if it gives low t-values, it indicates that the expected long run difference between the prices in the two mills is very low. This is what we find also if we investigate the price differences shown in Fig.3.

Maybe we could get some interesting results if we estimate the prices of the two mills as a function of the earlier prices in both mills?

$$P_{A,t+1} = \alpha_A + \beta_A P_{A,t} + \beta_B P_{B,t} + \varepsilon_t \tag{6}$$

where

$$P_{A,t+1} = 16.148 - 0.177P_{A,t} - 0.952P_{B,t}$$

(1.249) (-0.283) (1.501) $\sigma_{\varepsilon_t} = 8.562.$

and

$$P_{B,t+1} = \alpha_B + \beta_B P_{B,t} + \beta_A P_{A,t} + \varepsilon_t \tag{7}$$

Where

$$P_{B,t+1} = 19.774 - 0.280\,P_{B,t} + 0.997P_{A,t} + \varepsilon_t$$

(1.470) (-0.431) (1.511) $\sigma_{\varepsilon_t} = 8.907.$

Again, we observe that the models give very low t-values. Some other approach is needed.

We may also run the following regressions:

$$dP_A = \alpha_1 + \alpha_2 P_A + \alpha_3 P_B + \varepsilon_{t,A} \quad (8)$$

Where dP_A is defined as $P_{A,t+1} - P_{A,t}$.

$$dP_B = \alpha_4 + \alpha_5 P_A + \alpha_6 P_B + \varepsilon_{t,B} \quad (9)$$

dP_B is $P_{B,t+1} - P_{B,t}$.

Table 1 shows the results of these regressions.

Table 1. Parameters based on the timber price data.

	α_1	α_2	α_3	α_4	α_4	α_6	$\varepsilon_{t,A}$	$\varepsilon_{t,B}$
Parameter value	16.148	0.952	-1.177	19.774	-0.003	-0.280		
Standard deviation	12.933	0.634	0.625	13.454	0.660	0.650	8.562	8.907
t- statistics	1.249	1.501	-1.883	1.470	-0.005	-0.431		

We conclude this section by the following observations:
The AR process estimations of different types gave low t-values. The two price processes seem to be stationary but no definite results were obtained this way. Hence, we will move over to a dynamic game theory approach and investigate if we can interpret the empirical findings that way.

5. Expected pay off and Nash equilibrium

The profit in one of the mills may be calculated by the following function:

$$\pi = -F + P_S V_S + P_P V_P - P_T V_T \quad (10)$$

Where π is the net profit, F is the fix production cost, P_T is the timber price, P_S is the net sawnwood price, P_P is the net pulpwood price V_S is the volume of sawnwood production, V_P is the volume of pulpwood production and V_T is the purchased timber volume.
Below, we ignored the fix cost, because it has the same effect in two sawmills.
We assume that from 1.2 m^3 timber it possible to produce 1 m^3 sawnwood and pulpwood (0.7 m^3 sawnwood and 0.3 m^3 pulpwood).

We may rewrite equation 10 like:

$$\pi = 0.7VP_S + 0.3VP_P - P_T 1.2V \quad (11)$$

Where V is the sum of sawnwood and pulpwood $(V = V_S + V_P)$.

Sawmill A has higher capacity than sawmill B. They are both located close to the forest, about 500 km away from each other. The independent forest harvesters and privately planted forests sell their timber to these two sawmills.
Here the situation is a non cooperative game. Each sawmill uses a mixed strategy and gives a high or a low bid. Compare Table 2.

We determine the elements of the profit (pay off) matrix this way:

In case the timber price is high:

$Ps = 110$ (€/m^3), $Pp = 20$ (€/m^3), $P_T = 65$(€/m^3), $V=1\ m^3$
If we substitute these values into equation 11, the profit is 5 €/ m3

In case the timber price is low:

$Ps = 110$ (€/m^3), $Pp = 20$ (€/m^3), $P_T =55$ (€/m^3), $V=1\ m^3$
By substituting these values into equation 11, the profit is 17 €/ m3.

Table. 2. The payoffs matrix for two sawmills.

	Low (Y)	High (1-Y)
Low (X)	$V_A = 126$ (1.) $V_B = 108$ $P_A = 55$ $P_B = 55$ $\pi_A = 1785$ (2.) $\pi_B = 1530$	$V_A = 120$ $V_B = 336$ $P_A = 55$ $P_B = 65$ $\pi_A = 1700$ $\pi_B = 1400$
High (1-X)	$V_A = 456$ $V_B = 84$ $P_A = 65$ $P_B = 55$ $\pi_A = 1900$ $\pi_B = 1190$	$V_A = 360$ $V_B = 300$ $P_A = 65$ $P_B = 65$ $\pi_A = 1500$ $\pi_B = 1250$

V is the timber volume (1000 m^3).
π is the net profit (1000 €).

Let us determine the Nash equilibrium:

The expected payoff of mill A is:

$$E_A = 17.85XY + 17X(1-Y) + 19Y(1-X) + 15(1-X)(1-Y) \quad (12)$$

$$E_A = 15 + 2X + 4Y - 3.15XY \quad (13)$$

$$\delta E_A / \delta X = 2 - 3.15Y = 0 \quad (14)$$

From this, we conclude that firm A has no reason to change X if Y = 0.634

The expected payoff of mill B is:

$$E_B = 15.3XY + 14X(1-Y) + 11.9Y(1-X) + 12.5(1-X)(1-Y) \tag{15}$$

$$E_B = 12.5 + 1.5X - 0.6Y + 1.9XY \tag{16}$$

$$\delta E_B / \delta Y = -0.6 + 1.9X = 0 \tag{17}$$

Hence, firm B has no reason to change Y if $X = 0.316$

The mixed Nash equilibrium is $(N_X, N_Y) = (0.316, 0.634)$

We may with the mixed Nash equilibrium values of N_X and N_Y, determine the expected payoffs of mills A and B: E_A = 1753708 € and E_B = 1313382 €

Hence, we realize that both mills expect to get these payoffs if both buy the timber according to the mixed Nash Equilibrium.

6. The dynamics of the mixed strategy game

As we mentioned, it is not likely that the managers of the two mills have complete information concerning the properties of the other mills. The costs and revenues of the competitor are not perfectly known. The mixed strategy frequencies are however observed. Now, we introduce the dynamic rules of the game:

Each mill continuously observes the frequencies of the other mills action.

The expected marginal profits, $\delta E_A / \delta X$ and $\delta E_B / \delta Y$ are calculated based on this information. In case the marginal profit of mill A is strictly positive (zero or strictly negative), mill A increases (leaves unchanged, decreases) X. In case the marginal profit of mill B is strictly positive (zero or strictly negative), mill B increases (leaves unchanged, decreases) Y. We assume that the speed of adjustment (of X and Y) is proportional to the expected marginal profits and that both mills A and B have the same relation between speed of adjustment and expected marginal profit.

We assume that $W_1$and W_2 are the speed of adjustment for mills A and B, respectively and W1=W2.

We may rewrite the Eq. (14) like:

$$\dot{X} = W_1(\delta E_A / \delta X) \tag{18}$$

or $\dot{X} = W_1(2 - 3.15Y)$ (19)

We can rewrite the Eq. (17) like,

$$\dot{Y} = W_2(\delta E_B / \delta Y) \tag{20}$$

or $\dot{Y} = W_2(-0.6 + 1.9X)$ (21)

The resulting mixed strategy trajectories are found in Fig. 4.

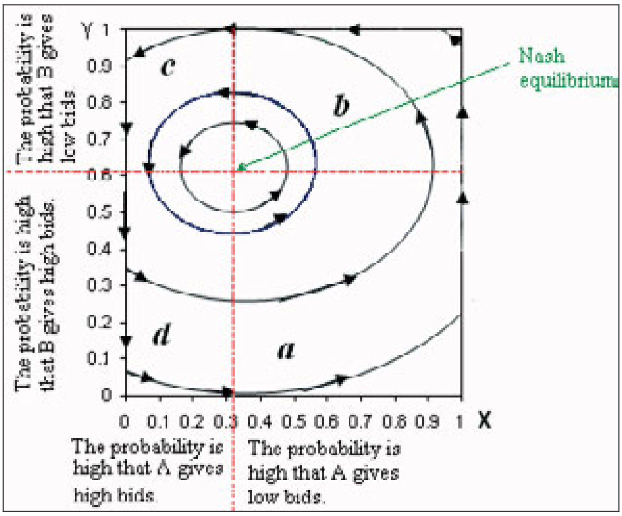


Figure. 4. The dynamics of the mixed strategy probabilities of the timber game.

We can make the following observations in Fig. 4.
The trajectories found in Fig.4 show possible time paths of the strategy combination (X, Y).

Region a:
X>0.316, Y<0.634. Sawmill A often gives a low bid, and sawmill B often gives a high bids. Since A frequently gives a low bid, B finds it profitable to increase the frequency of low, so he decides to give low bids more often and the system moves upwards and to the right and soon reaches the region b.
Region b:
X>0.316, Y>0.634.Both mills often give low bids.
A realizes that it profitable if he increases the frequency of high bids, so he gives high bids more often and the system moves upwards and to the left, reaching region c.

Region c:
X<0.316, Y>0.634. Sawmill A often gives high bids, and sawmill B often gives low bids.
B finds that it profitable to give high bid more often and the system moves down reaching region d.

Region d:
X<0.316, Y<0.634. B prefers frequently give high bids.

A finds that it profitable if he more often gives low bids. He decides to increase the frequency of low bids and the system is moved to the right reaching region a again.

7. Formal analysis of the dynamics

The aim is to show that the mixed strategy probabilities follow the trajectories in Fig. 4. The formal analysis of the differential equation system is found in the Appendix B.

$$\dot{X} = \alpha_1 + \beta_1 Y \qquad (22)$$

$$\dot{Y} = \alpha_2 + \beta_2 X \qquad (23)$$

The following assumptions are satisfied:

$(\beta_1\beta_2 < 0)$, $(\alpha_1\beta_1 < 0)$, $(\alpha_2\beta_2 < 0)$

The solution is:

$$X(t) = A_1 \cos(\theta\, t) + A_2 \sin(\theta\, t) + N_X \qquad (24)$$

$$Y(t) = A_3 \cos(\theta\, t) + A_4 \sin(\theta\, t) + N_Y \qquad (25)$$

(N_X, N_Y) is the Nash Equilibrium and $N_X = -\frac{\alpha_2}{\beta_2}$, $N_Y = -\frac{\alpha_1}{\beta_1}$.

$X(0) = X_0$

$Y(0) = Y_0$

$A_1 = X_0 + \frac{\alpha_2}{\beta_2}$, $A_2 = \frac{\beta_1 A_3}{\theta}$, $A_3 = Y_0 + \frac{\alpha_1}{\beta_1}$, $A_4 = \frac{\beta_2 A_1}{\theta}$, $\theta = \sqrt{-\beta_1\beta_2}$.

The trajectories X(t) and Y(t) are shown in Fig. 5 and 6.

(X(t), Y(t)) will follow an orbit around the Nash equilibrium (N_X, N_Y). This is called a center in the theory of dynamical systems.

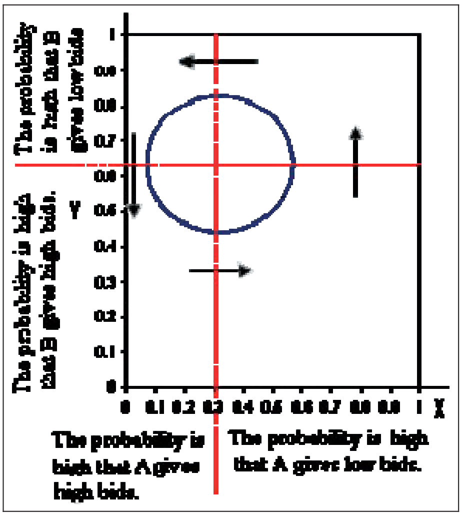


Figure. 5. The dynamics of the mixed strategy probabilities of the timber game for two players A and B.

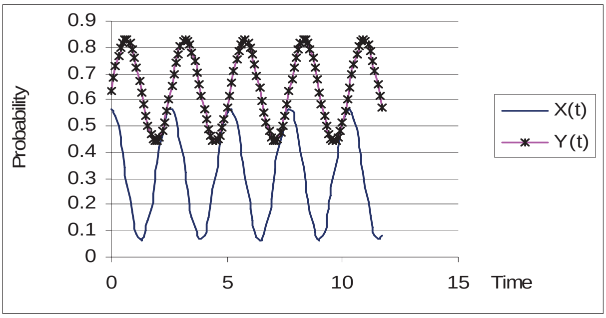


Figure. 6. The probability path of the mixed strategy timber game.

Now, we may determine the expected price, the expected profits and marginal profit for the two players. A simulation model programmed in Lingo found in Appendix C was used to determine these values. The results show the dynamics of the expected prices, the expected profits and the expected marginal profits for each player.

Fig. 7 shows how the expected price difference changes for two players when the high and low price offers are 55 and 65 €/m^3 respectively and $W_1=W_2=1$ for both players.

Now, it is time to recall the price differences in the real world, found in Fig. 3.

To obtain a price differences path similar to the empirical data found in Fig. 3, we consider a price difference of 15 €/m^3 between high and low bids and $W_1=W_2=1$ for both players. We assume that the Nash equilibrium is still the same as in the case with high and low prices of 65 €/m^3 and 55 €/m^3, respectively.

Now, however, we assume that, for different reasons, there are differences between the two areas where the two mills A and B are located. A high price is 4 €/m^3 higher in the area of mill B than in the area of mill A. this is quite reasonable since there may be all kinds of local reasons why the conditions are different. We do not have documented reasons for such possible differences in cost and revenue background data, however.

Now, we determine θ such that the period of the system fits the empirical data.

The period is 4 years according to the data found in Fig. 3. That means that $\frac{2\Pi}{4} = \theta$, which gives $\theta = 1.57$

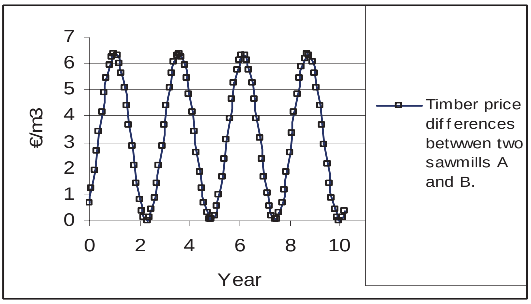


Figure. 7. The expected price difference path with the first game model version.

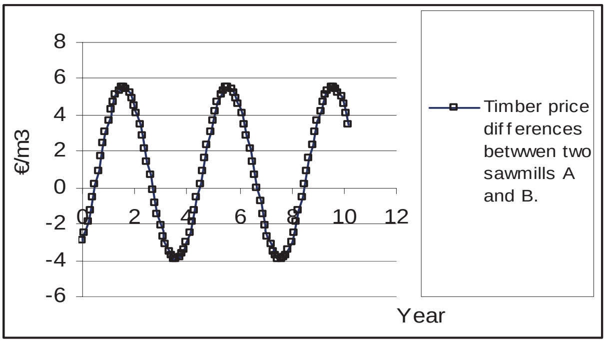


Figure. 8. The expected price difference path when the parameters have been adapted to fit the empirical price difference data.

8. Dynamic sensitivity analysis of the timber market game

Now, we will partially modify the initial Nash equilibrium to investigate the behavior of each sawmill under these new assumptions.

Case 1.
According to the duopsony game formulated above.
Equilibrium: $(N_X, N_Y) = (0.316, 0.634)$. Illustration: Fig. 4 and 5.
Case 2.
We assume that the equilibrium is $(N_X, N_Y) = (0.5, 0.5)$. In this situation, A and B will have equal probability to participate in the game with high or low bids.
Illustration: Fig. 9.

Case 3.
We assume that the equilibrium is $(N_X, N_Y) = (0.7, 0.3)$.
Compared to case 1, the probability that A gives high bids decreased and low bid increased. In this case the probability that B gives high bids increased and low bids decreased. Illustration: Fig. 10

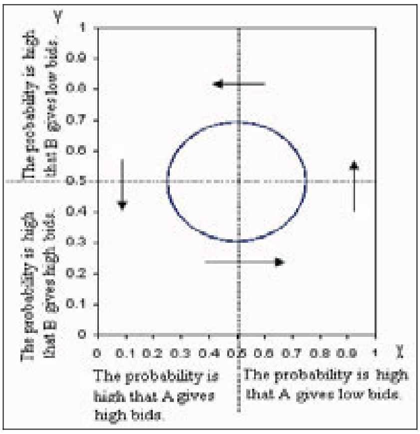


Figure. 9. The mixed strategies of timber game when the Nash equilibrium is $(N_X, N_Y) = (0.5, 0.5)$.

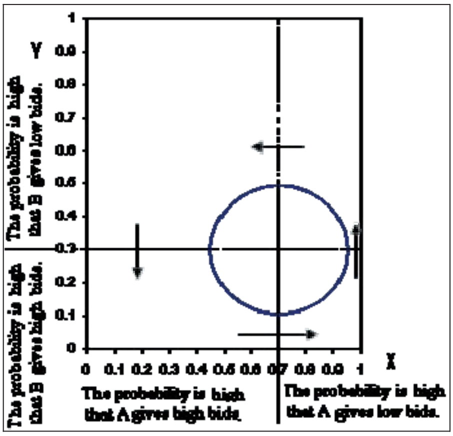


Fig. 10. The mixed strategies of timber game when the Nash equilibrium is $(N_X, N_Y) = (0.7, 0.3)$.

According to our investigation we may write the following observations:

Each player optimizes his expected payoff via a mixed strategy conditionally on the decision frequencies of the other player. In the mixed strategies, every decision should have a strictly positive probability.

The differential equation system governing the simultaneous optimal adjustments of the decision frequencies of the two players give cyclical solutions, sine and cosine functions.

The Nash equilibrium solution, $(N_X, N_Y) = (0.316, 0.634)$, will never be reached unless that happens to be the initial state of the system.

If the system follows a trajectory, an orbit or a center that passes through the four different regions without touching the boundary of the feasible area, then the system will follow this orbit for ever.

If the system follows a trajectory that somewhere touches the boundary of the feasible area, then the system will follow the boundary for some time. Finally the system will start to follow an attractor, a center, for ever. This attractor will be the largest center that can be constructed around the equilibrium, without touching the boundaries, which is consistent with the unconstrained differential equations. Note that most of the small circles in Fig. 4 have been trapped for ever in the respective attractors.

Conclusion

In this paper, a dynamic two person, non - zero sum game was applied in a duopsony situation in the timber market in the northern part of Iran where most of the industrial forests are located. The trajectories of the decision probability combination were investigated. It was found that a large number of initial conditions make the decision probability combination follow a special form of attractor and that centers can be expected to appear in typical games. The probability that the Nash equilibrium will be reached is almost zero.

Real world games are complicated. Hopefully, the reader has found the analysis in this paper to be a step in the right direction. When we find a game in reality where the players use mixed strategies and change the frequencies over time, we have an indication that the present theory is relevant. The properties of the empirical observations, found in Fig. 3, should be expected if our game model is relevant.

In Fig.7, the corresponding model results are shown. Our interpretation is that the game model results closely match the real world data. Since we have not found any other model that gives more realistic results, we conclude that our game approach may be the best choice.

Appendices:

Appendix A. Real timber purchase price in two sawmills in north of Iran during 1990 to 2004.

year	Timber price in Shafarod (€/m3)	Timber price in Neka Chub (€/m3)	Consumer Price index in Iran	Real timber price in Shafarod (€/m3)	Real timber price in Neka Chub (€/m3)	Timber price differences between two sawmills (€/m3)
1990	4.2	4	18.6	59.61	56.77	2.84
1991	4.5	4.3	22.4	53.03	50.67	2.36
1992	6	5.5	27.9	56.77	52.041	4.73
1993	6.6	7	34.3	50.79	53.87	-3.08
1994	9	10	46.3	51.31	57.01	-5.70
1995	14	15	69.2	53.41	57.22	-3.82

1996	27	26	85.2	83.66	80.56	3.10
1997	29	27	100	76.56	71.28	5.28
1998	34	36	118.1	76.00	80.47	-4.47
1999	42	40	141.8	78.19	74.47	3.72
2000	48	50	159.7	79.348	82.65	-3.31
2001	56	58	177.9	83.10	86.07	-2.97
2002	61	60	206	78.17	76.89	1.28
2003	65	63	238.2	72.04	69.82	2.22
2004	70	64	264	70	64	6.00

Appendix B:

Formal analysis of the dynamics:

$\dot{X} = \alpha_1 + \beta_1 Y$ (1)

$\dot{Y} = \alpha_2 + \beta_2 X$ (2)

We assume $(\beta_1\beta_2 < 0)$, $(\alpha_1\beta_1 < 0)$, $(\alpha_2\beta_2 < 0)$.

$\ddot{X} = \beta_1 \dot{Y}$

$\ddot{X} = \beta_1(\alpha_2 + \beta_2 X)$

$\ddot{X} = \beta_1\alpha_2 + \beta_1\beta_2 X$ and $\ddot{X} - \beta_1\beta_2 X = \beta_1\alpha_2$ (3)

In general form we have $\ddot{X}$ + aX-b = 0 where a = -$\beta_1\beta_2$ and b=$\beta_1\alpha_2$

Homogenous solution of equation (3):

$\dot{X} + aX = 0$ (4)

Let X(t)=Ae^{Lt}

$\dot{X}$ =LAe^{Lt}

and

$\ddot{X}$ = L^{2}Ae^{Lt}

Ae^{Lt} (L^2 + a)=0

L=$\pm\sqrt{\beta_1\beta_2}$; i=$\sqrt{-1}$

then L=$\pm\sqrt{-\beta_1\beta_2}$ i (5)

Particular solution of equation (3):

X(t)=m+nt.

$\dot{X}$ =n and $\ddot{X}$ =0 By using this results in equation (4), we get:

0+a (m+nt)=b

n=0 then am=b and m= $\frac{b}{a}$ so we get m= $\frac{+\beta_1\alpha_2}{-\beta_1\beta_2}$ or m= $-\frac{\alpha_2}{\beta_2}$

As a consequence, we have X(t)= $Ae^{\pm\sqrt{-\beta_1\beta_2}\, it} + (-\frac{\alpha_2}{\beta_2})$

Hence,

$$X(t) = e^{0t}(A_1 \cos(\sqrt{-\beta_1\beta_2}\, t) + A_2 \sin(\sqrt{-\beta_1\beta_2}\, t) - \frac{\alpha_2}{\beta_2}$$

or $$X(t) = A_1 \cos(\sqrt{-\beta_1\beta_2}\, t) + A_2 \sin(\sqrt{-\beta_1\beta_2}\, t) - \frac{\alpha_2}{\beta_2} \quad (6)$$

$$\ddot{Y} = \beta_2 \dot{X} \quad (7)$$

By substituting equation (2) in equation (7) we get:

$\ddot{Y} = \beta_2(\alpha_1 + \beta_1 Y)$

$\ddot{Y} = \beta_2\alpha_1 + \beta_1\beta_2 Y$

$\ddot{Y} - \beta_1\beta_2 Y = \beta_2\alpha_1$

Finally we get this solution:

$$Y(t) = A_3 \cos(\sqrt{-\beta_1\beta_2}\, t) + A_4 \sin(\sqrt{-\beta_1\beta_2}\, t) - \frac{\alpha_1}{\beta 1} \quad (8)$$

We define θ as $\sqrt{-\beta_1\beta_2}$.

We rewrite equations (6) and (8) like this:

$$X(t) = A_1 \cos(\theta\, t) + A_2 \sin(\theta\, t) - \frac{\alpha_2}{\beta_2} \quad (10)$$

$$Y(t) = A_3 \cos(\theta\, t) + A_4 \sin(\theta\, t) - \frac{\alpha_1}{\beta 1} \quad (11)$$

The first order derivatives of these equations are:

$$\dot{X} = -A_1\theta \sin(\theta t) + A_2\theta \cos(\theta t) \quad (12)$$

$$\dot{Y} = -A_3\theta \sin(\theta t) + A_4\theta \cos(\theta t) \quad (13)$$

If we substitute equations (10) and (11) into equations (1) and (2), we have:

$$\dot{X} = \alpha_1 + \beta_1(A_3 \cos(\theta\, t) + A_4 \sin(\theta\, t) - \frac{\alpha_1}{\beta 1}) \quad (14)$$

$$\dot{Y} = \alpha_2 + \beta_2(A_1 \cos(\theta\, t) + A_2 \sin(\theta\, t) - \frac{\alpha_2}{\beta_2}) \quad (15)$$

After simplifying, we get:

$$\dot{X} = \beta_1 A_3 \cos(\theta t) + \beta_1 A_4 \sin(\theta t) \quad (16)$$

$$\dot{Y} = \beta_2 A_1 \cos(\theta t) + \beta_2 A_2 \sin(\theta t) \quad (17)$$

From equations (12, 13) and (16, 17) we get the following equalities:

$$\begin{cases} \begin{cases} -A_1\theta = \beta_1 A_4 \\ A_2\theta = \beta_1 A_3 \end{cases} \\ \begin{cases} -A_3\theta = \beta_2 A_2 \\ A_4\theta = \beta_2 A_1 \end{cases} \end{cases} \quad (18)$$

From equation (18), we get:

$\frac{A_1}{A_2} = -\frac{A_4}{A_3}$, $\frac{A_3}{A_4} = -\frac{A_2}{A_1}$, $A_2 = \frac{\beta_1 A_3}{\theta}$, $A_3 = \frac{A_2\theta}{\beta_1}$, $A_4 = \frac{\beta_2 A_1}{\theta}$ (19) Consequently, the following equations can be written:

$$\begin{cases} X(t) = A_1\cos(\theta t) + A_2\sin(\theta t) - \frac{\alpha_2}{\beta_2} \\ Y(t) = (-\frac{\beta_2 A_2}{\theta})\cos(\theta t) + (\frac{\beta_2 A_1}{\theta})\sin(\theta t) - \frac{\alpha_1}{\beta_1} \end{cases} \quad (20)$$

or

$$\begin{cases} X(t) = A_1\cos(\theta t) + (\frac{\beta_1 A_3}{\theta})\sin(\theta t) - \frac{\alpha_2}{\beta_2} \\ Y(t) = A_3\cos(\theta t) + (\frac{\beta_2 A_1}{\theta})\sin(\theta t) - \frac{\alpha_1}{\beta_1} \end{cases} \quad (21)$$

Then:

$X(0) = A_1 - \frac{\alpha_2}{\beta_2} \Rightarrow A_1 = X(0) + \frac{\alpha_2}{\beta_2}$

$Y(0) = A_3 - \frac{\alpha_1}{\beta_1} \Rightarrow A_3 = Y(0) + \frac{\alpha_1}{\beta_1}$.

The Nash Equilibrium values for X and Y are $N_X = -\frac{\alpha_2}{\beta_2}$, $N_Y = -\frac{\alpha_1}{\beta_1}$, respectively.

Appendix C.The Lingo code is found below.

```
Model:
sets:
time/1..60/:x,y,EA, EAd, EB, EBd,MA, MB, EPA, EPB, EPDIFF;
endsets
! Speed of adjustment coefficients;
wA = 0.005;
wB = 0.005;
```

```
step = 0.1;
! Initial conditions;
x(1) = 0.35;
y(1) = 0.50;
! Parameters;
PAM = 60;
PAD = 5;
PBM = 60;
PBD = 5;
SSawnw = 0.7;
Spulpw = 1-SSawnw;
Use = 1.2;
PSawnw = 110;
PPulpw = 20;
! Calculations of profit per cubic metre finished;
ProfPm3A_LOW = SSawnw*PSawnw + SPulpw*PPulpw - Use*(PAM-PAD);
ProfPm3A_HIGH = SSawnw*PSawnw + SPulpw*PPulpw - Use*(PAM+PAD);
ProfPm3B_LOW = SSawnw*PSawnw + SPulpw*PPulpw - Use*(PBM-PBD);
ProfPm3B_HIGH = SSawnw*PSawnw + SPulpw*PPulpw - Use*(PBM+PBD);
! Volume calculations;
VolA_Alow_Blow = 105*Use;
VolB_Alow_Blow = 90*Use;
VolA_Alow_Bhigh = 100*Use;
VolB_Alow_Bhigh = 280*Use;
VolA_Ahigh_Blow = 380*Use;
VolB_Ahigh_Blow = 70*Use;
VolA_Ahigh_Bhigh = 300*Use;
VolB_Ahigh_Bhigh = 250*Use;
! Profit calculations;
ProfA_ll = ProfPm3A_LOW*VolA_Alow_Blow/Use ;
ProfA_lh = ProfPm3A_LOW*VolA_Alow_Bhigh/Use ;
ProfA_hl = ProfPm3A_HIGH*VolA_Ahigh_Blow/Use ;
ProfA_hh = ProfPm3A_HIGH*VolA_Ahigh_Bhigh/Use ;
ProfB_ll = ProfPm3B_LOW*VolB_Alow_Blow/Use ;
ProfB_lh = ProfPm3B_HIGH*VolB_Alow_Bhigh/Use ;
ProfB_hl = ProfPm3B_LOW*VolB_Ahigh_Blow/Use ;
ProfB_hh = ProfPm3B_HIGH*VolB_Ahigh_Bhigh/Use ;
! Simulation of the system;
! The expected profits per period for players A and B are denoted EA and EB;
 EA(1) = 0;
 @FOR( time(t) | t#GT#1: EA(t) = ProfA_ll*x(t-1)*y(t-1)          +
                          ProfA_lh*x(t-1)*(1-y(t-1))      +
                          ProfA_hl*(1-x(t-1))*y(t-1)      +
                          ProfA_hh*(1-x(t-1))*(1-y(t-1)) ) ;
 EB(1) = 0;
 @FOR( time(t) | t#GT#1: EB(t) = ProfB_ll*x(t-1)*y(t-1)          +
                          ProfB_lh*x(t-1)*(1-y(t-1))      +
                          ProfB_hl*(1-x(t-1))*y(t-1)      +
                          ProfB_hh*(1-x(t-1))*(1-y(t-1)) ) ;
! The expected profits per period for players A and B are changed by
```

```
 EAd and EBd if X or Y are increased by 0.001;
d = 0.001;
 EAd(1) = 0;
 @FOR( time(t) | t#GT#1: EAd(t) = ProfA_ll*(x(t-1)+d)*y(t-1)          +
                        ProfA_lh*(x(t-1)+d)*(1-y(t-1))       +
                        ProfA_hl*(1-x(t-1)-d)*y(t-1)         +
                        ProfA_hh*(1-x(t-1)-d)*(1-y(t-1)) )    ;
 EBd(1) = 0;
 @FOR( time(t) | t#GT#1: EBd(t) = ProfB_ll*x(t-1)*(y(t-1)+d)          +
                        ProfB_lh*x(t-1)*(1-y(t-1)-d)         +
                        ProfB_hl*(1-x(t-1))*(y(t-1)+d)       +
                        ProfB_hh*(1-x(t-1))*(1-y(t-1)-d)  )  ;
! The marginal expected profits per period for players A and B are
  MA and MB if X or Y are increased;
@FOR( time(t) | t#GT#1: MA(t) = (EAd(t) - EA(t))/d );
 @FOR( time(t) | t#GT#1: MB(t) = (EBd(t) - EB(t))/d );
@for(time(t): @FREE(MA(t)));
@for(time(t): @FREE(MB(t)));
! Now, X and Y are increased (or decreased) in case MA and MB are positive (negative);
 @FOR( time(t) | t#GT#1: X(t) = X(t-1) + MA(t)*wA*step  );
 @FOR( time(t) | t#GT#1: Y(t) = Y(t-1) + MB(t)*wB*step  );
! The expected prices of A and B and the expected price difference are calculated;
@FOR( time(t) | t#GT#1: EPA(t) = (PAM-PAD)*x(t) + (PAM+PAD)*(1-x(t))    );
@FOR( time(t) | t#GT#1: EPB(t) = (PBM-PBD)*y(t) + (PBM+PBD)*(1-y(t))    );
@FOR( time(t) | t#GT#1: EPDIFF(t) = EPA(t)-EPB(t)                       );
@for(time(t): @FREE(EPDIFF(t)));
END
```

References

Aumann, R. J., Hart, S.1992. Handbook of Game Theory with Economic Applications. Amsterdam, North-Holland, Vol. 1.

Bellman, R. 1953. On a new iterative algorithm for finding the solutions of games and linear programming problems. Research Memorandum P-473, The RAND Corporation, Santa Monica.

Brown, G.W. 1951. Iterative solutions of games by fictions play, in koopmans, T.C. (editor), Activity Analysis of Production and Allocation, (proceeding), Cowles commission Monograph 13, Wiley, New York.

Brown, G.W. and von Neumann, J. 1950. Solution of a game by differential equations," in Kuhn, H.W., Tucker, A.W. (editors), contributions to the theory of games, I, Annals of Mathematics Studies, Vol. 24, Princeton University Press, Princeton.

Carter, D. R., Newman, D. H. 1998. The impact of reserve prices in sealed bid federal timber sale auctions, Forest Science, Vol. 44, No.4, 485-495.

Cournot, A.A. 1938. Recherches sur les principes mathe matiques de la theorie des Richesses. M. Riviere and Cie. Paris.
Researches into the mathematical principles of wealth (english translation). A. M. Kelly, New York. 1960.

Dresher, M. 1961. Games of strategy, theory and applications. Prentice-Hall.

Flåm, S. D. 1990. Solving non-cooperative game by continuous subgradient projection Methods. Dept of Economics, University of Bergen, Norway.

Flåm, S. D., Moxnes, E. 1991. Til minne om Cournot. Dept. Of Economics, University of Bergen, Norway.
Flåm, S. D., Zaccour, G. 1991. Stochastic games, event-adapted equilibria and their Computation. Dept. Of Economics, University of Bergen, Norway.
Isaacs, R. 1965. Differential games, A mathematical theory with applications to warfare and pursuit, control and optimization. Wiley.
Kalai, E., Smorodinsky. M.1975. Other Solutions to Nash's Bargaining Problem. Econometrica Vol. 43, 513-518.
Koskela, E., Ollikainen, M. 1998. A game-theoretic model of timber prices with capital stock: an empirical application to the Finnish pulp and paper industry. Canadian Journal of Forest Research, Vol. 28, No, 10.
Lohmander, P. 1994. Expansion dynamics and noncooperative decisions in stochastic markets: - Theory and pulp industry application, in: Helles, F., Linddal, M. (editors). Scandinavian Forest Economics, Proceedings from the Scandinavian Society of Forest Economics, Denmark, No. 35.
Lohmander, P. 1997. The constrained probability orbit of mixed strategy games with marginal adjustment: General theory and timber market application. System Analysis - Modelling - Simulation, Vol. 29.
Luce, R.D., Raffia, H. 1957. Games and decisions, Introduction and critical Survey. Wiley.
Maynard, S.J. 1982. Evolution and the theory of games. Cambridge University Press.
Nash, J.F. 1950a. Equilibrium points in n-person games. Proceedings of the National Academy of Sciences, January, USA.
Nash, J.F. 1950b. The bargaining problem, Econometrica. 18. USA.
Nash, J.F. 1951. Non- cooperative games. Annals of Mathematics, Vol. 54, No.2. USA.
Nash, J.F. 1953. Two-person cooperative games, Econometrica, Vol. 21. USA.
Neumann, J., O. Morgenstern 1944. *The Theory of Games and Economic Behavior.* Princeton University Press, 2nd edition.
Robinson, J. 1951. An iterative method of solving a game. Annals of mathematics, Vol. 54.
Schelling, T. 1960. Strategy of conflict. Harvard University Press.
Selten, R. 1975. Reexamination of the perfectness concept for equilibrium points in extensive games. International Journal of Game Theory Vol. 4, 25-55.
von Neumann, J. 1951. An iterative method of solving a game, Annals of Mathematics Vol. 54.
von Neumann, J. 1954. A numerical method to determine optimum strategy. Naval Research Logistic Quarterly, Vol. 1.
von Neumann, J., Morgenstern, O. 1944. Theory of games and economic behaviour. Princeton.
von Stackelberg, H. 1934. Marketform und gleichgewicht. Wien.
von Stackelberg, H. 1938. Probleme der unvollkommenen konkurens. WeltwirtschaftlischesArkiv. Vol. 48.

Towards national ownership in forestry sector development? possibilities and constrains of forestry sector support

Irmeli Mustalahti, Tomi Tuomasjukka and Anniina Kostilainen*

Abstract
The current international development co-operation aims to build sector wide approach programmes (SWAPs), programme based co-operation through budget support and joint financing arrangements with other donors in order to enhance recipient governments' ownership. In this paper we aim to clarify the shift from project approach towards SWAPs in forestry sector. We argue that forestry SWAPs can take place in countries where there are clear sector policies and development strategies for forestry, government and donor's commitment to support the forestry sector and willingness to harmonise the donor support. It is important to acknowledge that to develop SWAPs in the forestry sector is a long-term process that is related to other reforms and policy changes in each specific country. The whole process of developing a SWAP is complicated and highly dependent on the development of the quality of government systems and an adequate institutional capacity of forestry sector. Also, we have recognised that there is an emerging understanding among the stakeholders that the key factors influencing to the management of forests lay outside of the forest sector. The complexity of the forest sector, and rural development in general, need to be tackled and supported in different ways. The current paper gives examples of Finnish supported forestry development programmes and the purpose of the paper is to discuss the possibilities and barriers of the allocation of the support to forest sector under the partner countries' own national development frameworks for forestry.

Keywords: Forestry sector, sector wide approach, poverty reduction, donor countries, recipient countries, National Forest Programmes

Introduction

Donor countries along with recipient countries, all together 190 countries, have committed itself to the United Nation's Millennium Development Goals (MDGs), adopted in the UN General Assembly of 2000. The eight MDGs aim to reduce poverty, build up global partnerships and to create an environment favourable to development.

Forests are directly linked to national economic potential and to a wealth of social and environmental benefits of local, national and global importance. Sustainable forest management in developing countries can contribute improvement the various dimensions of poverty: It provides income generation and work places; poorest households rely on forests for their subsistence; forests provide low-cost energy; and forest resources ownership and management generate rural development and increase governance skill of local people (FAO 2001). Actions that aim at improving the living conditions in the rural areas of developing countries contribute significantly to reaching the MDGs, since three quarters of the poor of the world live in rural areas.

Emphasis of poverty reduction aims also greater aid harmonisation and donor co-ordination to ensure effective aid delivery. Delivering the aid to the partner countries in an effective way requires tools. Direct budget support (DBS) and sector wide approach programmes (SWAPs) are the two mechanisms proposed for achieving greater aid effectiveness. The SWAPs are based on processes called sector approaches. The Guidelines for EC (2003) support to sector programmes define the three common objectives of sector approaches as follows: To broaden ownership by partner Governments; to increase the coherence between sectoral policy, spending and results; and to minimise the transaction costs associated with the provision of external funding.

The IMF, the World Bank, and other major donors engage differently in these new management structures of assistance depending on the recipient governments' institutional and financial structures. For example in Tanzania Denmark, Finland, the World Bank, has more focused on the common basket while the EU, the United Kingdom, Sweden, has taken the form of direct budget support. Netherlands, Norway and Switzerland use both common basket and budget support according to their purposes. The United States, Germany, Japan and the UNDP, and have limited participation in the common basket and budget support. The each donor country proceeds with its development assistance in accordance with its own development policy in a framework where various assistance modalities are flexibly adopted.

The SWAPs in forestry as a mechanism for forestry development aims to co-ordinate donor support under the country's own national development framework, such as National Forest Policy and Poverty Reduction Strategy (PRS). In the past, development co-operation has been based on projects, which often followed expectations of the donor.

The projects have either not had common goals or common ways of implementation. The strategies behind projects have varied, often leading to a situation where some areas of the sector have been covered with overlap while some others have been left untouched. Working through various separate projects can easily lead to a situation where the complexity of the situation of the whole sector is not understood.

The shift from the current project-based modality towards a clear sector wide approach programme should be seen in light of the complexity of conditions in each country. The environment for cooperation varies in partner countries, this is a factor that must be taken into consideration. (White and Mustalahti 2005)

The purpose of this paper is to discuss the possibilities and some of the critical barriers on the way towards sector wide programmes in forestry. This paper is based on literature review1 and open discussions and interviews with stakeholders in Finland and Finland's partner countries. Our method is comparative and this paper seeks to provide an analysis of current development of SWAPs in forestry sector.

Important background information for the current paper has also been the results of the Evaluation of Finnish Forest Sector Development Co-operation (2003). Also we have discussed with consulting companies, authorities at Ministry for Foreign Affairs of Finland, current- and ex-project team members from different Finnish supported forestry projects. However, this document should not be interpreted as the only truth and answer on the way forward in forestry co-operation. Rather it gives themes for discussion and also some recommendations as seen by the authors.

Development of Sector Wide Approach

The sector wide approach programmes (SWAPs) and direct budget support (DBS) seek to take the interests of both recipient government and donors into consideration, while providing more effective support at sector level. DBS as a funding mechanism can be defined as a step forward from SWAPs. While SWAPs gather both donors and the partner government together to plan the sector funding, DBS functions as a more self-governing support under the recipient government's budget. In this paper we discuss mainly SWAPs in the forestry sector

1 Mustalahti, I., Kostilainen, A., Tuomasjukka, T., and Siltanen, M. 2004. Forestry Development Cooperation. Towards national ownership in forestry sector development. Impact Consulting Ltd. for the Ministry for Foreign Affairs of Finland. 50 p.

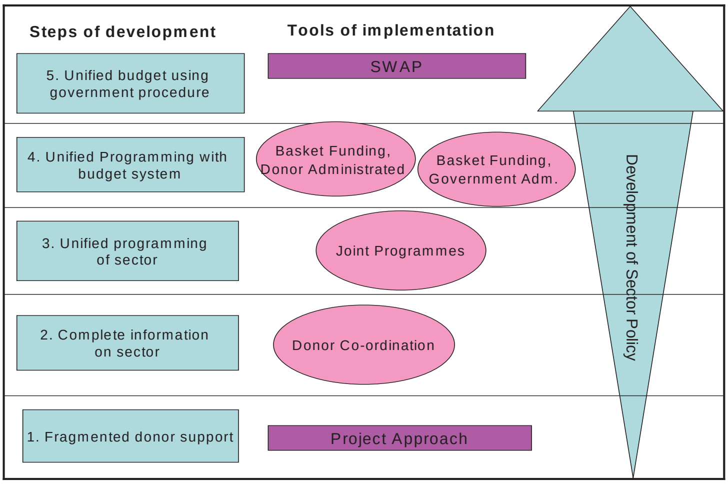


Figure 1. From project approach towards sector wide approach programmes (SWAPs)2

The process of shifting from a project approach to SWAPs is long and complicated. It needs to be planned according to the requirements of each specific country. In figure 1 we try to illustrate how a unified planning and resource allocation system is built up step by step. The EC Guidelines for Sector Support Programme use a similar figure to illustrate the transition from fragmented to unified procedures within a sector approach. Clearly, figure 1 is a schematic presentation and an oversimplification, which assumes that the process towards a full-fledged SWAP is linear, which probably is not always the case. However, it aims to help the understanding of the process.

At sector level, partnerships between the government and development agencies aims to improve the effectiveness of development policies and broaden government ownership over public sector policy and allocation of resources. The ownership of the developing country is vital for the success of a development. The developing country needs to be committed to supporting and developing the sector. The donors can, and do have a marked influence on negotiation process in the preparation of the sector programme, but respect for national sovereignty in the process is important.

It is important to recognise that SWAPs are not simply mechanisms for allocating donor funds. According to Gould et al 1998 ideally the SWAPs could include the following features:

A program-aid approach; funding is not organised via bilateral projects run by individual donors, but collective funding of an overall programme, implemented by the partner government in form of programme components;

An attempt, through a dialogue based on ‘partnership’, to harmonise the policies and procedures of aid provision;

A long-term ‘evolutionary’ processes with protracted negotiation and continual monitoring by stakeholders;

The recipient is in the proverbial “driver’s seat”

These elements are rather interesting, particularly when compared against the concept of National Forest Programmes (NFPs). We argue that development towards a SWAP in forest sector is most likely to take place in countries where there are clear sector policies and

---

2 European Commission. 2003. Guidelines for European Commission Support to Sector Programmes. Version 1.0. Accessed 10.1.2006 from http://global.finland.fi/koyhyys/aineisto/EU_SPSP.pdf

development strategies for forestry. The NFPs can be seen as a way forward towards clear sector policy and better management structures (Wencelius 2003). Other necessary elements obviously are government and donor's commitment to support the forestry sector and willingness to harmonise the donor support.

The NFP provides a comprehensive framework for managing forests in a sustainable manner by all stakeholders (Geller and Owino 2002). Several countries have recognised that their policies and institutions need to be reformed in order to develop the right conditions for sustainable forest management and rural development (Oksanen et al 2003). For example in Tanzanian NFP document recognises the need for the NFP in order to increase the forest sector's political priority and political commitment to forestry. In international discussion the Tanzania NFP works often as an example of the NFP's. The NFP model in Tanzania is based on four implementation programmes: 1) Forest Resources Conservation and Management Programme, 2) Institutions and Human Resources Programme, 3) Legal and Regulatory Framework Programme, and 4) Forestry Based Industries and Sustainable Livelihoods Programme.

Discussion

In theory, a sector wide approach promotes the effective delivery of aid and reduces the cost of aid management, and so doing increases funds that can be allocated to activities with impacts on the field under the government own development framework. In practice, the new sector wide approach processes might take several years to begin producing real, concrete results. Importance of supporting the policy development and building up the central government structures should not be underestimated. However, the support to central governments should not be the way to eyewash the real recipients of aid and aims to deliver the aid. The lower levels of government administration and local people in rural areas should also be taken into account. The majority of forestry activities are implemented in rural areas, often very remote from capital cities. In these areas there are many limiting factors but especially management of allocated financial resources can form a "bottle neck".

In Vietnam, between 2004 and 2006, efforts have been ongoing to prepare a new National Forest Strategy (NFS) to cover the period 2006-2020. Hopefully, the NFS could give a frame for government effort to develop the sector in national wide. In 2006 the Joint Review Mission of the Trust Fund for Forsts (TFF) regocnised that thus far it has been very difficult to build up a harmonised system to support government-led plans and there has been little progress towards the objective of introducing a SWAP approach. And it seems that government has not taken a lead to coordinate aid to the sector and develop mechanism to allocate funds to provincial, district and village level activities through unified planning, budgeting disbursement and accounting systems.

In Vietnam, there exists a coordination office for on-going efforts to develop the Forest Sector Support Programme. The programme was broadened in 2001 to become the Forest Sector Support Program and Partnership (FSSP&P), which has a basket fund under so called Forest Trust Fund. However, these funds have up to now been used for supporting short term projects or studies which are not integrated to the government plans and budgeting.

The unified programming has become a step forward when the common pool arrangement is established, thus unifying the accounting and disbursement systems for external financial activities, while continuing to operate in parallel with the government budgetary and accounting systems. This would already significantly reduce the transaction costs of multiple accounting systems. For example, in Mozambique this has been one reason to develop a unified programming agriculture investment programme (PROAGRI) with a budget system for donors (Cuco et al 2003).

The common procedures are intended to eliminate the parallel structures of projects and to commit donors to harmonising their needs in terms of procedures for accounting, procurements and auditing. However, PROAGRI in Mozambique have shown that effective delivery of sector support is complicated issue: Delivery of allocated financial resources down to local levels is difficult because of bureaucracy.

In Mozambique, the local government administration system is still weak and the restructuring of central government bodies and policies have consumed so many resources that PROAGRI funding is not yet to reach the local levels. Contrary to Tanzania, the districts in Mozambique have only very few administrative and extension staff members and this far the development and implementation of forestry activities in rural areas has been slow and facilitated mainly by central and provincial authorities, or by external consultants from development projects. In the future, if the districts are to take over more responsibility for managing forest resources, this would require a significant increase in human resources as well as also an improvement of their financial and administrative capacity to access appropriate funding sources such as PROAGRI.

In most developing countries, the central government headquarters are both psychically and culturally very distant from local villages. However, different countries are very different in case of their decision making processes. In Vietnam and Laos central governments have troubles to carry out efficient sector development and law enforcement because strong decision-making powers in provincial level. In Vietnam and Laos high provincial authorities and party members have often more power than the central ministries (Stuart-Fox 2006).

If these real decision makers under the party system do not agree the new roles and regulations, it is difficult to implement forest policies and coherent forest sector development. For example the donor organisations' aims to facilitate forest management planning and implementation forest laws can be very contradictory with local authorities' ideas for example in case of logging activities; what is legal and what is illegal depends to whom we are talk with (McElwee 2004).

If a recipient government lacks the means to ensure accountability of their institutions, the ownership of the sector programme will not be in appropriate hands. Monitoring and evaluation of allocated funds is crucial in order to built up accountability and improve the partnership between the donor and the recipient country.

Effective development assistance requires establishing management structures that provide donors with the assurance that development funds are used for the agreed purposes without imposing the on local partner's ownership. These management structures include several elements, which are vary depending on the sector, design intervention and recipient government structures.

Increasingly, in the future partner country governments may have a legitimate interest in autonomy of action and be accountable to its legislature and people. However, the donor governments will still be answerable to their constituencies on the use of the development resources they provide. Periodic impartial external audits are needed to assure the donor community about the transparency of the financial management.

In the future, sector wide approaches aim at developing the partner country's own monitoring and evaluation systems rather than imposing them parallel systems with all donor contribution. Since, for example, the forestry sector is usually supported by a number of donor agencies, integration to the recipient government structures is crucial but rather difficult, and requires donor co-ordination. National Forest Programmes, when being appropriately formulated, include a plan of monitoring and evaluation of the performance and impacts of forestry activities in the country. These monitoring and evaluation systems should be consisted with both the national forest policy and the donor requirements to avoid duplicate processes.

Unfortunately, there are examples were the government driven review and evaluation report are not available for donors. For example in Vietnam, the government carried out a mid-term evaluation of implementation of the 5 Million Hectare Reforestation Programme (5MHRP) for 1998-2010. However, this critical document is not translated in English, only some part of it is available in English and discussed with the donors. Currently, under the broader Forest Sector Support Program and Partnership which includes the 5MHRP, there are 25 international partners. In 2006 the partners organised as Joint Review of the Forest Sector Support Programme and Partnership. However, this review was mainly concentrating organisational issues related to the donor coordination and implementation of sector support funding approach. In Vietnam, there is very limited information available about the practices and impacts of 5MHRP in district and village level.

The monitoring of financial flows is not – and should not be - the only concern of the recipient government and the donor community. The impacts of support in both, the macro and micro level need to be monitored. Although moving towards SWAPs means more autonomy of initiatives in the forestry sector, the donors should bear the responsibility of the impacts of the funds allocated to the sector. This can't be done without adequate monitoring and evaluation systems.

However, it should also be noted that there is a real danger of too much bureaucracy from using too detailed indicators or monitoring frameworks. A balance needs to be found. And the question that comes up is the following: What is the participation of final beneficiaries, such as the rural poor and their organisations? There is danger that monitoring of sector support programs and direct budget support could have an effect of biasing accountability in favour of increasing extent to which the recipient government is answerable to donor, at the expense of accountability to domestic stakeholders.

Conclusions

The optimist among the authors argue that building a SWAP through a participative process can act as an important tool for obtaining good results in enhanced national ownership in forest sector development. It is important to acknowledge that to develop SWAP for example in forestry sector is long-term exercise and it is related to other reforms and policy changes in specific country. Before the SWAPs can be judged, time is needed for them to be implemented and take effects. However, it is important to keep in mind that the main objective of current development aid is poverty reduction.

The authors of this paper have mixed views of the extent to which the poor are benefiting of the current shift towards SWAPs. The significant question is how long it takes to reach a full SWAP, and how much support for planning and strategy development is needed before the implementation of SWAP can have tangible benefits in forestry sector. Cynically, we can say that in a valuable sector such as forestry there is the danger that SWAPs management can allow the political and administrative elite to divert public assets to their own private ends. The present shifting toward SWAPs and direct budget support should not mean “the quick and dirty” way to support developing countries. The donors should still be concerned about the impacts of their support, especially to rural livelihoods and poverty reduction.

Acknowledgements
We would like to acknowledge Markku Siltanen from Impact Consulting of his all effort during literature review in July 2004. We would also like to thank unofficial discussions with numerous people provided us with inspiration during the process and helped us to analyse the existing material: Thank you for all those who have contributed to the process by sharing their thoughts with us.

References

Cuco, A., Songane, F. and Matusse, C. 2003. Building Linkages Between Poverty Reduction Strategy and National Forestry Programme: the Case of Mozambique. In Forests in Poverty Reduction Strategies: Capturing the potential. Oksanen, T., Pajari, B. and Tuomajukka, T. European Forest Institute, Finland. Proceedings 47.

European Commission. 2003. Guidelines for European Commission Support to Sector Programmes. Version 1.0. Accessed 10.1.2006 from http://global.finland.fi/koyhyys/aineisto/EU_SPSP.pdf

FAO. 2001. How forests can reduce poverty. Food and Agriculture Organisation of the United Nations. Forestry Department, Forest Policy and Planning Division. Rome, Italy.

Geller, S. and Owino, F. 2002. Qualitative Assessment of National Forest Programmes. Final Report. LTS International Ltd.

Gould, J., Takala, T. and Nokkala, M. 1998. How Sectoral Programs Work. An analysis of education and agriculture sector programs in Zambia, Etiopia, Mozambique and Nepal. Policy Papers. Institute of Development Studies, University of Helsinki, Finland.

Joint Review of the Trust Fund for Forests (TFF). 2006. Review, Options and a Roadmap of Critical Decisions. Hanoi, Vietnam

McElwee, P. 2004. You say illegal, I say legal: the relationship between 'illegal' logging and land tenure, poverty and forest use rights in Vietnam. The Haworth Press Inc. pp 97-135.

Ministério da Agricultura e Desenvolvimento Rural. 2003. Avaliação do PROAGRI. Relatório Final.Volume 1.

Ministry for Foreign Affairs of Finland. 2003. Evaluation of Finnish Forest Sector Development Co-operation. Prepared by LTS International Ltd.

Ministry for Foreign Affairs of Finland. 2000. Guidelines for programme design, monitoring and evaluation. Department for International Development Cooperation.

Ministry of Natural Resources and Tourism of the United Republic of Tanzania, 2001. Tanzania National Forest Programme 2001-2010. Forestry and Beekeeping Division, Tanzania.

Mustalahti, I., Kostilainen, A., Tuomasjukka, T., and Siltanen, M. 2004. Forestry Development Cooperation. Towards national ownership in forestry sector development. Impact Consulting Ltd. for the Ministry for Foreign Affairs of Finland. 50 p.

Oksanen, T., Katila, M. and Tuomasjukka, T. 2003. Forest Sector Contribution to Rural Development: Facts, Issues and Potential Ways Forward. A discussion Paper for the Process to Develop a New Strategy for Finnish Rural Development Cooperation. Helsinki, Finland.

Stuart-Fox, M. 2006. The Political Culture of Corruption in the Lao PDR. Asia Studies Review. Vol.30, pp. 59-75

Wencelius, F. 2003. National Forest Programmes. In Forests in Poverty Reduction Strategies: Capturing the Potential. Oksanen, T., Pajari, B. and Tuomajukka, T. EFI Proceedings No. 47.

White, P. and Mustalahti I. 2005. Finnish Forestry Assistance: Success story or failure? Analyses of case studies from Sub-Saharan Africa and their possible impacts on poverty reduction. Silva Carelica 48, University of Joensuu, Finland.

Carbon credits and the forest sector

Guillaume Pajot

Abstract
In the context of Kyoto Protocol, forests can be used to create carbon credits. Contrary to the energetic sector where emissions reductions are considered as definitive, managing forests to mitigate climate change has been crticised because of the risks of reversibility. Biological carbon sinks are said to be non permanent. So, how can we compare carbon emissions reductions to carbon sequestration by sinks? What is the value of the carbon credits issued from forestry?
In this study, we consider the debate surrounding carbon credits attribution. As a first step, we recall methods that have been suggested. Results of a case study dealing with a forest located in southwestern France are presented in the second part of the paper. In a final discussion, we wonder about financial impact of different geopolitical strategies.

Keywords: Biological sinks, sequestration non permanence, carbon sinks valuation.

Introduction

Climate change is a crucial environnemental problem faced by human kind. Temperature on Earth's surface could rise in an important way if nothing is made to reduce GHG emissions. Kyoto Protocol lays down sigantories countries to not exceed some limits on their greenhouse gases emissions. To meet their commitments at a lower cost, three types of tools can be used:
exchange of carbon credits between Annex I countries. Carbon credits are obtained by countries that emit less than the amount that was imposed on them by Kyoto Protocol (KP); those carbon credits can be sold to countries wanting to emit more GHG than the amount fixed in KP;

Joint Implementation allows Annex I countries to obtain credits trough investments in carbon emissions reductions projects in another Annex I country;
Clean Development Mechanism allows Annex I contries to obtain credits trough investments in carbon carbon emissions reductions projects in a developping country.

Energetic and industrial activities are mainly concerned by those tools. But, considering the part played by forests in the carbon cycle, forestry is concerned by attempts to mitigate climate change. Under UNFCCC, countries must inventory carbon emissions by sources and carbon sequestration by sinks. Under article 3-3 of KP, countries can obtain carbon credits trough activities of afforestation or reforestation (plantation on lands that were not forested on december 31st, 1989 (debits are created for deforestation; clear cutting implying a land use change). For France, those activities imply some debits (Petroula, 2002). To compensate, countries can use forest management activities under article 3-4. We imagine that intentional management activities (longer rotations, light thinning regimes etc.) could be implemented. In the two cases, countries must prove that activities have been undertaken under human control, since 1990. Contrary to energetic sector where emissions reductions are considered as definitive, carbon sequestration by biological sinks is non permanent. Actually, forests can become Co2 sources, because of natural risks or human actions. This non permanence characteristic is one of the most heavy criticism against the use of forest resources to mitigate climate change. In this paper, we consider the debate surrounding carbon crediting methods in the context of forestry activities. With those methods, we try to compare carbon credits obtained trough forestry activities with carbon credits due to emissions reductions in energetic or industrial sector. In the first part of the paper, we recall methods that have been considered. In the second part of the paper, we present the results of a case study involving a maritime pine forest, located in Southwestern France. Even if France has decided to not subsidy forestry activities in the context of climate change management, this study should contribute to put an economic value on carbon sequestration. In an increasing number of countries, foresters and landowners are paid for environmental services provided by their forests, especially for carbon sequestration ().

1. A survey of carbon crediting methods for forestry

We present successively four carbon crediting methods. Due to some problems to their implementation, the two first methods, ton year and average stock, have been abandonned. Stock change approach will be used for verifying Annex I countries' commitments and temporary credits approach will serve to value carbon credits in the context of Clean Development Mechanism.

1.1: The average stock approach

This method has been considered for projects we can anticipate successive harvesting replanting cycles (Gabus, 2001; Phillips, 2002; Schlamadinger, 2002). Establishing carbon credits on the average of stored quantities allows avoiding numerous transfers between credits and debits. Forest owner does not have to buy credits when he decides to cut the stand.

Credits are given annually according to carbon stocks increases. When the average stock is reached, let us call this moment *X*, carbon crediting stops. The Net Present Value of the income received by the forest owner over one rotation is

$$Y = p_c \int_0^X s'(t) e^{-rt} dt$$

with p_c the carbon price, $s'(t)$ the marginal flow of carbon at instant t and r the interest rate. The main advantage of this method is that it permits compensating losses due to forest management by biomass growth without having to credit carbon stocks changes each year. But credits obtained with this method depend strongly of the duration chosen for the project (Gabus, 2001; Phillips, 2002; Schlamadinger, 2002). If this duration is too short, the quantity of carbon credits is important, reducing environmental credibility of the system. On the opposite, if this duration is too long, financial attractiveness of projects will be reduced and forestry to mitigate climate change will not be an interesting option for landowners. Because of the impossibility of choosing an acceptable duration for the projects, this method has been abandoned.

1.2: The ton year approach:

A ton of carbon emitted does not result in a permanent increase in atmospheric Co2. Carbon dioxyde concentration in the atmopshere decreases trough time as carbon is naturally absorbed by the oceans and the biosphere. This lenght defines the global warming potential of carbon dioxyde; its environmental impact. Considering this element, we can define the time a ton of carbon must be sequestered to reach the environmental impact of an emission reduction of one ton. This lenght is called the equivalence factor(Gabus, 2001; Herzog and al., 2003; Marland and al., 2001; Sedjo and Marland, 2003; Philips, 2002; Schlamadinger and al., 2002). If the equivalence factor is 100, this means that to reach the environmental impact of a non emission, carbon must be sequestered during one century. Litterature on the subject indicates some important disparities, the factor could vary between 42 and 150. As for the preceeding method, the choice of an equivalence factor is very controversial. A high level of the equivalence factor could reduce financial attractiveness of the projects (Marland and al., 2001). On the opposite, if this factor is too small, the quantity of carbon credits should be very important, reducing environmental credibility of the project. Numerous uncertainties about the carbon cycle and interactions between GHG in the atmosphere have driven to renounce to this approach. Another important matter rising with this type of approach is liability issue. At the end of the project, no one is held liable if carbon goes back to the atmosphere; the forest owner can sell new carbon credits (or even change land use) and the initial emitter has paid for his emissions.

1.3: The stock change approach:

This approach concerns Annex I Countries having to face a limit on their GHG emissions. Carbon credits are attributed when carbon stocks increase and debits must be paid when carbon stocks decrease. The income received by the forest owner over one rotation is

$$F(T) = \int_0^T p_c(0)e^{\beta t}s'(t)e^{-rt}dt - p_c(0)e^{\beta t}s(T)e^{-rT}$$

where $s(T)$ is carbon stock constituted in the forest at time T and T is the end of the rotation. If we consider forest owner is liable for wood products (so, emissions are weighted by wood product length life), the income is

$$F(T) = p_c\left[\int_0^T s'(t)e^{-rt}dt - \int_T^{T+D} s'(a)e^{-ra}da\right]$$

where D is the moment when wood products are destroyed. As

$$s(T)e^{-rT} > \int_T^{T+D} s'(a)e^{-ra}da$$

the income received by the forest owner is superior with this second approach.

Those results are consistent with constant carbon prices. As numerous studies have shown, the introduction of such a carbon crediting method in the objective function of forest owners should increase rotation lenghts. But authors generally do not consider carbon prices changes, that could alter economic viability of projects.

$$F(T) = \int_0^T p_c(0)e^{\beta t}s'(t)e^{-rt}dt - p_c(0)e^{\beta t}s(T)e^{-rT}$$

If we consider carbon price is not constant, the first equation is written as

$$F(T) = \int_0^T p_c(t)s'(t)e^{-rt}dt - p_c(T)s(T)e^{-rT}$$

If $p_c(0)$ is carbon price at time *0* and β its growth rate (when we suppose it is known),

$$F(T) = \int_0^T p_c(0)e^{\beta t}s'(t)e^{-rt}dt - p_c(0)e^{\beta t}s(T)e^{-rT}$$

Rearranging, we have

$$F(T) = p_c(0)\left[\int_0^T s'(t)e^{(-r+\beta)t}dt - s(T)e^{(-r+\beta)T}\right]$$

We can underline the following results concerning financial viability of projects.

If $\beta = r$,

$$p_c(0)\int_0^T s'(t)e^{(-r+\beta)t}dt = p_c(0)S(T)e^{(-r+\beta)T}$$

because $e^{(-r+\beta)t} = 1$ and

$$\theta(T) = \frac{e^0 T}{1}$$

So, $F(T) = 0$. From a financial point of view, carbon sequestration is a neutral operation.

If $\beta > r$,

$$p_c(0)\int_0^T s'(t)e^{(-r+\beta)t}dt < p_c(0)S(T)e^{(-r+\beta)T}$$

When *t=0, F(T)=0*. The derivative of F(T) with respect to time is equal to

$$-(-r+\beta)S(T)e^{(-r+\beta)T}$$

and is negative in the case where $\beta = r$. So, subsidies increase at a smaller rate than the tax as *T* increases. Consequently, $F(T) < 0$. In this context, carbon sequestration is not viable.

If $\beta < r$,

$$p_c(0)\int_0^T s'(t)e^{(-r+\beta)t}dt > p_c(0)S(T)e^{(-r+\beta)T}$$

Actually, the derivative of *F(T)* with respect to time is positive in this case. So subsidies increase at a more important rate than the tax. Consequently, $F(T) > 0$.

Externalities related to the contribution of forests to carbon cycle are fully internalised but this approach presents several limits:

it implies numerous transfers between debits and credits;

The area is dedicated to forestry and if the landowner decides to cut his forest stand, he is liable for carbon losses; so it implies a permanence of forest cover. At the scale of countries, it has been described as a constraint upon their sovereignty and a threat to their food security (see Blanco and Forner, 2000, quoted by Marland et al., 2001).

Permanence in this context is insured, because accounting for credits on an area involves following future events modifying carbon stocks on this area (Schlamadinger and al., 2002; Gabus, 2001).

1.4: The temporary credit approach:

Another way to credit carbon sequestration activities could consist in temporary crediting. This method will be used for valuing carbon credits issued from forest plantations in the context of Clean Development Mechanism. Forest owners sell to carbon emitters a temporary permit to emit GHG. At the end of the contract, Co2 emitters must reduce their emissions, or buy a permanent credit on the market, or renew the temporary contract. This allows an intertemporal arbitration to Co2 emitters, according to carbon prices changes and technological developments. Carbon sequestration is viewed as a temporary solution allowing to buy time, before buying for example a new technology. The fundamental difference comparing to the stock change approach is that liability for Co2 emissions is the Co2 emitters' one, not the forester's.

Because forestry is an alternative to Co2 emitters, we focus now on their behaviour; and the conditions that create a demand for temporary credits issued from forestry. When an emitter is faced to a constraint on his GHG emissions, he has three options:

- reducing GHG emissions;
- buying a permit on the market (said as a permanent credit);
- buying a temporary credit issued from forestry (

The first option is a technological solution. Co2 emitters can replace current technology by a less carbon intensive technology. But specific conditions can make of this option an unattractive solution, for example, if new technologies are expensive. In this case, he can think of the two other solutions.

The second and third solutions are market solutions. In the second case, Co2 emitter buys a carbon credit to other emitter that emits less than his quota. Co2 emitter buys the right to emit. Because emissions reductions are considered as definitive, these carbon credits are said to be permanent. But the price of these permanent credits could be prohibitive. In this case, Co2 emitter can buy a temporary credit to a forest owner, knowing that he will have to replace it by a permanent credit at the end of the contract. In this case, Co2 emitter gives his liability to the forest owner during the length of a contract. At the end of the contract, liability for carbon emissions comes back to the initial emitter, and he has to choose once again between the three options (he can too renew temporary contracts). Forest owner can freely choose future land use. He is only temporarily liable for carbon storage. Environmental integrity of the system is due to liability for carbon emissions that goes back to the initial emitter at the end of the contract. The third option consists so in buying a temporary credit now and a permanent credit in the future. A rational Co2 emitter will choose this option if it is less costly than for example, buying a permanent credit. The value of a temporary credit can be expressed as the delay obtained by the Co2 emitter faced to a limit on his GHG emissions. The willingness to pays of a Co2 emitter for a temporary credit is the maximum price he will accept to pay for a temporary credit. When this price is at a maximum, Co2 emitter is indifferent between the three options.

To obtain a non arbitrary condition, the following identity must be satisfied (when we suppose there are no transaction costs). Buying a temporary credit now and a permanent credit in the future must cost the same amount as buying a permanent credit now (Subak, 2003).

$$p_{\max} + \frac{pc_T}{(1+r)^T} = pc_0$$

$$p_{\max} = pc_0 - \frac{pc_T}{(1+r)^T}$$

where $p_{\max}$ is the willingness to pay of a Co2 emitter for a temporary credit, pc_0 is the current price of permanent credits, pc_T is the anticipated price (at time *T*) of permanent credits, r is the discount rate.

If we suppose that the carbon price rises at a rate β , we can write pc_T as

$$pc_T = pc_0(1+\beta)^T$$

and the willingness to pay of a Co2 emitter is written as

$$p_{\max} = pc_0 - pc_0\frac{(1+\beta)^T}{(1+r)^T}$$

$$p_{\max} = pc_0\left[1 - \frac{(1+\beta)^T}{(1+r)^T}\right]$$

We are faced to four situations;
carbon price rises faster than the discount rate ;
carbon price rises slower than the discount rate;
carbon price rises at the discount rate;
carbon price decreases to zero.

In situation (1), it is not interesting for a Co2 emitter to buy a temporary credit. His willingness to pay is negative ($p_{\max} < 0$). Buying a temporary credit now and a permanent credit in the future will cost him more than buying a permanent credit now. One can expect to this type of situation when technological developments are still experimental, or when more severe climatic policies are anticipated.

In situation (2), it is interesting for a Co2 emitter to buy a temporary credit. The cost of buying a temporary credit and a permanent credit *T* years after is smaller than the cost of buying a permanent credit. One can expect to this situation in the case of low carbon intensive technologies running inexpensive, or in the case of climatic policies becoming less severe.

In situation (3), $p_{\max}$ is equal to zero. Buying a temporary credit now and a permanent credit *T* years after is the same amount as buying a permanent credit now; the Co2 emitter is indifferent.

In situation (4), carbon price decrease to zero; it could happen if international regulation on carbon use would fail and stop in a few years; in this case, buying a temporary credit (and so, no permanent credit *T* years after) is the same thing as buying a permanent credit.

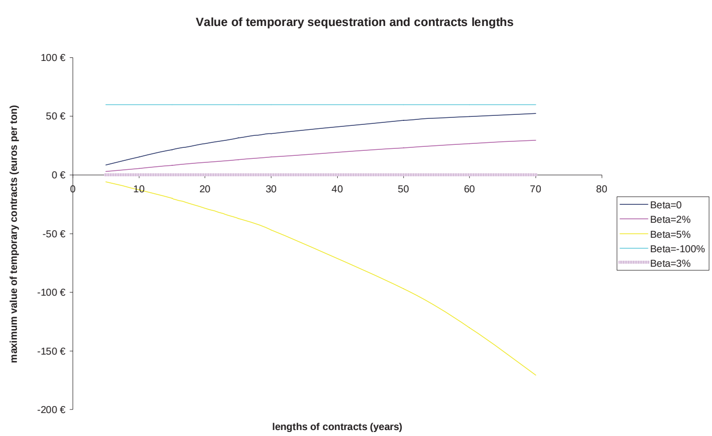
To summarise, willingness to pay of Co2 emitters for buying temporary carbon credits depends on anticipations concerning carbon prices and the discount rate.

An example of the value of temporary credits

Table 1 and Graph 1 present some examples of the value of temporary credits

Table 1: In this table, we show willingness to pay of Co2 emitters according to several assumptions of carbon price growth rate and lengths of contracts. Carbon price is assumed to be 60 euros per ton of carbon.

		Lengths of contracts (years)						
Discount rate	***Beta***	***5***	***10***	***25***	***30***	***50***	***60***	***70***
3%	0	8	15	31	35	46	50	52
3%	2%	3	6	13	15	23	27	30
3%	3%	0	0	0	0	0	0	0
3%	5%	-6	-13	-37	-47	-97	-130	-171
3%	-100%	60	60	60	60	60	60	60



Graph 1: We can see that increasing lengths of contract make increase Co2 emitter's willingness to pay for temporary credits (the upper limit is the price of permanent credits, as the length of contracts increases).

2. The case study:The afforestation project:

We suppose the stand is the result of a new forest (additional). The stand is harvested when it is 45 years old. Five thinning are planned during the rotation. This corresponds to a classical silviculture of maritime pines. Volumes and carbon stocks are obtained with software

OptimFor©, developed for maritime pine silviculture in SouthWestern France. The general approach funding the building of this software is dynamic programming, based on Bellman's algorithm. It permits to optimise forest management according to different criterions (economic, biologic etc.), assess biological and economic impacts of management options or of exogenous events (storms, forest fires etc.). Parameters that describe growth of trees are those of Lemoine's model.
Carbon stocks are directly linked to wood volumes. We determine it as follows: an expansion factor gives total wood volume starting from marketable wood. As a second step, we must calculate dry weight of the trees. As a third step, we need to know the carbon content of the dry weight of trees. The equation and coefficients used in this study are, following Malfait et al. (2003):

$$Sc(t) = v(t).E.D.Car \quad (6)$$

Where *Sc(t)* is the carbon stock at age *t*, *E* is the expansion factor; *D* is the part of the dry weight of trees and *Car* is the carbon content of dry weight. The values of parameters are: *E=1,6; D=0,5; Car=0,43.*

We suppose carbon price is 60 euros per ton, discount rate is 3%; and we deal only with the present value of carbon storage incomes. We comment results for each method presented in the first part of the paper. I

2.1: The average stock approach:
Credits are attributed marginally according to fluxes (annual fluxes). When average stock is reached, carbon crediting stops. In this example, average stock is 62 tons of carbon, and is reached when the stand is 23 years old. According to this approach, income of one rotation is 2 405 euros per hectare.

2.2: The ton year approach:
We suppose an equivalence factor equal to 100. This equivalence factor has been chosen in KP to define equivalence between climatic effects of different greenhouse gases. Carbon credits are attributed annually, and incomes weighted by the equivalence factor. The income received by the forest owner is 657 euros per hectare during one rotation. Incomes obtained with this method depend strongly of the equivalence factor and are inversely proportional. For example, if the equivalence factor is 50[1], income doubles (1314 euros).

2.3: The stock change approach:
Carbon credits are attributed according to stocks changes observed during the rotation. Income obtained by a forest owner is 4 126 euros per hectare. If we consider clear cutting of the stand (verification is made at year 46), the income is 1 828 euros per hectare

2.4: The temporary credit approach:
We suppose the length of contracts is 10 years, and prices of permanent credits are constant. Value of temporary credits is 15.35 euros per ton of carbon. Credits are attributed as follows: During the first ten years, credits are given according to stocks changes. The first contract finishes at year 10. At the end of this contract, a new contract begins and new credits are given according to stocks changes. But as long as the stand continues to sequester carbon, credits of the first contract are renewed and this process follows for the other contracts. The income obtained by the forest owner is 2 205 euros per hectare.

[1] This means that to obtain the climatic effect of an emission reduction of one ton, less effort is required ; carbon needs to be sequestered during only 50 years to reach the environmental impact of an emission reduction.

Discussion

In this analysis, we assume carbon price is constant during the rotation. In a real environment, carbon price would be subject to long term trends. Technological developments, international regulations, political strategies influence carbon prices. In the following analysis, we suppose carbon credit prices will be influenced by technological development and demand of carbon credits coming from large emitters countries as China, India, Brazil and USA. Currently, those countries are not constrained by KP[2]. If they come into the process, they will demand carbon credits and carbon price will rise.

in a first case, we could imagine that technological developments as hydrogen will arrive in a few years and that USA, China, India and Brazil stay outside KP. We would expect to a relatively small and decreasing carbon price. From the point of view of a forest owner, stock change approach would give positive financial results as shown in the first part of the paper. Concerning the demand for temporary credits, it would be positive too, if we assume that carbon price grows at a smaller rate than the discount rate;

in a second case, we assume that technological development will arrive in a moment that exceeds the horizon of human life (and economic calculations);and that China, India, Brazil and USA come into Kyoto process. Carbon price would increase because of the important demand for credits. The stock change approach would give negative results while the demand for temporary would be negative. Carbon sequestration would not be an output of forestry activities.

Even if France has decided to not subsidy carbon sequestration activities, forests represent an important point in the "Plan National de Lutte Contre les Changements Climatiques". This plan insists on afforestation strategies, use of wood as building material, or as a substitute to fossil fuel combustion and forest management (article 3-4) should be used to reach France's Kyoto commitments. As the greatest artificial forest area of Europe, this forest could contribute to help France meeting her goal.

References:

Chomitz Kenneth M. (2002), Baseline, leakage and measurement issues: how do forestry and energy projects compare, Climate Policy 2 pp 35-49

Dutschke Michael, Shlamadinger Bernhardt (2003), Practical issues concerning temporary carbon credits in the CDM, HWWA Discussion Paper 227, Hamburg Institute of International Economics.

Dutschke Michael, Schlamadinger Bernhardt, Wong Jenny, Rumberg Michael (2004), Value and risks of expiring carbon credits from CDM afforestation and reforestation, HWWA Discussion Paper 290, Hamburg Institute of International Economics.

Gabus André (2001), Markets discounts for sinks: A concept for restricting forest contributions in accounting for emission reductions, International Institute for Applied Systems Analysis, Interim Report 01-012 (mars 2001).

Herzog Howard, Caldeira Ken, Reilly John (2003), An issue of permanence: assessing the effectiveness of temporary carbon storage, Climatic Change n°59, pp 293-310

Malfait Jean-Jacques, Pajot Guillaume, Point Patrick (2003), Le puits de carbone landais, Communication au VIIième Colloque Arbora, décembre 2003, Bordeaux (France).

Marland Gregg, Fruit Kristy, Sedjo Roger (2001), Accounting for sequestered carbon: the question of permanence, Environmental Science and Policy volume 4 (2001) pp 259-268.

Petroula, T. 2002. Sinks as an option to meet CO2 emission reduction targets in Europe, Report 500005001/2002. The Netherlands: RVIM.

[2] China, India, Brazil are Annex II countries while the US have not ratified KP.

Sedjo Roger A., Marland Gregg (2003), Inter-trading permanent emissions credits and rented temporary carbon emissions offsets : some issues and alternatives, Climate Policy volume 3 issue 3 pp 435-444.

Subak Susan (2003), Replacing carbon lost from forests: an assessment of insurance, reserves, and expiring credits, Climate Policy 3 pp 107-122.

Phillips Gareth (2002), Lulucf Projects in the CDM Accounting regimes and proposals for simplified rules and modalities, Discussion Paper for the International Emissions Trading Association (IETA) produit par SGS, mai 2002.

Schlamadinger B., Aukland L., Berg S., Bradley D., Ciccarese L., Dameron V., Faaij A., Jackson M., Marland G., Sikkema R., (2002), Forest-based carbon mitigation projects : Options for carbon accounting and for dealing with non permanence, www.bib.fsagx.ac.be/coste21/ftp/2002-04-22/report.pdf

Buying certification: pigs in pokes, warm glows, and unexploded bombs

Colin Price

Abstract
Creating markets is becoming a popular way of treating forest products that were once routinely regarded as externalities. Following this philosophy, a certification premium might be regarded as a valuation of the environmental (and possibly social) benefits of growing timber sustainably and in an environmentally friendly manner. However, the free-rider problem, the multiplicity of interpretations of sustainability, and profound ignorance of the relationship between certified products bought and environmental benefits achieved, all make it unlikely that the premium (if it exists) reflects anything other than a degree of moral satisfaction achieved by purchasing certified timber. Whether even this is to be regarded as an addition to welfare is debatable. However, a certification premium might be paid as a way of "acting rightly". This justifies a proper and direct evaluation of the externalities, and of the costs required to avoid them.

Introduction: markets, quasi-markets, and non-markets
A market has been defined as: "a collection of sellers and buyers of a product in contact and exchange with each other". One of the great advances in economics during the twentieth century was a realisation and acceptance that markets did not regulate all the important effects of economic activity: in particular, the generation of externalities, by definition, lay outside the scope of markets (Pigou, 1929). One response was to evaluate the externalities in monetary equivalents, by a range of methods, and to incorporate them in cost–benefit analysis (Price, 1989). By the beginning of the third millennium, however, an alternative approach was gaining ground: to create a market or quasi-market for the previous externalities, by changing the structure of property rights, increasing the capability to exclude non-payers, and attaching a premium price to products which (it is asserted) have been created with due regard to externalities (Mantau *et al*., 2001; Pagiola *et al*., 2002).
During this period, certification of timber has become a popular topic of research. Investigations have tended to focus on institutional aspects (Rametsteiner, 2002; O'Brien & Teisl, 2004; Cashore *et al*., 2005). Some have regarded certification simply as a means of oversight and regulation. But others have considered the premium attached to certified timber as a way of evaluating the environmental and social externalities of timber production – ideally, such that costly and controversial evaluation of these effects in the field is made unnecessary. Thus certification appears to create a quasi-market for what was previously non-marketed.

However, this interpretation depends on the product offered by the sellers being the same as that desired by the buyers. Assisted by a pilot survey, this paper discusses the product that people may believe themselves to be buying when they purchase certified timber; the plausibility of the view that respondents offer of their motives; and the implausibility of the notion that certification creates a well-defined market in which both sellers and buyers are clear about what might be the basis of a premium price. For brevity, we will take it that the product is something called "timber grown under a system of sustainable forest management (SFM timber)". In practice what this requires, or is envisaged to embrace, will vary from producer to producer, consumer to consumer, and between producers and consumers.

The survey sample size was small, and was not drawn from a representative cross-section of the population. It was intended to do no more than highlight some possible interpretations and difficulties. Percentages are sometimes quoted below for clarity, but they should not be taken to indicate precision.

An unlikely story

The following sections discuss what it is, in theory, that consumers *might* pay for, when they buy certified timber. They evaluate the plausibility of the possibilities, the perceptions and reasons that consumers explicitly espouse, and what, if anything, may be deduced about the relationship between the product offered and the product desired.

All respondents had either bought timber known to be certified, at a premium price, or expressed an hypothetical willingness to do so, if it was available. In general the acceptable percentage premium lay in the range 10%–25% of sale price, although there was one outlier at 400%.

Several hypotheses may be advanced about what it is that consumers are actually obtaining, when they purchase certified timber. This is not necessarily the same as what they *think* they are obtaining, nor what they *say* they are seeking to obtain.

A few respondents indicated that they would purchase certified timber for the benefit of themselves or their descendants or both. However, out of all the direct benefit from certified production, the actual proportion which accrues to one individual and descendants is vanishingly small. The self-interested consumer can be a free-rider, obtaining benefit from the certifiable forest management which results from all other consumers' purchase of certified products.

If the stated willingness to pay really did represent the incremental benefit *of* the individual's purchase *to* the individual's direct well-being, it would have to be scaled up enormously to represent the global environmental benefit of SFM timber. Suppose that the individual puts a value of 1 euro on the direct benefit *that accrues to him or herself* as a result of growing 1 cubic metre of SFM timber. If that individual is a typical world citizen, world citizens in total receive 1 euro × 6 500 000 000 of benefit from the growing of that one cubic metre. The total volume of timber entering world markets is approximately 10 000 000 000 cubic metres per year. If half of this was SFM timber, the implied global value of the certified component of SFM would be 32 500 000 000 000 000 000 euros, which is an implausibly large multiple of gross world product [what multiple?]. It can be concluded that individual benefit is not be a realistic motivation for paying a premium.

Seventeen percent of respondents answered that their motive was "for the good of the world in general". Such an altruistic motivation has been used as a basis for models of markets for certified timber (Ibanez, 2001). However, doubt has been cast on the likelihood of pure altruism's existing. Why should someone do something which is not in their own interest? Answer: either because they feel good about the well-being of others, or they would feel bad if they did not take account of others' interests. This is indirect self-interest, but it is self-interest nonetheless.

Pig in pokes

There is no one unique form of sustainable forest management. Many intensities of forest activity may be sustainable; many different products may be produced in different proportions; many levels of environmental values of different kinds may be maintained. Thus certification could potentially assure many things. Equally, there is no very clear baseline which is the absolute minimum required for sustainability of any kind.

The two main certification agencies, Programme for the Endorsement of Forest Certification Schemes (PEFC), and Forest Stewardship Council (FSC) state their objectives in rather general terms. PEFC "provides an assurance mechanism to purchasers of wood and paper products that they are promoting the sustainable management of forests" (Programme for the Endorsement of Forest Certification, 2006). Its approach to sustainability embraces the following:

"Sustainability

Benefits the biodiversity of nature and the environment.

Promotes the economically viable, environmentally appropriate and socially beneficial management of forests. …" (Programme for the Endorsement of Forest Certification, 2006).

FSC's mission states that it "shall promote environmentally appropriate, socially beneficial and economically viable management of the world's forests" (Forest Stewardship Council, 2003). The following explanations are given.

"**Environmentally appropriate** forest management ensures that the harvest of timber and non-timber products maintains the forest's biodiversity, productivity and ecological processes.

Socially beneficial forest management helps both local people and society at large to enjoy long term benefits and also provides strong incentives to local people to sustain the forest resources and adhere to long-term management plans.

Economically viable forest management means that forest operations are structured and managed so as to be sufficiently profitable, without generating financial profit at the expense of the forest resources, the ecosystem or affected communities. …"

Sustainability means "capable of carrying on as it is". But it is overwhelmingly probable that many purchasers of timber do not know the existing situation, and, if they did, would desire an improvement on it, in a variety of ways. In a well-functioning and differentiated market, it would be expected that different potential niches for improved performance would be explored, and a certification system would develop in which consumers would be offered a wide range of packages that achieved whatever is perceived to be the minimum baseline for sustainability, and rose above it in different ways and to different degrees.

However, in reality there is only a small number of certifying bodies. They tend to compete on delivery to the producers of what *they* want: which is a large potential market and a low cost per hectare certified, rather than assuring different aspects or intensities of SFM. From governments' point of view, it is easier to regulate a small number of "respected" agencies, rather than allow a free-for-all of small bodies, each delivering to a particular market segment (Rametsteiner, 2002). Differences between agencies lie in field methods of supplying certification, rather than in the kind of production process certified.

This would be of little consequence if the product all consumers wanted had the same mix of components. But consumers clearly desire different things. Table 1 shows responses to a question concerning what it was that they would want to pay for, when they bought certified timber. Of all the possibilities, only "ecological sustainability" was identified by all respondents as a component. (But does ecological sustainability forbid only deterioration of ecosystem functions? Technically it does not require "whatever improvement is possible", even though that might be what people would like, all else being equal.) At least one respondent deemed each of the other characteristics not essential. Many respondents desired a mix of features, in which case the maximum percentage of the premium allocated to a feature is recorded.

Table 1. The desired product of certification

What do you feel you would be paying for?	Number	Maximum % of premium
Ecological sustainability	18	70
Economic sustainability	12	50
Social sustainability	11	30
Friendliness of production process to environment	9	33
Friendliness of production process to people	8	25
Assurance that logging had been done legally	14	50
Fair trade	1	–
Conscience money	1	20

Plainly one standard of certification will not meet the best desires of all purchasers, except in the unlikely case that one form of SFM maximises all these features.

Not only did all consumers want a different package of products. Also, few of them even *claimed* to know how a wood product that they purchased would relate to the area of forest affected: yet forest area (rather than, say, timber volume) is the basis for most of the ecological and social effects which interested consumers. Twenty-eight percent thought they would consider the conversion factor between the product they would buy and the volume of timber required to make it. Seventeen percent would consider how many cubic metres would stand on a hectare of the relevant forest type. Thirty-three percent would consider how long it would take to grow the timber. Only one respondent claimed that all these things would be considered. Only by this respondent was it claimed that the product could be related to how much forest was affected, over what period. Significantly, one respondent, who had spent many years in timber marketing and trade, was realistic enough *not* to attempt quantification of any of these relationships.

Approaching the linkage from a different angle, one respondent thought he/she had "a rather vague idea of the link between what I would pay and the good thereby achieved for the world in general". Two claimed to have a clear idea of the link. No others could relate their payment to an expected outcome.

In summary, then, people are willing to pay a price for certification, that may in practice represent a way of managing a hectare of forest that doubtfully conforms with their most desired configuration of objectives. Few would consider the whole chain of relationships that translates the piece purchased into impact on the forest of origin, and it is likely that even fewer would, as a result of their consideration, form an accurate picture of what their purchase would imply for the actual forest. Yet most were prepared to pay some premium for the scarcely-specified consequences of their purchase, and most would consider the size of the price differential, in deciding whether to purchase certified timber at all.
Furthermore, suppose that I *am* actually altruistic. Then, in making my purchase and in some tiny way changing the state of the world, I am buying a pig in a poke as a present for friends – the population of the earth – whose desires for the elements of SFM timber production are quite unlikely to resemble my own.

It seems rather probable that my willingness to pay is, in any event, for a symbolic gesture, rather than for a well-defined physical outcome.

Warm glows

By contrast with an altruism that imparts no personal reward, it is very plausible that people should be prepared to pay something for the warm glow imparted by behaving in a way that is felt to be good for the planet, for its people (and possibly for other sentient creatures). Two respondents were explicit that purchasing certified timber would make them feel good about themselves; four others said that "It would avoid my feeling bad about myself, which would be the case if I knowingly bought uncertified timber, when certified timber was available." Five accepted the view of buying certified timber as a gesture: "That was all that was on offer, as a way of expressing concern about environmental, social justice and sustainability issues in timber production."

The theoretical arguments that make warm glows credible are as follows.

Warm glows are genuinely for sale in a clearly defined market transaction – much clearer, for example, than by the "purchase of moral satisfaction" (Kahneman & Knetsch, 1992) in contingent valuation exercises. Consumers seek a warm glow. It is available for purchase at the price of the premium. If the premium is not paid, the warm glow cannot be felt, but rather a self-reproaching cold sweat is risked. It is a private good, from which consumers can be excluded (by non-purchase) and which (because of the demands placed by certification) has a marginal cost in resources required. Yet it has potential (largely through certification) to be produced jointly with the more evidently public good of SFM.

The effects are entirely experienced by the consumers making the purchase, so no judgements need be made of what characteristic of SFM it is, that other consumers value.

The effects are known and precisely so, because they can be, and have been, repeatedly experienced: we can hardly know what the results of our purchasing certified timber are for the forest that produced it, but we can know what were the results for ourselves, when we purchased certified timber, or failed to do so.

Warm glows are symbolic, attracting a willingness to pay for what certification stands for, rather than for what it actually achieves. Thus the unknown constitution of the mix, and the relationship between pieces bought and sustainability achieved do not matter. The purchaser accepts the certifying agency's assurance that the product is "sustainably produced". Oliver (2006) reports that "end users are not at all interested in the detail of certification schemes, and just need an assurance that they are recognised by a credible body …." Such a gesture of support for SFM is something whose value is probably more constant across consumers, than their valuation of actual effects in the forest. On the other hand, some surmise has to be made about the actual effects, in order that "permissive altruism" legitimises a warm glow. One respondent in the end did not fill in the questionnaire, and would refuse to pay a premium for certified timber because of the uncertain effects: mistrust – not just failure – of certification can undermine warm glows, because warm glows arise from perception, not reality.

None of this is to deny, cynically, that consumers might value the actual well-being of others. Rather, it is to suggest that such valuation enters their own sense of well-being. This interdependence of well-being is, perhaps, a more reliable basis for a functioning community, than one which requires a cold and rational altruism, of which personal well-being is *not* a product.

There is, potentially, a problem of "glow-out" (Price, in review). There are many ways of acting rightly, and many of these require expenditure of money. It is possible that, by spending extra money on certified timber, consumers reduce their ability or willingness to pay for other worthwhile things, or to donate to other worthwhile causes. In this sense, the availability of certified timber would not increase the global total of warm glows experienced. In fact, of those who guessed what they might do with money *not* spent on certified timber, only 18% expected to "spend it on some other cause that I feel good about."

The indication is, that mental accounts are not generally compartmentalised in a way that allocates a budget to things one might feel good about.

Unexploded bombs

A purchase of certified timber does not guarantee that on the whole the world changes for the better. There may be malign ripple effects, intended or not, conscious or not, resulting from the attempt to achieve whatever it is that is assured by certification.

Unless and until all timber production is certified, it is possible that purchase of certified timber by one concerned agent may withhold that timber from another agent, who (being less aware or concerned) instead buys uncertified timber. Only 11% of respondents would have considered the possibility of such leakage, which would, in effect, mean paying for nothing to change. The great majority would continue to buy certified timber in the face of 20% and 50% possibility of such leakage. However, an 80% possibility would cause 28% to stop buying certified timber.

Similarly, the operation of the market can cause such neutralising, from the supply side. Certification and preservation of the environment in one's own local woodland may mean transfer of demand, and the felling of someone else's local woodland; one nation's conservation policy may undermine conservation in another nation (Sedjo, 1996).

In practice, no substantial premium may be paid for certified timber from the forest, which may remain the case through the supply chain. If so, certification imposes the burden of extra costs on the producer, without any compensation from extra revenue. Healey *et al*., (2000) and Price *et al*., (2001) indicate that a carbon offset agreement in East Malaysia made no allowance for the extra operational costs of reduced impact logging. Longer operational time per cubic metre produced, with a piecework rate for the workers, implies reduced income as well as reduced impact. Environmental damage may be replaced by social injustice. Many respondents to the questionnaire were concerned about environment but not about social justice. But this is an inadequate ethical basis for ignoring social justice.

If a price differential exists, it may result from uncertified timber's price being depressed, rather than from a premium on certified timber. In this case, producers have the options of reduced revenue from uncertified production, or increased costs from certified production. In either case, reduction in income to low-paid workers may result.

Finally, more stringent standards for managing existing forest areas may reduce the permitted volume of removals per hectare. In consequence, the area of forest exploited may increase, to meet a particular level of demand or requirement for revenue earning. Even if extraction from the newly exploited area meets certifiable standards, there may nonetheless be a decline in environmental quality compared with the pristine state. This extension of extraction is a further possible consequence of reduced impact logging.

Conclusions

What can we rightly conclude from willingness to pay a premium for certified timber, where such a premium exists?

It tells us about the ethical structures of the purchaser, but not much about the value of physical consequences for forests or their people: paying a premium is not buying a package of goods and services, for self, or descendants, or the world, but *conforming with a personally adopted constraint*. Table 2 shows accepted motivations which imply that buying certification is a way of complying with a code of right conduct.

Table 2. Motivations of a generally ethical nature

Motive for buying certified timber	Number of responses
That was all that was on offer, as a way of expressing concern about environmental, social justice and sustainability issues in timber production.	5
I have a general commitment to doing what I think is right.	10
I believe I should pay the full economic, environmental and social cost of what I buy.	6
One or more of the above	14
All respondents	18

On the other hand, that personal code does not seem to provide an absolute constraint: the majority of those expressing a "general ethical" motivation were nonetheless prepared to buy uncertified timber, if certified timber was not available, or if its premium was above the rather modest 20% average willingness to pay. About that level of premium can be regarded as the value of conforming with a general ethical constraint of acting rightly.

At best, the existence of a certification premium can be interpreted as a referendum on the desirability of including environment, social issues and sustainability in evaluations of, and actions in timber-producing forests: it does not replace the need for explicit and local evaluations, nor does it provide an adequate motivation for forest owners and managers to apply these evaluations in decision making. Nor does it provide plausible assurance to thinking purchasers, that all is well in the world of timber production, and that they themselves have played an adequate part in keeping things that way. Paradoxically, a consumer who knows that the purchased product is a warm glow, is less likely to feel a warm glow.

Hence, perhaps, the real meaning of "acting rightly" is commitment to accepting the results of cost–benefit analyses – or other trusted evaluation protocols – which take actual effects into account. The consumer does not need to know what these actual effects are, but does need to know that those effects *are known*, and are properly costed in setting a premium. Certification and full evaluation are in this sense complementary, rather than competing, instruments of achieving an ethically desirable management of forests. Premia generated by consumer demand are not themselves an adequate substitute for actual measurement and valuation of effects. There may be a market, but it is not for the benefits that actually accrue from environmentally and socially "responsible" management of forests, nor for the sustainability of such management.

Acknowledgements

I am grateful to Roger Cooper and Eleanor Price for their helpful comments on early drafts of the questionnaire, and to staff and students of my home institution, who might reasonably have expected that they were walking into a trap by responding to one of my questionnaires.

References

Cashore, B, van Kooten, G.C., Vertinsky, I., Auld, G. & Affolderbach, J. 2005. Private or self-regulation? A comparative study of forest certification choices in Canada, the United States and Germany. *Forest Policy and Economics* 7, 53-69.

Forest Stewardship Council 2003. *What is FSC?* http://www.fsc.org/en/about/about_fsc/mission

Healey, J.R., Price, C. & Tay, J., 2000. The cost of carbon retention by reduced impact logging. *Forest Ecology and Management* 139, 237-55.

Kahneman, D. & Knetsch, J.L. 1992. Valuing public goods: the purchase of moral satisfaction. *Journal of Environmental Economics and Management* 22, 57-70.

Ibanez, L., 2001. Competition and environmental labelling. *Scandinavian Forest Economics* 37, 179-207.
Mantau, U., Merlo, M., Sekot, W. & Welcker, B. 2001. Recreational and Environmental Markets for Forest Enterprises: a New Approach towards Marketability of Public Goods. CAB International, Wallingford. 558 pp.
O'Brien, K.A. & Teisl, M.F. 2004. Eco-information and its effect on consumer values for environmentally certified forest products. *Journal of Forest Economics* 10, 75-96.
Oliver, R. 2006. *Price Premiums for Verified Legal and Sustainable Timber*. Report to Timber Trade Federation and Department for International Development, London. 12 pp.
Pagiola, S., Bishop, J. & Landell-Mills, N. (eds) 2002. Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development. Earthscan, London. 299 pp.
Pigou, A.C. 1929. *The Economics of Welfare*. Macmillan, London.
Price, C. 1989. The Theory and Application of Forest Economics. Blackwell, Oxford. 402 pp.
Price, C., Tay, J. & Healey, J.R. 2001. Reduced impact logging and the economic cost of carbon retention. *Scandinavian Forest Economics* 37, 227-37.
Price, C. in review. Sustainable forest management, pecuniary externalities and invisible stakeholders. With *Forest Policy and Economics*.
Programme for the Endorsement of Forest Certification 2006. *Sustainable Forest Management*. http://www.pefc.co.uk/cgi-bin/user/pefc/artman/exec/search.cgi
Rametsteiner, E. 2002. The role of governments in forest certification – a normative analysis based on new institutional economics theories. *Forest Policy and Economics* 4, 163-73.
Sedjo, R.A. 1996. Local timber production and global trade: the environmental implications of forestry trade. In: Adamowicz, W.L., Boxall, P.C., Luckert, M.K., Phillips, W.E. & White, W.A. (eds), *Forestry, Economics and the Environment*. CAB International, Wallingford, pp.49-67.

Creaming: a fast track to continuous cover forests?

Colin Price and Martin Price

Abstract
The premises for designing economic transformation to continuous cover forests might be: early revenue is preferable to delayed revenue; big trees make more money than medium-sized trees; fast growth may bring quality penalties; small trees cost money to remove; there is an opportunity cost in felling trees not at optimal rotation; in the temperate/boreal zone regeneration may need a large canopy gap; planting more trees costs more money; the long period of transformation is a bad thing if the target system is more profitable than the existing one. Early revenue is obtainable by premature clear felling, at lesser cost than by transformation,. Removing the largest trees from an even-aged crop gives net revenues early; minimises deviation from optimal felling size; provides gaps large enough for some but not excessive regeneration. Successive removal of the largest trees creates fully diverse size structure quickly. Subsequent fellings will also be of high value trees. Both the resulting forest, and the process of transformation, could be more profitable than alternative treatments. Preliminary results of time study and stand modelling support this provisional conclusion.

Introduction
The trouble with silvicultural experiments is that they are designed by silviculturists. Economists get to analyse them afterwards, and the first conclusion may be that *these were the wrong experiments*.

In the early third millennium, the Forestry Commission in Wales instituted research into how Wales's largely even-aged forests could achieve some form of continuous cover structure. This followed declaration of a forestry objective "to convert at least half of the National Assembly [i.e. state-owned] woodlands to continuous cover over the next 20 years …" (National Assembly of Wales, 2001). One component of the programme was to study economic factors, in a privately owned forest, with a view to evaluating what kind of financial inducements might be necessary and appropriate, to encourage transformation in the private sector.

Given the project's economic orientation, it was surprisingly difficult to include economic reasoning in the *design* of experimental treatments. Conventional small-group felling was an agreed treatment; as was selection of frame trees, with crown thinning undertaken to favour them. These are silvicultural treatments often considered in the UK when continuous cover forestry is discussed. The base-line treatment was to continue the pre-existing low thinning, eventually followed by clear cutting and even-aged regeneration. Yet it is far from clear what economic advantages conventional treatments offer over clear cutting, even once transformation of age structure is complete. On the contrary, they involve harvesting on a small scale and in a dispersed pattern, which might be expected to increase harvesting cost, with no guarantee that conditions for "free" natural regeneration would arise. Moreover, to transform the age-class structure entails felling part of the crop prematurely, and part beyond its economically optimal rotation, with important short-term costs.

If, instead, one sought treatments likely to be economically attractive both at the outset, and in the long term, what would be designed? This was the thinking that underlay what was, and still is, regarded as a subversive incursion into UK silviculture. This paper describes the theoretical argument, the experiments set up to test its validity, some preliminary results, and an economic evaluation based on simple but reasonable models of the treatments' future development. It builds on work presented in Price and Price (2006), using refined figures for operational costs.

Purposefully economic transformation

Premises from basic forest economics, for designing an economic transformation to continuous cover structure, might include these following.

- Because of the effect of discounting, early revenue is preferable to delayed revenue, particularly for private sector forest owners with cash flow problems.
- Felling big trees makes more money than felling the same total volume of medium-sized trees.
- Very fast-grown trees may not yield good quality timber.
- Small trees cost money to remove. Taking them out in thinnings increases investment in the crop.
- By definition, there is an opportunity cost in felling trees either before or after their optimal rotation.
- In windy climates and exposed conditions, trees may not survive long after they reach a critical height.
- In the temperate and boreal zones, a large canopy gap may be needed to encourage regeneration, except with the most shade-tolerant species.
- The more trees that are planted and tended, the more money it costs.
- Transformation takes a long time, which is a bad thing if the target system is more profitable than the existing one (though possibly be a good thing if, as may be the case, it is *less* profitable).

Early revenue and early clear cutting

Particularly in the private sector, cash flow constraints may require premature felling of some trees in an even-aged forest: transformation to continuous cover forestry has been considered beneficial/advocated on these grounds (Knoke & Plusczyk, 2001). But early cash flow (or regular cash flow, or flexible cash flow, as desired) can equally be achieved by rescheduling the clear felling of whole stands (Brazee, 2003). Hence such a treatment was included in the experiment.

The expectation is that early clear felling will be better than the "silvicultural" transformation treatments, both because of cost economies of working on a large scale, and because the most valuable (large) trees may be removed. The only treatment that is (definitionally) superior is felling at optimal rotation, but this does not provide the required early revenue.

The design of the creaming treatment

An economically optimal transformation may depend on the preferred final state. However, it is also possible that the costs and forgone revenue incurred in the transformation may make some alternative final state more desirable – or less undesirable. The argument defining an economically attractive final state might go something like this.

We want to take as high a proportion of yield as possible in big trees.

We don't want to remove small thinnings *at all*: even if they could be sold. The reversed J-shaped curve of classical selection may have arisen from observation of natural forests. It may not be necessary for managed forests to replicate it. The traditional prescription for selection forestry, removal of volume from all size classes, and more trees from the smaller size classes, is anathema.

Wide spacing gives wide growth rings, high taper and poor strength qualities. In UK conditions, with the favoured species, fast growth may already be a barrier to premium markets. Even within an evenly spaced stand, larger diameter trees may be of low quality

(Meilby, pers.comm.). (However, where wind stability is a problem, wide spacing may be the only way to achieve desirable diameters before height becomes critical.)
So, we want to grow our big trees in *quite* competitive conditions, especially early in the rotation, when wide rings dimensional instability are likely to result from free growth …
… yet, to recap, without having to take out any more thinnings than necessary …
… except perhaps just a few to give us selection options …
… and at the same time we want big enough crowns late in the growth period, that a sufficient diameter is reached before wind damage becomes a problem.
And we don't want it to cost much.
This means that neither do we want to plant many trees (artificially), nor
… do we want too many to regenerate (naturally) – see 2. above, although …
… a gap big enough to encourage adequate regeneration is desirable.

Relative profitability, once in place

Once this regime is in place, it may be compared with a clear cutting regime in which all age-classes are represented in a normal age-class structure. The following figure shows the difference in capitalised profit between the regimes, at a range of harvesting and regeneration cost differentials. The basis for revenue is that felled trees are each of 1 m^3, at which size they obtain a price close to maximal per m^3. At plausible levels of cost differential, the creaming treatment is more profitable.

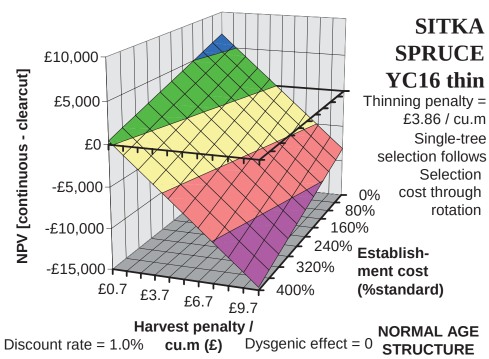


Figure 1. Continuous cover versus clear cutting – regime up and running

Note that, while the discount rate affects the land expectation value of both regimes, it does not affect their *relative* profitability. Both regimes provide a regular annual cash flow, and a constant difference of cash flow, whose capitalised value is inversely proportional to discount rate. This is displayed in figure 2. *The discount rate affects neither whether a regime is profitable or not, nor which of the regimes is the more profitable.*

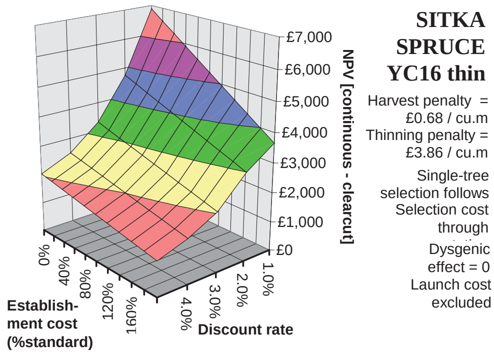


Figure 2: Effect of discount rate on profitabilities

Working the transformation

However, the discount rate may influence whether it is economically advantageous to *change* from clear cutting to continuous cover forestry. (It could also affect whether it is advantageous to change back, if continuous cover forestry turns out to be less profitable than clear cutting.)

Using the premises already discussed, what might be the most economically acceptable treatment, to move from an even-aged forest to one with a continuous cover structure? The following should be borne in mind.

We don't want it to cost much.

We do want it to yield substantial revenue …

… early rather than late.

On the way there, we don't want to take out trees too small, or leave them until too big.

And, on the assumption that the new regime is better than the old one once we get there (else why would we be going there anyway?), the sooner we're up and running, the better.

So, what do we do?

The answer is relatively simple. It corresponds to the earliest rule adopted by humanity for managing forests: take out trees of the size you want, when you want them. Nowadays this is contemptuously referred to by silviculturists and ecologists as "creaming" or "high-grading". Such a prescription also emerges from an economic approach to thinning even-aged stands: take out the biggest trees first, because they earn you the most money, and they are closest to their optimal rotation (Price, 1987, 1988).

So there is not much mysterious about it. It is just not a commonly advocated route to a silvicultural state characterised by obsession with long-term stand development and doing things as expensively as possible.

In practice, the rule used to identify trees for removal was not simply taking the largest trees in the plot, until the required reduction in basal area had been achieved. Because of irregularity of spatial distribution, this would have left substantial gaps in some places. Instead, the area was divided into cells of such a size that removing the largest tree per cell achieved the required reduction.

Relationship of this regime to target diameter cutting

Target diameter cutting is used elsewhere in the UK, including in transformation to continuous cover structure. In these cases, target diameter results from the technical limits of harvesting or processing machinery. The *economic* target is to achieve a suitable basal area for regeneration, by taking out the largest available trees. The economic target may also have a technical upper limit, but it may be smaller than that limit. We may fell also before economic target diameter is achieved in transformation. But once the regime is up and running, we do not want to take out anything below target (optimal) dimension. By contrast, in regular target diameter regimes, low thinning through most of the rotation may be a planned feature.

Possible dysgenic effects

If the largest trees are large because of genetic superiority, their removal early in the regeneration period will somewhat reduce the productivity of the successor trees. On the other hand, large size may simply result from accidental micro-site conditions giving initial competitive advantage. There are indeed indications that small trees grow faster (Zingg and Sterba, 2001). However, this may be for an already uneven-aged crop, where small trees have the physiological vigour characteristic of early middle life. The effect would not be replicated in single-aged crops where large trees may be large precisely because of inherent vigour.

Because of this possible dysgenic effect, part of the plot was replanted artificially in different patterns, one of which established two trees at the site of each "creamed" tree (but not of earlier removals) to give selection potential. This will eventually lead to a substantially smaller number of trees being planted over the transformation period than would be the case over a clear cutting rotation, but in several successive operations.

Note that, once the first regeneration cycle is complete, there is no further dysgenic effect. Although the trees felled continue to be the largest in the crop, they are large because they have been growing longest, not because of superior genetic quality. Maintaining genetic quality through the transformation period is the key.

The seal of disapproval

Significantly, passing silviculturists have referred to this treatment as "economic" thinning; which to silviculturists, it might be supposed, is a term of abuse. (Silvicultural thinning, of course, is purely for the benefit of the trees, or of silviculturists.) A footnote might be appended, that the "silvicultural" treatments were each given two replicates, whereas the two "economic" treatments were allowed only a single replicate – and that, only after a protracted struggle by this economist.

The problem of plot productivities

By misfortune, the experimental plots, which were judged to be uniform in a preliminary survey, turned out to have markedly different productivities. Group, frame-tree and low-thinning treatments had a mean productivity of 20 m^3 ha^{-1} $year^{-1}$, creaming treatment only 16 m^3 ha^{-1} $year^{-1}$ on one site type. Lower productivity was found on another site type, but no creaming plot was included. The premature clear cutting plot had a very high 26 m^3 ha^{-1} $year^{-1}$ – which meant that felling was hardly premature in financial terms. In consequence of these differences, valid comparisons could only be made by modifying the actual results, to indicate what might have happened in a "synthetic stand" with the mean characteristics of the actual stands. The details of this process are not relevant to this paper's main theme, but it was and is being rigorously developed.

Time study results

Detailed time studies were made during the entire period of harvesting. The same two machines (a harvester and a forwarder) and the same two operators undertook all the work. The detail of the time study is given elsewhere. The mean costs per m3 for the different treatments are shown below.

Table 1: Cost of harvesting per m^3 for the experimental treatments

Treatment	Clear cutting	Low thinning	Group felling	Creaming
Cost/m^3	£9.14	£13.00	£12.40 (£11.80)	£9.82
Difference from clear cutting	–	£3.86	£3.26 (£2.66)	£0.68

The figures in parenthesis are estimates. The original group felling cost included the (high) cost for low thinning the area surrounding the groups. Separate figures for groups and surrounds have not yet been calculated.

Details of the volumes and prices net of harvesting cost for the product assortment obtained from each plot (see table 2) were used:
to derive a price–size relationship for long-term modelling;
to calculate short-term cash flows.

Table 2. Proportion of products (%), adjusted for differences in tree volume between plots; highest value products at top of column

Product (type, length)	Clear cutting	Low thinning	Group felling	Creaming
Log, 495 cm	69	57	53	68
Log, 315 cm	12	17	17	13
Bar, 375 cm	6	5	8	2
Bar, 254 cm	4	5	6	3
Stake	4	–	4	0
Pulp, 300 cm	5	16	12	14

Some further economic analyses

Extra cost and saved cost

The extra cost of harvesting in the smaller units and constrained working conditions of continuous cover forestry are not likely to be compensated by greater volume production (Price, 2003). In small group felling – which effectively fells a typical cross-section of tree sizes – it is unlikely that any price premium will exist. And such a premium, if it existed, would only arise at the end of a further growth cycle, from which its value would be discounted before comparison could be made with the harvesting cost penalties incurred in creating the group. Thus groups are not expected to produce larger revenue: they can only be justified by reduced cost of immediate establishment and subsequent protection.
With a measured harvest cost penalty of £3.26 (£2.66) / m^3, a hectare's worth of small plots would cost approximately £1500 (£1200) more to clear, compared with the same area of clear felling. Given an estimated cost of artificial regeneration of £1000 / ha, such a saving seems improbable!

The result of group fellings may not be *more* regeneration, but rather *more controlled* regeneration via management of light levels. This may save on respacing cost as might exist in clear cutting areas, where in UK conditions natural regeneration may fail, but may also appear in embarrassing and unpredictable abundance. However, reported figures of

£300–£500 per hectare for respacing suggest that this cost, too, is worth incurring, rather than the harvesting penalty of group felling.

On the other hand, the measured harvest cost penalty for creaming, £0.68 / m^3, is covered by the better product assortment, both in the long term and immediately. Neither is there any delay between incurring costs and realising higher revenue.

The transformation process

It was agreed between silviculturists and economists that the experimental transformation had begun too late. Already high costs and low revenues had been incurred in early low thinning. Moreover, given the constraint on long rotations imposed by wind hazard, there is little time to complete the first phase of transformation before the remaining crop will have to be cleared.

For this reason, the figures derived from the time study were used in a standard yield model adapted to allow NPV comparisons between clear cutting and:

a) group fellings at the measured harvest cost penalty, transformation being initiated at the least unprofitable time, the one minimising departure from optimal felling time;
b) transformation by creaming, starting at the same time, again using the measured harvest cost penalty.

In either case transformation was considered to be complete by the end of one clear cutting's rotation.

As expected, transformation to group felling would entail loss of profitability, unless there is some increase in revenue, as in figure 3. It is, however, difficult to envisage why revenue should increase under group felling.

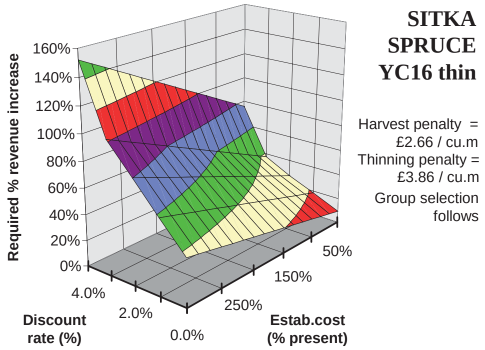


Figure 3. Required revenue gain to justify transformation by group felling.

To the losses incurred through the harvesting penalty, are added those caused by untimely felling. These are apparent in figure 4, in which no harvesting penalty has been applied. Where establishment costs are equal to those of clear cutting, nonetheless transformation incurs a loss, which disappears as the discount rate goes to zero: at this point, the short-term opportunity costs of transformation become insignificant, compared with the long-term equality between the two regimes: any regeneration cost advantage to group felling makes it (slightly) more profitable than clear cutting.

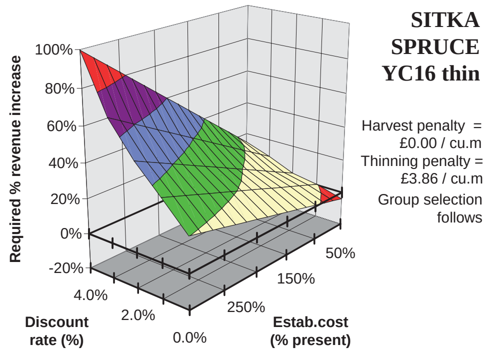


Figure 4. The same, but with no harvesting cost penalty.

Creaming treatment compared with clear cutting

By contrast, creaming transformation is superior to retaining the existing clear cutting regime under a broad range of conditions. Figure 5 shows the comparison between creaming transformation, and continuing with clear cutting, all costs of transformation now being included.

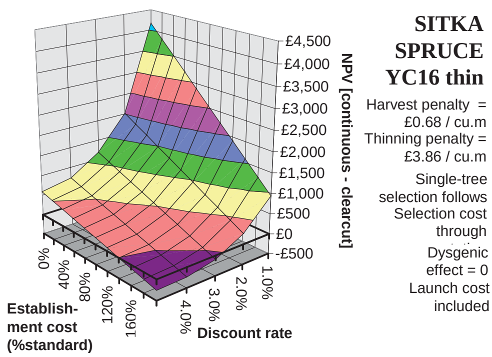


Figure 5. Costs, including those of transformation itself.

As can be seen, even at high discount rates, it is worth transforming using creaming, except with a much-greater-than-normal establishment cost.

Figure 6 shows the results, if there is a dysgenic effect, such that productivity drops by 20% as a result of the transformation.

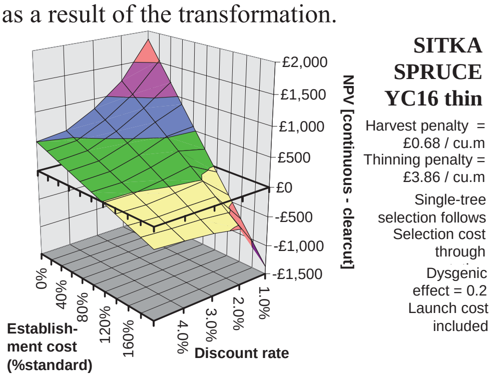


Figure 6. The same, but with a 20% dysgenic effect.

The positive results at a high discount rate indicate that in the short term (first cut) and medium term (during transformation) the transformation to continuous cover forestry offers greater profitability than clear cutting. By contrast, at low discount rates loss of long term productivity is more important than the immediate advantages of felling large trees, if establishment costs are no higher in the transformed system.
The dysgenic effect can be avoided by undertaking artificial regeneration. A preliminary time study has been undertaken, of artificial regeneration following creaming. One treatment was at a much lower density than the original, with a view to avoiding the need to take out small trees as thinnings. (In the ideal regime, there is no thinning as such: increase of light to the growing trees is achieved by felling trees of target size.) Artificial regeneration is only needed during transformation. Thereafter, removed trees are large because they are old, not because they are genetically superior.

Early revenue: the least-cost method

Suppose a forest owner wished to raise a certain extra amount of revenue in the short term, or at some specific point in time. It has been proposed that this can be achieved by initiating transformation to continuous cover forestry. It should now be clear that a creaming-based transformation may be able to do so at less cost than by felling small groups. But premature clear cutting offers a further option. Table 3 compares the cost of raising £10 000 by group cutting and premature felling, at various ages for the crop. The cost is calculated from the number of hectares that would have to be treated to reach the target amount of money, multiplied by the loss of NPV resulting from applying the treatment, rather than continuing with clear cutting on an optimal rotation. Costless regeneration following group felling is assumed. As creaming is superior to clear cutting anyway, under reasonable assumptions, no calculations have been made for it: a rational owner would wish to initiate it anyway, irrespective of the need for early revenue.

Table 3. The cost of raising £10 000 by initiating transformation at various crop ages

	Extra revenue generated per hectare (£)	Loss / ha (£) compared with clear cutting on optimum rotation (present value at age of obtaining revenue)	Hectares to treat to obtain £10 000	Overall loss (£)
At age 27				
Group felling	28	944	357	337 000
Premature clear cutting	860	3361	12	40 000
At age 37				
Group felling	260	854	38	32 000
Premature clear cutting	3750	1679	3	11 000

Even with favourable assumptions about regeneration cost, group felling is not the best option, and early in the rotation it results in unthinkable loss of profit. If creaming is, for some reason, not feasible or desirable, early clear cutting is a much less costly way of obtaining revenue, at all stages of the crop's life.

Conclusions

If an economically attractive silvicultural regime is wanted, it is best designed with economic considerations in mind. There may yet prove to be unforeseen or not-incorporated problems in the regimes designed for this experiment. However, such problems of innovation are unlikely to be either confirmed or circumvented, by resolutely refusing to do anything different from the regimes that have evolved within traditional silviculture.

In the foregoing, “economic” has been used in its confined sense, of having to do with the making of money. In the broader sense of the word, of course, externalities, distortions and distribution are also part of being “economic”. There are intertemporal distributional judgements embedded in discounting; an opportunity cost less than the market wage might favour some of the labour-intensive operations inherent in continuous cover forestry. Otherwise, distribution and distortion have doubtful relevance to this choice of silvicultural regime. But externalities, particularly environmental ones, have often been urged in favour of continuous cover forestry. There are, however, some arguments that suggest continuous cover forestry may have environmental disadvantages too (Price, 2003). For the private forest owner, sometimes struggling with low timber prices, the main question that may be asked about alleged non-market benefits is, how are they to be paid for? If a silvicultural regime has prospects of paying for itself in short and long term, as it appears creaming transformation may, the provision of environmental benefit to society becomes less of an issue.

Acknowledgements

We are grateful to the following, who were instrumental in designing, setting up, making measurements for, and commenting on results of this project: Christine Cahalan, John Healey, Arne Pommerening of SAFS; Sam Catchpole, Carl Foster and Chris Jones of Forest Research Wales; Andy Hall, Duncan Ireland, Bill Jones of Forestry Commission Technical Development; Bill Mason of Forest Research and of course the forest owner, George Johnson, who also supplied the research facility and provided many back-up services. Lyndon Cooper and John Lewis, the machine operators, and Mark Price, supervisor for the contractors, ensured that the experimental treatments were dealt with in, as far as possible, a manner representing good commercial practice. John Winterbourne of the Forestry Commission (England) provided key ideas for the design of the creaming transformation process. We acknowledge with thanks the financial support of Forestry Commission Wales for this project.

References

Brazee, R.J. 2003. The Volvo theorm: from myth to behavior model. In Helles, F. Strange, N. and Wichmann, L. (eds*). Recent Accomplishments in Applied Forest Economics*. Kluwer, Dordrecht, pp.39-48.

Knoke, T. and Plusczyk, N. 2001. On economic consequences of transformation from a Spruce (*Picea abies* (L.) Karst.) dominated stand from regular into irregular structure. *Forest Ecology and Management* 151, 163-79.

National Assembly for Wales 2001. *A Woodland Strategy for Wales*. National Assembly for Wales, Cardiff. 49 pp.

Price, C. 1987. Further reflections on the economic theory of thinning. *Quarterly Journal of Forestry* 81, 85-102.

Price, C. 1988. One more reflection on the economic theory of thinning, *Quarterly Journal of Forestry* 82, 37-44.

Price, C., 2003. The economics of transformation from even-aged to uneven-aged forestry. In Helles, F. Strange, N. and Wichmann, L. (eds*). Recent Accomplishments in Applied Forest Economics*. Kluwer, Dordrecht, pp.3-17.

Price, M. and Price, C. 2006. Creaming the best, or creatively transforming? Might felling the biggest trees first be a win–win strategy? *Forest Ecology and Management* 224, 297-303.
Sterba, H., Zingg, A., 2001. Target diameter harvesting – a strategy to convert even-aged forests. *Forest Ecology and Management* 151, 95-105.

Superficial citizens and sophisticated consumers: what questions do respondents to stated preference surveys really answer?

Colin Price

Abstract
Stated preference surveys have been criticised for many biases and uncertainties, including whether the "product" valued is seen symbolically or as means to "moral satisfaction". Recently, criticism has focused on their propensity to elicit consumer valuations, in a context where citizen values are deemed more appropriate. Thus surveys have been conducted which explicitly elicit citizen values. Often these emulate the format of a referendum. It is not clear that in a referendum people would vote other than for their own best interest. Nevertheless, reflecting in citizen mode is likely to restructure people's values. A genuinely selfless citizen would promote "the best good of all", which is largely an aggregate of individual values, with some ill-defined communitarian supplement. Understood in these senses, values revealed from citizen-format questionnaires may better represent consumer values than consumer-format questionnaires do: they legitimise the profession of individual values, and reduce problems of protest votes and of confusion between "willingness to pay" and "willingness to play" (the valuation game).

Introduction
Ever since the first sceptic asked an economist "How can you put a value on a beautiful sunset?", the answer "well, you could ask people what they were willing to pay for it" has hung in the air. In a formal sense, however, the contingent valuation method (CVM) has emerged as a technique within the armoury of cost–benefit analysis over the past 50 years.

From the early days (Davis, 1963; Bohm, 1972; Randall *et al*., 1974; Brookshire *et al*., 1976; Price, 1978) it was recognised that the approach, for all its straightforward honesty, was beset by potential problems of understanding and of bias. Such problems were most evident for environmental goods which were not usually embodied in economic choice: as when they formed the background to everyday life (where CVM is subject to hostility bias, and rejected for ethical inappropriateness); or, contrariwise, when they were distant and exotic elements of global environment, which a respondent conceived and enjoyed *in absentia*, as a mental construct (where CVM is subject to hypothetical and part–whole biases).

This paper focuses particularly on the difficulties arising from symbolic values, moral satisfaction, protest bids, and the perceived distinction between consumer and citizen roles. It suggests that the "citizen" perspective is important, less for the different kind of value that it reveals, than for facilitating the revelation of true self-interest; and that this quantified self-interest is more useful to researchers than a hard-to-interpret "true" citizen value.

It draws partly on the results of small samples from atypical populations. These would clearly be an inadequate basis for valuing environmental resources. They do, however, adequately demonstrate weaknesses and errors that may arise from assuming that respondents actually answer the question appearing on the questionnaire.

Ghosts at the contingent valuation banquet

The contingent valuation method has been hailed, explicitly or by implication, but in all cases misguidedly, as:

- the only way to reveal passive use values (Department of the Environment, 1991);
- the preferred way to value non-market effects in cost–benefit analysis (Mitchell & Carson, 1989);
- an alternative to cost–benefit analysis.

Despite its dominance in current environmental economics, however, it is just one among eight broad approaches to valuing environmental effects within the cost–benefit analysis framework (Price, 2003).

Moreover, its potential problems have always been recognised. For example, the question "what are you willing to pay …?" might seem unethical, or unfamiliar to respondents. There are strategic incentives for respondents to misrepresent true willingness to pay (though interestingly Bohm (1972) found little evidence of such strategic bias).

In recent times, the literature has grown astonishingly, such that only those researching the topic full-time could hope to keep up. Much literature concerns particular applications, which blithely ignore or skip round fundamental problems. Much concerns attempts to resolve particular problems of questionnaire design and analysis. Some undermines the meaning of questionnaire responses. No short paper could review it all, and it has become traditional to confine review to what bears on the authors' own interests. This tradition is followed here.

Among the unresolved problems are:

- protest bids, in which a stated zero willingness to pay represents ethical objection to the question;
- part–whole bias, in which the offered specific environmental good is treated as symbolic of environmental values generally;
- "purchase of moral satisfaction" (Kahneman & Knetsch, 1992), whereby the respondent signifies a desired image or self-image.

It is not difficult to find evidence in follow-up questions which reveal each of these.

Many authors, with Sagoff (1988) prominent among them, have asserted that evaluations made by individuals *as consumers* do not reflect the judgements they would make *as citizens*. Importantly in the context of this paper, Sagoff attributes different preferences in consumer and citizen contexts to sets of individual values which change with context. In fact, however, a citizen context may offer options (such as solution of a free-rider problem) which are unavailable in the individual choice context (Price, 2000). It is no surprise if different preferences are expressed, when the set of options changes. Moreover, the consumer valuations which Sagoff believes CVM to elicit are not, he also believes, importable to cost–benefit analysis. But, for related reasons, the values elicited by alternative, citizen-orientated decision processes, such as deliberative democratic forums, are even more susceptible to damaging biases (Price 1999b).

Among the proposed correctives for these perceived problems are the following two.

1. The emergence of choice experiments (Sievanen, 1992; Adamowicz, 1995) may be partly attributed to the perceived problems of symbolic values and moral satisfaction. Instead of confronting a stark choice between money and environment, the respondent face two or more packages, each of which at minimum contains a given level of an environmental good and a given level of monetary payment or reward. This approach can be traced back to the work of political scientists (e.g. Hoinville, 1971) on social preference. It represents an economic equivalent of cross-cutting in the political arena, in which packages are offered for debate which do not pit one constituency's values against another's, but rather offer, within each package, positive elements for every constituency (Alston & Freeman, 1975). In the consumer–citizen context, such choices move the ethos away from cash purchase, which is central to the notion of

being a consumer, and present money as just one of a number of worthwhile things to have, a framework which relates more closely to that of social choice.
2. The contingent referendum approach attempts to model social choice by casting the questionnaire in the form of a proposal which seeks democratic approval. In some European countries the referendum is a familiar format of social choice. Answering honestly may be seen as an expression of responsible citizenship, rather than of the self-interested consumership which CVM seems to encourage. (However, democratic referenda have also been subject to criticism, in relation to intensity of preference, and strategic response (Price 2000).)

Post-CVM questions: reflecting on motivations

In order to obtain information on the processes behind a particular answer to a contingent question, it has become a frequent stratagem to ask follow-up questions, on such matters as:

- How do you see yourself? As a consumer? as a good citizen?
- Why were you not willing to pay the suggested amount of money? This often seeks to identify protest votes (Edwards & Anderson, 1987; Ovaskainen & Kniivilä, 2005).
- Why did you answer in that way? For example, asked *why* they had expressed a certain willingness to pay for *Rafflesia priceiana* (syn. *Rafflesia arnoldii*), respondents gave the following answers (Price, 2000).

Table 1. Reasons for expressing a passive use value for *Rafflesia*

	Reason for giving this value for the species	Number of responses
I	I knew about the importance of this species	2
II	I believe that genetic resources should be maintained intact	9
III	I suspected that this species does not really exist	6
IV	I thought you would not have asked these questions if it wasn't important	
V	I want to be seen as someone who is concerned about nature conservation	
VI	I didn't know anything about it	13

Of these, responses II, III and IV are evidently symbolic, and response V suggests a quest for moral satisfaction.

However, not all self-revelation about motives (especially in face-to-face interviews) is flattering to the respondent, and *responses* such as V may under-represent the prevalence of the *motivation* in the population.

Similarly, respondents to a question about the value of a red squirrel conservation programme clearly had loaded their interpretations with many values in addition to the cost of the squirrel's local extinction (Price, 2001).

Consumer-orientated contingent valuation versus citizen-orientated referenda

Declared willingness to pay – or to accept compensation – for an environmental change depends on the context of choice (Knetsch, 2005). Although there has been much discussion of the distinction between responses to consumer- and citizen-orientated questionnaires, practical tests do not have a uniform finding. Curtis & McConnell (2002) found similar responses to questionnaires designed to elicit citizen and consumer responses. Wyatt (pers.comm.) also reported no significant difference between formats, when the valued object was a clean bathing beach in Greece – suggesting that the beach was considered an essentially commercial holiday experience. By contrast, Ovaskainen & Kniivilä (2005) found large and significant differences in willingness to pay extra taxes for additional conservation measures, in freely and publicly accessible forests.

Blamey (1996) explores potential sources of difference from the perspectives of psychology and social choice literature. He appears to argue that probabilities of achieving the desired outcome and having to pay for it are asymmetrically arranged in citizen and consumer formats. This *could* be the perception, but it would be realistic for the respondent to assume "no product, no payment", equally for both formats.

In the following discussion, a common-sense approach is adopted to the question: why *should* monetary valuations differ in the consumer and citizen contexts?

Cognitive altruism

Altruism is much discussed in the wider literature of economics, but the terminology is not well agreed. I will use the term "cognitive altruism" to mean that a respondent casts himself or herself, naïvely perhaps, as a kind of citizen cost–benefit analyst. Such a person would give a higher value to a project by making judgements about, and including, the benefits it offers to fellow-citizens. Explicitly, one might say "there is this much value to me, and I must increase that value in proportion to however-many-people receive benefit, and with regard to how my personal valuation stands in relation to an average value – if only I knew these things!" The informational requirements – knowing how typical one's valuation is likely to be, knowing how many people are affected – are onerous. They lie beyond an individual's capacity, being data that even professional cost–benefit analysts struggle to gather.

Moreover, empirical evidence shows that this can hardly be what is in people's minds. To scale up personal values to those for the whole community would mean multiplying personal values by thousands or even millions. Yet the multiple between consumer and citizen valuations is typically much more modest – two-fold in Ovaskainen & Kniivilä (2005).

But if respondents scale up benefits to themselves by the supposed affected population, they should also scale up the cost to themselves, because everybody will pay the *same tax* as well as receive the *same benefit*. If they consider everyone to be like themselves, there should be no difference of result between consumer and citizen formats: a worthwhile individual cost for the individual's benefit, scaled up by the relevant population, is a worthwhile community cost for the community's benefit. Respondents can handle this judgement by knowing no more than "an unknown number of people are affected" and "I believe myself to be typical of these people".

"What am I willing to pay for the satisfaction of all humanity?" is not at all the same question as "What should each individual sacrifice for his or her own satisfaction, according to my judgement?"

Brookshire *et al*. (1976) argue that those who believe they will enjoy a higher-than-average benefit have an incentive to exaggerate willingness to pay fees or taxes: the cost will fall equally on all, but this group will receive a great-than-average share of the benefit. However, this will be so equally in consumer and citizen formats, unless citizens, but not consumers, make self-denying adjustments to allow for their atypically high valuations. (Similarly, consumers believing themselves to enjoy a lower-than-average benefit have an incentive to understate true willingness to pay. In practice Brookshire *et al*. found no evidence of the bimodal distribution of willingness to pay that would result from such strategic bidding.)

The warm glow of moral satisfaction: affective altruism

Cognitive altruism (except that which merely scales up costs and benefits to oneself) neither is intrinsically very plausible, nor does it tally well with experimental results. By contrast, the satisfaction derived from favouring some community proposal is a matter of common experience, and common report (9% of the assessed value of wetland conservation was explicitly attributed to this cause (Price, 1999a)). To value a warm glow requires no calculation of how extensively the advantages of the proposal will be experienced: it is just something I experience myself, within the bounds of my current understanding of how widely benefits will be shared. The warm glow has sometimes been attributed to interdependent utility functions: the pleasure you derive from something, really adds to my pleasure. Yet the warm glow of moral satisfaction remains an individual value: it would really exist, even if the subject of the warm glow (other people's pleasure) was never in practice fulfilled, but not *known* to be unfulfilled. It shares this feature with the option value of conservation.

Warm glows may be stimulated and given legitimacy by a citizen format of question. *It is right and proper to feel good about the well-being of the whole society: yes, I recognise within myself that aspect of being a good citizen; I shall give that feeling full scope to express itself ….*

Now there is no reason why a sophisticated consumer could not recognise this warm glow as a personal value, which makes one's own life pleasanter. But even such a one might respond to a direct injunction to consider "solely your own welfare" as being an explicit directive from the interviewer to filter out such warm-glow sensations.

Sophisticated consumers: the demeaning view of self

Take the following "consumer" questionnaire format (Ovaskainen & Kniivilä, 2005). The preamble included the direction "Consider the pros and cons of the alternatives solely from the point of view of your own welfare." The following question asked: "Would you personally be willing to pay FIM X yearly as an extra tax …." At the most extreme, such a format could be read with the subtext "Consider your own narrow-minded, self-interested pleasure" or even "Do you wish other people to consider you as a narrow-minded, self-interested pleasure seeker? If so, please take this question seriously, and answer with a big value." (And it should be said that some CVM formats emphasise more strongly than this one did, the individualistic element of purchase of an environmental product.)

Contrast this with the direction given in the "citizen" questionnaire format: "Consider the pros and cons of the alternatives as a citizen from the point of view of your own welfare as well as the whole society." The question asked "If [the conservation measure] caused you an extra yearly tax of FIM X, would you vote for preservation?" Could the subtext be "In your role as a good citizen, taking account (as no doubt you do) of the broad welfare of your fellow-citizens, would you vote …"? Use of the words "citizen", "society" and "vote" shift emphasis from a context of pursuing individual self-interest, to one of acting for the good of the community: "Do you wish other people to consider you as a public-spirited, responsible citizen? If so, please take this question seriously, and answer with a big value."

This difference of formats, then, may not only distinguish an individual's roles in society, but offer a different way of looking at him- or herself, or the kind of person he or she wishes to be seen as. It would not be surprising if such differences in the invited self-perception changed people's "willingness to *play* [the game of valuation]". To accept playing the game might entail acceptance of whatever picture of self it is, that the questionnaire format leads towards. The citizen format seems to present, for most people, a more attractive self-image, and so is likely to be acceptable more frequently. And indeed, Ovaskainen & Kniivilä (2005) found a much lower proportion of protest votes among respondents to the citizen format question.

Sophisticated consumers: the degraded product

Even if respondents are prepared to volunteer some willingness to pay for a proposal in consumer format, the format may make the product seem less worth paying for. Willis (1994) records a mean stated willingness to pay for entrance to Durham Cathedral (a World Heritage Site) of £0.45 per head. Yet at that time the mean *voluntary* donation was £0.48 per head. By

contrast, the expectation is that voluntary donations would understate true willingness to pay, because of the free-rider problem (Price, 1994). The explanation may be that a cathedral to which entrance is free is *a more valuable product* than one that is treated as a market product. Some things lend themselves to the consumer ethos less than others do.
Focusing respondents' attention on individual benefit from public proposals similarly may make them seem a less valuable product than one presented as a shared resource.

Why would anyone vote in a referendum for something other than their own interest? It seems to be widely assumed that in referendum format respondents will choose altruistically (however defined). But why should they? In real-world referenda, do people do anything different from voting for their own interest? That self-interest may include the pleasure derived from the well-being of cherished others, and pleasure derived from seeing justice prevail, and avoiding the bad feeling of acting badly by other people: it is self-interest nonetheless. Why would *voters* wish to be less happy than they might be, any more than *consumers* would?

Why would we *want* them to vote against their own interest?

In praise of self-interest

Customary critiques of CVM, and even of cost–benefit analysis, often take it for granted that self-interest is an abhorrent propensity, vigorously to be excluded from evaluative processes. By contrast, Adam Smith (1776), a founding parent of modern economics, famously believed that pursuit of self-interest within a free market would, by the guidance of an "invisible hand", achieve the best good of all. Environmental economics identifies why the invisible hand of the market fails (particularly, through the existence of externalities), seeks values for what is not valued through the market, and (sometimes) tries to co-opt the invisible hand by creating markets for what is not traditionally marketed (Mantau *et al*., 2001; Pagiola *et al*., 2002).

Seen in this sense, the evaluator's task is, precisely, to elicit self-interested consumer values, that may stand on the same ground as existing market prices, which themselves are formed by the exercise of self-interest. Environmental economists generally acknowledge the virtue of everyone determining values for themselves, and recognise that, if the economic valuation system is abandoned, other modes of choice must be substituted: these themselves are not immune to distortion and unequal exercise of power – indeed, the citizen values revealed and debated in the forum of deliberative democracy suffer many of the problems that arise in interpreting CVM (Price, 1999b, 2000).

Such a perspective may be unacceptable to those who cherish a more socialised concept of choice. However, the perspective presented here does not deny that people are concerned about the well-being of others. It just asserts that such a concern is internalised in their own well-being: this is a quite adequate basis on which to create a caring community – and possibly a more reliable basis than one which requires people to act against their own interest (Price, in process). Within this perspective, warm glows are part of consumer values, as much as of citizen ones.

There is a particular class of benefit, shared with others, that may be termed a *communitarian* value. For example, I value a free national health service not just because it provides health care for me (which I could achieve by private health insurance), but because I value the fact that everyone else has the same access as I do myself. This is a preferred state even to knowing that everyone else had private health insurance, because its provision is an expression of togetherness. A sedate lady hymn-writer (Larcom, 1931), living in the USA at the time of that country's rapid capitalist expansion, expressed the view in these surprisingly seditious lines.

I learnt it in the meadow path,
I learnt it on the mountain stairs:
the best things any mortal hath
are those which every mortal shares.

The grass is softer to my tread
because it rests unnumbered feet;
sweeter to me the wild rose red
because she makes the whole world sweet.

Wealth won by others' poverty?
Not such be mine! let me be blessed
only in what they share with me
and what I share with all the rest.

Perhaps these lines were admitted to the hymn book only because the compilers failed to understand their full economic meaning. It is not just a hymn in praise of public goods, but one repudiating the factor shares produced by the market.

But this care for community, too, becomes internalised as an individual value: again our personal well-being depends on the well-being of others. Do we teach such an attitude to our children? If yes, why? Presumably because we believe, from experience or from discourse, that concern for others is both rewarding for self, and creates motivations by which the objectives of a democratic society may be achieved. (I doubt that this can be an original thought, and I take this opportunity to apologise to those philosophers and political theorists of the past whose works I have not had time to read and to honour with a reference. I particularly suspect that John Stuart Mill would have been here before.)

It is essential, then, to avoid assembling a value for a proposal which merely looks at the countable benefits it delivers, without considering the *framework* of provision. With that, the critics of cost–benefit analysis would agree.

Constituting a legitimate cost–benefit analysis

How, then, should a cost–benefit analysis be constructed, bearing in mind the discussion above?

Firstly, the relevant willingness to pay is that *of* the individual respondent *for* that individual respondent's perceived benefit. According to McConnell, 1997), no altruistic assessment of benefits accruing to others is required, nor is it desirable.

… genuinely altruistic values impart no utility except whatever is directly experienced by the ultimate beneficiary: it is circuitous and inaccurate (and contrary to the spirit of neo-classical economics) to evaluate them by reference to a third party's assessment of their importance (Price, 1997).

And

… such altruism, while morally praiseworthy, represents no additional benefit: it merely double-counts values accruing to other contemporaries and to future generations, which a well-constructed cost–benefit analysis would account for by other, more reliable means. (Price, 2005)

As it happens, affective altruism may not be a problem in practice: when explicitly offered the option, no-one in a survey of willingness to pay for conservation claimed anything identifiable as an affective altruistic motive (Price, 1999a). One may doubt whether such a pure motive would actually exist, even if it was declared. As it happens, too, it does not matter if respondents engage in cognitive altruism, provided

- they take account of costs as well as benefits accruing to others, and
- they project to others the same valuation that they ascribe to themselves.

Although we do not need, and do not wish, respondents to be altruistic, if their altruism takes the above (reasonable) form, their responses can be interpreted as though they were the respondent's individual valuation. A representative sample of the population provides the required unbiased estimate of individual values. This remains the case, even if some respondents treat the valuation individualistically, and others engage in cognitive altruism.

What *is* problematical are incorporated judgements, that other people's values will be in some systematic way different from one's own. The poet William Wordsworth (1844), in his conservative later years, wrote:

The imperfectly educated classes are not likely to draw much good from rare visits to the [Lake District of England] … [and] the humbler ranks of society are not, and cannot be, in a state to gain material benefit from this beautiful region.

We would not, I think, wish to reflect such elitist judgements in a cost–benefit analysis. There is no need for them. In properly designed and representative surveys, each segment of society has the opportunity to represent its own interest. The format of the questionnaire should encourage respondents to do so.

The objection may be envisaged, that such a valuation, made in the spirit of cost–benefit analysis, takes no account of the values people hold and wish to express as citizens. Yet why need it do so? *What should the good citizen desire, except the satisfaction of the needs felt by the individuals constituting the community?* If an additional value inheres in this good citizen's desire, then it can only be rightly attached to what would, in any case, be the preferred outcome in an appropriate cost–benefit analysis. In fact, the closest we can get to cognitive altruism is a kind of quasi-true-altruism, in which we make a periodic contract with ourselves to accept the results of cost–benefit analysis, even when they are against our interest and we intuitively prefer another outcome. But such a citizen's value has the same magnitude, irrespective of the actual outcome of the evaluation, and so does not weigh in favour of any particular proposal.

Obversely, if what is seen as "good citizenship" entails anything different from concern for the well-being of all who constitute the community, it is in fact self-serving *bad* citizenship. It may lead to defence of special interests, and excessive expenditure of resources.

Thus the elicitation of self-interest, understood in this embracing sense, is the duty of the responsible researcher: *that* self-interest and no more.

It is not denied that shared projects have value to the community, on top of the utilities the project is designed to deliver. These are however values that may be felt and anticipated by respondents, and incorporated in their individual valuations of the community projects. The real difficulty is a subtler one. Bread is not a public good, but I would be happier if I knew that it was provided to the world community in sufficient quantity. Now cost–benefit analysis should work on a level playing field, and its opportunity costs should therefore also include a mark-up for the communitarian values of any *alternative* means of disbursing funds. This is a possible reason for *excluding* some communitarian values: not that they are *unreal*, but that they are *pervasive*. Here, the opportunity cost of project finance is relevant: if the project is financed from taxes, would any private expenditure forgone involve not only forgone benefits measured at market prices, but also forgone communitarian values not measured at all? Perhaps it would not be so, but the question ought to be asked.

If people take broadly self-interested decisions, whatever the format of questionnaire may be, then the need is to elicit that self-interest *fully*, but not *in excess*. Contingent referenda, as to a citizen, are to be preferred to classical contingent valuation, precisely because they enable the citizen to respond genuinely as a self-interested consumer. And to respond free from the fear of the interviewer's (perhaps imagined) disapproval of self-interest, and from the corrosive aftermath of self-censure. In this context, protest bids are also likely to be less prevalent (Ovaskainen & Kniivilä, 2005).

By contrast, the consumer format may demean the respondents' self-image, and degrade the perceived value of the offered product. And, if the consumer format is "successful" in persuading respondents to ignore that part of their personal utility which derives from the utility of others, it becomes an incomplete assessment of personal utility: instead of avoiding double-counting of altruistically declared values as intended, it promotes under-counting of self-satisfying warm glows.

The citizen referendum format may for this reason elicit consumers' values more accurately than the consumer format does, and estimate consumers' values better than it does citizens' values (the greater part of which may illusory and valueless, as they are commonly understood).

However, the project to be valued should not be given special status. Citizen-orientated questionnaires may induce a more reflective attitude to communitarian values, and create genuine values that did not exist before. But, in doing so, they make respondents unrepresentative of the whole relevant population, the great majority of whom have not been stimulated into this more reflective state. Thus respondents' values cannot legitimately be scaled up to the whole population (Price 1999a).

Moreover, the questionnaire may create a symbolic response, such that an excessive proportion of the portfolio of warm glow and communitarian values is attached to the proposal being valued: an individual's feelings about nature conservation for example, and about warm glow and communitarian values, load onto the particular proposal, temporarily, because this is the only opportunity offered to express such feelings. The revealed willingness to pay (taxes) may then express moral satisfaction about "acting rightly" or "caring about the proper things".

But truly virtuous moral satisfaction is not a function of a *particular* choice, but rather of *any* choice that maximises well-being in general. Moral satisfaction is a legitimate utility, but its annexation by a particular questionnaire response is not. Indeed "moral *self*-satisfaction – that is, satisfaction with self rather than with morality – is an anti-communitarian attitude, likely to be obstructive to the best satisfaction of the community's wishes.

It may even be that only a strictly limited amount of well-being can be derived from warm glows: thus denial of the opportunity to realise one potential source of warm glows may merely displace the warm glow to another project. In this case the fulfilment of a particular project may offer no addition to the total of warm glow values.

To avoid any supercharge of altruistic, warm glow and communitarian values that might be induced, while also avoiding the demeaning and degrading influences of a narrowly self-interested format, the willingness to pay question should be phrased somewhat as follows: "Please only consider your own viewpoint and wishes about this issue. We shall be asking a cross-section of the population similar questions, so they will have the opportunity to represent their own interests." This, while emphasising the communal nature of the decision process, defines relatively clearly the individual's role within it.

Further, the format of choice experiments, in which nothing is headlined as the "moral, environmentally and socially responsible choice", is to be preferred to a questionnaire in which only one (community) project is proposed, with saving of (the individual's) money the only alternative.

The objective of the referendum format is to elicit a value for use in cost–benefit analysis. Consonant with other values entered in cost–benefit analysis, the mean willingness to pay is the appropriate value. The median willingness to pay is a guide, should anyone want it, to the maximum tax that could be proposed in support of the project, without the project's being rejected in a referendum. It has no particular relevance to cost–benefit analysis.

Conclusions

Consumers are not just mindless graspers after instant and personal gratification. Their behaviour, in life decisions and in markets and in responding to questionnaires, shows they are more sophisticated than that. Their own gratification includes what arises from anticipating the gratification of others, and this, arguably, is both part of what they are willing to pay for, and a genuine addition, which cost–benefit analysis should include, to the well-being of a caring community. If this is *not* part of what consumers are willing to pay for, then no addition should be made to the values which other consumers experience for themselves: these values should be included in cost–benefit analysis directly, rather than through the vicarious estimation of fellow-consumers.

On the other hand, the superficiality of citizens *acting as citizens* lies firstly in their supposing that it is their task alone, to represent the interests of the community. It is ingenuous of citizens to suppose that they have the knowledge to judge benefits to the whole beneficiary community. Those who consciously and obdurately act as such citizens, by guessing at the values which other people hold, introduce unnecessary inaccuracies to the evaluation of public proposals. It is superficial also to suppose that in expressing moral self-satisfaction, one is seeking satisfaction of the community's moral needs.

The ethos of western politics at the end of the twentieth century made a virtue of the individual's pursuit of self-interest. But markets and quasi-markets have delivered externalities and injustice. We need to be careful not to accelerate the counter-swing of the pendulum by decrying individuals' estimation of values accruing to themselves. If individual consumers are sophisticated enough to know their real values, we should encourage them to divulge such values. In this way, we can help to construct the outcome that a sophisticated and generous-spirited citizen would desire: the best good of all.

Acknowledgements

The thoughts embodied in this paper, which have existed in nebulous form for many years, took firmer shape while I was involved in examining the doctoral thesis of Matleena Kniivilä at Joensuu University in 2004. I am grateful to her, and to Ville Ovaskainen and Olli Saastamoinen, her co-authors in some of its constituent papers, for this stimulus, and for further discussion of the ideas embodied here.

References

Adamowicz, W.L. 1995. Alternative valuation techniques: a comparison and movement to a synthesis. In: Willis, K.G. and Corkindale, J. (eds), *Environmental Valuation: New Directions.* CAB International, Wallingford, pp.160-77.

Alston, R.M. & Freeman, D.M. 1975. The natural resources decision-maker as political and economic man: towards a synthesis. *Journal of Environmental Management* 3, 167-183.

Blamey, R.K. 1996. Citizens, consumers and contingent valuation: clarification and the expression of citizen values and issue-opinions. In Adamowicz, W.L., Boxall, P.C., Luckert, M.K., Phillips, W.E. & White, W.A. (eds). *Forestry, Economics and the Environment*. CAB International, Wallingford, pp.103-33.

Bohm, P. 1972. Estimating demand for public goods: an experiment. *European Economic Review* 3, 111-30.

Brookshire, D.S., Ives, B.C.& Schulze, W.D. 1976. The valuation of aesthetic preferences, *Journal of Environmental Economics and Management* 3, 325-46.

Clark, J., Burgess, J. & Harrison, C.M. 2000. "I struggled with this money business": respondents' perspectives on contingent valuation. *Ecological Economics* 33, 45-62.

Curtis, J.A. & McConnell, K.E. 2002. The citizen versus consumer hypothesis: evidence from a contingent valuation survey. *Australian Journal of Agricultural and Resource Economics* 46, 69-83.

Davis, R. 1963. Recreation planning as an economic problem. *Natural Resources Journal* 3, 239-49.

Edwards, S.F. & Anderson, G.D. 1987. Overlooked biases in contingent valuation surveys: some considerations. *Land Economics* 63, 168-78.

Hoinville, G. 1971. Evaluating community preferences. *Environment and Planning A* 3, 33-50.

Kahneman, D. & Knetsch, J.L. 1992. Valuing public goods: the purchase of moral satisfaction. *Journal of Environmental Economics and Management* 22, 57-70.

Knetsch, J.L. 2005. Behavioral economics and sustainable forest management. In: Kant, S. & Berry, A.L. (eds), *Sustainability, Economics and Natural Resources: Economics of Sustainable Forest Management*. Springer, Amsterdam, pp.91-103.

Larcom, L. 1931. I learned it in the meadow path. In: Anon. (ed.). *Songs of Praise*. Oxford University Press, p.199.

Mantau, U., Merlo, M., Sekot, W. & Welcker, B. 2001. *Recreational and Environmental Markets for Forest Enterprises: a New Approach towards Marketability of Public Goods*. CAB International, Wallingford. 558 pp.

McConnell, K.E. 1997. Does altruism undermine existence value? *Journal of Environmental Economics and Management* 32, 22-37.

Mitchell, R.C. & Carson, R.T. 1989. *Using Surveys to Value Goods: the Contingent Valuation Method*. Resources for the Future, Washington. 488 pp.

Ovaskainen, V. & Kniivilä, M., 2005. Consumer versus citizen preferences: evidence on the role of question framing. *Australian Journal of Agricultural and Resource Economics* 49, 379-94.

Pagiola, S., Bishop, J. & Landell-Mills, N. (eds) 2002. *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development*. Earthscan, London. 299 pp.

Price, C. 1978. *Landscape Economics*. Macmillan, London. 168 pp.

Price, C. 1994. Donations, charges and willingness to pay. *Landscape Research* 19 (1) 9-12.

Price, C. 1997. Valuing biodiversity: what, how and by whom? *Scottish Forestry* 51, 134-42.

Price, C. 1999a. Contingent valuation and retrograde information bias. In: Roper, C.S. & Park, A. (eds). *The Living Forest: Non-market Benefits of Forestry*. HMSO, London, pp.37-44.

Price, C. 1999b. Stated and revealed preference analysis. In Helles, F., Holten-Andersen, P. & Wichmann, L. (eds), *Multiple Use of Forests and Other Natural Resources*. Kluwer, Dordrecht, pp.46-65.

Price, C. 2000. Valuation of unpriced products: contingent valuation, cost–benefit analysis and participatory democracy. *Land Use Policy* 17 187-96.

Price, C. 2001. Exact values and vague products? Contingent valuation and passive use value. In Sievanen, T., C.C. Konijnendijk, L. Langner & K. Nilsson (eds). Forest and Social Services – the Role of Research. *Research Paper* 815 of Finnish Forest Research Institute, Vantaa, Finland, pp.205-17.

Price, C. 2003. Quantifying the aesthetic benefits of urban forestry. *Urban Forestry and Urban Greening* 1, 123-33.

Price, C. 2005. How far can cost–benefit analysis be extended? *Silva Carelica* 50, 10-21.

Price, C. in review. Sustainable forest management, pecuniary externalities and invisible stakeholders. *Forest Policy and Economics*.

Randall, A., Ives, B. & Eastman, C. 1974. Bidding games for evaluation of aesthetic environmental improvements. *Journal of Environmental Economics and Management* 1, 132-49.

Sagoff, M. 1988. *The Economy of the Earth*. Cambridge University Press. 271 pp.

Sievänen, T., Pouta, E. & Ovaskainen, V. 1992. Problems of measuring recreational value. *Scandinavian Forest Economics* 33, 231-43.

Smith, A. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. Harmondsworth: Penguin, 1986. 537 pp.

Willis, K.G. 1994. Paying for heritage: what price for Durham Cathedral? *Journal of Environmental Management* 37, 267-77.

Wordsworth, W. 1844, quoted in Kay, G. 2002. *Access for Countryside Walking*. Staffordshire University Press, Stoke-on-Trent. 259 pp.

The use of a scaffolding model to increase interaction and learning in web based teaching in tropical forestry

Carsten Smith Olsen and Anita Monty*

Abstract
In recent years, KVL has been involved in developing and implementing distance learning in its tropical forestry teaching programme. This paper reports on experiences with using Gilly Salmon's five-stage scaffolding model with the particular aim of increasing student participation in computer mediated conferencing in order to promote joint knowledge construction and increase learning. The model is briefly introduced as are the two courses used as a case. Emphasis is on describing considerations behind the move from theory to practice, the experiences gained at each stage of the model, student behaviour, and the changed role of the teacher. It is concluded that teaching based on the model did result in high degrees of student participation and interaction with indications of higher than usual student grades.

Key words: teaching, e-learning, student participation, tropical forestry

1. Introduction

The Royal Veterinary and Agricultural University (KVL) in Denmark has developed and implemented web-based distance teaching since 2002. Experiences from the first years revealed that the largest challenge was to establish on-line interaction and discussion among participants (Olsen et al. 2004). To meet this challenge, we adopted the use of a five-stage scaffolding model (Salmon 2004) that has been developed specifically to promote interaction among students. This paper briefly presents the model and how it has been implemented in tropical forestry teaching at KVL. In addition, the new role of the teacher (when moving from traditional face-to-face teaching to web-based teaching) is commented upon and we provide suggestions for further developing the model. The key question we are trying to answer in the paper is: can we increase interaction and improve learning in distance education?

2. The model

Students' learning environment is continuously changing. In recent years, it has changed from being exclusively associated with auditoria, labs and books to including internet pages, virtual discussion fora, video clips and social activities such as group work. In online work and studying, the learning environment is always at hand; students are not limited by space or time but can study when it best fits into their portfolio of activities. Online studying is thus not simply a new teaching tool but provides a new context for learning (Bates and Poole 2003; Salmon 2004). The role of the teacher changes from giving lectures and supplying facts to being a guide or facilitator, with emphasis on helping students to construct their own knowledge. Students should use their computer for solving problems, collaborating and as a tool to make (better) decisions (Salmon 2004). Technology-enhanced teaching should thus result in more student-oriented teaching, more group work and improved learning.

As noted by Salmon (2004), there are many differences between oral and written communication forms; this needs to be explicitly considered when designing online teaching. It can not just be assumed that online students will start to share views, collaborate, etc. It is necessary to create an environment facilitating online work and co-operation. Salmon's (2004) five-stage scaffolding model has been designed to promote online networking and group work while also allowing for scaffolding of individual development. There are two basic building blocks in the model, both of which are essential in promoting student interaction and learning:

- 1. The teacher is an e-moderator, i.e. responsible for starting and moderating discussions in order to promote student learning. She prepares exercises, including e-tivities (see below), facilitates discussions, for instance by making summaries, providing different angels on issues and asking new questions.

- 2. Use of e-tivities. These activities (exercises) contain an explicit purpose, task and deadline. Contents vary across the model's five stages. They are designed to develop students' abilities to collaborate online with the ultimate aim of starting to construct new knowledge via discussions.

Students learn to use the e-learning system (learning management software) along with learning about tropical forestry; this is integrated from the start of the courses. The scaffolding model is presented in Figure 1.

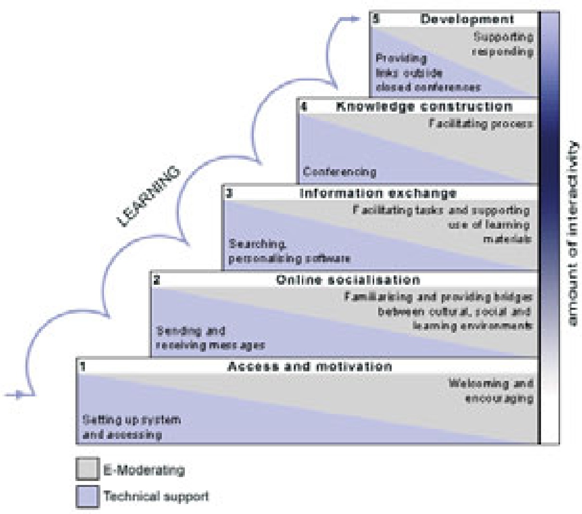


Figure. 1. Gilly Salmon's five-stage model (Salmon 2004)

Individual access and the induction of participants into online learning are essential prerequisites for online conference participation. Stage 1 aims to provide students with a good start: welcoming them and providing support to tackling any technical challenges. Stage is over when students have posted their first messages. In Stage 2, individual participants establish their online identities and start interacting. Students are getting used to the virtual learning environment. At Stage 3, participants start to engage in mutual exchange of information and focus on the learning management software as a human network rather than a technology. In Stage 4, group discussions develop and the interaction becomes more collaborative. Students embark on knowledge construction and working towards a common group goal; they share information and intellectual resources and learn from each other as well as from learning materials and the e-moderator. The main role of the latter is to weave discussions and share summaries (akin to face-to-face teaching). The promotion of independent critical thinking and reflection is at the core of Stage 5.

3. The case

We used the model on two courses, that are part of the two-year MSc programme in Agricultural Development (http://www.kvl.dk/uddannelse/kandidatuddannelse/ad.aspx), in autumn 2005. Both courses are 7.5 ECTS and concerned with aspects of tropical forestry (see course descriptions at http://kurser.kvl.dk/2005/2006/presentation.aspx?coursecode=290004 and http://kurser.kvl.dk/2005/2006/presentation.aspx?coursecode=310017). Both courses last nine weeks; in each course students are expected to work around 20 hours per week. There were 15-20 participants in each course; from a large number of countries. Almost none had any previous experience with using information and communication technology in teaching. Course materials are hard copy compendia, online supplementary materials, and online cases and exercises.

Each course started with a two-hour face-to-face session. Participation in this session is not compulsory (as some participants live and work abroad); the session focused on introducing the scientific purposes and contents of the course. Participants are not introduced to the used software (ABC Academy); written guidelines are, however, available (Monty 2005). Each course is designed to make participants familiar with the software through step-wise introduction of functions. Each participant needs access to the internet (min 56K) and a browser; no software needs to be installed.

Each course is made up of a number of modules; typically participants have to complete one module per week. Each module has the same structure: Introduction, Overview, Read and Exercises. A detailed module description is provided by Olsen et al. (2004). Exercises are multiple-choice questionnaires and e-tivities. The former provides participants with an opportunity to check if they have understood terminology and the most important points and arguments in the text material; in case of wrong answers each participant immediately and automatically receives a brief text explaining why the chosen option is not correct. The latter are assignments that participants solve in collaboration. Each e-tivity is build up around a Title, Purpose, Task and Deadline. An example is provided in Figure 2. An excellent description of e-tivities is found in Salmon (2002).

E-tivity 1.4: Working with the first case

Purpose: to gain experience with working together in the small groups on a case

Task: Read the newspaper article "They speak for the trees". You will find this case text under exercises in the "Paradigms in tropical forestry" module. You can also click here. Think about: (i) what is the main conflict described in the article? Can you describe the conflict in your own words? (ii) how can the conflict be explained using the forestry paradigms introduced in the compendium? Each group member should contribute to answering these two questions by posting messages and responding to comments. Your e-moderator will summarise the discussion.

Deadline: Friday 9 September 14.00 CET.

Figure. 2. Example of structure of an e-tivity

Participants work with e-tivities in groups of 4-8. In the later stages of a course, we also use e-tivities that are discussed across all course participants. In order to allow participants to ask questions directly to the responsible teachers, we also organised a small number of chats with each group. From stage 4, we designed and implemented e-tivities where a participant functioned as e-moderator. This included preparing summaries of group discussions and posting of summaries for discussion in plenum (across all participants). This increased sharing of knowledge across groups and served to establish a common group identity ("we are many on this course with similar interests and concerns").

4. Results and discussion

From theory to practise

We aimed at supporting the participants through the entire learning process: (i) reading and reflection over chosen subjects (compendium), (ii) checking understanding of basic elements within each subject (multiple-choice and chats), and (iii) working with and critically discussing each subject (e-tivities). This paper focuses on experiences with (iii), i.e. designing e-tivities, creating interaction between students, promoting participants possibilities for critical reflection and common knowledge creation, and establishing a close connection between the completed work and the evaluation form. In connection to the organisation of each course, the following points were emphasised:

- *Consequent structure*. Building on our earlier experiences (Olsen et al. 2004) and the work by Salmon (2002), we decided to make e-tivities well defined with explicit goals. E-tivities are all structured in the same way and can be completed within a week.

- *High degree of flexibility*. To provide participants with the greatest amount of flexibility as to when and where they work with e-tivities, almost all e-tivities were designed as asynchronous net-based plenum discussions. But there were also tight deadlines, typically at least one per week in order to close one module before moving on to the next.

- *Cogent implementation*. In each e-tivity there are explicit goals and specification of participation requirements. Roles are clearly distributed, e.g. individuals are assigned responsibilities before e-tivities are initiated. The teacher strives to show his virtual presence, especially in stages 1-3.

- *Participant input to improved implementation and contents of courses*. To ensure the best possible inputs from the participants, we designed e-tivities focusing explicitly on reflection over course contents and form.

There was a high level of activity in both courses. The average number of scientific postings per participant was around 30 and 20 on the two courses (in addition to multiple-choice questionnaires, participation in chats, and written assignments). The ratio of student/teacher postings was around 5. In general, student postings were longer than teacher postings and the number of teacher postings decreased in the later stages of the courses. It should also be noted that the scientific quality of student postings were generally high (using compendium material as theoretical framework for discussions, innovative and sound application of theory on cases, critical discussions of compendium papers, etc.). There is also no doubt that many participants highly valued the teachers' virtual presence (welcome greetings, comments to postings, asking new in-depth questions, etc.).

Evaluation

We attempted to connect the working mode (multiple-choice and e-tivities) closely to the evaluation of the performance of each participant. This was done by making exercises, including e-tivities, count with 50% of the final mark (with the remaining 50% from a written exam). For instance, each e-tivity counted with a certain weight of the final mark (e.g. 1%) and the final mark was decided using a scale of 0-100%. Furthermore, in order to gain access to the written exam, participants had to successfully pass at least 75% of exercises. Participation in e-tivities was evaluated as pass/failed based on an individual assessment of the quality of participant inputs. Drop-out rates were as in ordinary class-room courses.

The average student grade (using the Danish 13-scale system; the higher the number, the better the performance; scale average 8) in the past five years in one of the courses, using ordinary class-room teaching, ranged from 7.50 – 8.47. In 2005, using the scaffolding model, the grade average was 9.17; this was only significantly different from one of the previous years (2002, $p < 0.05$) but indicates an above average result. The same pattern was found in the second course.

In connection to course evaluation, we developed an e-tivity called "Leave your footprints". Participants were asked to critically describe their experiences with course participation and to formulate advice and recommendations to the next class. This e-tivity generated a lot of highly useful feed-back and discussions. Regarding the computer mediated conferencing, participants generally agreed that discussions were most rewarding when all group members participated. It was also noted that the more postings there are, the more participants are motivated to log on and participate (we did not experience overload). Group members who are absent should in advance inform other group members that they will not be able to participate in a specific e-tivity. The flexibility was highly appreciated. One participant wrote "... I have also understood that e-learning is actually not simply a way of teaching used by lazy teachers who don't feel like teaching (hahaha). I think that it is a way of teaching/learning that has its place in the current institutions because it allows flexibility for the students and teachers, while keeping them at work on a steady rhytm." Several participants also emphasised the importance of e-moderator visibility, e.g. "I think that Carsten did a very good job in commenting and participating to our discussion. Furthermore, I really agree that e-moderator participation is crucial as I have felt over the last few weeks (when we have been having less comments and feedbacks due to exams and…) that my motivation has dropped considerably.” Many participants also appreciated the structured, step-wise approach offered by the modular course structure ”The good thing about having e-tivities and questionanaires during the week is that one is forced to read the texts in time and you don’t end up starting on the reading just before the exam – not that I would ever do so, but some students do :-)“.

The role of the teacher

Teaching using the five-stage model and e-tivities changes the role of the teacher from being a centrally placed instructor to being a more peripherally located coach. In our case, the teacher is still responsible for developing teaching materials and ensuring the academic quality of the teaching. But his main task is now to promote participant independence in the learning process and her ability to critically reflect over both subject matters and her own learning. The asynchronous net-based discussions are an important tool that promotes critical reflection. This can be supported by the teacher through constructive criticism and providing pointers that allow for further submersion and discussion. In our case, we found that the “… borders between the traditional and the more scaffolding oriented teachers are being broken down” (Jensen 2003:3). While the five-stage model is student-centred, it can also be adopted to suit more traditional teaching if so required.

Many authors have noted that the development and implementation of e-learning is time consuming and expensive (e.g. Heiberg 2004). However, our experiences from these two courses are that time required for course maintenance, development and implementation are comparable to ordinary face-to-face classroom courses. Of course, an investment is needed (Olsen et al. 2004) to convert from classroom teaching to distance teaching.

5. Conclusion

We found a high level of participation – with more postings by participants on one course using the scaffolding model and e-tivities than in all other university courses (using a standardised software system allowing posting) combined – and high quality of participation. Student performance was comparable, in terms of grade averages, with previous ordinary classroom teaching in the same courses, with a tendency to higher grades when using the scaffolding and e-tivity approach. Participants also provided critical reflection on learning processes and constructive feed-back to course responsible teachers. Based on our positive experiences with using the five-stage model and e-tivities, we see very good scope for using this approach as the basis for further development of university courses at KVL using Learning Management System software. The approach is useful in both distance courses (as in the present case) and in mixed mode teaching – in the latter case it is important to maintain sufficient time for on-line socialisation (this can probably not be substituted by, e.g., a face-to-face weekend programme). We used the scaffolding model with success in two courses, each with duration of nine weeks. It may be difficult to use the model on shorter courses, at least with inexperienced users, as there will then be insufficient time to move through all five stages.

We used the software ABC Academy but the model can be used on all types of Learning Management System software as long as there are good electronic conference facilities available. Of course, choice of software should also take other issues into consideration, such as structure of pages, ease of administration, costs, etc. There are also new technical features that are potentially useful in supporting learning processes such as electronic participant portfolios.

Finally, it should be noted that there are still ample opportunities for further developing the five-stage model and e-tivities. For instance, to develop standard criteria for assessing (i) the quality of participant inputs in e-tivities, (ii) when construction of shared learning is achieved, and (iii) individual participant's ability to critically reflect on views and arguments.

References

Bates, A.W. and Poole, G. 2003. Effective teaching with technology in higher education. San Francisco: Jossey-Bass.

Heiberg, B. 2004. E-learning og kompetenceudvikling. Tidsskrift for universiteternes efter- og videreuddannelse 1.4(2004). Online:< http://www.unev.dk/files/birgitte_heiberg_4.
pdf> (downloaded 27.3.2006).

Jensen, H.B. 2003. Forandring af undervisningspraksis – hvordan bruger lærere IT i nærundervisningen? Tidsskrift for universiteternes efter- og videreuddannelse 1(2003). Online:< http://www.unev.dk/files/helle_baekkelund.pdf> (downloaded 27.3.2006).

Monty, A. 2005. Velkommen til KVL eLearning – vejledning til studerende. København: KVL, 2005. Online: <http://elearning.kvl.dk/Help/Dansk/guide_dansk_student.pdf> (downloaded 27.3.2006).

Olsen, C.S., Treue, T., Nielsen, Ø.J., Hansen, J.N., Flensmark, M. and Olsen, C.H. 2004. Experiences with web-based teaching in forestry. Working Papers No. 1-2004, Copenhagen, Danish Centre for Forest, Landscape and Planning, Copenhagen. Online: <http://www.sl.kvl.dk/Publikationer/Udgivelser.aspx> (downloaded 27.3.2006).

Salmon, G. 2002. E-tivities – the key to active online learning. London: RoutledgeFalmer.

Salmon, G. 2004. E-moderating – the key to teaching and learning online. London: RoutledgeFalmer, 2nd Edition.

Preliminary analysis of South Asian medicinal plant markets: can you talk to actors and use their own-reported data to estimate net marketing margins?

Carsten Smith Olsen & Finn Helles*

Abstract
There is a huge trade in medicinal plants in South Asia. This paper investigates whether it is possible to talk to medicinal plant harvesters and traders involved in the medicinal plant market in Nepal and India in order to be able to conduct a net marketing margin analysis. Using a marketing chain approach, data was collected through open-ended questionnaires administered to harvesters (n = 639) and traders (n = 166) in 15 districts in Nepal, central wholesalers (n = 90) throughout the country, and regional wholesalers (n = 53) in India. Basic distributional statistics indicate that actors' own-reported data is consistent and thus useful for further analysis. Net marketing margin analysis indicated pricing inefficiency in the market, with local traders operating with very low net margins.

Keywords: Non-timber forest products, trade, validity, Nepal, Himalaya

1. Introduction

Medicinal plants are plants used for maintaining health and/or treating specific ailments and diseases – they may constitute the most common human use of biodiversity (Hamilton 2004). Most work on medicinal plant trade has focused on biological rather than economic aspects. Despite the scale and importance of medicinal plant trade, there are few studies on medicinal plant markets that go beyond mere analysis of what species are traded. However, from studies of the trade in medicinal plants from Nepal to India, we know that: simple technology is required for harvesting, drying, storing and transporting raw materials (Olsen 1998); all products are air-dried and non-perishable (Edwards 1996; Olsen 1998) and thus can be subjected to rough handling, transport and long-term storage; there is a low threshold to entry for harvesters - no formal training of harvesters is required and capital requirements are insignificant (Olsen and Helles 1997a; Olsen 1998); men, women and children are all involved in harvest (Pandit and Thapa 2003; Olsen and Bhattarai 2005) while traders and wholesalers are men only (Olsen and Bhattarai 2005); returns to labour in wild harvesting are highly variable depending on season, location, harvesting strategy (opportunistic vs. dedicated), available male labour, physical strength and experience (Olsen 1998; Olsen and Larsen 2003); collection is considered an arduous and low prestige activity (Larsen and Smith 2004); access to resources ranges from open to private depending on product and location (Larsen and Olsen in press); there is a standard marketing chain with standard actors (Olsen and Bhattarai 2005); the market is mature with simple product specifications and private treaty trading (Olsen and Helles 1997a; Olsen 1998); there are usually simple relations between actors – though these are dynamic and may also be complex, e.g. involving social networks and procedures such as advance payment, e.g. Daniggellis (1997); lack of marketing information up the marketing chain (Olsen and Helles 1997a; Rawal and Poudyal 1999); and high threshold to entry at trader and wholesaler levels due to capital requirements and marketing networks (Olsen and Helles 1997a). Furthermore, the general volume and value of medicinal plant trade at the national level have been estimated (Olsen 2005a, b) and 93% is estimated to be exported unprocessed, i.e. just air-dried, to India (Olsen 2005b).

Medicinal plant harvest and trade in Nepal is heavily regulated (Forest Regulations 1995): some species are banned from harvest, others may not be exported unprocessed, all harvesters need collection permits, transport permits are needed for transport out of district of origin, police and forest staff have rights of inspection, etc. This means that almost all harvest is illegal (Larsen et al. 2005) as is most of the trade (Olsen 2005a) and that rent-seeking is wide-spread (Edwards 1996; CECI 1999; Olsen and Helles 1997b). Is it, in such circumstances, possible to obtain valid and reliable data from the involved economic agents? This question has not been explicitly analysed or answered in the literature, except for a brief analysis by Olsen (2005c) who found that actors' own-reported prices for two products were useful and consistent.

The purpose of the present study is to investigate whether it is possible to talk to medicinal plant harvesters and traders involved in the medicinal plant market in South Asia in order to be able to conduct a net marketing margin analysis. As seen above, available literature allows a first understanding of the physical, exchange and facilitating functions of marketing as well as marketing efficiency and market performance. Building on this, we would expect to find:

Hypothesis 1. That it is possible to interview economic agents in the medicinal plant trade and collect valid and reliable data.

Hypothesis 2. Pricing inefficiency expressed as skewed distribution of net marketing margins along the marketing chain.

2. Methodology

2.1 Study area

The study was conducted at the national-level – from harvest across Nepal to the wholesaler markets in India. Nepal was chosen as it was known to have high and regular levels of medicinal plant extraction; while India is known to be a major medicinal plant consumption country. This paper uses the actor terminology provided by Olsen and Bhattarai (2005) – harvesters, local traders, central wholesalers and regional wholesalers. Harvesters collect medicinal plants, mainly in the wild, and sell them to local traders who consolidate large numbers of small sales into large lots for sale to central wholesalers (bulking up). These then sell to regional wholesalers in India who sell to intermediaries, such as producers of traditional medicine, or retailers mainly in India (bulk breaking).

2.2 Data collection

To most effectively explore the market, we adopted a marketing chain approach. We followed the medicinal plant products from harvesters to regional wholesalers and determined the number and nature of each actor along the chain. The emphasis was on estimating marketing costs and margins, for each product and main actor group involved in the trade. To investigate the trade at the national level in Nepal, we first stratified the country into 15 cells using the three main physiographic zones and five development regions as proxies for north-south altitude and east-west climatic variations. In each cell, a district was randomly chosen. During field work in the districts, all encountered harvesters (n = 639) and all traders (n = 149; some were encountered in more than one location so total number of trader interviews is n = 166) were interviewed. All central medicinal plant wholesalers (n = 90), regardless of their location in Nepal, were interviewed as were regional wholesalers (n = 53) in the main importing cities in India. Wholesalers were identified through existing lists (such as ANSAB 1997) and interviews with traders and other wholesalers. All actors were interviewed face-to-face using standardised open-ended questionnaires. General annual data as well as data for the case year 1997-98 were collected; field work was conducted from

August 1998 to September 1999. Medicinal plant species that are banned from collection were not included in the survey.

2.3 Data analysis

An overview of the national level annual volume and value of commercial medicinal plant trade in Nepal is provided in Olsen (2005a). It was found that the top four products made up almost 44% of the total value of trade in 1997-98 (with each remaining product having a share of the total value of trade of 0 – 6%); this paper focuses on the top four products. The validity and reliability of the trade data rely on harvesters, traders and wholesalers own-estimates of amounts and values. It may be that these are incorrect, e.g. if traders feel obliged to answer questions but do not wish to disclose information. In order to further verify data and the accuracy of reporting, basic distributional statistics for selected prices and costs, such as storage costs and rent-seeking, were analysed. If responses are invalid, a high degree of randomness in responses would be expected. Then, for each of the four species, marketing margin analysis was done.

3. Results

3.1 Validity and reliability of own-reported data

The basic distributional statistics for actors' own-reported data (Table 1) indicate that such data is consistent: standard derivation is small compared to the mean, and the mean and median values are close as are the modal and median values. The only exception is local traders' storage rent with large standard deviation; this can be explained by the variation in local trader trade volume (Olsen and Bhattarai 2005). This indicates close clustering around the mean and little skewness – not to be expected if actors answered randomly. The reason that rent-seeking values are consistent is that rent-seeking is institutionalised with standard rates that vary little.

Table 1 - Basic distributional statistics for actors' own-reported key data

Actor and factor	*n*	Unit	Mean	s.d.	Median	Mode	Min	Max
Harvester								
Price for *S. chirayita*	45	Nr/kg	62.2	14.6	65	60	40	85
Price for *S. mukorossi*	56	Nr/kg	10.2	2.6	10	10	7	15
Price for *A. racemosus*	147	Nr/kg	79.2	6.9	80	80	60	90
Price for *N. scrophulariiflora*	127	Nr/kg	77.4	12.1	80	80	60	105
Rent-seeking[1]	511	Nr/load	8.5	3.4	10	10	0	25
Local trader								
Buying price *S. chirayita*	56	Nr/kg	71.7	16.5	75.5	90	40	100
Buying price *S. mukorossi*	102	Nr/kg	10.9	2.5	11	8	8	16
Storage rent[2]	162	Nr/month	1867	1918	1200	1500	100	8000
Av. storage time	165	Months	2.8	0.8	3	3	1	5
Storage weight loss	160	%	2.9	1.2	3	2	1.25	8
Packaging	164	Nr/sack	20.4	2.9	20	20	5	30
Handling/loading truck	132	Nr/truck	168	74	150	150	80	600

Truck transport[3]	136	Nr/truck	3869	1016	3900	3500	1500	8500
Taxes	22	Nr/truck	500	0	500	500	500	500
Rent-seeking by forest staff	138	Nr/truck	299	133	300	300	100	1000
Rent-seeking by police	138	Nr/truck	239	90	200	200	100	600
Central wholesaler								
Buying price *S. chirayita*	45	Nr/kg	93.4	14.5	100	100	50	105
Buying price *S. mukorossi*	43	Nr/kg	13.3	2.7	15	15	9	18
Storage rent	90	Nr/month	4154	2927	3500	1500	800	18000
Av. storage time	90	Months	2.7	0.9	3	3	1	5
Storage weight loss	90	%	2.7	1.1	2.5	2.0	1.3	10
Packaging	90	Nr/sack	20.0	1.6	20.0	20.0	16.0	25.0
Handling/loading	88	Nr/truck	136	56	110	100	60	300
Truck transport	90	Nr/truck	9006	2047	10000	10000	4000	12000
Taxes	6	Nr/truck	500	0.0	500	500	500	500
Rent-seeking: Nepali custom officials	90	Nr/truck	1198	404	1200	1000	200	2000
Rent-seeking: Nepali forest staff	89	Nr/truck	839	179	800	1000	500	1200
Rent-seeking: Indian custom officials	90	Nr/truck	3461	537	3500	3500	1750	4500
Rent-seeking: Indian police	89	Nr/truck	1816	517	1800	2000	1000	3500

[1] Rent-seeking primarily by forest guards (69% of cases) but local government staff also involved (9%) as is police personnel.
[2] All entries not mentioning a particular species are calculated across all species.
[3] Rent of truck, gasoline, and driver. Weight loss during transport was only mentioned by seven local traders (loss of 4.6±2.1%) and is assumed zero.

To investigate if answers were systematically biased, the harvester selling price and local trader buying price, which should be equal, were compared for all four products using one-way analysis of variance (ANOVA). Except for S. mukorossi ($F_{1,155} = 2.0$, $p = 0.157$), all prices are significantly different ($p < 0.002$) with harvester reported prices being lower than local trader reported prices. This indicates that harvesters may be systematically under-reporting selling prices and/or that local traders are over-reporting buying prices.

Furthermore, for valid data, we would expect the sales price to significantly increase with each actor along the marketing chain for each of the four products. Using one-way ANOVA and post hoc LSD tests, we found significant price increase at each link along the marketing chain ($p < 0.001$ for each product) regardless of whether we used harvester selling prices or local trader buying prices for the first transaction.

3.2 Net marketing margin analysis

The national-level price breakdown along the medicinal plant marketing chain is provided in Table 2. Using species specific agent data on shrinkage (e.g. local traders reported loss during storage of 3.8 (±1.7) % for S. chirayita, n = 55), conversion factors (e.g. (1/(1-0.38) = 1.04 for S. chirayita) are used to express all costs and margins in terms of 1 kg of the final product (e.g. the average harvester selling price of 62.22 is multiplied by 1.04 to get the local trader buying price for S. chirayita).

Table 2 - National level average marketing margins for trade in the top-four medicinal plant products traded from Nepal to India

	S. chirayita			*S. mukorossi*			*A. racemosus*			*N. scrophulariiflora*		
Factor	*n*	Nr/kg	% of India wh price	*n*	Nr/kg	% of India wh price	*n*	Nr/kg	% of India wh price	*n*	Nr/kg	% of India wh price
Harvester												
Selling price	45	62,22	39,4	56	10,24	34,4	147	79,24	55,5	112	77,4	40,4
Rent-seeking	511	0,13		511	0,13		511	0,13		511	0,13	
Net margin		62,09	39,4		10,11	33,9		79,11	55,4		77,27	40,4
India wholesale price	26	157,7		27	29,81		26	142,8		32	191,5	
Local trader												
Selling price	45	96,11		43	11,24		32	92,07		30	119,5	
Buying price	45	64,71		56	10,55		147	82,41		112	78,95	
Gross margin		31,40	19,9		0,69	2,3		9,66	6,8		40,56	21,2
Storage space												
Rent	166	1,52		166	1,50		166	1,52		166	1,49	
Interest charge	55	2,10		100	0,43		78	2,91		47	2,45	
Transport												
Packaging	52	0,50		99	0,41		78	0,42		43	0,44	
Handling/loading	132	0,05		132	0,05		132	0,05		132	0,05	
Truck	136	1,09		136	1,07		136	1,08		136	1,13	
Royalties		3,00			2,00			5,00			10,00	
Rent-seeking	138	0,16		138	0,14		138	0,15		138	0,15	
Net margin		22,98	14,6		-4,92	-16,5		-1,47	-1,0		24,85	13,0
Central wholesaler												
Selling price	26	157,7		27	29,81		26	142,8		32	191,5	
Buying price	45	98,99		43	11,58		32	95,75		30	121,90	
Gross margin		58,73	37,2		18,23	61,2		47,02	32,9		69,55	36,3
Storage space												
Rent	90	0,79		90	0,79		90	0,80		90	0,785	
Interest charge	45	2,59		43	0,65		32	3,88		30	4,712	
Transport												
Packaging	45	0,41		43	0,42		32	0,41		30	0,408	
Handling/loading	88	0,04		88	0,04		88	0,04		88	0,041	
Truck	90	2,78		90	2,63		90	2,79		90	2,591	
Custom duty		0,49			0,06			0,48			0,61	
Rent-seeking	89	0,82		89	0,77		89	0,82		89	0,765	
Net margin		50,80	32,2		12,87	43,2		37,80	26,5		59,64	31,2

There is very little species specific variation in cost factors; differences in cost levels between species are due to differences in raw material prices. In fact, raw material purchasing price is the absolute dominant cost factor with no other cost above 5 Nr/kg with the exception of the royalty rate for N. scrophulariiflora. In total, costs of storage, transport, royalties, duties and rent-seeking constitute 15% or less of costs for local traders and central wholesalers; the exception is the low value product from S. mukorossi where raw material cost makes up from 62 – 64% of total costs. For this product, central wholesaler transport costs (14%) and local trader royalty payment (12%) become important. In general, the cost structure and cost level are similar for local traders and central wholesalers, with the exception that local traders carry the cost of royalty payment. Regarding margins, it is seen that harvesters operate with net margins from 33 – 56% of the India wholesale price. Local traders operate with negative net margins for two products; as the calculations are done based on average prices, and not a negative scenario, this indicates that this group is under pressure. In all cases, their average net margins, ranging from -17 to 15%, are well below the net margins of the central wholesalers at 26 – 43%.

4. Discussion

4.1 Validity and reliability

There appears to be a belief among social scientists that traders (incl. wholesalers) are very difficult to talk to (Harriss 1992); researchers working with non-timber forest products have also expressed concerns that NTFP traders are difficult to interview (e.g. Padoch 1992, te Velde et al. in press). As the value of the presently investigated trade is 25 times higher than the officially recorded value of the herb trade (Olsen 2005a), interviewing traders is obviously sensitive yet indispensable as official data is so inaccurate that it is almost useless. Building on the South Asian experiences with trader interviews reported by Harriss (1992), we emphasised the following when planning and implementing interviews: that we were independent of national and local governments; that the purpose was to uncover the contribution of trade to the national economy and ensure sustainable supplies; flexibility in setting up interviews in order to minimise traders' opportunity costs; minimisation of environmental error by using only one older highly qualified Nepalese researcher, with in-depth understanding of medicinal plant utilisation and markets, as interviewer; conducting interviews in private and guaranteeing anonymity; providing small special gifts such as Elaeocarpus sphaericus necklaces from the famous Hindu pilgrimage site of Pashupatinath in Kathmandu; and taking time to allow traders to ask us questions and always try to be helpful, e.g. in facilitating contact to potential buyers. The analysis of basic distributional statistics for traders' own-reported data shows that this approach results in consistent answers. It does not, however, eliminate systematic bias and there is a pronounced tendency for all actors to underestimate their own incomes through their price reporting. This does not, at least in the present case, distort the general findings, e.g. it is clear that local traders' net margins are very low. Regarding Hypothesis 1, it is concluded that the presented findings are robust and that it is possible to interview economic agents in the medicinal trade and obtain valid and reliable data.

4.2 Net marketing margins

The consistently high net marketing margins captured by central wholesalers and the very low ditto for local traders indicate an exploitative relationship between these two groups. It may be, as previously argued by Olsen and Helles (1997a), that central wholesalers act as a passive oligopsony: they are few and their position in the marketing chain combined with the services they provide, not least Indian networks and their ability to negotiate prices, allow them set low buying prices. Furthermore, almost 78% of central wholesalers provided credit to local traders – this may be contributing to establishing control of local traders by limiting their number of sales points. It should, however, also be noted that functions of good governance (Veeman 2002) are not present in the market: rules and regulations regarding harvest and trade of medicinal plants can be locally interpreted and implemented (Larsen et al. 2005), prices for some products may change rapidly over short periods of time (Olsen and Bhattarai 2000), and rent-seeking at all levels is common. This means that central wholesalers carry financial risks that are not presently included in their net margins (risk bearing costs). But the same set of factors also implies risk bearing costs for local traders; costs that can not be covered within the present low levels of net margins. It could be that local trader net margins vary significantly from year to year and that the present case year just constitutes a bad year for local traders. However, previous local level studies of net margins (Sharma 1995; Olsen and Helles 1997a; Olsen and Bhattarai 2000) confirm the findings in the present paper; and no case study has ever reported high local trader net margins and low central wholesaler margins for the same product in the same trading season. Regarding

Hypothesis 2, it is concluded that net marketing margin analysis indicates pricing inefficiency in the South Asian medicinal plant market.

5. Conclusion

A large number of actors were interviewed along the marketing chain, from the harvesters in remote areas of Nepal to large wholesalers in India. Analysis of basic distributional statistics for actors' own-reported data indicated that such data is consistent, even though there may be a systematic bias in price data, and thus useful for market analysis. An analysis of net marketing margins along the marketing chain further indicated that the there is pricing inefficiency in the South Asian medicinal plant market; while harvesters and central wholesalers operate with acceptable margins, local traders realise very low net margins even when not including risk bearing costs. This paper is a contribution to the painting of a comprehensive picture of the economics of wild herb trade from the Himalayas – further detailed studies are required in order to understand market performance.

Acknowledgements

We are grateful to the harvesters, traders and wholesalers along the marketing chain who participated in the study. Nirmal Bhattarai is thanked for his efforts during field work, Malene Hall for her contribution to data handling. The study was funded by the Council for Development Research of the Danish Ministry of Foreign Affairs and the Royal Veterinary and Agricultural University, Denmark.

References

Ansab, 1997. Nepal NTFP Entrepreneurs' Directory. Asia Network for Sustainable Agriculture and Bioresources, Kathmandu.

CECI, 1999. Subsector analysis of high-altitude NTFPs in the Karnali zone. Draft version. Canadian Centre for International Studies and Cooperation, Kathmandu.

Daniggelis, E. 1997. Hidden wealth – the survival strategy of foraging farmers in the Upper Arun Valley, Eastern Nepal. Mandala Book Point, Kathmandu.

Edwards, D.M. 1996. The trade in non-timber forest products from Nepal. Mountain Research and Development 16, 383-394.

Forest Regulation. 1995. Forest regulation, 2051 (1995). Ministry of Forest and Soil Conservation, Kathmandu.

Hamilton, A.C. 2004. Medicinal plants, conservation and livelihoods. Biodiversity and Conservation 13: 1477–1517.

Harriss, B. 1992. Talking to traders about trade. In Devereux, S. and Hoddinott, J. (eds) Fieldwork in developing countries, Harvester Wheatsheaf, London, pp. 138-151.

Larsen, H.O. and Olsen, C.S. In press. Unsustainable collection and unfair trade? Uncovering and assessing assumptions regarding central Himalayan medicinal plant conservation. Biodiversity and Conservation.

Larsen, H.O. and Smith, P.D. 2004. Stakeholder perspectives on commercial medicinal plant collection in Nepal. Mountain Research and Development 24: 241–248.

Larsen, H.O., Smith, P.D. and Olsen, C.S. 2005. Nepal's conservation policy options for commercial medicinal plant harvesting: stakeholder views. Oryx 39: 435-441.

Olsen, C.S. 1998. The trade in medicinal and aromatic plants from central Nepal to northern India. *Economic Botany* 52: 279-292.

Olsen, C.S. 2005a. Valuation of commercial Central Himalayan medicinal plants. Ambio 34: 607-610.

Olsen, C.S. 2005b. Quantification of the trade in medicinal and aromatic plants in and from Nepal. *Acta Horticulturae* 678: 29-35.

Olsen, C.S. 2005c. Trade and conservation of Himalayan medicinal plants: *Nardostachys grandiflora* DC. and *Neopicrorhiza scrophulariiflora* (Pennell) Hong. Biological Conservation 125: 505-514.
Olsen, C.S. and Bhattarai, N.K. 2000. Forest resources and human welfare in Himalaya: the contribution of commercial medicinal plants. Paper presented at the IUFRO World Forest Congress, Kuala Lumpur, 7-12 August. Conference Proceedings Vol. 2: 242.
Olsen, C.S. and Bhattarai, N.K. 2005. A typology of economic agents in Himalayan plant trade. *Mountain Research and Development* 25: 37-43.
Olsen, C.S. and Helles, F. 1997a. Medicinal plants, markets and margins in Nepal Himalaya: Trouble in paradise. *Mountain Research and Development* 17: 363-374.
Olsen, C.S. and Helles, F. 1997b. Making the poorest poorer: policies, laws and trade in medicinal plants in Nepal. *Journal of World Forest Resource Management* 8: 137-158.
Olsen, C.S. and Larsen, H.O. 2003. Alpine medicinal plant trade and Himalayan mountain livelihood strategies. *Geographical Journal* 169: 243-254.
Padoch, C. 1992. Marketing of non-timber forest products in Western Amazonia: general observations and research priorities. Advances in Economic Botany 9: 43-50.
Pandit, B.H. and Thapa, G.B. 2003. A tragedy of non-timber forest resources in the mountain commons of Nepal. Environmental Conservation 30: 283-292.
Rawal, R.B. and Poudyal, A. 1999. Marketing of non-timber forest products in Nepal. In Rawal, R.B., Bhatta, B. and Paudyal, A. (eds) Non-timber forest products: production, collection and trade in Mid-western development region of Nepal, New Era, Kathmandu, pp. 26-37.
Sharma, P. 1995. Non-wood forest products and integrated mountain development: observations from Nepal. Non-Wood Forest Products 3: 157-166.
te Velde, D.W., Rushton, J., Schrekenberg, K., Marshall, E., Edouard, F., Newton, A. and Arancibia, E. in press. Entrepreneurship in value chains of non-timber forest products. Forest Policy and Economics.
Veeman, M. 2002. Understanding local and regional markets for forest products. In Campbell, B.M. and Luckert, M.K. (eds) Uncovering the hidden harvest, Earthscan Publications Ltd, London, pp.66-102.

Assessing protected areas management using soft systems analysis: The case of Carrasco National Park, Bolivia

Alvaro Rico

Abstract
The establishment of protected areas has often been a top-down process, based on elitist concepts of land use and surrounded by restrictive legislation. Many protected areas and buffer zones in Bolivia, as in other countries, exist only on paper. The objectives and guidelines for their establishment are either not viable or unclear, resulting in management plans being overly simplistic or non-existent. In this study the various problems associated with the implementation/non-implementation of protected areas and buffer zone are considered from a systemic perspective. The paper outlines the application of soft systems methods to approach a complex problematic situation and presents preliminary results for protected areas in Bolivia.

***Key words*:** Community Development; Conflicts Analysis; Local Participation; Buffer Zone; Soft Systems Methodology

Introduction
The management of protected areas (PAs) in developing countries presents profound challenges, given widespread conditions of poverty, rapid population growth, and political instability. PAs are buffeted by these local conditions and by powerful international forces as well. Although globalization and neoliberal reform have brought greater external funding to developing countries for PAs, these same reforms have also opened remote areas to logging, oil extraction, and mining (Bowles et al., 1998). Conservationists thus struggle to build alliances with communities neighbouring PAs while simultaneously defending parks from industrial-scale resource extraction and promoting sustainability in national policies (Naughton-Treves et al., 2005). In this respect, buffer zones (BZs) have in recent year become widely known as an operational approach to nature conservation, and are often applied in Integrated Conservation and Development projects (ICDP)/(Ebregt and De Greve, 2000). Despite the creation of the first Bolivian PA in 1939 (Sajama National Park), SNAP (Bolivia's National System of Protected Areas) is one of the youngest in Latin America. Established through the Law of the Environment 1992, its fundamental objectives is the conservation of representative samples of the country's major ecosystems and it is administered by SERNAP (Bolivia's National Protected Areas Service), under the jurisdiction of the MDSP (Bolivia's Ministry of Sustainable Development and Planning). The SERNAP is responsible for defining and enforcing the laws and regulations pertaining to the management of the country's genetic and biological resources, as well as to administer and implement the Convention of Biological Diversity signed by Bolivia at the Rio Conference (1992) and ratified in 1994. At present SNAP is composed of 22 nationally recognized PAs, covering approximately 17 million hectares (15,82 % of the national territory) and divided into National Parks, National Reserves, Biosphere Reserves, Wildlife Reserves and Integrated Management Natural Areas. In parallel with SNAP, there is a growing contingent of PAs of lesser hierarchy, such as Forest Reserves, Watershed Protection Areas, and Departmental, Regional, and Municipal Parks and Reserves. Although Bolivia's PAs include some of the world's most biodiverse areas, they are also home to a large part of Bolivia's poorest people. Poverty rates in and around PAs average 80% (USAID, 2005).

Since SNAP and SERNAP were implemented, important improvements were incorporated in the PAs management system, one of which is the conformation of committees for the development and implementation of the areas' management plans. Some PAs have active committees and approved management plans, and a few are even reviewing the plans after years of implementation. Other PA areas have neither committees nor management plans (e.g., Carrasco) and are threatened by conflicts with pre-existing communities or new immigrants. All PAs in Bolivia have local communities within or around their perimeter. It is estimated that about 1.5 million people, indigenous and others, mostly in poverty, are living within and around PAs (USAID, 2005).

The development challenge to authorities in Bolivia is to manage PAs for producing tangible benefits to local communities and alleviate poverty, thereby helping to conserve the PAs' globally important resources in a sustainable manner. In that way, BZs are seen as important tools to both conserve areas of ecological importance and address development objectives of local people (Ebregt and De Greve, 2000), (SERNAP, 2005b). In late 2005, official reports from SERNAP (SERNAP, 2005a) point to main challenges to PAs and BZs management: on one hand, the difficulty of defining clear concepts of PA, BZ, and their zoning functions; and on the other hand, the multiple conflicts reported in all of 22 existing PAs. Moreover, the urgent need to promote and to improve local participation in the managing of PAs, as it is strong demanded through the new slogan produced by SERNAP saying: "*parks with people*" (SERNAP, 2005c).

The general objective of this paper is to contribute to a better understanding of the current situation of PA and BZ management in Bolivia; more specifically: *i*) to review the general context about the establishment of PAs and BZs, *ii*) to analyze the relation between PAs and community development, *iii*) to analyze the main issues of the complex problem situation in Bolivia's PA management, *iv*) to analyze the case of Carrasco National Park (CNP) management from a systematic and systemic perspective, and *v*) to analyze the potential applicability and usefulness of Soft Systems Methodology (SSM) on the CNP case study as a pre-fieldwork stage.

Soft Systems Methodology

The Systems Thinking is an interdisciplinary and comprehensive approach to the analysis and unfolding of complex problem situations (Hjortsø, 2002). Therefore, Systems Thinking constitutes a compelling answer to the above-mentioned search for a problem-solving platform.

At the heart of SSM is a comparison between the world as it is, and some models of the world as it might be. Out of this comparison arises a better understanding of the world ("research"), and some ideas for improvement ("action") (Dick, 2002). Recent literature and the earlier SSM literature also, offer a 7-stage description (Checkland's methodology), which follows.

The problem (situation unstructured): the researcher makes as few presumptions about the nature of the situation as possible.

Rich picture (the situation analysis, issues and primary tasks): the researcher develops a detailed description, a "rich picture", of the situation within which the problem occurs. This is most often done diagrammatically.

Relevant systems and their Root Definitions: Now the "root definitions", the essence of the relevant systems, are defined. For the logical analysis, Checkland (1981) provides the mnemonic CATWOE as a checklist for ensuring that the important features of the root definitions are included: (i) the Customers, who are system beneficiaries, (ii) the Actors, who transform inputs to outputs, (iii) the Transformation, from inputs into outputs, (iv) the

Weltanschauung, the relevant world views, (v) the Owner, the persons with power of veto, (vi) the Environmental constraints, that need to be considered.
Conceptual models: The researcher now draws upon her knowledge of systems concepts and models. She develops descriptions, in system terms, of how the relevant parts of the situation might ideally function.

Comparison of conceptual Model with Rich Picture: The purpose is not to implement the conceptual models. Rather, it is so that models and reality can be compared and contrasted. The differences can be used as the basis for a discussion: how the relevant systems work, how they might work, and what the implication of that might be.

Debate with people involved in the situation: From the discussion the last step above, certain possible changes are identified. They are likely to vary in desirability and feasibility.
Implementation of agreed changes: The most desirable and feasible changes identified at the above stage are now put into practice.

Application of Soft System Methodology to Carrasco National Park case study
Carrasco National Park background

In 1988, CNP was declared in an initial surface of 180,000 hectares, in 1991 increased to 622,600 hectares as mitigation of the environmental impact generated by the construction of the Chimoré-Yapacaní Highway between Cochabamba and Santa Cruz, and to incorporate the *Cavernas del Repechón* Wildlife Sanctuary, created in 1986 (SERNAP, 1999).

In the beginning of 1980 the unplanned increment of population in the northern limit of CNP initiated a progressive pressure on the park and that constitutes one of the main reasons for the several social, economic, environmental, and political conflicts currently found in the area (CERES, 2000). In those days the critic economical situation of the country made immigrants start grow coca illegally within and around CNP, which having to increased the difficulty to open spaces of dialogue and made distance between CNP authorities and local communities within and around the park.

Currently, CNP is subjected to severe direct and indirect pressures and threats, jeopardizing its medium- to long-term viability, including: Pressures like illegal settlements and land invasions, agriculture, timber extraction, cattle raising, hunting and fishing, oil drilling; and threats like drug-trade related coca production, social resistance, and local participation (ParksWatch, 2005)**.**

Recent studies on the efficiency and effectiveness in the management of CNP conclude that there is an extremely high risk that the park will fail to protect and maintain biological diversity in the immediate future (O'Phelan & Argandoña, 2001; Pauqet, 2005). According to these authors CNP appears considerably behind the rest of PAs in Bolivia and the following aspects are considered the main issues for improvement: local participation improvement, protected area boundary definition, protected area regulations, protected area design, make a management plan, zoning, increase staff number, improve staff training, implement research, enforcement activities.

In 2005, SERNAP in its Strategic Agenda initiated a long-term strategy to systematically approach relevant stakeholders, including especially local participation as one of the most important inputs to deal with the paradigm "Protected Areas with People", putting emphasis on the social and political dimensions (SERNAP, 2005b). The implementation of this strategy is particularly important in the case of CNP because of its strategic geographical location in the middle of the country and its potential role as a guide for a participatory management in the PAs in Bolivia, considering its status as a one of the most threatened PAs in the country.

Applying Checkland's methodology (7 stages)

This paper is mainly based on literature survey, previous knowledge on the subject and study area situation. It was decided use SSM as the overall framework to obtain for the further research on the development of CNP, as it was perceived to allow incremental development based on ongoing discussion (Hjortsø, 2002).

Stage 1. The problem situation unstructured: During the initial exploration phase, few presumptions are formulated based on the collected information: Lack of social and local participation on the design, establishment, and management of Pas, too many conflicts to deal with in the short term, social resistance, international dependence for funds, complex situation. The key sector of stakeholders (SHs) in the management of CNP were identified: (i) Public sector composed basically of the authorities of CNP who are part of SERNAP; (ii) Civil Society, here the Association of Municipalities of the Tropics of Cochabamba representing local communities within and around CNP; (iii) International Cooperation comprising Foundations, NGO's, and (iv) Agencies and Research institutions mostly in Bolivia.

Stage 2. Rich picture, main tasks and issues: For each SH a synthesis of the information collected is shown in Table 1.

Table 1: Tasks and issues in CNP management (SERNAP a, 2005)

• Illegal hunting and fishining • Existing infrastructure in PA (roads, buildings, etc.) • Occupation of green communal areas in PA • Land tenure in the BZ • Plan of management needs to be updated, to be finished or to be approved • Land tenure within PA boudary • Illegal extraction of timber from PA • Insufficient or inexistent social participation in the management of PA • Illegal human settlements within PA • Conflicts between gamekeepers and farmers in PA, and fauna • Conflicts between legal settlements and illegal settlements • Cutting and clearing communal areas in PA	• Unclear status of environmental services (access to water) • Conflict between municipality authorities because of unclear PA and BZ boundaries • Illegal activities like production and traffic of coca leaves • Unclear administration and management of PA • Increasing of agricultural frontier in harming PA and BZ • Environmental negative impact because of infrastructure and tourism facilities and activities • Landowners sell more property that they own, creating spatial, social, and economic problems • Gamekeepers under risk or hazards from illegal settlements, wood cutting, etc. • Communal land use practices not appropriate in PA (burning and slashing)

Stage 3. Comparison of conceptual Model with Rich Picture, relevant systems: The next step is to formulate root definitions for relevant sub-systems of the overall human activities systems (HAS) identified at the previous stage. Emerging sub-systems developed from the predefined tasks, or perceived as having an influence on these tasks were identified. At this stage, root definitions provide a platform for focusing on the whole context rather than discipline oriented technical solutions (Hjortsø, 2002). The overall HAS was defined by human activities performed within the boundary of CNP and its BZ. Within the boundary a sub-system was the CNP organization. This sub-system included other third-order systems, such as PA management system, and within this system the specific short-term planning activities constitute a fourth-order subsystem. Within the short-term planning sub-system a fifth-order sub-system was defined as a "protected area management" (Fig 1).

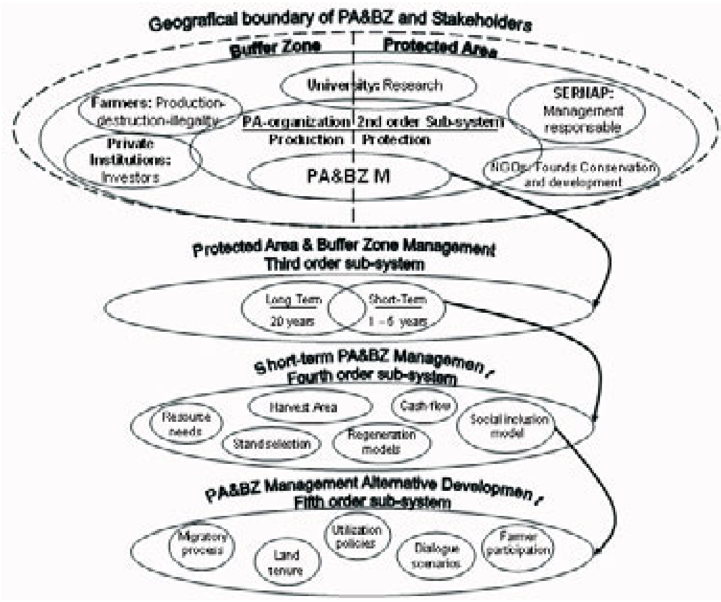


Figure. 1: The figure illustrates the systemic perspective applied in the case study (From Hjortsø et al., 2005a)

The possible (issue based system) root definition of the PA management (PAM) identified is illustrated in CATWOE. The process of formulating root definitions and the use of CATWOE are very useful in providing a venue for open analysis and assumption surfacing, and show the dual focus on CNP's need for a PAM on the one hand, and enhancement of community development through participatory local involvement on the other hand (Hjortsø et al., 2005a). The latter is expressed in the root definitions for a sub-system to develop new PAM alternatives as follows:

CATWOE:

Customers: MMTC (Association of Municipalities of Tropics of Cochabamba) municipalities and farmers; government (SERNAP); NGOs; private institutions

Actors: MMTC (municipalities and farmers), government (SERNAP), and researchers

Transformation process: A process of establishment and management of PA and BZ without social participation → Sustainable management of PA and BZ in which both nature conservation and development of the region are supported by social participation

Weltanschauung (world view): A PA and BZ that contributes positively to the household economy throughout its sustainable management including social participation in the establishment and management plan

Owners: Government, MMTC

Environmental constraints: The social and political situation in Bolivia in the last 30 years was uncertainty; the budget for the management of PA; the unclear technical terminology used for PAs and BZs zoning functions.

Stage 4. Conceptual models:

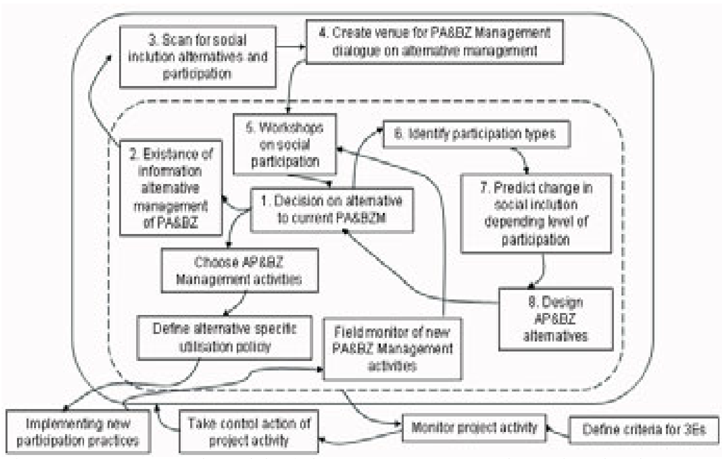


Figure. 2: Conceptual model of the PA management alternative development system defined in CATWOE (From Hjortsø et al., 2005a)

Based on the transformation process defined in the root definition (CATWOE), the inputs and activities which allow the transformation process to take place, a model was included according to the previous knowledge and literature review. In order to make a realistic and robust system, the exercise to accommodate the different interests based on the available data was difficult. The modelling process concerned with the root definition in CATWOE converged to the conceptual model shown in Fig 2.

Stage 5. Comparison of conceptual model with Rich Picture. In this brief comparison oriented toward local participation within the PAM, the literature reviewed due to the problem situation approached (background) plays a fundamental role, since no participatory survey method (e.g. cognitive mapping) was applied. The balance of the logic-based and cultural analysis streams established by the methodology (Checkland, 1981), is an important task to consider in this comparison. Since no interlocutor or interviewer is participating directly in this research, the presumptions formulated at stage 1 based on the literature reviewed are the reference to make such a theoretical comparison. Following this and taking the presumption related to lack of social and local participation on the design, establishment, and management of PAs as example, it is possible to say that the local participation in CNP is partial and hardly managed by the authorities of CNP and SERNAP. The activities oriented to improve not just the number of meetings but also the activities oriented to measure the effectiveness and efficiency of local participation must be implemented, and the fulfilling of objectives formulated in the PAM in this respect must be monitored constantly by a committee representing by all the stakeholders involved in the PAM.

Activity in Model	Exist?	How it is done?	Who? Good/Bad (Criteria to judge)	Alternatives? Comments?
1. Decision on alternative to current PAM	Partly	Establishing calendar for meetings between farmers and SERNAP authorities to analyze the situation.	The efficiency and effectiveness of the achieved results at the meetings based on fulfilling the objectives proposed	Meetings are a kind of formalism needed to SERNAP justify its activities in the area
2. Existence of information alternative management of PAM	Yes	There is relevant information cumulated mainly from meetings between farmers and municipalities, and reports from SERNAP are available.	Researchers calculate quantity and quality of information available. If they consider enough quantity and quality they can improve the process	Even if the information exists and is available, it should be important to verify the reliability and source Collect data from all SHs involved in the management of CNP
3. Scan for social inclution alternatives and participation	No	Establishing activities to monitor and evaluate social participation.	Researchers have to establish parameters needed to evaluate and monitor	It is possible to abolish parameters because the difficulty

Figure 3 Part of the output comparison stage in CNP management alternative development system

The comparison stage is one of the steps before starting the debate with people and then the implementation of the agreements achieved (stages 6 and 7 in checkland's methodology). To open the possibilities and to handle the potential building scenarios of dialogue throughout this step is crucial to the ongoing discussions, maintain a balance between the cultural analysis and logic based analysis streams mentioned before.

Discussion and conclusion

About PAM and case study

The unclear definitions of the PA and BZ concepts and terminology affect the efficiency and effectiveness of PAs management in Bolivia, which is especially sensitive in the case of CNP (Pauqet, 2005) because of the dynamic and changing social, political, and economic situation in the study area. Another aspect which is considered relevant to this research is the need to define the zoning functions between PAs and BZs in the field, working with the communities, improving and promoting the local participation. At the beginning of 2006 the official literature reports the exceptional case of Cotapata and Cordillera de Sama Biological reserves (SERNAP, 2005a), the two first biological reserves in Bolivia with a participatory management plan including the local participation of communities. Nonetheless, there are many other several conflicts reported in the management of PAs (showed in Table 1) which are common in all PAs in Bolivia, which shows structural deficiencies in the SNAP (eg. insufficient budget). A mere 3% of the total budget for the management of the 22 PAs is provided by the Bolivian government, the other 97% is supplied by international donors. As Danielsen et al. (2000) affirm for developing countries in particular, where money and human capacity are scarce, the biodiversity monitoring and management systems should be based on locally available capacity to be sustainable. In the case of Bolivia this principle is far from being achieved, especially taking into account the fact that PAs management is a long-term commitment in terms of social, economic and environmental impact (Fortes, 1999; Jackson, 2000).

This research has focused upon the analysis of local participation in the management of PAs because it is considered one of the main aspects for the sustainable management of

PAs (Pacheco & Kaimowitz, 1998; Pyhala, 2002; de Oliveira, 2005). On one hand SERNAP has prioritized the participation of local communities settled within and around PAs which is going to contribute to the sustainable management of PAs, but on the other hand, SERNAP should be aware that this process, according with some authors like Borrini-Feyerabend (2004) takes a long-term view.

About the methodology applied

As Matthews et al. (2003) affirm, SSM is not only a methodology to structure a problem situation like the case of CNP management but also a flexible tool per se, considering on one hand its cyclical analysis and on the other, its capacity to combine the analysis with different techniques and tools like Participatory Rural Appraisal (PRA) or Geographical Information Systems (GIS) which provide a flexible analytical framework where the trade-off between social, economic and environmental impacts can be evaluated. This is particularly useful in the case of complex problem situations like the case study in CNP, in which SSM was useful in helping to structure the main issues around PAs in Bolivia and the different perspectives of different SHs in a systematic and systemic approach.

The possibility to visualize the field work stage and to structured the problem situation as an office-analysis before a field work stage using SSM, is a good pre-practice action which can contribute to take better future decisions, helping the stakeholder analysis, establishing a preliminary list of key contact and key informant people, and also contributing to make better use of economic sources and time schedule improving the logistic of the survey.

This research does not offer a ready-made formula for PAs and BZs managing. Rather it seeks to contribute directly to improve the problem identification and structuring in the case of CNP using SSM as and “office-based” analysis (Warner, 2000). As mentioned in the introductory section, a field work stage must be developed applying before the full version of SSM methodology, which is the application of Checkland’s stages 6 and 7.

References

Borrini-Feyerabend, G. 2004. Collaborative Management of protected Areas: Tailoring the approach to the context. Issues in Social Policy By Social Policy Group, IUCN (available on line at: tp://iucn.org/themes/spg/Tailor/Tailor.html).

Bowles, I., Rosefeld, A., Sugal, C, and Mittermeier, R. 1998. Natural Resource Extraction in the Latin American Tropics.Washington, DC: Conserv. Int.

Ceres 2000. Los Conflictos Socioambientales en el Parque Nacional Carrrasco. Centro de Estudios de la realidad Economica y Social. Editorial AROL. Bolivia. 104 pp

Checkland, P. 1981. Systems Thinking, Systems Practice. Chichester,Wiley.

Danielsen, F., Balete, D., Poulsen, M., Enghoff, M., Nozawa, C. and Jensen, A. 2000. A simple system for monitoring biodiversity in developing countries. Biodiversity and Conservation 9:1671-1705.

De Oliveiria, A. 2005. Enforcing Protected Area Guidelines in Brazil. What Explains Participation in the Implementation Process?. Brazilian School of Public and Business Administration (EBAPE), Getulio Vargas Foundation (FGV), Rio de Janeiro, Brazil

Dick, B. 2002. Soft systems methodology. Session 13 of Areol - action research and evaluation on line. (Available online at: URL http://www.uq.net.au/action_research/areol/areol-session13.html).

Ebregt, A., De Greve, P. 2000. Buffer Zones and their Management. Policy and Best Practices for terrestrial ecosystems in developing countries. Theme Studies Series 5, Forest, Forestry and Biological Support Group. National Reference Centre for Nature Management, International Agricultural Centre, The Netherlands, 64pp.

Fortes, M. 1999. Combining research and education in protected area management. Wise Coastal Practices for Sustainable Human Development Forum / Ulugan Bay-Philippines. (Available online at: http://www.csiwisepractices.org/?read=78).
Hjortsø, C. 2002. A Rapid Stakeholder and Conflict Assessment for Natural Resources Management using Cognitive Mapping: The case of Dam Doi Forest Enterprise, Vietnam. Department of Economics and Natural Resources, The Royal Veterinary and Agricultural University, PhD Dissertation, Study IV, Copenhagen. 145-170
Hjortsø, C.; Christensen, S. and Helles, F. 2005. Using soft systems methodology to develop a mangrove forest management and planning decision support system in a buffer zone, the case of Dam Doi Forest Enterprice, Vietnam Danish Centre for Forest, The Royal Veterinary and Agricultural University Landscape and Planning, Working Papers / Forest & Landscape. 33pp.
Jackson, R. 2000. Community Participation: Tools and Examples. Paper presented at the Management Planning Workshop for the Trans-Himalayan
Matthews, K., Buchana, K., Sibbald, A.and Craw, S. 2003b Using soft-systems methods to evaluate the outputs from multi-objective land use planning tools. A The Macaulay Land Use.
Naughton-Treves, L., Buck, M. and Brandon, K. 2005. The Role of Protected Areas in Conserving Biodiversity and Sustaining Local Livelihoods. Annu. Rev. Environ. Resour. 30:219–52. (Available online at: http://portals.conservation.org/downloads/storedfile/Document/annurev.energy.30.050504.pdf).
O'Phelan, G. and Argandona, F. 2001. Metodologia para la Medicion de la Efectividad del Manejo del SNAP (MEMS). MDS, SERNAP, Bolivia. 30 pp.
Pacheco, P. and Kaimowitz, D. 1998. Municipios y Gestión Forestal en el Trópico Boliviano. Municipalities and Forest Management in the Bolivian Tropics.CIFOR/CEDLA/TIERRA/BOLFOR. 485 p.
ParksWatch 2005. Strengthening Parks to Safeguard Biodiversity. Center for Tropical onservation, Duke University, USA. (Available online: http://www.parkswatch.org/main.php? l=eng&p=country&p2=bol#s).
Pauqet, S. 2005. Field-testing of Conservation Internatioinal's, Management Effectiveness Assessment Questionnaire in Seven Protected Areas in Bolivia. Report on Field Application of CI Traking Tool in Bolivian Protected Areas. ParksWatch, 40 pp
Pyhala, A. 2002. Institutions and Protected Area Management in Western Amazonia. Paper presented at the 9th Biennial Conference of IASCP, Victoria Falls, Zimbabwe (17-21).
SERNAP. 1999. Proyecto Parque Nacional Carrasco. MDS. Cochabamba, Bolivia.
SERNAP 2005a. Plan Estrategico para el Desarrollo Integral del Sistema Nacional de Areas Protegidas (documento de trabajo), MDS, Servicio Nacional de Areas Protegidas, La Paz, Bolivia, 70 pp.
SERNAP 2005b. Las Zonas Externas de Amortiguación. MDS y Planificación, Servicio Nacional de Áreas Protegidas. La Paz, Bolivia, 46 pp.
SERNAP 2005c. Informe de Gestion Enero – Diciembre 2005. MDS, Servicio Nacional de Áreas Protegidas, La Paz, Bolivia. (Available on line at:http://www.sernap.gov.bo/inf%20final%202005/Informe%20enero%20diciembre%202005%20SERNAP.pdf).
USAID 2005. Environment Strategic Objective, "Forest, Water and Biodiversity Resources Managed for Sustained Economic Growth". United States Agency of International Development. (Available on line at: http://www.usaidbolivia.org.bo/US/4Env.htm)
Warner, M. 2000. Conflict Management in Community-Based Natural Resources Projects: Experiences from Fiji and Papua New Guinea. Overseas Development Institute, Sorking Paper 135 London: Overseas Development Institute. (Available on line at: www.odi.org.uk/publications/wp135.pdf.)

Consumer research and attribute elicitation for the development of outdoor wooden decking

Anders Roos and Anders and Qvale Nyrud*

Abstract
Increased concern about the environmental and health effects of wood preservation methods motivate producers to find new wood products for outdoor use that combine durability, environmental friendliness and consumer appeal. Consequently, the industry must improve its ability to elicit key product attributes for the consumers and to transform this knowledge in popular wood products. Different approaches for attribute elicitation and marketing planning for outdoor wood are applied and discussed in this paper. The approaches are sensory analysis, free elicitation, segmentation, and conjoint analysis. The results indicate that all these methods are promising for new product development in the wood industry. The methods have different strengths and weaknesses and their application and successful use for new products also involve the development of new capabilities in the industry.

Keywords: New product development, preserved wood, consumer research.

Introduction

The demand for outdoor wood products is increasing throughout Europe. In the UK, for instance, presentations in magazines and TV-programs have resulted in increased demand for wooden garden furniture and terrace decking (UK Forestry Commission 2004; UK Forestry Commission 2005). At the same time, wood treated with CCA-preservatives (a water-soluble preservative containing copper, chromium and arsenate) and Creosote (a petroleum-based preservative) are being restricted in many countries in Europe, the United States and Australia (Jacobsen and Evans 2002, European Commission 2003, Housenger 2003; Environmental Protection Agency 2005, Australian Pesticides & Veterinary Medicines Authority 2005a; Australian Pesticides & Veterinary Medicines Authority 2005b). Consequently, chemical industries are developing wood products for outdoor use that are environmentally friendly, accepted by public authorities in addition to being competitive with respect to price, durability and aesthetic properties. The alternatives contain less harmful substances, or they are made of naturally resistant wood species.

Although insight about consumers' preferences for different product attributes can provide competitive advantages for wood industries, little research has yet been done in this field. However, innovation and product development in the wood industry is receiving increased attention since the 1990s (see e.g. Cohen and Sinclair 1990, Narver and Slater 1990, West and Sinclair 1991, Lee et al. 1999, Cohen and Kozack 2001, Fell et al. 2002, Schaan and Anderson 2002, Montgomery and Giroux 2002, Schuler and Buehlmann 2002, Korhonen and Niemelä 2003, Van Horne et al. 2004, Hovgaard and Hansen 2004, Välimäki et al. 2004, Rametsteiner et al. 2005, Rametsteiner and Weiss 2005, Bull and Ferguson 2005, Diaz-Balteiro et al. 2005, Nord 2005). The conclusion of the research to date is that innovation is limited in the wood industry, focusing on incremental process innovations. Several industry analyses and industry-wide policy documents therefore warrant increased innovation in the sector (see e.g. "Vision 2030 – Innovative and sustainable use of forest resources, a technology platform initiative by the European forest-based sector").

Knowledge about customers' preferred product attributes is an important factor for competitive advantage, according to the Resource Based View on strategy (Peteraf 1993, Barney 1991, and 2001). Innovativeness is furthermore a means to renew and exploit such advantages in a dynamic perspective (Eisenhardt and Martin 2000, Stendahl et al. 2006, Danneels 2002), which is important for the firm's profitability and growth (Cho and Puick 2005).

Consumer preferences or and attribute elicitation is one key activity in the early stages of the innovation process (Figure 1). Studies of consumer liking for wood and wood attributes have been presented by Marchal and Mothe (1994), and Broman (2000). Key attributes of wood products were also analysed by Hansen et al. (1996), Hansen and Bush (1999), Weinfurter and Hansen (1999), Ozanne and Smith (1998), Ozanne, *et al*. (1999), Veisten (2002), Hansmann et al. (2004), Bigsby and Ozanne (2002), Anderson and Hansen (2004), Reddy and Bush (1998), Pakarinen (1999), Pakarinen and Asikainen (2001), Bigsby, *et al*. (2005), and Jonsson (2005). Attitudes to treated wood were surveyed by Vlosky and Shupe (2002, and 2004), and for outdoor wood by Donovan (2004). An attempt to link the academic research with the current strategic decision making in the industry was presented by Wagner and Hansen (2004).

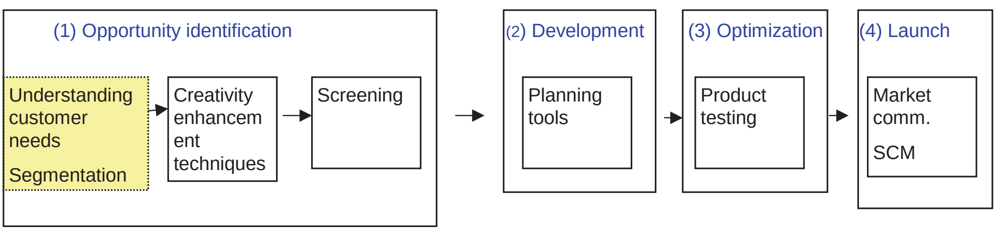


Figure 1. The role of attribute elicitation in the early stages of new product development (van Kleef et al. 2005)

While there is an increasing number of studies on product and service attributes of wood products, applications of well-established elicitation methods is les frequent (Brandt and Shook 2005). Reviews, e.g. van Kleef et al. (2005) and more specifically for the forest industry by Brandt and Shook (2005), show that there is a range of elicitation methods to be applied and in the forest products industries. Sensory analysis **(**Lawless and Heymann 1998**)**, free elicitation, segmenting and conjoint analysis (van Kleef et al. 2005) are examples of such approaches.

The purpose of this study is to apply different consumer research approaches for attribute elicitation and new product development. The methods are applied on real and potential products for outdoor decking. Finally, we briefly discuss the implications for researchers and the industry.

Theory

General model of consumer behavior

We foundation of our study is the general consumer behaviour theory (see e.g. Engel, *et al*. 1986) and the contribution by Lancaster (1966) that consumers demand characteristics of products rather than specific products. Thus, surveying attitudes towards salient product attributes provides information to predict the choice of consumers. Fishbein's Multiattribute Attitude Model (Fishbein 1963) indicates that a consumer's attitude towards a product is influenced by a set of salient product attributes. The consumer evaluates product attributes in a cognitive process influenced by his intention of consumption (Figure 2).

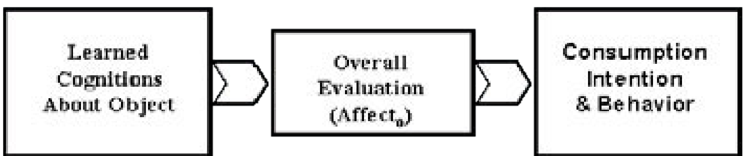


Figure 2. Fishbeins' multiattribute model (from Ryan 1986).

The challenge for the producer, e.g. of wood for outdoor use, is to identify and analyse key attributes that are most appreciated by potential customers and to use this knowledge in the product and marketing processes

Method

Sensory analysis

Sensory analysis is one such method that involves the definition and measurement of product attributes perceived by sight, sound, smell, taste and touch (Lawless and Heymann 1998) The method can be used for descriptive (Lea, *et al*. 1997; Lawless and Heymann 1998), or hedonic purposes (Evin and Siekierski 2002).

Five different terrace decking alternatives were prepared for analytical sensory evaluation and hedonic consumer evaluation by potential consumers (Figure 3 and Table 1). The samples were square modules measuring 100x60 centimetres. All boards were 95 millimetres wide. Four modules were made for each decking. Nine trained assessors agreed upon a consensus list of attributes for profiling the samples using generic terms The analysis respected prescribed standards for panel selection, laboratory design and procedures in sensory analysis (ISO 8586-1 1993, ISO 13299 2003, ISO 8589 1988). In the hedonic exercise 92 non-expert potential consumers rated their preferences for each type of decking.

Figure 3. Five samples of decking used in the study (left to right: Untreated Ipé, Organic biocide treated Pine, Furfuylated Pine, Untreated Russian Larch, Copper treated Pine).

Table 1. Descriptive information about decking samples

Tree species	Sample	Commercial name	Treatment	Origin	Price (NOK/m^3)
Tabebuia spp	I	Ipé	Untreated tropical hardwood	Brazil	620
Pinus silvestris	II	TMF	Pressure treatment, organic biocides	Norway	136
Pinus silvestris	III	Kebony	Pressure treatment and curing, Furfuryl-alcohol	Norway	150
Larix sibirica	IV	Russian Larch	Untreated heartwood from larch	Russia	208
Pinus silvestris	V	Wolmanit	Pressure treatment, Copper	Norway	93

Both the descriptive and hedonic sensory procedures used 7 graded rating scales. Principal Component Analysis and Partial Least Squares (PLS) (Abdi 2003) together with the Tukey HSD All-Pairwise Comparisons Test were used to analyse the data.

Free elicitation

In the hedonic study respondents were also asked to briefly reveal why they liked or disliked a specific product. In this analysis, these comments were recorded for the individual's most liked, or disliked alternative, yielding the reasons or motives for 'strong' positive or negative preferences (van Kleef et al. 2005).

Segmentation

Market segmentation is widely used to distinguish separate consumer groups with similar attributes and preferences. The approach can be used to target specific groups of customers, for product development or for differentiation (Grant 2003). Clustering techniques are often used for segmentation. In our study, an explorative hierarchical clustering study was carried out, using the Ward clustering method. Preference ratings were used as clustering variables (Green 1977).

Conjoint analysis

Sample II, III and V in the sensory analysis were finally selected for a conjoint analysis study among visitors to a large garden fair in the Oslo area. In the conjoint research approach several attributes are evaluated jointly, to mimic a real choice situation (Green and Srinivasan 1978, Green and Krieger 1991). In addition to the display of samples for inspection, we incorporated price, environmental labelling, augmented product and service as factors in the study. Factors and levels are presented in table 2.

Table 2. Conjoint analysis

Factor	**Levels**	Number of levels
Photo and product	TMF, Kebony, Wolmanit	3
Price	P1 (lowest), P2 P3 (highest)	3
Environmentally certified	Yes, No	2
Service	Yes, No	2
Ready to assemble box	Yes, No	2

Results

Sensory study

Eighteen relevant attributes were successfully identified and measured in the analytical sensory analysis. Principal component analysis (PCA) revealed that the variation between the samples could be described according the main dimensions, PC1, representing mainly surface texture, explaining 64% of the variation in the sensory data, and PC2, representing brightness of colour with *whiteness* as one important characteristic of the samples opposite to *colour hue* (case yellowish-red), explaining 21% of the variation (Figure 6). Additional principal components did not contribute substantially to describing the data material.

Ipé, copper treated Pine and untreated Larch presented extreme values on the sensory scores. Pine treated with copper appeared to be the most green/yellow and intense in colour. Organic biocides treatment exhibited less red colours than the furfurylated Pine. The amount of surplus colour was less visible for wood treated with organic biocides compared to the two other treatments. The samples of Copper treated wood had more and bigger knots as well as more distinct growth rings than the other Pine samples, but this relates to wood properties rather than method of treatment (the copper impregnated wood was bought in a builders' store, whereas the other samples were procured from the factories).

The decking from untreated Ipé and Larch were most liked by the customers (Figure 5). The two samples from pressure treated wood (copper and organic biocides) achieved low average scores. Consumer acceptance for pressure treated pine was significantly lower than the other samples.

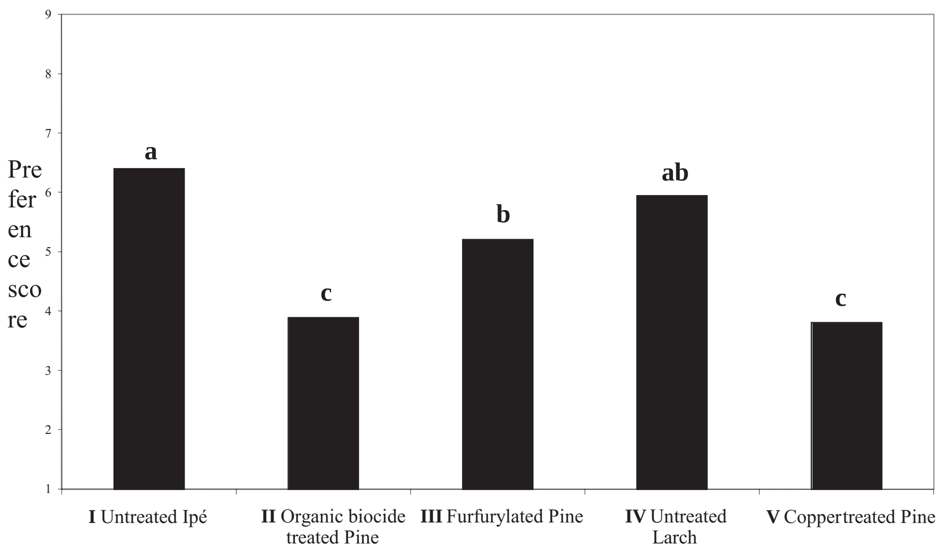


Figure 5. Consumer acceptance of the different types of decking. Average rating of 92 consumers. Samples with identical index letters are not significantly different (Tukey HSD All-pairwise comparison test).

Using the results from the Partial Least Squares (PLS) analysis, the sensory and consumer acceptance data were mapped according to the dominant principal components loadings, PC1 and PC2 (Figure 6). Consumer response is clustered in the right end of PC1, which suggests that most consumers prefer decking with corresponding characteristics (evenness, high growth ring density etc.).

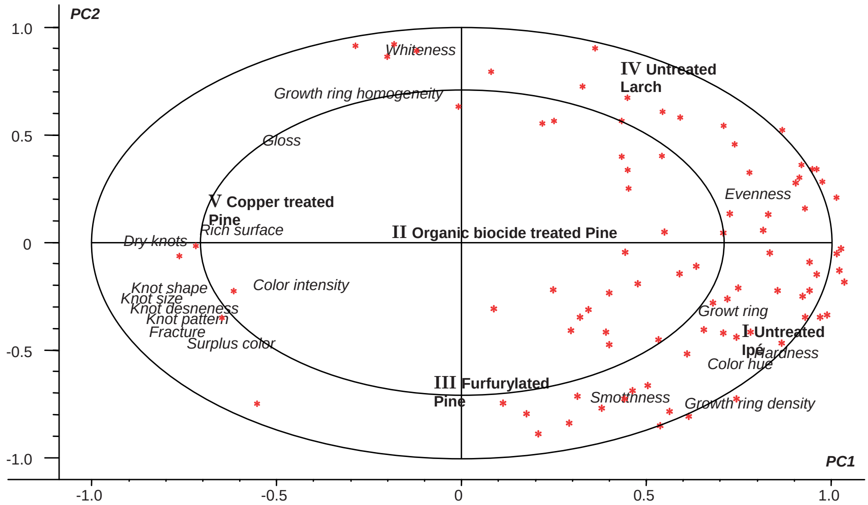


Figure 6. Preference map, plotting product attributes (*italics*), individual consumers (asterisks *) and the five samples of wooden decking (numbered I through V).

Free elicitation

The elicited reasons for most pronounced liking or disliking each of the samples are presented in Table 3. Some adjectives were mentioned by two or more respondents. For natural reasons the most liked products (Ipe and Larch) showed most positive comments, while the least liked decking had more negative observations.

Table 3. Free alicitation results

Sample	Reasons to prefer	Reasons not to prefer
Ipe	Suits the colour of my house Nice colour Solid impression Looks exclusive Trendy colour Nice dark colour Tough colour, resistant Doesn't need treatment Would be nice in my garden Few knots Seems resistant Will last over years	Too dark Deforestation? Rainforest species? I don't like dark Uneven colours
TMF	Looks real Colour Light and nice Inviting Light and pleasant	Pink colour? Reddish colour – seems unnatural Too light red – unpractical, doesn't fit anywhere
Kebony	Nice colour Conforms to the colour of my house OK colour Dark and even colour Gives a solid impression Like a roof of a cabin	Too dark! This type of colour is not trendy Looks dirty
Untreated heartwood from larch	Light, pleasant colour Aesthetically appealing wood Looks natural Neutral and nice colour Looks like good quality wood	Gets easily stained Needs regular treatment Too much patterns Too light
Wolmanit	Nice colour Green is a known colour for preserved wood	Don't like the colour! Associated with pressure treatment Too green Looks poisonous Low quality wood! Uneven colour

The comments give substance to some of the sensory analysis of e.g. Ipe and Larch, and Wolmanit. The comments also bring other associations and reactions – e.g. environmental properties - to the surface.

Cluster analysis

The hierarchical cluster analysis results are shown in table 4, which also presents approximate labels and most distinguishing features of each cluster.

Table 4. Cluster analysis results

Cluster No	N	Likes	Dislikes	Comments
1	15	(Kebony, Larch)	Wolmanit*, TMF	Young
2	13	Ipe	TMF, (Larch*)	
3	18	Larch*, (TMF*)	(Wolmanit, Ipe*, Kebony*)	Old
4	22	Kebony, (TMF*)		
5	5	Ipe	Kebony*, TMF	

* significant cluster property, in brackers: not very extreme rating

Unfortunately, the clusters were not distinct in terms of internal homogeneity and external differences. Moreover, additional descriptive data that might had confirmed and supported our cluster solution, were not available.

Conjoint analysis

The preliminary conjoint analysis results on a section (200 observations out of 296) of the data are shown in the summary Table 5.

Table 5. Conjoint results

Label	**Utility**	**Importance** (% Utility range)
Intercept		4
Wolmanit	-0.4	17
TMF	0.2	
Kebony	0.2	
P1	0.5	24
P2	0.0	
P3	-0.5	
Certified	0.9	48
Not certified	-0.9	
Service	0.1	3
No service	-0.1	
Box	-0.2	8
No box	0.2	

Respondents rated the treatment, price and environmental attributes as the most important aspects for their purchase. As in the sensory analysis, the green wolmanite-treated wood was least preferred. Improved service and advice, or ready-to-assemble box features were not important product attributes.

Discussion

The aim of this study was to apply and compare different methods for attribute elicitation for consumer-led product development. For the sake of realism we provided wood for outdoor decking as examples. The methods used were sensory analysis, free elicitation, segmentation, and conjoint analysis. Our main impression of this example is that all methods yield important information for marketing planning. However, the methods vary in focus and application. The methods could be used individually or in conjunction to provide different types of answers to the product developer. Sensory analysis gives a basis for exploratory innovation and a general indication of the direction of the product development. In some cases the sensory analysis results could be complemented by free elicitation or, when different segments can be expected, by segmentation studies. Conjoint analysis can provide important input when product concepts designed.

An assessment of the different methods and their application in product development is shown in Table 6. However, it must be stated that each of the approaches can be further refined to answer to more precise market planning questions. The methods are mainly a sample from a larger toolbox of for marketing research. This means that there is a great challenge ahead to use established marketing research methods in the forest products industry.

Table 6. Evaluation of elicitation methods

Method	Main results	Applications	Resources needed
Analytic sensory analysis	Yields a high amount of attributes Objective measures of sensory attributes Provide main dimensions based on attributes	First stage in NPD Map similarities and differences between products based on objective sensory attributes	Requires resources, e.g. a sensory panel and trained analysts that are rare in forest products research
Hedonic sensory analysis	Associates attributes with preferences Distinguishes attributes with negative, neutral or positive impact on preference	Indicate directions product development based on attributes. Useful for product placement and differentiation	Requires resources and skills (see above). I also entails new competences to use the information productively for new product development
Free elicitation	Seeks the individual's own reason for likes/dislikes. Considers the respondent's own vocabulary	Provides advice on further improvements. Indicates possible content in marketing communication	Simple method. Fewer requirements on the user. Easy to apply and analyse although it benefits from experienced and trained project team
Segmentation	Identifies consumer segments for product development and differentiation	Can indicate potential products for different segments. The method is less powerful when background data about	Easy to apply and interpret. Trained assessors are needed for a realistic approach in the application

		the segment is scarce	
Conjoint analysis	Identifies important attributes for consumer preferences Reveals preferred properties Resembles a typical choice situation	Powerful tool in product design – at different stages of the product development process Good basis for segmentation	Analytical skills Statistical skills and software.

Acknowledgements
The study was financed by the Research Council of Norway

Literature cited

Abdi, H. 2003. Partial Least Squares (PLS) Regression. *In* Encyclopedia of social sciences research methods. Edited by M. Lewis-Beck, A. Bryman, and T. Futing. Sage Publishing, Thousand Oaks, California. pp. 792-795.

Ajzen, I., and Fishbein, M. 1977. Attitude-behavior relations: A theoretical analysis and review of empirical research. Psychological Bulletin 84: 888-918.

Ajzen, I., and Fshbein, M. 1980. Understanding attitudes and predicting social behavior. Prentice-Hall, Englewood Cliffs, New Jersey. 278 pp.

Anderson R C, Hansen E N 2004. The impact of environmental certification on preferences for wood furniture: A conjoint analysis approach. Forest Products Journal 54(3): 42-50

Australian Pesticides & Veterinary Medicines Authority. 2005a. The Reconsideration of Registrations of Arsenic Timber Treatment Products (CCA and arsenic trioxide) and Their Associated Labels - Report of Review Findings and Regulatory Outcomes Summary Report. Australian Pesticides & Veterinary Medicines Authority.

Australian Pesticides & Veterinary Medicines Authority. 2005b. Some uses of CCA timber treatments to be phased out. Media Release - 15 March 2005. Available from: http://www.apvma.gov.au/media/mr0501.shtml [cited 11 December 2005].

Barney J B 1991. Firm resources and sustainable competitive advantage Journal of Management 17: 99-120.

Barney J. 2001. Is the resource-based view a useful perspective for strategic management research? Yes. Academy of Management Review 26: 41-56

Bigsby, H., Rai, C., and Ozanne, L. 2005. Determining Consumer Preference for Furniture Timber. Journal of Forest Products Business Research 2.

Brandt J.B., and Shook S.R. Attribute elicitation: Implications in the research context. Wood and Fibre Science 37(1): 127-146.

Broman, N. 2000. Means to measure the aesthetic properties of wood. Doctoral thesis, Luleå University of Technology, Luleå, Sweden

Bull L, and Ferguson I. 2005. Factors influencing the success of wood products innovations in Australia and New Zeeland Forest Policy and Economics (in press)

Cho H-J, and Puick V. 2005. Relationship between innovativeness, quality, growth, profitability, and market value. Strategic Management Journal 26:555-575

Cohen D H, Sinclair S A. 1990. The adoption of new manufacturing technologies: impact on the performance of North American producers of softwood lumber and structural panels. Forest Products Journal 40(11/12): 67-73

Cohen D. H. , Kozack R. A. 2001. Research and Technology: Market-driven innovation in the twenty-first century. The Forestry Chronicle 78(1): 108-111

Danneels E. 2002. The dynamics of product innovation and firm competences. Strategic Management Journal 23: 1095-1121
Diaz-Balteiro L, Herruzo A C, Martinez M, and Gonzalález-Pachón. 2005. An analysis of productive efficiency and innovation activity using DEA: An application to Spain's wood-based industry. Forest Policy and Economics (in press)
Eisenhardt K. M., Martin J. A. 2000. Dynamic capabilities: What are they? Strategic Management Journal 21: 1105-1121
Engel, J.F., Blackwell, R.D., and Miniard, P.W. 1986. Consumer behavior. The Dryden Press. 633 pp.
Environmental Protection Agency. 2005. Chromated Copper Arsenate (CCA): Timeline of Major CCA Actions. Available from: http://www.epa.gov/oppad001/reregistration/cca/timeline.htm [cited 11 December 2005].
European Commission. 2003. Commission Directive 2003/2/EC of 6 January 2003 relating to restrictions on the marketing and use of arsenic (tenth adaptation to technical progress to Council Directive 76/769/EEC). Available from: http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=32003L0002&model=guichett [cited 11 December 2005].
Evin, E., and Siekierski, E. 2002. Sensory evaluation of heating and air conditioning systems. Energy and Buildings 34: 647-651.
Fell D, Hansen E, Punches J. 2002. Segmenting single-family home builders on a measure of innovativeness. Forest Products Journal 52(6): 28-34
Fishbein, M. 1963. An investigation of the relationships between beliefs about an object and the attitude towards that object. Human Relations 16: 233-240.
Grant R M. 2003. Contemporary Strategy Analysis - Concepts. techniques, applications. Malden MA: Blackwell.
Green PE (1977) A new approach to market segmentation. Business Horizons 20, February, 61-73
Green P. E., and Srinivasan V. 1978. Conjoint analysis in consumer research: issues and outlook. Journal of Consumer Research 5:103-152
Green P. E., and Krieger A. M. 1991. Product design strategies for target marketing positioning. Journal of Product Innovation Management 8:189-202
Hair J F, Anderson R E, Tatham R L, and Black W C 1998. Multivariate Analysis. Prentice Hall International, Inc.
Hansen, E.N., Bush, R., and Fern, E. 1996. An empirical assessment of the dimensions of softwood lumber quality. Forest Science 42: 407-414.
Hansen E, and Bush R J. 1999. Understanding customer quality requirements - Model and application. Industrial Marketing Management 28 (2): 119-130
Hansmann R., Koellner T., and Scholz R.W. 2004. Influence of consumers' socioecological and economic orientations on preferences for wood products with sustainability labels. Forest Policy and Economics (2004)
Housenger, J.E. 2003. Response to Requests to Cancel Certain Chromated Copper Arsenate
(CCA) Wood Preservative Products and Amendments to Terminate Certain Uses of other CCA Products. Available from: http://www.epa.gov/fedrgstr/EPAFR-CONTENTS/2003/April/Day-09/contents.htm [cited 11 December 2005].
Hovgaard A., Hansen E. 2004. Innovativeness in the forest products industry. Forest Products Journal 54(1): 26-33
ISO 8586-1. 1993. Sensory analysis - General guidance for the selection, training and monitoring of assessors. Part 1: Selected assessors.
ISO 8589. 1988. Sensory analysis - General guidance for the design of test rooms.

ISO 13299. 2003. Sensory analysis - Methodology - General guidance for establishing a sensory profile. pp.
Jacobsen, B.H., and Evans, F.G. 2002. Beskyttelse av tre utendørs - Del 1. Norsk treteknisk institutt. Oslo, Norway.
Jonsson, R. 2005. Studies in the competitiveness of wood - market segmentation and customer assessment. PhD-thesis, Växjö University, Växjö, Sweden. 53 pp.
Korhonen S., and Niemelä J. S. 2003. Strategy Analysis of the Leading European and North American Wood-Industry Companies in 1998-2001. University of Helsinki Seinäjoki Institute for Rural Research and Training. Series B:30.Kubeczko K, and Rametsteiner E. 2002. Innovation and entrepreneurship – A new topic for forest related research? Institut für Sociоökonomi der forst- und holzwirtschaft. Nr P/2002-1
Lancaster, K. 1966. A New Approach to Consumer Theory. Journal of Political Economy 74: 132-156.
Lawless, H., and Heymann, H. 1998. Sensory evaluation of food: principles and practices. Chapman & Hall, New York, New York. 819 pp.
Lea, P., Næs, T., and Rødbotten, M. 1997. Analysis of Variance for Sensory Data. John Wiley & SonsLtd., London, England. 102 pp.
Lee L, Cohen D, Maness T. 1999. Markets and technology in Western Canadian Sawmills. Forest Products Journal 49(7/8): 36-42.
Marchal, R., and Mothe, F. 1994. Appreciation of oak wood for the French consumer and wood professionals. Annales des Sciences Forestieres 51: 213-231.
Montgomery K., Giroux Y. The Canadian Forest Industry – Innovation Profile. The Forestry Chronicle 78(6):786
Narver J C, and Slater S F. 1990. The effect of market orientation on business profitability. Journal of Marketing (4): 20-35
Nord T. 2005. Structure and developments in the solid wood value chain. Luleå University of technology, Department of Civil Environmental Engineering, Division of Structural Engineering – Timber Structures. Licentiate Thesis No. 7. LTU-LIC-05/57-SE
Ozanne, L., and Smith, M. 1998. Segmenting the market for environmentally certified wood products. Forest Science 379-388.
Ozanne, L., Bigsby, H.R., and Vlosky, R. 1999. New Zealand consumer perceptions and willingness to pay for environmentally certified forest products. New Zealand Forestry 43: 17-23.
Pakarinen T. 1999. Success factors of wood as a furniture material. Forest Products Journal 49(9): 79-85.
Pakarinen, T., and Asikainen, A. 2001. Consumer segments for wooden household furniture. Holz als Roh- und Werkstoff 59: 217-227.
Peterlaf M. A. 1993. The cornerstone of competitive advantage: A resource based view. Strategic Management Journal 14(3): 179-191.
Petiot J-F., and Yannou B. 2004. Measuring consumer perceptions for a better comprehension, specification and assessment of product semantics. International Journal of Industrial Ergonomics 33:507-525
Rametsteiner E, and Weiss G. 2005. Assessing policies from a systems perspective – Experiences with applied innovation systems analysis and implications for policy evaluation. Forest Policy and Economics (in press)
Rametsteiner E, Hansen E, and Niskanen A. 2005. Introduction to the special issue on innovation and entrepreneurship in the forest sector. Forest Policy and Economics (in press)
Reddy VS, Bush RJ. 1998. Measuring softwood lumber value: A conjoint analysis approach. Forest Science 44 (1):145-157

Ryan, M. 1986. Implications from the "old" and the "new" physics for studying buyer behavior. *In* Perspectives on methodology in consumer research. Edited by D. Brinberg, and R. Lutz. Springer-Verlag, Berlin, Germany. pp. 37-63.

Schaan S, Anderson F 2002. Innovation in the forest sector. Working Paper. Science, Innovation and Electronic Information Division. Statistics Canada.

Schuler A, Buehlmann U. 2003. Identifying future competitive business strategies for the U.S. residential wood furniture industry: Benchmarking and paradigm shifts. United States Department of Agriculture. Forest Service, Northeastern Research Station. General Technical Report NE-304.

Stendahl M, Roos A, Hugosson M., 2006. An investigation of product development in the Swedish and Finnish Nordic Pine Sawmilling Industry. Paper presented at the SSFE conference, Uppsala May 2006.

UK Forestry Commission. 2004. UK Timber market statement - September 2004. United Nations Economic Commission of Europe Timber Committee.

UK Forestry Commission. 2005. September 2005 UK timber market statement. United Nations Economic Commission of Europe Timber Committee.

Van Horne C, Frayret J-M, Poulin D. 22004. Creating value with innovation: From centre of expertise to the forest products industry. FORAC Research Consortium, Université Laval, Quebec, Canada.

van Kleef E., van Trijp H.C.M., and Luning P. 2005. Consumer research in the early stages of new product development: a critical review of methods and techniques. Food Quality and Preference 16:181-201

Wagner ER, Hansen EN. 2004.A method for identifying and assessing key customer group needs. Industrial Marketing Management 33 (7): 643-655

Veisten, K. 2002. Potential demand for certified wood products in the United Kingdom and Norway. Forest Science 48: 767-778.

Vlosky, R., and Shupe, T. 2002. Homeowner attitudes and preferences for building materials with an emphasis on treated wood products. Forest Products Journal 52: 90-95.

Vlosky, R., and Shupe, T. 2004. U.S. homebuilder perceptions about treated wood. Forest Products Journal 54: 41-48.

Weinfurter, S., and Hansen, E.N. 1999. Softwood lumber quality requirements: explaining supplier/buyer perception gap. Wood and Fiber Science 31: 83-94.

West C D, and Sinclair S A. 1991. Technological assessment of the wood household furniture industry. Forest Products Journal 41(4):11-18

Välimäki H, Niskanen A, Tervonen K, and Laurila I. 2004. Indicators of innovativeness and enterprise competitiveness in the wood products industry in Finland. Scandinavian Journal of Forest Research 19(Suppl. 5): 1-7

Minimum required rotation age for get profit in small-scale forest plantations of Schizolibium parahyba

Eduardo Sandoval

Abstract
Encouraged by international co-operations and private investment firms, farmers in the Bolivian lowland are incorporating small-scale forest plantations their productive system, for income generation from timber. Schizolobium parahyba, Eucalyptus spp. and recently Tectona grandis are mainly used because of their fast growth and potential to produce benefits within a short time horizon. However, issues such as economic return, market access, timing of thinning and productivity are still unknown. This study's objectives are to discuss the economic fundamentals of plantation forestry with S. parahyba, using the land expectation value (LEV) (Faustmann formula). Growing functions are calculated using data from permanent plots established by the Agricultural Tropical Research Centre (CIAT). It considers sales at local market conditions. Optimal biological, optimal economic and minimum economic rotations are estimated. In addition, a sensitivity analysis with varying discount rate and stumpage price is made. The analysis demonstrate that the optimal biological, optimal economic and minimum economic rotation ages are 38, 23 and 13 years, respectively, but the last one could diminish to 6 years if the market accepted logs of smaller diameter. Increasing capital costs reduce the LEV value logarithmically, and increases in timber price shift up the LEV and reduce the rotation age.

Key words: Bolivia, Schizolobium parahyba, small-scale forest plantations, maximising profit, minimum rotations.

Introduction

In the lowlands of Bolivia, in the regions of Santa Cruz and Cochabamba, small and medium-scale farmers have begun to invest in forest plantations in small areas. Some of them are doing it with external support and others by own effort. Little is known about yield, price and markets for wood from plantations in Bolivia, however, the investors are hoping for good profit. The most used species is Schizolobium parahyba, because of its fast growth. Currently, the local industry is utilising this species from the natural forest to make veneer. Timber of S. parahyba from forest plantations has not yet been sold.

S. parahyba is a typical light demanding pioneer species which invades gaps in the natural forest. It belongs to the Caesalpinaceae family and has two subspecies (S. var. amazonicum and var. parahyba). It is native to America and has a distribution range from Brazil to Mexico, being most abundant in the Amazon. In Bolivia this species is found in the departments of Santa Cruz, Cochabamba, La Paz, Beni and Pando, in areas with precipitation of up to 1000 mm. per year. S. parahyba reaches between 25 to 40 m in height and has a cylindrical and well formed stem of almost 100 cm of diameter at the breast height (DBH) (Justiniano et al., 2001). Maldonado and Escobar (2000) reported that in Colombia S. parahyba can reach 46 m in height and 80 cm DBH, and Justiniano et al. (2001) have estimated its life cycle to be 60 years.

The current forest plantations in the lowland of Bolivia are being established by small-scale farmers and by citizens who see an interesting alternative of investment. International co-operations and private investment firms are encouraged to do that. In the colonized areas, where the plantations are mostly located, the plot sizes are typically 20 ha.

On the plots approximately 5 ha is destined to agricultural uses, 5 ha to cattle and the remaining 10 ha is left for future use.

The objectives of this study are: a) to calculate the optimal biological, optimal economic and minimum economic rotation age for S. parahyba, and b) to build a matrix for decision making when choosing a rotation age, taking into account the discount rate and stumpage price. The study area is classified as subtropical region, with rainfall between 1420 to 2800 mm/year and 23 to 24oC of temperature (Aguirre, 2002).

Methodology

Grow function

The growth data for S. parahyba in forest plantations of 1 – 25 years of age (Table 1) were collected by the Agricultural Tropical Research Centre (CIAT) in Santa Cruz, Bolivia (Aguirre, 2002). Data on S. parahyba growth in natural forests were obtained from Justiniano et al. (2001) and Maldonado and Escobar (2000), in order to build growth functions for the complete estimated life cycle. Data were plotted to find regression equations between age and diameter, and between age and height.

Table 1: Growth data of Schizolobium parahyba in Santa Cruz, Bolivia1

No	Age (years)	DBH (cm)	Height (m)	No	Age (years)	DBH (cm)	Height (m)	No	Age (years)	DBH (cm)	Height (m)
1	0.1	0.0	0.9	14	3.6	12.6	10.3	27	5.5	24.3	15.8
2	1.0	9.1	6.9	15	3.7	14.4	21.3	28	5.7	19.0	10.9
3	1.2	6.0	4.4	16	3.8	15.8	10.6	29	6.7	24.9	14.8
4	1.2	10.2	8.0	17	3.8	14.0	11.8	30	6.8	26.3	20.2
5	1.6	5.3	4.3	18	4.4	17.1	11.7	31	6.9	22.6	15.2
6	1.9	9.0	6.3	19	4.4	17.7	10.8	32	7.3	23.5	17.4
7	1.9	10.6	8.0	20	4.8	15.5	13.6	33	8.0	27.2	20.4
8	1.9	10.8	9.0	21	4.8	16.7	14.9	34	8.7	25.5	20.3
9	2.0	12.3	11.3	22	4.9	14.8	12.5	35	9.9	26.8	19.5
10	2.0	8.4	6.5	23	4.9	15.3	13.0	36	24.8	70.3	28.0
11	2.1	14.4	13.6	24	5.0	18.5	13.5	37*	50.0	80.0	35.0
12	2.3	12.8	12.8	25	5.1	13.5	10.6	38**	60.0	100.0	40.0
13	3.3	12.0	12.3	26	5.4	19.2	16.2				

Source: Aguirre (2002) DBH: Diameter at breast height

Later the expected diameter and height are calculated for up to 50 years rotation age. The volume was estimated using the Schumacher and Hall model (Eq. 1) cited by Ruiz (2003) and a theoretical model representing grow of an individual tree was found. The mean annual increment (MAI) was estimated through dividing the volume of a tree with the stand age (Eq. 2). The current annual increment (CAI) was estimated by subtracting the volume of the previous year (Vt-1) from the volume in year t (Vt) (Evans and Turnbull, 2004) (Eq. 3).

1 Data for no. 1 to 36 were taken from permanent samples plots (Aguirre, 2002), data for no. 37 and 38 are theoretical data based on observation in natural forest (Maldonado and Escobar, 2000; Justiniano et al. 2001).

(1)	$V = \frac{\pi}{4} D^2 * H * Ff$	Where: V = stumpage in m3/tree D = diameter at breast height in cm H = commercial height in m (assuming 50 % of total height) Ff = form factor (0.65)
(2)	$CAI = V_t - V_{t-1}$	Vt = volume in m3/ha in year t; Vt-1 = the volume in the previous year
(3)	$MAI = \frac{V_t}{A_t}$	At = the age of the stand in year t

Optimal biological rotation

The largest increment in the volume of the tree occurs when the CAI falls to the MAI level, therefore the point of intersection between both curves, where the MAI equals the CAI, is the optimal biological rotation age. After this point the MAI starts to decrease gradually (Evans and Turnbull, 2003).

Optimal economic rotation

Cash flow was calculated for the regular activities carried out in plantations, like soil preparation, fence, seedlings establishment, weeding, pruning and thinning. It was assumed that the land is bare and that there are no harvesting costs because the timber is sold as standing trees. The costs were adapted from Ruiz (2003), AD/BOL/97/C23 (2004) and from the author's experience (Table 2). The land value is not taken in account. The current timber price of S. parahyba at the local market is USD 12/m3 stumpage value, found through direct information. At the same time it was assumed that there are no incomes from early thinning because the wood is not good for firewood and is only used for plywood. The minimum diameter accepted by the buyers in the standing trees is above 40 cm DBH, so this is the minimum commercial diameter assumed. Normally, the plantation owner sells the standing trees to middleman, who cut the stand and transport the logs to sawmills.

Table 2: Estimated cost of establishment and maintenance of a forest plantation (USD/ha)

Tasks	Years					total
	0	1	2	3	8	
Establishment (seedlings, transport, soil preparation and plantation. Initial density of 1111 trees/ha (USD/ha)	556					
Clearing (3 times per year) (USD/ha)		51	51	51		
Pruning (USD/ha)			8	8		
Thinnings, leaving a final density of 277 trees/ha (USD/ha)				30	175	
Total (USD/ha)	556	51	59	89	175	950

(Costs are in constant collars at 2006)

The management regime assumed is an initial density of 1111 trees/ha, two thinning to get a final density of 277 trees/ha, and pruning and clearing in the three firsts years (Aguirre, 2002).

The model used to estimate the profitability of the plantations was the Land Expectation Value (LEV), based on the Faustmann formula. Klemperer (2003) explains that this formula is used for calculating the present value of a stand assuming infinite rotations, giving a value that represents the maximum that an investor her is willing to pay for bare land (WPL∞) to use it for forest plantations indefinitely, earning at least a minimum acceptable return rate (MAR) over the invested capital. Therefore, a reforestation project would be acceptable if the WPL is greater or equal to the land price. In this model the land is the only asset (Navarro, 2006). The optimal economic rotation was found by identifying the year in which the stand reaches the highest WPL∞ value.

$$WPL_{\infty} = \frac{\sum_{t=0}^{n} \frac{R_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}{1-(1+r)^{-n}} \qquad (4)$$

Where:
Rt = income from timber sold in year t
1/(1+ r)t = the discount factor (r = MAR = 6%)
Ct = the costs in year t
1/1-(1+r)-n = the perpetuity factor (n = rotation)

Minimum economic rotation

The minimum economic rotation age corresponds to the year when the trees reach the minimum trade diameter and the WPL∞ value is positive. This can be interpreted as the minimum period required for obtaining profit.

Sensitivity analysis

New WPL∞ values are found by applying variations in the discount rate and in the timber price, in order to evaluate the influence of this variation on the optimal and minimum economic rotation age.

Matrix for decision making in the short run

In a scenario where small-scale plantations are established by farmers in poor rural areas it is necessary to use the following assumptions:

Assumption 1: A small-scale farmer, whose livelihood depends on his annual production, cannot wait too long for harvesting the timber, even though the optimal rotation length will be longer. It means that the producer is going to sell the trees when they reach the minimum trade diameter.

Assumption 2: The timber is going to be sold as stumpage to local buyers.

A factorial interaction was made with the following variables: stumpage price, discount rate and short rotations. It was assumed that the farmer already owns the land and that he will carry out plantations in perpetuity, so the land cost was not taken in account. The mathematical model was:

$$C = r * p * t \qquad (5)$$

Where: C = possible combinations
r = discount rate (3%, 6%, 9% and 12%)
p = stumpage price in USD/m3 (9, 12, 15, 18)
t = rotation length in years (13 to 23)

Values of WPL∞ for all possible combinations were calculated to generate a matrix for decision making. Also, the equivalent annual annuity (EAA) was calculated in order to compare the investment in plantations with other land uses (Klemperer, 2003).

(6) $$EAA = NPV \frac{r}{1-(1+r)^{-t}} = \text{WPL}\infty * r$$

Where: EAA is Equivalent Annual Annuity; WPL∞ is willingness to pay for land; r is the discount rate and t is the rotation age

Results and discussion

Optimal biological rotation

The best fit between diameter at breast high (DBH) and age was obtained with a third degree polynomial (Equation 7, Fig. 1). The curve representing the relationship between height and age (Equation 8) is based on a logarithmic model (Vera and Poulin, 1994). Equations 7 and 8 allow to us develop the theoretical growth model for S. parahyba (Equation 9, Fig. 2) as a function of age.

(7)	D = 0.0001A3 – 0.0447A2 + 3.7923A R2 = 0.9637	Where: D = diameter in cm; A = age in years, and 0.0001; 0.0447; 3.7923 are parameters
(8)	H = 6.3104LnA + 5.1821 R2 = 0.7883	H = height in m; A = age in years, and 6.3104; 5.1821 are parameters
(9)	V = 0.00008A3 + 0.0066A2 + 0.0078A R2 = 0.9992	V = volume in m3/tree; A = age in years, and 8E-05; 0.0066; 0.0078 are parameters

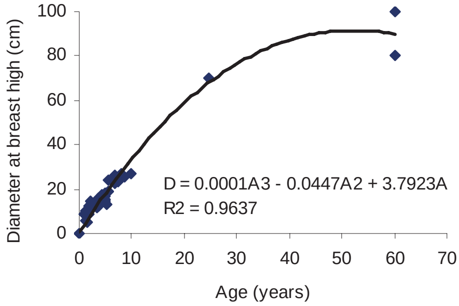


Figure. 1: Diameter (DBH) growth curve

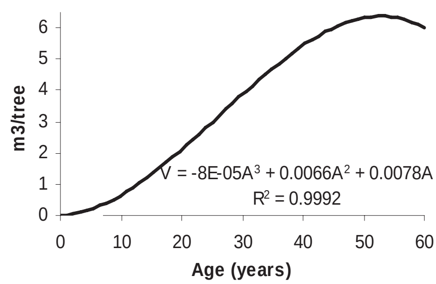


Figure. 2: Volume growth curve for an individual tree

The results from the calculation of the volume of an individual tree allowed a graphical intersection analysis between the MAI curve and the CAI curve. The intersection occurs when the tree reaches its maximum volume increment at 38 years of age (Fig. 3), thereafter it starts to decline. In Table 3 it can be seen that, the value of the MAI reaches 37.87 m3/ha at that age. Thereby, from a productivity point of view, the best moment to harvest the timber is at 38 years of age.

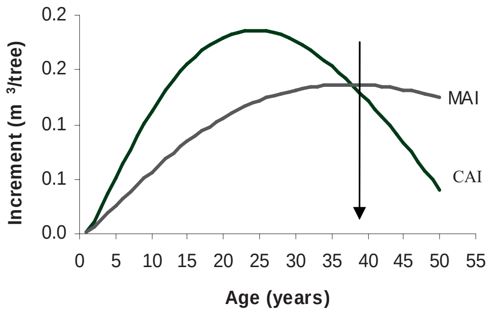


Figure. 3: Optimum biological rotation of S. Parahyba

Optimal and minimum economic rotations

Table 3 contains all data required for the calculation of different variables. Data in columns 2, 3 and 4 were calculated with equations 7, 8 and 1, respectively. Data in column 5 are the density of plantation assumed (starting with 1111, first thinning in year 3 and a second thinning in year 8, leaving a final density of 277 tress/ha). Column 6 contains volume/ha (column 4 times column 5). Data in columns 7 and 8 were calculated with equations 2 and 3, respectively. Column 9 contains the costs of establishment and maintenance (Table 2). Data in column 10 correspond to compound future value of the investment with 6 % rate of discount. Column 11 contains the revenue for timber sale at USD 12/m3. Column 12 corresponds to the net income (column 11 minus column 10). Column 13 contains the willingness to pay for land value (WPL∞) assuming reforestation in perpetuity, and Column 14 shows the internal rate of return (IRR).

It can be seen in Table 3 that the WPL∞ is negative at year 5 (-USD 2973/ha), and shifts to positive in year 6 (USD 454/ha), reaching its maximum value (USD 1988/ha) at year 23. Hereafter the WPL∞ begins to decrease. In the year 38 the WPL∞ is only USD 1151/ha.

Four points can be highlighted in Table 3:

In year 6, as long as there are buyers for trees of 20 cm DBH (column 2), the investors can recover their money and earn something additional at 9.20 % of internal rate of return (column 14). Notice that the WPL∞ has the lowest positive value (column 13). Notice also that in the local market buyers don't accept trees below 40 cm of diameter2, so this is an unrealistic return because there is no real market.

In year 13 the stand reaches the minimum commercial DBH (column 2) of 40 cm and therefore the investors get the real net income of USD 1356/ha (column 12) and with 11.13 % IRR. This is called the "minimum economic rotation".

In year 23 the stand reaches the maximum value in terms of WPL∞ (USD 1988/ha) although the IRR is lower. At the same time, the investors get a net income of USD 5604/ha. This is the best year to cut the trees and restart the rotation. Therefore 23 years is the optimum economic rotation. Harvesting after, or before, year 23 gives lower income.

In year 38 the stand reaches the maximum growth rate (MAI of 0.1367 m3/tree). From a production point of view this is the best year to cut the trees, however, the WPL∞ (USD 1151/ha) is lower than in year 23. Also the IRR is lower (8.29 %), even though in terms of

---

2 Personal communication with buyers in Bolivia

net income it seems be better because it reaches a higher value (USD 9385/ha), but from an economic point of view keeping the investment beyond year 23 means to decrease its worth because of the time (opportunity cost).

In Bolivia, the wood industry is still based on large diameters, because the logs from natural forest are of 50 cm of diameter, reaching even 150 cm. For timber from forest plantations the machines might be adapted to small diameter logs. For example, in Colombia the minimum diameter for Tectona grandis is 17 cm (Ladrach, 2005) and in Ecuador is 20 cm (Alder, 2006).

(1) Age years	(2) DBH (cm)	(3) HIGH (m)	(4) Volume m3/tree	(5) Density plantation	(6) Volume (m3/ha)	(7) CAI m3/tree	(8) MAI m3/tree	(9) Cost USD /ha	(10) Comp. Cost USD /ha	(11) Harvest USD /ha	(12) Net income USD /ha	(13) WPL ∞ USD /ha	(14) IRR	(15)
0								-576	576					
1	3,75	5,2	0,00	1111	2	0,00	0,00	-51	662	0	-662			
2	7,41	9,6	0,01	1111	15	0,01	0,01	-59	760	0	-760			
3	10,98	12,1	0,04	1111	41	0,02	0,01	-89	895	0	-895			
4	14,46	13,9	0,07	555	41	0,04	0,02		949	0	-949			
5	17,86	15,3	0,12	555	69	0,05	0,02		1005	831	-174	-2973		
6	21,17	16,5	0,19	555	105	0,06	0,03		1066	1256	190	454	9,20%	
7	24,39	17,5	0,27	555	147	0,08	0,04		1130	1766	636	1263	13,50%	
8	27,53	18,3	0,35	555	197	0,09	0,04	-175	1373	2358	986	1365	13,53%	
9	30,58	19,0	0,45	277	126	0,10	0,05		1455	1512	57	82	6,54%	
10	33,55	19,7	0,57	277	157	0,11	0,06		1542	1883	341	431	8,48%	
11	36,44	20,3	0,69	277	191	0,12	0,06		1635	2289	654	728	9,76%	
12	39,24	20,9	0,82	277	227	0,13	0,07		1733	2726	993	981	10,59%	
13	41,97	21,4	0,96	277	266	0,14	0,07		1837	3193	1356	1197	11,13%	MER
14	44,61	21,8	1,11	277	307	0,15	0,08		1947	3686	1739	1379	11,46%	
15	47,16	22,3	1,26	277	350	0,16	0,08		2064	4203	2140	1532	11,64%	
16	49,64	22,7	1,43	277	395	0,16	0,09		2188	4742	2554	1658	11,72%	
17	52,04	23,1	1,59	277	442	0,17	0,09		2319	5299	2980	1761	11,72%	

18	54,36	23,4	1,77	277	489	0,17	0,10		2458	5873	3415	1841	11,67%	
19	56,60	23,8	1,94	277	538	0,18	0,10		2605	6460	3854	1903	11,58%	
20	58,77	24,1	2,12	277	588	0,18	0,11		2762	7058	4296	1946	11,45%	
21	60,85	24,4	2,31	277	639	0,18	0,11		2928	7664	4737	1974	11,31%	
22	62,86	24,7	2,49	277	690	0,18	0,11		3103	8277	5174	1987	11,15%	
23	64,79	25,0	2,68	277	741	0,19	0,12		3289	8894	5604	1988	10,97%	OER
24	66,65	25,2	2,86	277	793	0,19	0,12		3487	9512	6025	1976	10,79%	
26	70,14	25,7	3,23	277	895	0,19	0,12		3918	10745	6827	1924	10,42%	
28	73,33	26,2	3,60	277	997	0,18	0,13		4402	11960	7558	1838	10,05%	
30	76,24	26,6	3,95	277	1095	0,18	0,13		4946	13140	8194	1727	9,68%	
32	78,86	27,1	4,29	277	1189	0,17	0,13		5557	14273	8716	1598	9,31%	
34	81,20	27,4	4,62	277	1279	0,16	0,14		6244	15346	9102	1456	8,96%	
36	83,26	27,8	4,92	277	1362	0,15	0,14		7016	16348	9332	1306	8,62%	
37	84,19	28,0	5,06	277	1402	0,1416	0,1367		7437	16818	9381	1229	8,46%	
38	85,05	28,1	5,19	277	1439	0,1352	0,1367		7883	17268	9385	1151	8,29%	OBR
39	85,84	28,3	5,32	277	1475	0,1284	0,1365		8356	17695	9338	1073	8,14%	
40	86,57	28,5	5,44	277	1508	0,12	0,14		8858	18098	9241	995	7,98%	

Figure 4 shows the ranking between years 13 to 23, which period contains all rotations with increasing WPL∞. The longer the rotation within this period, the higher is the WPL∞ value.

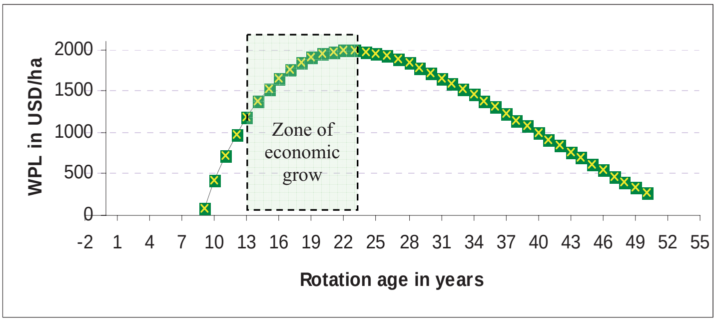


Figure. 4: Willingness to pay for land curve for S. parahyba

Data on volume increment in Table 3 are concordant with the findings by Ruiz (2003) who reports a MAI of 27.5 m3/ha at 17 years, although he suggests an optimal economic rotation of 17 years instead of 23 years. Another study made by the Project AD/BOL/97/C23 (2004) about of plantations with S. parahyba in the tropical area of Cochabamba estimates the MAI to be about 31 m3/ha at 12 years rotation age and a NPV of 2890 USD/ha. Alder (2006) found that in full stocking plantations of S. parahyba in Ecuador, the MAI was 20m3/ha at 20 years, but it continued to increase with time. In studies in Colombia it is reported that S. parahyba reaches a diameter of even 80 cm, heights of up to 46 m, a mean clean stem of 20 m, and a commercial volume of 7 m3/tree (Maldonado and Escobar, 2000). These data show that the capacity of S. parahyba to produce timber is comparable with the productivity of Gmelina arborea, which grows about of 40 m3/ha per year in Indonesia and 50 m3/ha per year in Costa Rica (Ladrach, 2004).

Column 13 of Table 3 shows the net income at year t. If the minimum commercial diameter were 20 cm, USD 190/ha worth be obtained in year 6 and major returns postponing the cutting to next years. However, all values in year 1 to year 12 are unrealistic due there still not being a market for logs of small diameter. After year 13, the calculation don't include income for the last thinning because it is assumed that the logs are not sold, so the net income now is realistic and represent the liquid money (it is discounting the compounded costs at year t) that investors would receive by harvesting the timber in the year t. After year 13 the real net income increases in absolute terms until year 38, but it decreases in relative terms.

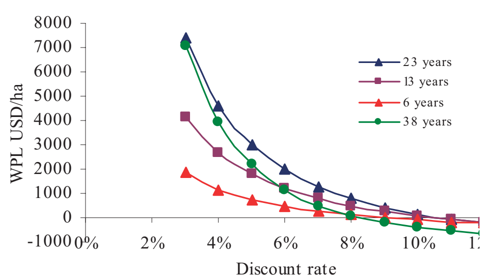
Rotation age	Discount rate 3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
6 years	1850	1152	733	455	257	109	-5	-97	-171	-233
13 years	4116	2645	1772	1197	793	495	268	90	-52	-168
23 years	7390	4623	3017	1988	1286	788	423	149	-60	-221
38 years	7047	3910	2185	1151	497	70	-216	-410	-544	-637

Sensitivity analysis

The results of the sensitivity analysis show that when the discount rate decreases, the WPL∞ value increases exponentially (Fig. 5, Table 4). Moreover, the optimal economic rotation (OER) and the minimum economic rotation (MER) are extended (Fig. 6). This means that decreasing opportunity cost of the investment, as represented by the discount rate, allows the investment to run for a longer period. An increase of the discount rate yields the opposite effect. The investment becomes unprofitable for discount rates 10 %. Navarro (2006) found similar results for Gmelina arborea plantations in Costa Rica.

In this context, it can be said that if the investor has own capital and expects at most a 4 % of rate of return by saving the money in the bank, he will prefer to invest in plantations. In the other hand, if he has to take a loan, the interest rate might be up to 10 %.

Table 4: Variation of WPL∞ for different rotation ages and discount rates



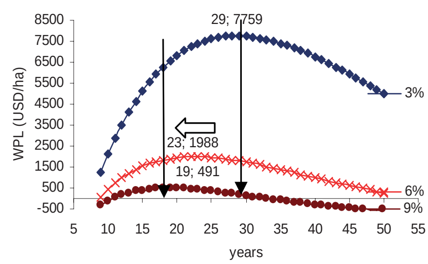
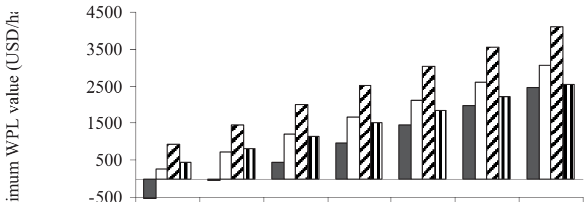


Figure. 5: LEV variation by changing the discount rate varying the discount rate

Figure. 6: Change of optimal economic rotation by

Figure 7 shows indirectly that for each dollar of increment in the timber price, the WPL∞ rises to 235 USD/ha for the minimum economic rotation, 263 USD/ha for the optimum economic rotation and 176 USD/ha for the optimum biological rotation. So, in the economic growth zone (Fig 4), the higher the price, the higher WPL∞ is. For a 6 years rotation the business becomes unprofitable with stumpage prices equal to or less than 10 USD/m3. As a reference, the stumpage price for Gmelina arborea in Costa Rica is USD 13.5/m3 when the stand is 6 years old at 6 years and USD 25/m3 at 12 years (Ladrach, 2002). Increments in the price have not influenced the rotations length.



Price USD/m3	8	10	12	14	16	18	20
■ 6 years	-545	-45	455	955	1455	1955	2456
□ 13 years	258	728	1197	1667	2137	2606	3076
23 years	936	1462	1988	2513	3039	3565	4090
38 years	445	798	1151	1504	1857	2210	2563

Figure. 7: WPL∞ variation by changing stumpage price

Matrix for decision making in the short run

Short rotations, in this case the minimum economic rotation of 13 years, are interesting not only because the small-scale farmers are not willing to wait for long periods, but also because the organisations that are promoting forest plantations are adopting rotations between 12 to 15 years (AD/BOL/97/C23, 2004).

Using Equation 5 and the levels of variation for the rotation, discount rate, and stumpage price, 176 possible combinations were identified. In Table 5 are presented the WPL∞ value and the equivalent annual annuity (EAA) of all combinations. The higher values of WPL∞ are obtained with prices of 18 USD/m3 and discount rate of 3% for all rotations between 13 and 23 years. With discount rates from 3 % to 6 %, any rotation is profitable at any price between 9 and USD 18 /m3. With discount rate of 9 % all combinations are profitable except when the price is 9 USD/m3 and the rotation is 13 or 14 years. Discount rate of 12 % makes the rotations profitable only if the sales price of the timber is USD 15/m3 or more, prices below this value give negative WPL∞.

Table 5: Matrix for decision making on investment in plantations with S. parahyba using rotations between 13 and 23 years

Discount rate (%)	Price (USD/m3)	Rotations age in years: 13		14		15		16		17		18		19		20		21		22		23	
		WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA	WPL	EAA
3%	9	2412	72	2853	86	3246	97	3594	10	3913	11	4179	12	4422	13	4636	13	4823	14	4978	14	5105	15
3%	12	4116	12	4651	14	5129	15	5554	16	5945	17	6267	18	6564	19	6824	20	7051	21	7237	21	7388	22
3%	15	5820	175	6448	193	7013	210	7513	225	7976	239	8356	251	8706	261	9012	270	9280	278	9497	285	9671	290
3%	18	7523	22	8246	24	8896	26	9473	28	1000	30	1044	31	1084	32	1120	33	1150	34	1175	35	1195	35
6%	9	493	30	649	39	780	47	888	53	980	59	1048	63	1104	66	1147	69	1177	71	1194	72	1199	72
6%	12	1197	72	1380	83	1532	92	1657	99	1764	10	1839	11	1901	11	1946	11	1976	11	1989	11	1987	11
6%	15	1902	11	2110	12	2285	13	2427	14	2547	15	2630	15	2698	16	2745	16	2775	16	2784	16	2775	16
6%	18	2606	156	2841	170	3037	182	3196	192	3330	200	3421	205	3495	210	3544	213	3574	214	3579	215	3564	214
9%	9	-11	-1	-48	-4	6	1	46	4	76	7	91	8	100	9	101	9	96	9	84	8	67	6
9%	12	268	24	345	31	404	36	445	40	474	43	486	44	490	44	484	44	471	42	450	41	422	38
9%	15	65	5	73	6	80	7	84	7	87	7	88	7	88	7	86	7	84	7	81	7	77	7
9%	18	1041	94	1133	102	1199	108	1243	112	1271	114	1275	115	1269	114	1251	113	1222	110	1182	106	1133	102
12 %%	9	-40	-4	-37	-4	-34	-4	-33	-4	-33	-4	-33	-4	-33	-4	-34	-4	-36	-4	-37	-4	-39	-4
12 %	12	-168	-20	-134	-16	-114	-14	-105	-13	-104	-12	-113	-14	-126	-15	-145	-17	-167	-20	-193	-23	-221	-27
12 %	15	70	8	103	12	121	15	126	15	122	15	107	13	86	10	60	7	29	3	-6	-1	-44	-5
12 %	18	307	37	340	41	356	43	357	43	349	42	326	39	298	36	264	32	224	27	180	22	133	16

Conclusions

According to the predictive growth model found in this paper, Schizolobium parahyba reaches its maximum growth in plantations at 38 years of age. So, the optimal biological rotation is 38 years.

The willingness to pay for land value (WPL∞) calculated using 6 % as discount rate and USD 12/m3 as stumpage price, reaches its maximum value when the stand has 23 years of age. Therefore, the optimal economic rotation is 23 years.

In the same sense, the stand reaches the minimum diameter accepted by at local market (40 cm DBH) at year 13, and the WPL∞ value is positive, so the minimum economically acceptable rotation is 13 years, i.e. this is the minimum period that the investor has to wait to recover his investment.

The sensitivity analysis with varying stumpage price shows that the highest the price, the highest is the WPL∞ value. Increments in the capital cost (discount rate) yield a reduction of both the WPL∞ and the rotation age. The investment is unviable at discount rates higher than 10 % at the current stumpage prices of USD 12/m3.

Assuming that small-scale farmers are not willing to wait for long rotations to recover their investment in forest plantations, the matrix for decision making allows choosing the best economic rotation in the short run, using the discount rate and the expected stumpage price. For instance, for a discount rate of 6 % and stumpage price 12 USD/m3, 13 years rotation age produces a WPL∞ of USD 1197/ha, while for a 15 year rotation age the WPL∞ is 1532 USD/ha. The choice has to be taken by the investor.

References

Aguirre, R. 2002. Las plantaciones forestales en Santa Cruz – avances y recomendaciones. Centro de Investigación Agrícola Tropical. Santa Cruz, Bolivia.

AD/BOL/97/C23. 2004. Análisis técnico-financiero de planes de manejo forestal, plantaciones forestales y sistemas agroforestales para el trópico de Cochabamba. Proyecto AD/BOL/97/C23. Cochabamba, Bolivia.

Alder, D. 2006. Growth and yield of some plantations species of the lowlands tropics in Ecuador. Foundation Juan Manuel Durini, Quito, Ecuador. (http://www.bio-met.co.uk/pdf/ffjmd3.pdf. Accessed in June 10, 2006)

Evans, J. and Turnbull J. 2004. Plantation Forestry in the Tropics. Third edition. Oxford University Press, New York, Unit States of America.

Justiniano, M.J.; Fredericksen, T.S.; Nash, D. 2001. Ecologia y silvicultura de especies menos conocidas –Serebo o Sombrerillo Schizolobium parahyba (Vell.) S.F. Blake, Caesalpiniaceae. Proyecto de Manejo Forestal Sostenible BOLFOR. Santa Cruz, Bolivia.

Klemperer, W. D. 2003. Forest Resource Economics and Finance. McGraw-Hill, Inc., Virginia, United States of America.

Ladrach, W. 2004. Harvesting and comparative thinning alternatives in Gmelina arborea plantations. New Forest 28:255-268.

Ladrach, W. 2005. Situación Forestal Mundial y sus perspectivas in Reforestación Conferencias de William Ladrach. Universidad de Bogota Jorge Tadeo Lozano. Colombia.

Maldonado, E. and Escobar, M. 2000. Selección de árboles plus de frijolito, Schizolobium parahyba, para mejorar genéticamente la especie en Santander Colombia. Santander, Colombia.

Navarro, G. 2006. Diseño y análisis microeconomico de los mecanismos monetarios de fomento a las plantaciones forestales en Costa Rica. CATIE. Turrialba, Costa Rica. (http://www.una.ac.cr/inis/docs/refor/navarro.pdf. Accessed in June, 2006)

Ruiz, C.A. 2003. Land cover analysis and afforestation potential for mitigation of climate change in the lowlands of Bolivia. Master thesis at The Faculty of Forestry and Forest Ecology, Georg-August Universitat Goettingen. Goettingen, Germany.

Vera, S. and Poulin, M. 1994. Catalog of curves for curves fitting-biometric information handbook series. ISSN 1183-9759. No. 4. Forest Science Research Branch, Ministry of Forest. British Columbia.

Product development in the sawmilling industry - drivers, obstacles and key success factors

Matti Stendahl, Anders Roos, Mårten Hugosson*

Abstract
Although several wood industry experts advocate the need for more product development in the industry, few studies have investigated the actual product development process in this context. This explorative study investigates innovation, specifically product development, in the Swedish and Finnish Nordic pine sawmilling industry. The data consists of interviews with product development managers in 14 sawmilling companies, which were viewed by industry experts to have vast experience of product development. The results reveal that product development has a central role for competitive position and self-image of the companies. The study also identifies drivers and motives that underlie the innovation process, the structure of the product development process, key success factors and obstacles for product development. The results are applicable on industry, company and project-level.

Key words: innovation, product development, strategy, resource-based view, forest industry, wood industry, sawmilling, exploratory study

1. Introduction
The customers of the Nordic sawmilling industry have started to demand specially adapted products and services with more value added. The importance of the product standards set up in 'Nordic Timber' (Assoc. of Swedish sawmillmen et al. 1995) has decreased. At the same time, relatively high costs, over-capacity, volatile markets and increased competitive pressure have resulted in low growth and profitability in the Nordic sawmilling industry (European Confederation of Woodworking Industries (ed.) 2004). The Nordic sawmilling industry is now aiming to develop its market position through regeneration of product- and market strategies and restructuring of the value system (TTJ October 2005 vol 415, p. 21). Development of new customer benefits combined with a continuous focus on cost efficiency, consolidation, shortening of the market channels, co-opetition and generic wood promotion are commonly suggested by researchers and consultants (Jakobsen et al. 2001; Korhonen & Niemelä 2003; European Confederation of Woodworking Industries (ed.) 2004; Nord 2005). Various product development initiatives can now also be seen in the industry (TTJ October 2005 vol 415, p. 21).

The topic of innovation has received much attention from researchers over the years. However, in the context of the forest sector, the topic of innovation is only briefly explored (Kubeczko & Rametsteiner 2002). Previous studies on innovation in the forest industry have acknowledged product, process and business systems innovation (Hovgaard & Hansen 2004). 'Investments in R&D' and 'new products and processes achieved' have been identified as important indicators of innovativeness (Välimäki et al. 2004). In the wood products industry, the focus of previous innovation-related research has been on process innovation, while product innovation has received less attention (see Hansen et al. 2005 for a review). Consequently, research on product development is 'a wide open field' (ibid.), and further exploratory research is motivated. Innovation research in the forest sector is in an expanding stage, and innovation and innovativeness in the wood industry receive increasing interest from researchers (Rametsteiner et al. in press).

2. Purpose of the study

The purpose of this research effort is to explore product development in large and medium-sized companies in the Nordic pine sector of the Swedish and Finnish sawmilling industry (SIC code 20101), a population called 'Swedish and Finnish Nordic pine sawmilling industry' in this paper. The objective is to find answers to the following research questions:

- What are the drivers, motives and outcomes of product development in the Swedish and Finnish Nordic pine sawmilling industry?
- What activities are included in the product development process in the Swedish and Finnish Nordic pine sawmilling industry, and how are those activities organised?
- What factors are the keys to successful product development in the Swedish and Finnish Nordic pine sawmilling industry?
- What are the most important obstacles for product development in the Swedish and Finnish Nordic pine sawmilling industry?

3. Theoretical background

Innovation is the generation, acceptance and implementation of new ideas, processes, products or services (Thompson 1967). Newness is a relative concept. In this study, the entry level for an innovation is that it must be new or significantly improved with respect to its characteristics or intended uses in the eyes of the focal company (OECD/European Communities 2005, p. 57). An innovation can also be new to the market or new to the world depending on if it has been implemented by other companies in the market or even in the world. Garcia & Calantone (2002, p. 124) defines *product innovativeness* as the continuum of product newness, from incremental to radical, as a second order factor consisting of market and technology newness on micro (firm) and macro level (industry). Furthermore, four types of innovations can be distinguished (OECD/European Communities 2005, p. 48-50): A *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. A *marketing innovation* is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. An *organisational innovation* is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. *Product development* is used as an assembly term for the span of innovation activities leading to, or that are intended to lead to, product innovations (OECD/European Communities 2005, p. 47).

Product development contributes to value creation and sustained and/or increased competitiveness during change of external conditions through facilitating adaptation to or influence of external conditions such as customer needs or competitors actions (Cooper 1996; Amit & Zott 2001, p. 497; Danneels 2002; Grant 2002, p. 316; Hult et. al 2004, p. 429, 430). Product development contributes to development of capabilities through its role in the coordination, integration, reconfiguration, recombination, transformation, creation or release of resources (Teece et al., 1997; Eisenhardt & Martin, 2000, Ireland et al. 2003, p. 980). In fact, firm competences and product development interact in a dynamic process of firm-renewal (Danneels 2002). A positive relationship between organisational innovativeness and performance has been found in many industrial contexts (Han et al. 1998, Hurley & Hult 1998; Hult et al. 2004) and also in the wood products industry (Cohen & Sinclair 1990; Korhonen & Niemelä 2004, p. 37; Välimäki et al. 2004).

On an organisational level, previous research have identified the following key factors for successful product development: clearly specified product development strategy in line with corporate strategy; resources specifically designated for product development; large and diverse knowledge base; support from senior management for development work; and market orientation (Montoya-Weiss & Calantone 1994; Brown & Eisenhardt 1995; Cooper & Kleinschmidt 1995; Atuahene-Gima 1995; Kahn 2001; Ernst 2002; Trott 2005). On a project level, the following factors have been pointed out: new product with superior customer value in relation to competing products; relatedness between required and existing resources and capabilities; clear specification of the new product concept; structured and complete product development process; cross-functional composition of the product development team, especially including market and processing technology competence; structure and attention to detail in projects with low uncertainty; flexibility and trial-and-error approach in projects with high uncertainty; autonomy of the product development team and full responsibility of the result; good communication within the product development team; power, vision and management skill of the project leader; and continuous active monitoring and management of the running project, including decisions about changes or termination (Montoya-Weiss & Calantone 1994; Brown & Eisenhardt 1995; Cooper & Kleinschmidt 1995; Tatikonda & Montoya-Weiss 2001; Ernst 2002; Trott 2005). In studies of the wood industry specifically, the following organisational-level factors have been identified by previous research as important prerequisites for successful product development (Lee et al. 1999; Crespell et. al forthcoming; Bull & Ferguson in press; Vestlund & Hugosson 2004): market orientation; clear specification of the company's 'arena'; proficient market, technical and commercial knowledge; firm-wide support for the innovation strategy; support from senior management for development work. On project-level, a structured and complete new product development process has been pointed out as a key factor (Crespell et. al forthcoming).

4. Methodology

A qualitative methodology, including examination of a set of informative cases, was chosen for this study (Eisenhardt 1989, p. 548; Merriam 1994, p. 175; Trost 1997, p. 15-16; Silverman 2001, p. 32; Yin 2003). Semi-structured interviews (Merriam 1994, p. 86-88; Trost 1997, p. 19-20) was chosen as method for data collection, which was carried out during year 2005.

When choosing cases to study, purposive sampling was used (Silverman 2000, p. 102). In order to locate informative cases, the sampling procedure began with identification of companies in the Nordic pine sector of the Swedish and Finnish sawmilling industry (SIC code 20101) that have much experience of product development. For this task we benefited from the help of industry experts in both countries who were asked to mention companies that fit this description.

We constructed two categories of size, medium-sized (50-249 employees) and large (> 249 employees) companies, which we covered in the sample of case companies. Considering the differences in integration structure between companies in the Swedish and Finnish pine sawmilling industry, and the possible effects on the topic of the study, we also considered it to be relevant to control for differences in integration structure. Accordingly, two population categories for integration structure were constructed and covered in the sample: 'pure wood industry' and 'fibre conglomerates'. In total 8 Swedish and 6 Finnish case companies were included in the study, making a total of 14 case companies.

The first contact with the case companies was made by phone. We spoke to the CEOs and identified key persons that were responsible for product development activities in the respective companies. Those key persons were targeted as interviewees, and time and place for a personal meeting was agreed with them personally. Before the meetings, a summary of the research project and the main topics for the interview were sent to the interviewees. An interview guide with the following set of questions was used:

- How is product development work organised in your company?
- Please describe two recent product development projects:
- What was the new product idea?
- Why was it started?
- What activities were carried out during the development process?
- What was the outcome of the process?
- Were you satisfied with the result?
- What were the key factors for success (or failure)?
- How is product development included in your business strategy?
- What are the strength and weaknesses of the Nordic pine sawmilling industry compared to competing industries?

The interviews were conducted at the office of the interviewees, and took anywhere from 45 minutes to 4 hours. The interviews were tape-recorded and field notes were taken. The analysis of the data set started by writing summaries of the interviews (Kvale 1997, p. 175-180). The summaries were sent to the interviewees for feedback (Merriam 1994, p. 179-180; Yin 2003, p. 34). In some cases, this resulted in changes of the interview summaries, but only on a detail level. The next step of the analysis was to categorise the compressed data (Kvale 1997, p. 175-180). Themes that were in accordance with the research questions and directly observable in the data were formulated (Boyatzis 1998, p. 33-37). The aim was to identify different aspects of each theme in an inductive way based on the data from the interviews. In line with the principles of replication logic (Eisenhardt 1989, p. 537; Silverman 2000, p. 178-185; Yin 2003, p. 47-51), a view and/or opinion stated by several respondents was considered to be a key finding of each theme.

5. Results

Product, process and marketing innovation was referred to by the respondents as an important tool to exploit the opportunities inherent in the challenging current market conditions and take advantage of the potential of the Nordic pine wood. Increased competitive advantage and improved financial performance was mentioned as the ultimate objective for undertaking product development. Adaptation of the product portfolio and improvement of customer relations, market orientation, entrepreneurship and knowledge were mentioned as important outcomes of product development. The effects of product development on product portfolio are however more acknowledged than those on resource and capability portfolio. The most frequently mentioned drivers, motives and outcomes of product development are summarised in table 1.

Table 1. Drivers, motives and outcomes of product development.

Drivers	Motives	Outcomes
Changing customer demands	Differentiation strategy	Changes in product portfolio
Specific actions by competitors	Exploiting strategic opportunities	Investments in machine equipment
Low-cost competition in general	Forward integration	New market and technology related knowledge
Diversifying material flow	Enter into new markets	Improved customer relations
New technology	Take care of consequential products	Improved intra-company communicative ability
A willingness among senior management to innovate		
Market changes, e.g. restructuring in the retail industry, new building regulations		

Many respondents pointed out that there is a difference between product development and continuous improvement. Product development was described as something with more 'innovation height'. Some respondents also pointed out that product development commonly is organised in form of a project, whereas continuous improvement was described as more of an on-going process resulting in minor changes. When describing product development projects, almost all interviewees also described some type of process development. It was described as an integrated part of product development leading to everything from major investments in equipment to minor changes in production processes or logistic flows. Some respondents also described development of new marketing or organisational practices as an integrated part of product development. Overall, product development was described as a dynamic testing and problem-solving process. The activities of the development work was reported to be going on parallel and intertwined with frequent feedback-loops. The most frequently mentioned activities included in the product development process is shown in table 2.

Table 2 Product development activities

Product development activities
Idea generation
Basic analysis: raw-material, production, marketing
Decision on continuation, termination or postponement
Project set-up
Development work: raw-material, production, marketing
Test production and delivery
Customer and employee input
Occasionally loop back to development work
Product launch
Project close
Continuous improvement

.

Although mainly drawing on internal resources, respondents reported that, if needed, external resources could also be employed during the product development process. The most frequently mentioned external resources are shown in table 3:

Table 3. External resources for product development

External resources for product development
Customers for product feed-back
Universities and research institutes for product testing, development of equipment or market analysis
Consultants for specific design issues, market studies or design of marketing material
Equipment suppliers for development of equipment
Raw material suppliers for adaptation of raw material
Sub-contractors for special processing capacity

Referring to the high work-load of the daily operations, many respondents pointed out the importance of finding sensible ways to put priority on product development activities. Managing the complexity and uncertainty inherent in the product development process and creating a creative climate in the organisation was also described as a major challenge. Some specific factors were frequently pointed out as key factors for successful product development (see table 4).

Table 4. Key factors for successful product development

Key factors for successful product development
Product advantage
Relatedness between current and required resource base
Human resources specifically designated for product development work
Organisation of strategic business units according to market segments
Strong customer relations
Mix of experience-based and academic market and technology competence
Knowledge about market launch tactics (for consumer products)
Support from senior management for product development work
Previous experience of product development
Versatile production equipment
Informal project organisation
Speedy, trial-and error approach
Clearly defined project goals
Dedicated project manager

.

According to the respondents, product development is often seen as complicated and strenuous. It is considered to be difficult and yield insecure results. The most frequently mentioned obstacles for product development are listed in table 5:

Table 5. Obstacles for product development.

Obstacles for product development
Relatively high heterogeneity of the Nordic pine wood material results in uncertainty regarding the determination of product yield and in the control of the diverging material flow.
The processing and marketing of consequential products complicates and hinders the development of new products.
Weaknesses of the wood material hinder further development of some product segments. Issues such as deformation, splitting, and poor fire resistance is still not fully solved. More knowledge about these issues is needed, something that was considered too big tasks for individual companies.
Short-term financial performance restrain investment in product development. The shortage of resources was generally blamed on the low margins of the Nordic wood industry.
Structural short-comings of the supply chains to some market segments, e.g. the construction industry, delimit product development since exchange of knowledge and goods with further processors and end-users is blocked and knowledge is missing.

6. Discussion and conclusions

In general, the respondent's description of product development and its key success factors produced results in line with findings from previous research. However, some interesting differences were found:

Many managers of the industry seem to primarily acknowledge effects of product development on product portfolio rather than on renewal of firm competences. Hamel and Prahalad (1994) referred to this as product-market myopia, something that can impede both competence exploitation and exploration.

The respondents integrated view of product and process innovation contrasts to that of a previous study of innovation in the forest industry that sees product, process, marketing, and organisational innovation as separate processes (Hovgaard & Hansen 2004). The integration of innovation types in the sawmilling industry has however been acknowledged by Crespell et al. (forthcoming, p. 23).

The role of trial runs and customer- and employee feedback as core activities of the product development process and the analysis of availability and suitability of raw-material and occasionally development of customised raw material supply illustrates interesting differences compared to other industries.

As a contrast to the benefits of structure and completeness of the development process advocated by previous research (e.g. Crespell et al. forthcoming), the respondents in our study stressed informality, flexibility, trial-and-error and speed as key factors for maintaining energy and creativity in the project which contributed positively to the result of product development efforts. This contradiction suggests a careful balancing of structure and flexibility in management of product development projects in this industrial context.

The importance of knowledge about market launch is also acknowledged in cross-industry research on the product development process (e.g. Cooper 1996). It has however not been highlighted in much of previous research in the wood industry context. The importance of market launch was specifically pointed out for the retail and construction industry segments. The development projects for these segments score relatively high on product innovativeness, which suggests that launch capabilities are especially important for 'radical' or 'really new' products.

7. Limitations of the study

The focus in this study was on internal validity, rather than on external validity, which often is the main concern in research using quantitative methods. Nevertheless, when describing a complex organisational process like product development, one must admit that the description only can be approximate. Both occurrence and sequence of activities are subject to context, project and company specificity. Despite this, and in order to promote understanding, findings comprise both occurrence and sequential order, derived through replication logic. It is important here to point out that the aim of using replication logic was to establish the occurrence of events and the meanings given to those events by key actors, rather than identifying the frequency of events.

From the comments made by the experts during the nomination exercise, we have reason to believe that there is a bias towards successful innovators among the companies that were chosen. A sample including both successful and unsuccessful innovators would probably have given a better understanding about the topics of the study.

8. Further research

Regarding key factors for successful product development, the statements by the respondents only revealed the occurrence of the respective factors, and not the amount or strength of them. The lack of quantification complicates the understanding of the factors and their respective influence. Operationalisation and validation of key factors for successful product development as well as antecendents of organisational innovativeness should be a hot topic, especially for practitioners. A positive relationship between innovativeness and performance (commonly manifested in profitability or growth) has been established by previous research. Nevertheless, a validation of that relationship in the context of the wood products industry would also be of interest. Finally, research on the properties and functionality of wood, on processing technology and control of production flow are encouraged to overcome some of the factors perceived by managers to hamper product development initiatives.

Literature cited

Amit R. & Zott C. 2001. Value creation in e-business. *Strategic Management Journal* 22 (6-7): 493-520

Association of Swedish sawmillmen, Association of Finnish sawmillmen and The Norwegian Sawmillmens association. 1995. *Nordic Timber*. 1st ed.

Atuahene-Gima K. 1995. An exploratory analysis of the impact of market orientation on new product performance - a contingency approach. *Journal of Product Innovation Management* 12: 275-293

Boyatzis R.E. 1998. *Transforming Qualitative Information. Thematic Analysis and Code Development*. London. Thousand Oaks. CA: Sage

Brown S. L., & Eisenhardt K. M. 1995. Product development: past research, present findings, and future directions. *Academy of Management Review* 2:343-378.

Bull L & Ferguson I. Factors influencing the success of wood products innovations in Australia and New Zeeland. *Forest Policy and Economics* (in press).

Cohen D H, & Sinclair S A. 1990. The adoption of new manufacturing yechnologies: impact on the performace of North American producers of softwood lumber and structural panels. *Forest Products Journal* 40(11/12): 67-73

Cooper R.G. 1996. Overhauling the new product process. *Industrial Marketing Management* 25 (6): 465-482

Cooper R.G. & Kleinschmidt E.J. 1995. Benchmarking the firms critical success factors in new product development. *Journal of Product Innovation Management* 12 (5): 374-391

Crespell P., Knowles C. & Hansen E. Innovativeness in the North American Softwood Sawmilling Industry. Forthcoming.

Danneels E. 2002. The dynamics of product innovation and firm competences. *Strategic Management Journal* 23: 1095-1121

Eisenhardt K.M. 1989. Building theories from case-study research. *Academy of Management Review* 14 (4): 532-550

Eisenhardt K. M. & Martin J. A. 2000. Dynamic capabilities: What are they? *Strategic management Journal* 21: 1105-1121

Ernst H. 2002. Success factors of new product development: a review of the empirical literature. *International Journal of Management Reviews* 4 (1): 1-40

European Confederation of Woodworking Industries (ed.). 2004. *Roadmap 2010 for the European Woodworking Industries.* Bruxelles.

Garcia R. & Calantone R. 2002. A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management* 19 (2): 110-132

Grant R.M. 2002. *Contemporary Strategy Analysis: Concepts, Techniques, Applications*. 4. ed. Malden, Mass. Blackwell publishers. 551 pp.

Hamel G. & Prahalad C.K. *Competing for the Future*. Harvard Business School Press. Boston. Massachusetts. 327 pp.

Hansen E., Korhonen S., Rametsteiner E. & Shook S. 2005. Current state-of-knowledge: Innovation research in the global forest sector. Unpublished white paper. Oregon State University. Department of Wood Science and Engineering.

Hovgaard A. & Hansen E. 2004. Innovativeness in the forest products industry. *Forest Products Journal* 54(1): 26-33

Hult G. T. M., Hurley R.F. & Knight G.A. 2004. Innovativeness: its antecedents and impact on business performance. *Industrial Marketing Management* 33: 429-438

Hurley R.F. & Hult G.T.M. 1998. Innovation, Market Orientation, and Organizational learning: An Integration and Empirical Examination. *Journal of Marketing* 62: 42-54.

Ireland R.D., Hitt M.A. & Sirmon D.G. 2003. A model of strategic entrepreneurship: The construct and its dimensions. *Journal of Management* 29 (6): 963-989

Jakobsen E.W., Vikesland M. & Holst L.K. 2001. *A Value Creating Forest- and Wood Products Industry (in Norwegian)*. Handelshöyskolen BI, Sandvika, Research report no. 6 2001.

Kahn K.B. 2001. Market orientation, interdepartmental integration, and product development performance. *Journal of Product Innovation Management* 18 (5): 314-323

Korhonen S. & Niemelä J.S. 2003. *Strategy Analysis of the Leading European and North American Wood-Industry Companies in 1998-2001*. University of Helsinki Seinäjoki Institute for Rural Research and Training. Series B:30.

Korhonen S. & Niemelä J.S. 2004. Guidelines for sustainable, external corporate growth: a case study of the leading European and North American companies in the wood industry. *Journal of Forest Products Business Research*. 1.

Kubeczko K, & Rametsteiner E. 2002. *Innovation and entrepreneurship – A new topic for forest related research?* Institut für Socioökonomi der forst- und holzwirtschaft. Nr P/2002-1

Kvale S. 1997. *The qualitative research interview* (in Swedish) Lund. Studentlitteratur. 306 pp.

Lee L, Cohen D. & Maness T. 1999. Markets and technology in western canadian sawmills. *Forest Products Journal* 49(7/8): 36-42

Merriam S.B. 1994. *The Case Study as a Research Method* (in Swedish, original in English: Case Study Research in Education). Studentlitteratur. Lund.

Montoya-Weiss M. & Calantone R. 1994. Determinants of new product performance - a review and meta-analysis. *Journal of Product Innovation Management* 11 (5): 397-417

Nord T. 2005. *Structure and developments in the solid wood value chain*. Luleå University of technology, Department of Civil Environmental Engineering, Division of Structural Engineering – Timber Structures. Licentiate Thesis No. 7. LTU-LIC-05/57-SE

OECD/Eurostat. 2005. *Oslo Manual*. Guidelines for Collecting and Interpreting Innovation Data. Third Edition.

Rametsteiner E, Hansen E, & Niskanen A. Introduction to the special issue on innovation and entrepreneurship in the forest sector. *Forest Policy and Economics* (in press)

Silverman D. 2000. *Doing Qualitative Research: A Practical Handbook*. Thousand Oaks. Calif.: SAGE. 316 pp.

Silverman D. 2001. *Interpreting Qualitative Data: Methods For Analyzing Talk, Text And Interaction.* 2. ed. London: SAGE. 325 pp.

Tatikonda M.V. & Montoya-Weiss M.M. 2001. Integrating operations and marketing perspectives of product innovation: The influence of organizational process factors and capabilities on development performance. *Management Science* 47 (1): 151-172

Teece D., Pisano G. & Shuen A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* 18(7): 509-533.

Thompson, J. 1967. *Organizations in Action*. London: McGraw-Hill.

Timber Trade Journal. 2005. Vol. 415, p. 23

Trost J. 1997. *Qulitative interviews* (in Swedish) 2. ed. Lund. Studentlitteratur.

Trott, P. 2005. *Innovation Management and New Product Development*. Financial Times Prentice Hall. Harlow, England. 426 pp.

Vestlund K. & Hugosson M. 2004. *Product Development for More Profitable Sawmills – Theory and a Case Study* (in Swedish). Report. Department of Forest Products and Markets. Uppsala.

Välimäki H, Niskanen A, Tervonen K, & Laurila I. 2004. Indicators of innovativeness and enterprise competitiveness in the wood products industry in Finland. *Scandinavian Journal of Forest Research* 19(5): 1-7

Yin R.K. 2003. *Case Study Research: Design and Methods*. 3. ed. Thousand Oaks. CA: Sage. 181 pp.

Excepted coverage of endangered species on Danish heathland

Niels Strange, Jette Bredahl Jacobsen, Peter Tarp and Bo Jellesmark Thorsen*

Abstract:
Considerable resources must be allocated for fulfilling the Habitat Directive and the question of optimal allocation is as important as it is difficult. In the present study, we estimate the expected species coverage of three non-probabilistic strategies: i) a maximum selected area strategy, ii) a hotspot selection strategy, and iii) a minimising cost strategy, and one probabilistic strategy a maximum expected coverage strategy. We show that the optimal network changes considerably with strategies. Thus, the study provides insights which may guide conservation authorities on how to target their actions so that they accomplish the most with limited budgets, while acknowledging the uncertainty of species presence. We finally discuss how welfare economic evaluations of conservation targets could be included in such conservation policy analysis.

***Keywords*:** biodiversity, expected coverage, heathland protection

1 Introduction

1.1 Planning for conservation

Pressures on natural habitats from agriculture, accelerating urbanisation, pollution and tourism have caused massive destruction of habitats and led to a marked decline in species populations with the result that half of Europe's mammal species and one third of reptiles, fish and bird species are currently endangered (European Commision 1997). According to the EU Habitat Directive, member states are obliged to establish a network of protected areas, known as Natura 2000, where special actions need to be taken to conserve biological diversity. Natura 2000 plans must be implemented before 2009, and actions taken to ensure that appropriate conservation status of the habitats is maintained. Considerable resources must be allocated for fulfilling these requirements, knowing that species presence may be uncertain, and connected with the stochastic nature of environment as well as area treatment and management. This increases the interest in identifying which areas of a given habitat are the most important to protect in order to conserve biological diversity in a probabilistic context. Hence, conservation authorities face the problem of designing their actions so as to accomplish the most with limited budgets, while acknowledging the uncertainty of species presence. Political priority settings require that the network design of reserved sites relies on sound biological information, not only information on species occurrence but also viability measures. Fragmentation of habitats may often lead to the formation of meta-populations (Hanski and Gilpin 1991), which may be more sensitive to local extinction if the species can not colonise new sites (Harrison 1994).

Two methods have been proposed in the literature for solving the reserve site selection problem with probabilistic presence-absence species information. One is the 'expected coverage' approach, which maximises the expected number of species covered (Polasky and others 2000). The other method is the 'threshold approach', which maximises the number of species covered, where a species counts as covered only if the probability of coverage reaches a specified threshold (e.g., Margules and Stein 1989, Haight and others 2000). Both selection approaches find that reserve network sites differ significantly when using probabilistic data to maximise the expected number of species represented versus using deterministic approaches. Arthur and others (2002) compared the expected coverage approach and the threshold approach and found that information on habitat quality and species viability is important when designing the network. The expected coverage problem is formulated as a nonlinear binary integer programme, which belongs to the group of non-polynomial hard problems (Camm and others 2002). Since the individual probabilities are nonlinear functions of the decision variables the objective functions cannot be transformed into linear form. However, Camm and others (2002) and Arthur and others (2004) show that linear approximations of the nonlinear problem can yield good solutions to even large problems. The present study builds on this linearisation procedure.

1.2. Study area - the Danish heathland

One of the natural habitats covered by the Natura 2000 regulations is the heathlands which are selected as case object for this study. The Habitat and Wild Birds Directives have been implemented in the Danish Forest Law, Nature Protection Law and Law of Environmental Objectives. The articles state that the EU member states shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans. Hence the member states need to take steps in order to maintain or restore the natural habitat types and species at a favourable conservation status.

The origin of the Danish heath can be traced back to the over-exploitation of poor soils since the beginning of the Bronze-Age and covered more than 600,000 hectares by year 1822 (Hansen, 1970). Today, the Danish heathland is mainly located in the western and northern parts of Jutland and cover roughly 80,000 hectares, or approximately 2% of the total land area (Buttenschön, 1993). The drastic reduction in area is largely attributed to cultivation of the heath (Hansen, 1970). Today, heath areas are protected by law from being converted into other uses. Nevertheless, atmospheric nitrogen deposition and lack of the nutrient-removing traditional agricultural practices are allowing grasses, bushes and trees to take over. The natural processes of nitrogen deposition are currently being accelerated by nitrogen being deposited from nearby farms and traffic. The nutrient-poor heath has a special flora and fauna which is not found elsewhere in Denmark. Twenty-five species unique for the heath in Denmark are red-listed as either critically endangered, endangered or vulnerable (Stoltze and Pihl, 1998), but it should be noted that all species also exist outside Denmark. Furthermore, the heath has a cultural value as a landscape type, e.g. described in the national romantic literature and art (e.g. Raadal 1942, Andersen 1860, Blicher 1920-34). The results of a brief telephone survey among responsible regional and state authorities suggests that currently about one fourth of the area is managed such as to preserve the heath ecosystem; the remainder is slowly being overgrown.

2. Methods and Materials

2.1 Biodiversity data

We use a geographically distributed data set on terrestrial and freshwater species to identify the potentially endangered occurrence of species on Danish heathland. Information on species distribution (and species assemblages within each cell in a grid) is compiled as present/absent, based on all Danish summer atlas data providing complete coverage of all species within a given taxon. The data set species include 41 orchids (Orchidaceae; Wind 2001), 18 species of crawling water beetles (Coleoptera: species within Haliplidae; Holmen 1981), 23 species of click beetles (Coleoptera: species within Elateridae; Martin 1989), 41 goldsmiths (Nielsen 1998), 26 grasshoppers (Nielsen 2000), 61 species of butterflies (Lepidoptera: species within Hesperioidea, Papilionoidea; Stoltze 1994), 156 species of large moths (Lepidoptera: species within Hepialoidea, Cossoidea, Zygaenoidea, Tineoidea, Yponomentoidea, Bombycoidea, Geometroidea, Sphingoidea, Notodontoidea, Noctuoidea;

Kaaber 1982), 252 species of hoverflies (Diptera: species within Syrphidae; Torp 1994), 19 species of amphibians and reptiles (Amphibia/Reptilia; Fog 1993), 48 mammals, 6 Lycopodium complanatum (Pihl and others 2000), 189 species of birds (Aves; Stoltze 1994). The database thus comprises a total of 1006 species of the "estimated" 30,000 species in Denmark (Stoltze and Pihl 1998, see Petersen and others 2005 for use and further description of this database). The data base contains one of the most complete data sets on natural flora and fauna species in Europe.

We generated a list of 11 endangered red-listed species from the total data set, which all are related to the heath habitat, i.e. the database does not contain accurate distribution data on the occurrence of all the above-mentioned 25 endangered species. The species include 2 hoverflies, 3 grasshoppers, and 6 large moths (see Table 1). The data are located in the 633 UTM (Universal Transverse Mercator) 10 x 10 km grid cells which provide a complete coverage of Denmark. For each of the 633 UTM cells we calculated the actual amount of heath land using data from The Danish Area Information System, which contains 40 detailed data layers, with area information based on more than two million polygons and with a precision of +/- 25 meters (Danish Ministry of Environment and Energy, 2000).

The geographical representation of the 11 red listed species is presented in Figure 1a and heath land areas in Figure 1b, both in the 10 x 10 km grid cells.

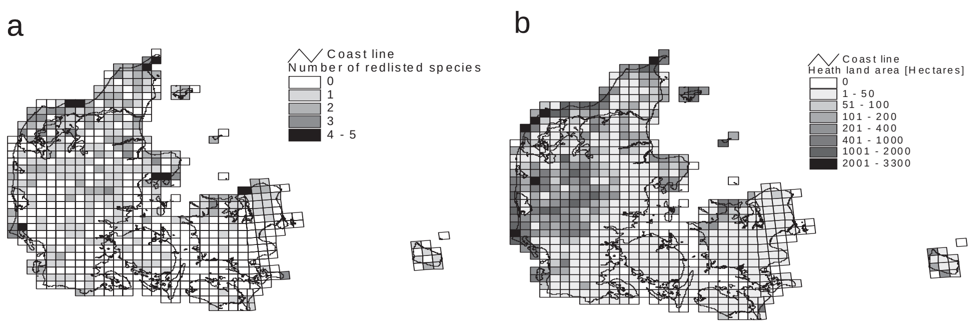


Figure 1. Red-listed species distribution and stratification of heath areas in Denmark using a spatial grain size of 10 x 10 km grid cells. (a) Species density of the 11 species included in the study, (b) heathland density.

2.2 Calculation of persistence probabilities

Species-specific persistence probabilities were calculated for all 11 species, based on the assumption that local persistence depends on the current abundance of species inside the grid cell, the habitat quality and the size of heath land. The abundance of the 11 redlist species inside each grid cell is based on the complete data base of species. If the species is not abundant in the grid cell, we assume the probability of persistence is zero. Otherwise the persistence probability is a composite of pressure on habitat quality and size. A major threat against habitat quality of Danish heathland is increasing air pollution loads caused by airborne nitrogen and phosphor from farms, traffic, energy production and industry

(European Environment Agency 2003). The aim of the Danish EUDANA-project is to develop and adjust existing tools for calculation of critical loads based on biodiversity targets and threshold values for favourable conservation status of terrestrial nature types, including heath, protected by the EU Habitat Directive and by the Danish Nature Protection Law (Bak and Ejrnæs 2004). We use Bak (2001) and Bak and Ejrnæs (2004) to assess the share of heath areas which have a critical load above the threshold values. In the following, we assume that shares of [0.05, 0.15, 0.25, 0.35, 0.45, 0.55, 0.65, 0.75, 0.85, 0.95] result in the following probabilities, λ_j, of a habitat, j, becoming degraded [0.50, 0.55, 0.61, 0.66, 0.72, 0.77, 0.83, 0.88, 0.94, 0.99], provided it is part of the conservation network. Otherwise, we assume the habitat will for sure be degraded (see the distribution in Figure 2).

However, species may be more or less sensitive to degradation of their habitat. Table 1 shows the 11 red listed species, their representation and assumed probabilities, φ_i for species i, of becoming locally extinct given habitat degradation using the IUCN criteria for 'Critically Endangered', 'Endangered' and 'Vulnerable' species (The Danish Red Data Book, 2005).

Table 1. Species list, red-list category and probability of extinction. The last column displays the number of grid cells, cf. Figure 1a, where the species is present.

Species name, i	Family	Red List Category	Probability of extinction given degradation, φ_i,%	Species representation
Chamaesyrphus lusitanicus	Hoverflies	Vulnerable	20	8
Chortippus mollis	Grasshoppers	Vulnerable	20	1
Erynnis tages	Moth	Endangered	40	48
Euphydryas aurinia	Moth	Critically endangered	100	6
Maculinea alcon	Moth	Vulnerable	20	3
Maculinea arion	Moth	Critically endangered	100	3
Oedipoda caerulescens	Grasshoppers	Critically endangered	100	1
Omocestus haemorrhoidalis	Grasshoppers	Critically endangered	100	5
Paragus finitimus	Hoverflies	Vulnerable	20	24
Plebejus argus	Moth	Vulnerable	20	120
Pyrgus malvae	Moth	Vulnerable	20	193

We assume that local extinction in a grid cell belonging to the network will only take place provided the habitats in that cell are degraded first. That is, for non-degraded habitats, the extinction probability is set to zero. For sites not in the network, however, the species is assumed to go extinct with certainty. Furthermore, we follow Gaston and others (2002) who show that the probability measures of local extinction may improve if we include a measure of habitat size. The resulting model for the persistence probability is defined as:

$$p_{ij} = \begin{cases} (1-\lambda_j\varphi_i)\cdot(0.0705\cdot Ln(\text{Area}_j + 0.01) + 0.4247) & if \quad j \in J_i \\ 0 \quad otherwise \end{cases} \tag{1}$$

, where λ_j is the probability of habitat degradation as given in the vector above , φ_i is the probability of species i becoming locally extinct if the habitat is degraded, cf. Table 1, and $Ln(\text{Area}_j + 0.01) + 0.4247$ is a natural logarithmic adjustment function, which is 1 when habitat j is larger than 3500 hectares and 0.1 when the area is close to zero. If species i is not present in site $j \in J_i$, the persistence probability is set at zero. Hence, for large areas (>3500 hectares) there is no adjustment of persistence probability, the opposite holds for smaller areas.

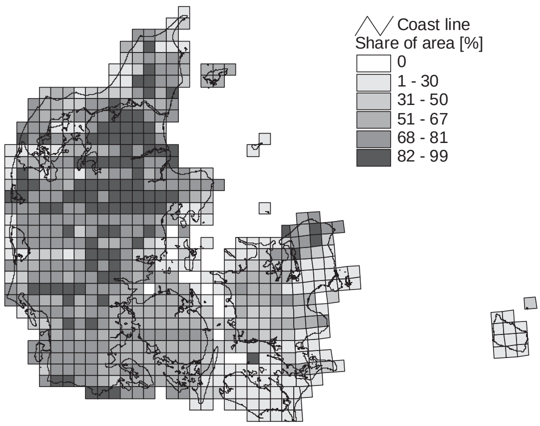


Figure 2. The share of heathland located in the grid cells which have a critical load above the threshold values.

2.3 Management and cost calculation

Heath lands have mainly been created and maintained by former agricultural management practices involving regular export of nutrients from the actual site (Webb 1998), e.g. by management in the form of sod-cutting, controlled burning and grazing. The disappearance of traditional management in line with increasing airborne nutrient deposits has enforced the heath land decline over the past few decades (Marrs 1993, Rose and others 2000). The precise form, and frequency, of habitat management will affect not only the regeneration potential of heath plant communities, but also the extent of nutrient removal from the system. Finally, this response of plant communities will exert an influence on the persistence possibilities of other species.

Controlled burning (Hobbs and Gimingham 1980, Bullock and Webb 1995) can remove as much as 95% of the nitrogen in the above ground portion of the plant communities (Chapman 1967). Other systems like grazing may also remove considerable amounts of nitrogen (Bullock and Pakeman 1997). However, the above-ground biomass accounts for less than 20% of the total nitrogen stores (Power and others 1998). Hence, managements that also remove the litter (e.g. Allison and Austen 2006) and/or humus layers, like sod/turf cutting (De Graaf and others 1998, Britton and others 2000) will result in a more substantial decrease in organic nitrogen stores in heathland ecosystems, thereby improving the conditions for *Calluna vulgaris*-dominated heathland vegetation.

Most heathland in Denmark is maintained by the Danish Forest and Nature Agency and most of it is managed by grazing and cutting the turf. The annual cost of heathland management is data supplied by the State Forest Districts (Danish Forest and

Nature Agency 2004). The cost data reveal that economics of scale prevail, since the cost per hectare decreases with increasing size of the maintained area. The cost of managing and operating on 100 hectares is EUR 78.4 per hectare, whereas the cost of managing 7000 hectares is approximately EUR 26.7 per hectare. The distribution of management cost is shown in Figure 3.

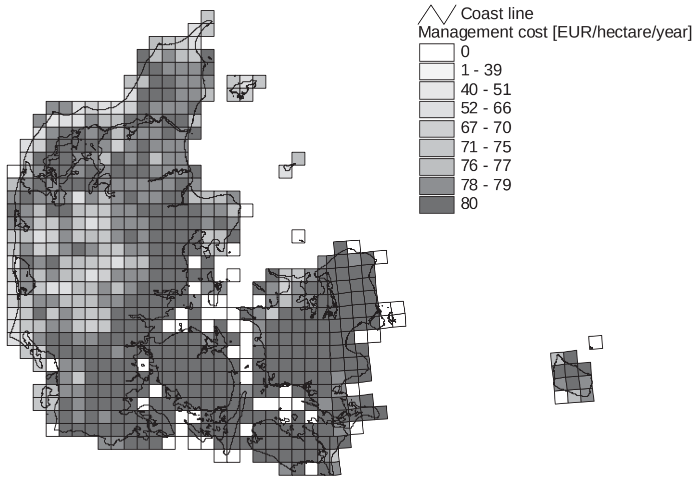


Figure 3. Distribution of heathland management cost

2.4 Non-probabilistic conservation policies

Three non-probabilistic conservation strategies were evaluated in the present study:

- Maximise selection area: This strategy implies that the main goal is to identify the maximum reserve area within a budget constraint, ignoring all species information.
- Hotspot selection: We use *a priori* information on the 11 red-listed species occurrences and apply a hotspot strategy where the most species-rich sites are selected (Myers 1988, Prendergast and others 1993). This corresponds to sorting the grid cells according to the number of species identified, and selecting the cells containing the highest number of species until the budget limit has been exceeded.
- Minimum cost representation: Since the hot spot strategy does not guarantee that all species are covered in the network, we apply the minimum cost representation strategy (Margules and others 1988), which ensures that all species are represented in the network at the lowest cost. Let I represent the set of threatened or endangered species in the database and let $X_j = 1$ if species i is present in site j, zero otherwise. Species i is present in all sites $j \in J_i$. The management cost is denoted c_j. Then the

minimum cost representation is: Minimise the opportunity costs, $\sum_{j \in J} c_j X_j$ while, fulfilling the requirement that all 11 endangered red-listed species should at least be represented r_i times in the network, $\sum_{j \in J_i} X_j \geq r_i$, or at least the maximum number of times the species occurs if r_i exceeds this number, $r_i = \#\{j \mid j \in J_i\}$, for all $i \in I$.

2.5 The expected coverage model

Species presence may be uncertain and related to the stochastic nature of habitat quality as well as management. Following the notion above, let p_{ij}, be the probability that species $i \in I$ persists at site $j \in J$. We assume that $0 \leq p_{ij} < 1$, cf. Equation 1. Assuming that probabilities are independent between sites the probability that a species does not persist in any of the sites, s_i, can be estimated as $s_i = \prod_{i \in I}(1 - p_{ij})^{X_j} \quad \forall \quad i \in I$.

Red-listed species may require particular attention and minimum coverage probabilities. Here we introduce the minimum probability threshold, h_i, that species i must be included in the selected sites at a minimum probability level $(1 - s_i) \geq h_i$. We set the minimum probability level at 0.4 for all 11 species.

The problem is nonlinear and we use the procedure of Arthur and others (2004) to create the linear approximation for ln(s_i). A set of K breakpoints is applied to approximate the interval L to 1, where $L > 0$ is the lowest possible probability of species persistence, if as many sites as possible within the budget limit were included in the network. Then the probability that a species is not covered, s_i, can be estimated as $\sum_{k=1}^{K} B_k b_{ik}$ where $\sum_{k=1}^{K} b_{ik} = 1$, B_k is the kth breakpoint and b_{ik} is a continuous variable that weights the the kth breakpoint for species i. In a natural logarithmic transformation this can be formulated as $\sum_{k=1}^{K} \ln(B_k) b_{ik}$. The management cost per hectare is assumed to be decreasing with area size (see section 2.3). Hence, we approximate the estimated non-linear cost function using a piece-wise linear function (Eqs. 7 and 8). The final model is expressed as:

$$Max \quad w$$

Subject to:

$$\sum_{k=1}^{K} \ln(B_k) \cdot b_{ik} = \sum_{j \in J} X_j \ln(1 - p_{ij}) \qquad \forall \quad i \in I \quad (2)$$

$$\sum_{j \in J} X_j \ln(1 - p_{ij}) \leq \ln(1 - h_i) \qquad \forall \quad i \in I \quad (3)$$

$$s_i = \sum_{k=1}^{K} \ln(B_k) \cdot b_{ik} \qquad \forall \quad i \in I \quad (4)$$

$$w = \sum_{i \in I} 1 - s_i \qquad (5)$$

$$\sum_{j \in J} a_j X_j = Area \qquad (6)$$

$$\sum_{m=1}^{M} a_{jm} = a_j \qquad (7)$$

$$\sum_{m=1}^{M} z_m a_{jm} = c_j \qquad (8)$$

$$\sum_{j \in J} c_j X_j \leq Budget \qquad (9)$$

$$\sum_{k=1}^{K} b_{ik} = 1 \qquad \forall \quad i \in I \quad (10)$$

$$0 < p_{ij}, s_i, b_{ik} < 1$$
$$X_j \in \{0,1\}$$

, where w is the expected number of surviving species. a_j is the area of site j, a_{jm} and z_n are the coefficients of the piece-wise approximation of the management cost function in site j, and c_j is the resulting cost of including site j in the reserve network.

We simulated a number of scenarios changing number of breakpoints and level of breakpoints. The number of breakpoints was increased to provide a more accurate approximation of the non-linear expected coverage problem, but of course as noted by Arthur and others (2004), at the expense of more variables b_{ik}. We defined a set of 25 breakpoints to approximate the interval L to 1.0 and we set L=9.0 E-400. Experiments showed that the smaller intervals close to 0 and close to 1, the better approximations were achieved.

3. Results

The expected coverage values of the 11 red listed species of the two non-probabilistic conservation strategies (maximise selected heath area and hotspot) and the maximum expected coverage are presented for different budget levels in Figure 4. The lowest performance of the four strategies is found when using the area maximising algorithm. The second worst is the hotspot strategy, which however increases its performance from a rather poor level of 2.8 species to the fairly good level of 9.7 species at a budget constraint of EUR 4.01 million per year. The highest coverage is achieved using the maximum expected coverage approach, beginning at 4.7 species at an annual budget of EUR 0.058 million per year and ending with the maximum coverage of 9.7 species at budgets above EUR 4.01

million per year. Increasing budget levels seem not to increase expected coverage, which may indicate that welfare economic losses may occur if annual management cost are too high.

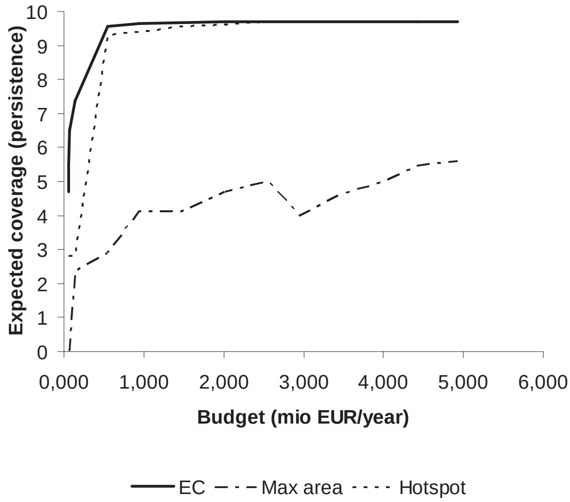


Figure 4. Expected coverage of the maximum expected coverage, maximum area and Hotspot strategies

We estimate the coverage of minimum set cost using a criterion of minimum 1 to 9 species representation. We find that the expected coverage increases only slowly when increasing the minimum required representations. It shows that the minimum set cost strategies do not take into account the probabilistic nature of the decision problem and that the minimum cost representation strategy is inferior to the other strategies, even the hot spot strategy.

4. Discussions

This study shows that conservation policies change significantly when including probabilistic measures of species persistence. This stresses the need for scientifically sound proxies and shows that the inclusion of information on biodiversity and estimates on species persistence can lead to a much more efficient protection of biodiversity in reserve networks (viz. when comparing to a non-probabilistic area maximising strategy). However, the result is ambiguous. We find that reserve selection strategies solely guided by area goals, aiming at protecting as large heath area as possible within budget limitations, out-perform the more traditional minimum set strategies. Hence, if species persistence information is not available, it may be more efficient to maximise the total heath area, rather than ensuring species representation in the network. Area goals will tend to favour large areas which, inherent to the model, are more capable to ensure the persistence of species located within their habitat. Minimum cost strategy will tend to prefer areas with lower persistence capabilities. Hence, our results supports the criticism against simple complementarity-based algorithms, which may fail to select areas where species have higher probabilities of persistence (e.g. Nicholls 1998, Williams 1998), thereby compromising the ultimate goal of efficient protection. Hot spot strategies favour areas with high species richness and higher persistence values, and hence will tend to perform better.

Another crucial feature of the model explored is the uncertainty of species survival. Persistence estimates are rarely available, and we chose to model an intuitively positive relation between species abundance and area size, and negatively related to ongoing environmental degradation. The larger the species abundance, the larger the sizes of areas and the lower the critical loads of air pollutants, the greater the probability that the species will survive. A number of studies attempt to develop models to estimate persistence (see e.g., Araujo and Williams 2000, Polasky and others 2000) either as probabilistic functions of suitable habitat, species currently colonising the area or threat/vulnerability. Some use expert opinions on species persistence within the areas (e.g., Arthur and others 2004). It is evident that the results are sensitive to these critical assumptions. However, since appropriate data for estimating species persistence are unavailable, we have to do with proxies.

Reserve site selection strategies and conservation management plans like those evaluated in this paper are rarely evaluated according to welfare economic measures. Rather a pure ecological approach is taken in most studies. This study shows that there may be a trade-off between benefits from expected species coverage/protection and conservation costs. We suggest that the presented modelling framework presented may be extended including benefit estimates of species protection (Boiesen et al. 2005) and an optimal level of management effort estimated.

References

Allison, M. and M. Ausden. 2006. Effects of removing the litter and humic layers on heathland establishment following plantation removal. Biological Conservation 127:177-182.

Andersen, H.C. 1860. Jylland mellem tvende Have [Jutland between two seas]. Illustreret Tidende 1(25):209. Reprintet in: Folkehøjskolens sangbog (1972). 5th edition, Foreningen for Højskoler og Landbrugshøjskoler, Foreningens forlag, Odense. [In Danish].

Araujo, M.B. and P.H. Williams. 2000. Selecting areas for species persistence using occurrence data. Biological Conservation 96:331-345.

Arthur, J.L., R.G. Haight, C.A. Montgomery and S. Polasky. 2002. Analysis of the threshold and expected coverage approaches to the probabilistic reserve site selection problem. Environmental Modeling and Assessment 7:81-89.

Arthur, J.L., J.D. Camm, R.G. Haight, C.A. Montgomery and S. Polasky. 2004. Weighing conservation objectives: maximum expected coverage versus endangered species protection. Ecological Applications14:1936-1945.

Bak, J. 2001. Kortlægnings- og analyseprojekt vedrørende væsentlige ammoniakpunktkilder og sårbare naturtyper i det åbne land. [Mapping and research project on nitrogen pollution in vulnerable natural habitat] Skov- og Naturstyrelsen, Wilhjelmudvalget, 31 pp. [In Danish].

Bak, J.L. and R. Ejrnæs. 2004. EUDANA – EUtrofiering af DAnsk Natur – videnbehov, modeller og perspektiver. [EUDANA – knowledge, models and perspective]. Danmarks Miljøundersøgelser, Faglig rapport fra DMU nr. 501., 52 pp. [In Danish].

Blicher, S.S. 1920-34. Samlede Skrifter 1-33 [Collected writings, 1-33]. Det Danske Sprog- og Litteraturselskab. [In Danish].

Boiesen J. H., J.B. Jacobsen, B.J. Thorsen, N. Strange and A. Dubgaard. 2005. Værdisætning af de danske lyngheder. [Valuation of the Danish moor land]. Skov & Landskab, KVL Arbejdsrapport Skov & Landskab, 14-2005, 68 pp. (In Danish).

Britton, A.J., R.H. Marrs, P.D. Carey and R.J. Pakeman. 2000. Comparison of techniques to increase Calluna vulgaris cover on heathland invaded by grasses in Breckland, south east England.

Biological Conservation 95:227-232.

Bullock, J.M. and R.J. Pakeman. 1997. Grazing of lowland heath in England: Management methods and their effects on heathland vegetation. Biological Conservation 79:1-13.
Bullock, J.M. and N.R Webb. 1995. Responses to severe fires in heathland mosaics in Southern England. Biological Conservation 73:207-214.
Buttenschön, R.M. 1993. Heder [Heath]. Naturplejebogen. Miljøministeriet, Skov- og Naturstyrelsen, Copenhagen, Pp. 64-72. (In Danish).
Camm, J.D., S.K. Norman, S. Polasky and A. Solow. 2002. Nature reserve site selection to maximize expected species covered. Operations Research 50: 946-955.
Chapman, S.B. 1967. Nutrient budgets for a dry heath ecosystem in south of England. Journal of Ecology 55: 677-689.
Danish Forest and Nature Agency. 2004. Budget analyse 2004. Danish Ministry of the Environment, 35 pp. [In Danish].
Danish Ministry of Environment and Energy. 2000. Areal Informations Systemet – AIS. Miljø- og Energiministeriet, Danmarks Miljøundersøgelser, 110 pp. [In Danish].
De Graaf, M.C.C., P.J.M. Verbeek, R. Bobbink and J.G.M. Roelofs. 1998. Restoration of species-rich dry heaths: the importance of appropriate soil conditions. Acta Botanica Neerlandica 47: 89-111.
European Commission. 1997. Natura 2000 - Managing our heritage. European Commision, 8 pp. Internet [http://ec.europa.eu/environment/nature/nature_conservation/useful_info/documents_publications/index_en.htm] Downloaded May 30 2006
European Environment Agency. 2003. Europe's environment: the third assessment. State of Environment report No 1/2003. Internet:[http://reports.eea.europa.eu/environmental_assessment_report_2003_10/en] Downloaded June 1, 2006
Fog, K. 1993. Oplæg til forvaltningsplan for Danmarks padder og krybdyr. Skov- og Naturstyrelsen. (In Danish).
Gaston, K. J., R.L. Pressey and C.R. Margules. 2002. Persistence and vulnerability: retaining biodiversity in the landscape and in protected areas. Journal of Bioscience 27: 361-384.
Haight, R.G., C.S. ReVelle and S.A. Snyder. 2000. An integer optimization approach to the probabilistic reserve site selection problem. Operations Research 48: 697–708.
Hansen, V. 1970. Hedens opståen og omfang [The origin and extension of the heath]. In: Böcher, T. W., Overgaard Nielsen, C., Schou, A. (eds.), Danmarks Natur: Heder, Overdrev og Eng. Politikens Forlag, Copenhagen, pp. 9-28. (In Danish).
Hanski, I. and M. Gilpin 1991. Metapopulation dynamics - brief history and conceptual domain. Biological Journal of the Linnean Society 42:3-16.
Harrison, S. 1994. Resources and dispersal as factors limiting a population of the tussock moth (Orgyia-vetusta), a flightless defoliator. Oecologia 99:27-34.
Hobbs, R.J. and C.H. Gimingham 1980. Some effects of fire and grazing on heath vegetation. Bulletin d'Ecologie 11:709-715.
Holmen, M. 1981. Status over Danmarks Haliplidae (Coleoptera) med bemærkninger om zoogeografi og autøkologi. [Status report on Danish occurences of Haliplidae (Coleoptera) including remarks on zoological geography and autecology]. Entomologiske meddelelser 49:1-14. [In Danish].
Kaaber, S. 1982. De danske sværmere og spindere. Geografisk udbredelse og fluktuationer 1850-1980. [Large moths in Denmark. Geographical distributions and fluctuations 1850-1980]. Dansk faunistisk Bibliotek, bind 3, Scandinavian Science Press. [In Danish].
Margules, C.R. and J.L. Stein 1989. Patterns in the distribution of species and the selection of nature reserves: an example from Eucalyptus forests in South-Eastern New South Wales. Biological Conservation 50: 219–238.

Margules, C.R., A.O. Nicholls and R.L. Pressey. 1988. Selecting networks of reserves to maximize biological diversity. Biological Conservation 43: 63-76.
Martin, O. 1989. Smældere fra gammel løvskov i Danmark. [Click beetles in old Danish broadleaf forests]. Entomologiske Meddelelser, bind 57, 1-2. [In Danish].
Marrs, R.H., R.J. Pakeman and J.E. Lowday. 1993. Control of bracken and the restoration of heathland. 5 effects of bracken control treatments on the rhizome and its relationship with frond performance. Journal of Applied Ecology 30:107-118.
Myers, N.1988. Threatened biotas:"Hot spots" in tropical forests. Environmentalist 8: 187-208.
Nicholls, A.O. 1998. Integrating population abundance, dynamics and distribution into broad scale priority setting. Pages 251-272 in G. Mace, A. Balmford and J.R. Ginsberg (eds.), Conservation in a Changing World: Integrating Process into Priorities for Action. Cambridge University Press, Cambridge.
Nielsen, O.F. 1998. De danske guldsmede. [Goldsmiths in Denmark]. Danmarks Dyreliv, Bind 8. Apollo Books, Stenstrup. [In Danish].
Nielsen, O.F. 2000. De danske græshopper. Danmarks Dyreliv, Bind 9. Apollo Books, Stenstrup. [In Danish].
Petersen, A.H., F.W. Larsen, C. Rahbek, N. Strange and M.P. Lund. 2005. Naturværdier i Danske Nationalparker. En kvantitativ analyse af biologisk mangfoldighed i potentielle danske nationalparker. [Nature values in Danish National Parks. A quantitative study of potentially biodiversity gains by Danish National Parks]. Center for Makroøkologi, Københavns Universitet. 331 pp. [In Danish].
Pihl, S., R. Ejrnæs, B. Søgaard, E. Aude, K.E. Nielsen, L. Dahl and J.S. Laursen. 2000. Naturtyper og arter omfattet af EF- habitatdirektivet. Indledende kortlægning og foreløbig vurdering af bevaringsstatus. [Natural habitats and species protected in the EU Habitat Directive. Preliminary survey and assessments of conservation status]. Faglig rapport fra DMU, nr. 322. Danmark Miljøundersøgelser. [In Danish].
Prendergast, J.R., R.M. Quinn, J.H. Lawton, B.C. Eversham and D.W. Gibbons. 1993. Rare species, the coincidence of diversity hotspots and conservation strategies. Nature 365:335-337.
Polasky, S., J.D. Camm, S.R. Solow, B. Csuti, D. White and R. Ding. 2000.Choosing reserve networks with incomplete species information. Biological Conservation 94: 1-10.
Power, S.A., Ashmore, M.R. and Cousins, D.A. 1998. Impacts and fate of experimentally enhanced nitrogen deposition on a British lowland heath.Environmental Pollution 102, Suppl. 1.:27-34.
Raadal, E. 1942. Et udvalg af billeder [A selection of pictures]. Vor tids kunst, 34. 48 pp. [In Danish].
Rodrigues, A.S, K.J. Gaston and R. Gregory. 2000. Using presence-absence data to establish reserve selection procedures which are robust to temporal species turnover. Proceedings of the Royal Society of London, Series B 267:1-6.
Rose, R.J., N.R. Webb, R.T. Clarke and C.H. Traynor. 2000. Changes on the heathlands in Dorset, England, between 1987 and 1996 Biological Conservation 93:117-125.
Stoltze, M., 1994. An Annotated Atlas of the Danish Butterflies. Ph.D. dissertation. Zoological Museum, Copenhagen, Denmark.

Stoltze, M. and S. Pihl. 1998. Redlisted species of flora and fauna 1997 in Denmark. Ministry og Environment and Energy, Danish Environmental Research Institute and Danish Forest and Nature Agency, 219 pp. [In Danish].
The Danish Red Data Book 2005. Redlisted species in Denmark. Internet [http://redlist.dmu.dk]. Downloaded June 1, 2006.

Torp, E. 1994. Danmarks svirrefluer (Diptera: Syrphidae). [Hoverflies in Denmark]. Danmarks Dyreliv, Bind 6. Apollo Books, Stenstrup. [In Danish].
Webb, N.R. 1998. The Traditional Management of European Heathlands. Journal of Applied Ecology 35:987-990.
Williams, P.H. 1998. Key sites for conservation: area-selection methods for biodiversity. Pages 211-249 in Mace, G., A. Balmford and J.R. Ginsberg (eds.), Conservation in a Changing World: Integrating Process into Priorities for Action. Cambridge University Press, Cambridge.
Wind, P. 2001. Overvågning af rødlistede planter 1999. Naturovervågning. Danmarks Miljøundersøgelser. Arbejdsrapport fra DMU 131. [In Danish].

Business environment and strategies of woodworking companies in Northwest Russia – results from a pilot study in Leningrad and Vologda regions

Anne Toppinen, Natalia Tatti, Ritva Toivonen , Antti Mutanen and Vadim Goltsev*

Abstract
Political and economic development in Russia and other Eastern European countries have been the major driving force of the changing European markets for wood products since the early 1990s. However, very little is known about the organizational structure, strategic orientation and future goals of woodworking firms in Russia. Theoretically, an increasing body of literature emphasises the strategic choices of core competencies/capabilities based on resources, and the combination of these with firm-level strategies. This study examines the issue in the case of 18 small/medium-sized wood industry companies in the emerging markets of Northwest Russia using thematic structured interviews. The interviewed Russian woodworking firms emphasised closeness to the markets, good logistic connections and large market size as the main sources of competitive advantage. Therefore, other than raw material based issues appear to provide competitive advantage or disadvantage to the Northwest Russian woodworking companies. High taxation, corruption and lack of capital strongly characterized the problems in their business environment. In the future, these companies wanted to change from commodity products towards more specialised products and focus more on export markets in Europe than the domestic markets. If the results are more generalizable, competition on the European markets for wood products will intensify, extending also to the markets for higher value added wood products.

Keywords: wood products industry, Northwest Russia, resources, business strategies, business environment, competitive advantage

Introduction

Political changes and economic development in Russia and the Eastern European countries have been the major driving force behind the changing European markets for wood products since the early 1990s. Recent development shows strong growth in exports of sawnwood and plywood from Northwest Russia (NWR), which have doubled since devaluation of rouble in 1998 (European forest sector…2005). Traditionally strong Scandinavian producers have lost their market share in European wood product markets for Russia and suffer currently from low profitability.

Russia has today 23 % of growing stock of forests and 50 % of coniferous forests. Russian forests maintain the highest diversity of boreal species globally and serve as a sink for 15 % of accumulated CO_2. Russia's forest resources are vastly under-utilized and final fellings account for only one quarter of allowable cut. Although the share of economically accessible timber is estimated to be only one half of total harvests due to lacking infrastructure and poor quality of road network, there is great potential in increasing the utilization of forests of Russia. Consumption levels of wood industry products in Russia are extremely low, for example official statistics show annual per capita consumption for sawnwood to be 0,06 m^3. Especially there is high potential to increase consumption of wood industry products around the booming cities of Moscow and St.Petersburg, where also the density of small and medium sized enterprises (SMEs) is highest (Liuhto et al. 2004). One of the biggest weaknesses of Russian enterprize sector is claimed to be a low number of medium sized firms, which would create flexibility in production.

The low wages, stumpage and energy prices together with high potential in consumption growth make Russia a very lucrative target for investments in forest sector. So far foreign investment activity in forest sector has been only modest and concentrated in less capital intensive woodworking industry. The current Russian economic policy presses development of wood processing industry instead of exporting roundwood, as is also indicated by the recent increase of export duties on coniferous roundwood from 1,5 € to 4 €/m3 (see www.idanmetsatieto.info). As a downside for the positive incentives related to market size, potential growth and cost competitive inputs, there are obviously many unresolved problems present in Russian economy. Investing in Russia includes significant risks, e.g. bureaucracy, changing legal environment and widespread corruption, which raise risk premiums for investments.

Despite of high potential of Russian forests and forest industry, economic research on Russian forest industry business is very limited. Also changing market and institutional environment requires topical research in order for results to have any relevance. Previous studies analysing Russian forest sector development (e.g. Backman 1995) have focused on market level issues and have not used firm level empirical data. As an exception, Nilsson and Söderholm (2002) have studied institutional obstacles in Russian forest sector from the viewpoint of foreign investors. Their study concluded that foreign investments in Russian forest sector are likely to remain low until a fundamental change takes place in the legal and political system.

This paper fills the gap partially by focusing on the business development and future prospects of woodworking firms in NWR. As a background, we shortly describe forest sector and woodworking industry in the regions of Vologda and Leningrad and in city of St.Petersburg. Second, we report results from a survey on Russian medium sized wood industry firms' marketing strategies, perceived sources of competitive advantage and the state and development of their business environment. This type of exercise gives new insights in the relative importance of market factors, institutional factors and firm's internal resources and capabilities in the self-observed competitiveness of woodworking firms. Results will be also useful as a background in assessing the future competitive situation of the European markets for wood products especially from the viewpoint of competitors in Scandinavian wood products industry.

Industry background

Wood and forest industry products account for 4 % of Russian export earnings, and lower value added products, i.e. roundwood represents over 40% in forest sector exports. Northwest Russia accounted for 29 % of total Russian exports of roundwood, 35 % of plywood exports and 40 % paper exports in 1999 (Dudarev et al. 2002). In terms of production of wood based panels, Vologda is most important region in NWR, while in sawnwood Vologda is second most important producing region and Leningrad fourth (Karvinen et al. 2005). Thus, in terms of competitors for Scandinavian forest industry, industry situated closest around St.Petersburg and in Vologda is of highest interest.

The role of forest resources and sawmill industry in the Leningrad and Vologda regions are compared in Table 1. Forest resources in Vologda region are twice the volume in Leningrad region and also the use of allowable cut is lower there. Instead, the population is concentrated in the city of St.Petersburg, which has a growth in construction industry around 10 % annually and thereby provides great consumption potential for wood products. Rate of capacity utilization in the sawmill industry is in both regions, and especially in the city of

St.Petersburg, very low, which provides potential for growth even without major new investments in capacity (Karvinen et al. 2005).

Table 1. Characteristics of Leningrad region, St. Petersburg and Vologda region (2003).

	Leningrad oblast	St.Petersburg	Vologda oblast
Population, mill.	1,67	4,66	1,27
Urban population %	66	100	69
GDP per capita (USD)	1696	2076	1865
Forest sector in region's exports, %	10,9	-	9,4
Value of forest sector exports, mill. USD	297	269	159
Forest resources, mill.m3	825	-	1602
Use of allowable cut in forests under Ministry of Natural Resources, %	54	-	41
Sawnwood production, 1000 m3	491	64	919
Capacity utilization rate in sawmill industry, %	65	4	54

Sources: Karvinen et al. (2005), Liuhto et al. (2004), Sutyrin, S. & Sherov, V. (2005).

Theoretical background and data

Our theoretical background is based upon an increasing body of literature, which emphasises the strategic choices of core competencies/capabilities based on resources and capabilities, i.e. resource based view (RBV, Barney 1991, Fahy 2002), and the combination of these with firm-level strategies in creation of sustainable profitability. Compared with traditional industrial organization perspective and Porter's (1985) generic strategies, where sustainable competitive advantage arises from cost leadership, differentiation or focus, resource based view (Barney 1991) defines availability of resources - either tangible, intangible or human - and their heterogenous combination in the formation of competitive advantage. While the Porter's commonly applied framework is dominantly based on the industry characteristics, resource based view underlines the role of firm's internal resources and is therefore more suitable for analysing heterogenous group of small- and medium sized firms, as in this case.

Previously, the resource based approach has been adopted in management studies of woodworking industry in e.g. Korhonen and Niemelä (2005), but not regarding transition countries. It is important to note that any component of the total offering may be a source for competitive advantage. In fact, quality of physical products and low costs may be strategic necessities or the "license to operate" in some markets, whereas the real competitive advantage is derived from elsewhere, such as service skills or relationships. Services, information and other intangible characteristics increasingly build up the total offering provided for customers also in wood products industry (e.g. Toivonen et al. 2005). As a remnant of socialistic era, networks are an important part of Russian business culture where firms based business relationships on informal ties and extending favours. Therefore, the role of institutions, politics and various modes of business networks between firms and relations between firms and local authorities need to be acknowledged as potential sources of competitive (dis)advantage.

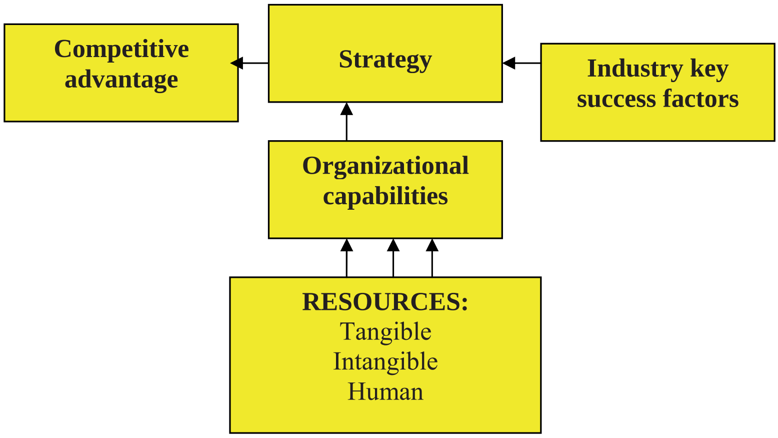


Figure 1. Relationships between resources, capabilities and competitive advantage (Grant 2002).

Figure 1, adapted from Grant (2002), broadly summarizes our theoretical frame of reference. Importantly, both competencies and capabilities need to be aligned with the business environment where the company operates to identify industry key success factors.

We operationalized in the empirical survey factors related to competitive advantage arising from various platforms, such as firm resources, market demand and other operating environment, technology and organizations, communication and logistics and external networking between firms as areas where potential sources of competitive advantage of Russian woodworking firms could be realized. The lists of potential attributes were given to the managers of the firms, and they were asked to weigh them according to their perceived importance. Some attributes were excluded, because companies were found not to be familiar enough with them (e.g. possibility to attend Kyoto protocol).

We also inquired about firm's marketing planning decisions, which are conceptualized here as a hierarchical process, where strategic decisions of products, customers, and market-area set guide-lines for marketing functions and structures (Juslin and Hansen 2003). The model results in a typology of three different product strategies (commodity product, specialty product and custom-made product strategies), three customer strategies (serving of as many customers as possible, few well defined end-use segments or a few known end users) and four market area strategies (export markets, domestic Russian markets, few target countries, as many countries as possible).

The questionnaire of 7 pages was prepared for the study, including both multiple choice sections on sources of competitive advantage, competitive position of firms and development of business environment, and a few open ended questions about future development (available in complete in Toppinen et al. 2006). The interviews were targeted to the companies that have actual production of sawnwood or other wood based products (not pulp and paper), and used annually more than 10 000 m3 wood.

Data were obtained through personal interviews of managers of the companies operating in the regions. Interviews in Leningrad region and St. Petersburg were conducted by M.Sc. Vadim Goltsev in May-June 2005 and in Vologda by Forestry Student Natalia Tatti in December 2005-January 2006. There were problems in Leningrad regions to get companies to participate (only 12 of contacted 45 firms agreed to participate and returned completed questionnaires in person or by mail afterwards). It was also difficult to compose an accurate timetable of meetings. In Vologda region practical problems were not present, possibly because interviewer was originally from Vologda herself and quite familiar with the industry there.

Due to small sample, we report mainly descriptive statistics averaged over regions. However, the small sample size (18) is typical of the difficulties in conducting quantitative research in transition countries, as also stressed by e.g. Mockaitis et al. (2006). Firms in transition countries are in general hesitant to participate in research and especially give out any financial information, which would be public in western economies and partially would also in Russia be available through public sources. Due to taxation and in the fear of organized crime, firms are not willing to show profitability in their operations. Most commonly used indicators for the success of companies were productivity of employed labor and sales growth, and financial performance came only third in importance. The interviews showed that the managers of the companies have large experience on forest business and know very well features of business processes within the Russian woodworking industry. There were just few cases of misunderstanding or incorrect interpretation of the questions that the interviewers had to clarify.

Results

Woodworking firms of the study

Background statistics of interviewed firms are given in Table 2. These value mostly refer to year 2004, but there were some exceptions that data was available only for the previous year. All interviewees represented private enterprises, which had either Russian or foreign ownership or were joint ventures.

All interviewed companies did not provide the value of their turnover, but the number of employees was given for each company. The average number of employees was 389 persons, but the range was wide form smallest (23 employees) to largest (1540 employees). Due to very low labour productivity in Russia, in terms of tunrnover these firms could nevertheless be classified with EU standards as either medium or small sized enterprises (SMEs).

14 firms of the sample produced sawnwood, one firm produced panels, three were in joinery and carpentery and two were doing also business in wholesale trade of roundwood. Nine companies reported that they had also sales of chips, sawdust or bark and 3 companies provided firewood as a byproduct. However, logging operations, which are in Russia classified in forest industry, provided the main source of turnover in 5 companies (origin in lespromhozes). Thus, we have here some examples of vertically integrated organizational structures typical in Russia.

Table 2. Summary of interviewed woodworking companies.

	Number or value
Year of establishment:	
Before 1991	4
During 1991-1999	9
After 1999	5
Average number of employees	389
In smallest company	23
In largest company	1540
Number of companies according to their main field of operations:	
Logging	5
Sawmilling	7
Joinery and carpentry	4
Other, wholesale trade of wood	2
For sawmills, average production in m3	32 000
Total average roundwood consumption in m3	136 200

An average volume of sawnwood production in our sample companies was 32 000 m3 and the respective roundwood consumption (including the joinery and carpentery etc. firms) 136 000 m3. Thus, our firms were of substantial size and represented about 65 % e.g. sawnwood production volume in Leningrad oblast.1. This counterbalances well the relatively small number of firms in the sample. Regarding Vologda, the firms were more oriented in production of panels, joinery and carpentery and the sum of sawnwood production in 3 interviewed firms producing sawnwood was 75 000 m3, representing a minor proportion of capacity (over 0,9 mill.m3) in the region.

Marketing strategies and sources of competitive advantage

Product, customer and market area strategies of companies were questioned regarding their choice of products (either commodity, specialty or customer made), customer (as many as possible, few well defined segments or known end-users) and by targeted market area. Most commonly, the companies did produce commodity products and they targeted their products for well defined end-use segments. Regarding the preferred choice of market area, export markets and Russian markets were equally appreciated.

The most important competitive advantages perceived by the managers of these companies are listed in table 3. The interviewerers gave a list of 33 potential attributes, and the managers ranked these with 3 point scale as a source of perceived competitive advantage. We have listed here issues that were most clearly ranked and gave insights for various factors in the operating environments. Some attributes were excluded, because companies were not familiar enough with these concepts (e.g. possibility to attend Kyoto protocol). We have reported in Table 3 the number of responses in extreme cases, i.e. those that were considered “very important” or “not at all important”. This type of excercise gives insights about the relative importance of market factors, institutional factors and firm resources in the perceived competitiveness of woodworking firms in Leningrad and Vologda regions.

1 Sum of estimated sawnwood production of interviewed firms in our data in St. Petrsburg and Leningrad Region was 378 000 m^3, while the official data for year 2003 indicated sawnwowood production of 555 000 m^3. However, after year 2003 there have been new foreign investments by e.g. Swedwood Tikhvin.

Table 3. Most important sources of competitive advantage for companies (3=very important, 2=not very important but also not clearly unimportant, 1=not important at all), calculated mean and number of responses in extreme values.

	Mean	"3"	"1"
Closeness to main market areas	2,4	13	5
Price of labour force	2,4	11	3
Good social relationships with people in other companies in the sector	2,4	9	2
Qualified and skilled personnel1)	2,3	10	4
Large markets	2,3	9	4
Strong R & D sources	2,3	10	5
Logistic connections	2,2	9	5
Possibility to learn from other companies in the same sector	2,2	8	5
Growth potential in the markets	2,2	7	3
Possibility to improve customer service	2,2	7	4
Secure and stable wood supply	2,1	9	7
Large potential forest resources in the region	2,0	7	11
Price of wood raw material	1,8	7	11
Low general cost level in the region	1,8	4	8
Existing networks of companies producing similar products	1,8	4	8
Low competition	1,7	2	8
Existing production facilities	1,4	3	14
Existing networks with distributors	1,4	3	14

According to these answers, closeness to main market area was seen on average as the highest: it was ranked as "very important" for all companies operating in Leningrad region, but only 1 company in Vologda region. The result is understandable as Vologda region is situated east of Leningrad, and therefore transposrtation distance is longer to export markets. Issues dealing with large markets and good logistic connections were given clearly higher grades in Leningrad region than on the average, which point out for the superior importance of market seeking motive in operating in Leningrad region. Factors dealing with labour quality and costs appeared also high on the agenda for these companies. Instead, issues relating with price of wood or low general cost level were given surprisinly low scores, and secure wood supply outweighted these factors. About 40 % of companies (and 100 % of companies in Vologda region) replied that price of wood is not at all important source for them as a competitive advantage. It is also notable that institutional factors, including good social relationships with administration were seen important (especially in Leningrad region), and in this aspect our results confirm the previous survey done for international forest industry companies operating or planning to operate in Nortwest Russia (Nilsson and Söderholm 2002).2

2 The same factors as for sources for competitive advantage in Table 3 were also asked in terms of the their importance for company location. However, since the number of companies with foreign ownership was so low and some of the Russian companies were not exactly certain about the meaning of the question, we decided not to report these scores in detail. However, some companies gave identical scores for the attributes asking the source of competitive advantage and the relative importance for their location decisions.

Development of business environment

The general business environment sets boundaries for the development of individual firms. The interviewer gave a list of 20 arguments decribing business environment, and the managers graded how well each of them decribes the environment with a scale from 1 to 5 (5= I fully agree, …1= I do not agree at all). In Table 4, the factors are listed in the order of importance. At the top of the list stand high taxation and problems with non-sound business practises (i.e. corruption). Lack of financing capital reflects on the difficulties to develop operations and increase the production volume and quality and is also seen in the lack of R & D and poor quality of production technology and facilities. Problems in raw material acquisition are perceived in many companies to be present, while there exists also a group of companies which does not face these at all.

Table 4. Importance of following arguments describing business environment of woodworking companies in Leningrad and Vologda regions, calculated mean and number of responses in extreme values (5="I fully agree",…, 1="I do not agree at all).

	Mean	"5"	"1"
High taxation	3,8	9	1
Non-sound business practices (e.g. corruption)	3,7	6	1
Lack of financing capital	3,6	9	3
Lack of R & D	3,6	5	0
Poor quality of production technology and machinery	3,5	6	3
Lack of trust between firms in the industry	3,3	4	2
Unexpected changes in legislation	3,3	5	4
Strong bargaining power of suppliers	3,3	5	4
Low competence of personnel	3,2	4	3
Problems in raw material acquisition	3,1	5	4
Strong bargaining power of buyers	3,1	5	4
High employment costs	3,1	4	3
High business cycle fluctuations	2,9	3	4
Difficulties in marketing and sales of products	2,9	3	6
Strict environmental regulations	2,8	4	5
Inflexibility of authorities	2,8	3	4
High competition between producers	2,6	4	7
Low investment barriers to entry the market	2,6	4	8
Oversupply of markets	2,6	3	6
High competition between substitute products	2,3	2	8

In the lower end of the Table 4, there are features in the business environment that the firms are ot uniformly agreeing with, which mainly characterize existing market conditions. For example, firms do not perceive oversupply of markets or competition between substitute products to be present very much. Regarding investment barriers to entry, they disagree strongly that these are low, which is consistent with the existing lack of capital that they agreed on average to be the most clearly present in their business environment. In an open ended question other possible impediments for business environment were inquired and lackinig investment mechanisms and structures was mentioned by two companies.

Overall, differences between companies in Leningrad and Vologda regions were not very high, although their operational environment differs both geographically and institutionally (see Table 1). Lack of trust between companies was seen less of a problem in Vologda, which is consistent with the result behind Table 3 where firms in Vologda emphasized good connections between firms as a source of competitive advantage. Strict environmental regulations and inflexibility of authorities were perveived to be less severe obstacles in Vologda than in Leningrad region.

Regarding the future development of companies and their goals during the next 3-5 years, the three most commonly favoured ones were to increase the physical quality of products, to increase the scale of operations to achieve better cost efficiency and to increase company size by greenfield investments. The intent of growing through greenfield investments is in the face of scarce capital resources perhaps somewhat unrealistic. In contrast, firms were least often interested in moving the company to more attractive location, attracting Russian investors or increasing the size of their operations by mergers or buy-outs. These answers again reflect the lack of capital, which is an acute problem for Russian medium sized firms.

Finally, the plans for future development of firms were inquired. According to the managers, export markets will be clearly favoured over domestic Russian martkets, possibly because of higher prices in export markets. If these findings bear any larger relevance in Russian forest industry, the role of Russian forest industry operating in European markets will strengthen in the future and extend also to markets of higher value added products.

Discussion

The study brought out new information about small and medium sized forest industry firms and their current business environment in Northwest Russia. In particular, the interviewed companies were found to agree upon closeness of main market area to be “very important” as a source of competitive advantage, especially to those firms interviewed in the Leningrad region. Also issues dealing with large markets and logistic connections were given higher than average grades, which points out for the superior importance of market seeking motive in operating in Leningrad region. Instead, issues relating with abundant forest resources, low wood prices or low general cost level were given relatively lower rankings, and secure wood supply outweighted these factors. This confirms results in previous survey by Nilsson and Söderholm (2002) on international forest industry companies operating or planning to invest in Russia, which found importance of well-developed infrastructure and market size to be more important factors for investment decisions than the cost of raw materials or low wages.

Regarding the external business environment, firms most commonly mentioned high taxation, which appears to be a general finding in studies of SMEs regardless of country. Problems with non-sound business practises (i.e. corruption) were also often claimed to exist. This reflects the real challenge especially for foreign investors. Nevertheless, due to lack of domestic capital in forest sector, Russian official policy has strongly pressed for the foreign investments in order to achieve higher utilization of forest resources and to modernize the capital stock to reach higher product quality.

Clearly our results can be considered only as a very preliminary step. Future studies should be targeted for obtaining a larger set of firms to enable better comparison between regions and between different ownership categories (i.e. Russian owned, foreign ownership and joint ventures). If data gathering provides very challenging, more case study oriented qualitative approach could be chosen instead of quantitative surveys. Also, to capture future development paths of forest industry firms in Russia, a comparative study could be planned for e.g. woodworking firms in the Baltic countries, who are in comparison with Russia clearly leading in the process of economic transition.

References

Backman, C. 1995. The Russian forest sector: production, consumption, and export prosepects. Post-Soviet Geography 36: 310-322.

Dudarev, G., Boltramovich, S. & Efremov, D. 2002. From Russian Forest to World Markets: A Competitive Analysis of the Northwest Russian Forest Cluster. ETLA B 195.154 p.

European Forest Sector Outlook Study. 2005. Geneva Timber and Forest Study Paper 20. Geneva. 234 p.

Fahy, J. 2002. A resource based analysis of sustainable competitive advantage in a global environment. International Business Review 11: 57-78.

Grant, R. 2002. Contemporary strategy analysis. Fourth Edition. Blackwell Business. 551 p.

Hamel, G. 2000. Leading the revolution. Harvard Business School Press, Boston.

Juslin, H. & Hansen, E. 2003. Strategic Marketing in the Global Forest Industries. 2003 Update. Authors Academic Press. Corvallis, Oregon.

Karvinen, S., Välkky, E. & Torniainen, T. 2005. Luoteis-Venäjän metsätalouden taskutieto. Finnish Forest Research Institute. 116 p.

Liuhto, K., Pelto, E. & Lipponen, K. 2004. Where to do Business in Russia – A report on Russian Regions, Firms, Foreign Trade and Investment flows. Pan-European Institute. Turku. Www.tukkk.fi/pei/e.105 p.

Mockaitis, A., Vaiginiene, E. & Giedraitis, V. 2006. The internationalization efforts of lithuanian manufacturing firms – strategy or luck. Research in International Business and Finance 20: 111-126.

Nilsson, M. & Söderholm, P. 2002. Foreign direct investment and institutional obstacles: the case of Russian forestry. Natural Resources Forum 26: 302-313.

Sutyrin, S. & Sherov, V. 2005. Russian regions and their foreign trade. The Research Institute of the Finnish economy. Discussion Papers 995. http://www.etla.fi

Toivonen, R.,Hansen, E., Järvinen, E. & Enroth, R. 2005. The competitive position of the Nordic wood industry in Germany – intangible quality dimensions. Silva Fennica. 39: 277-287.

Toppinen, A., Toivonen, R., Mutanen, A., Järvinen, E. Goltsev, V. & Tatti, N. 2006. Business environment and strategies of woodworking firms in Northwest Russia – results from a pilot study. Forthcoming in Working papers of the Finnish Forest Research Institute/Pellervo Economic Research Institute. 30 p.

www.idanmetsatieto.info

Development of forest industries in Latvia

Henn Tuherm & Sanita Ludvigsone-rudzite

Abstract

Forests have great importance for the Latvian economy, environment, landscape, flora and fauna. Forest sector contribution to the national GDP is 10…12 %, providing employment for 75…80 thousand people. In the paper was analysed accessible forest and wood resources in Latvia, forest harvesting volumes and dynamics of wood processing industries. Efficient investments in wood processing sector and the available local resources have provided the rapid growth of this field. Wood and wood products are the most important Latvian export products. It is also described strengths and weaknesses of the forest sector in Latvia.

Keywords: forest industries, Latvia, forest cluster, resources, market for timber products.

1. Introduction

The development of Latvia’s national economy has been greatly influenced both by its geographical position and political, social and economic situation. Advantageous geographical location of Latvia on the Eastern shores of the Baltic Sea and the crossing of ancient trade routes from Russia to Western Europe has determined the development of a significant transport network. Limited natural resources on the one hand and considerably well-developed infrastructure on the other facilitated the creation and speedy progress of processing industries.

Overall targets of Latvian forest policy are to balance possibilities in fulfilling societies interests in maintaining ecological values of Latvia’s forests and securing implementation of social functions of forest. The Latvia’s Forest Policy underline the principle that the Latvian forest sector has high capacity to provide material and social benefits, and that utilization of this potential will be encouraged to the extent that other values and benefits are not reduced or lost.

The Latvia's Forest Policy identifies **one general goal** - *sustainable management of forests and forest lands*. In the context of the Forest Policy, *sustainable* management is defined as stated by Resolution H1.

The Latvia’s Forest Policy’s **economic goal** is to guarantee, with the ecological and social concerns in mind, sustainable development and efficiency of the country’s forest sector, while providing for the maximum possible increase of the added value created via resource utilisation. In view of its specific public functions, the state-owned forest should be treated as the official capital. The State as the owner of this capital has two basic interests here:

the value of this capital (forest) must not decrease, it should increase;

the owner (the State) is interested to draw income from its capital (forest).

2. Forest Branch in Latvia.

The forestry, wood processing and furniture industries (the forest branch) is the second largest industrial branch in Latvia after the food processing industry. Forests have great importance for the Latvian economy, environment, landscape, flora and fauna. After the restoration of independence the Latvian economy is highly dependent on renewable forest resources as well as on forest industry; the foreign exchange of forest based export made up 35…40 % of the national total.

Latvia is of course in a great need of finding ways of exploiting its natural resources, to earn foreign currency desperately needed for the development of all sectors of the countries economy. It may be tempting to export saw logs and pulpwood as this is seen as a “short-cut” to foreign currency earnings. This may, however, be a dangerous way eventually making Latvia just as a raw material exporter, instead of the highly industrialized country it is. The export of logs should only be done if there is no practical possibilities to process the logs in Latvia and thus add more value to the raw material before it is exported. Thus it may be wise to export pulp logs, as there is no practical means of processing this part of the raw material in Latvia.

Forest Cluster comprises a rather wide group of sub-sectors of industry linked with wood processing and forestry as well as research and development institutes and undertakings indirectly linked with wood industry.

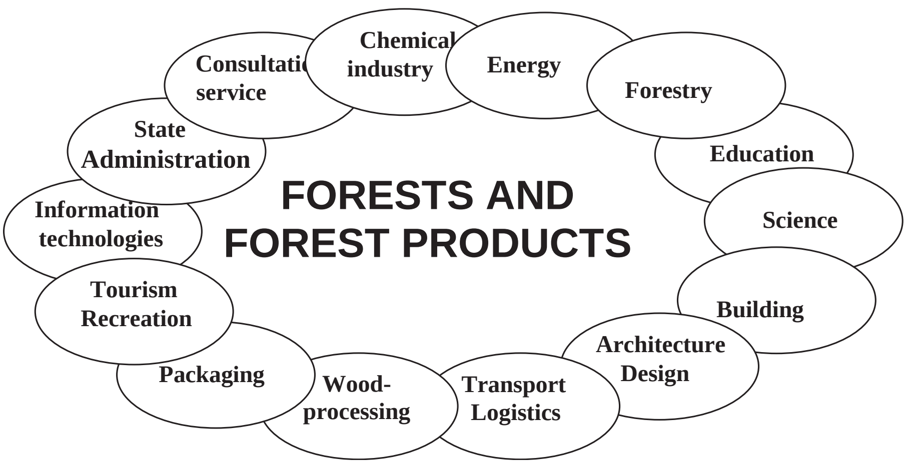


Figure.1. Forest Cluster Structure.

One of the key objectives of the Forest Cluster is to ensure long-term growth by increasing production and exports of goods and services with higher value added respecting sustainable development principles and promoting innovations. Long-term development strategy of the cluster was worked out; enterprises and institutions linked with various activities of the cluster participated in this work. Successful development of the forest sector contributes to the development of the related sectors as well as to the whole national economy. Providing that forest sector contribution to the nation GDP is 10…12 %, then forest cluster – 15…16 %, providing employment for 75…80 thousand people.

3. Forest and Wood Resources in Latvia

Since the early 1920’s the forest area of Latvia has increased from 24.7 % in year 1923 to 45.4 % in 2005, consisting presently 2.932 million ha of productive forest lands. In the land reform process in Latvia large areas of agricultural lands were abandoned and the process of aforestation of these lands is promoted. It is foreseen that approximately 350 000 ha can be overgrown during a 10-year period increasing the total forest coverage will be increasing up to 49 %.

In the Latvian forests the entire **standing volume** is up to 585 million m^3. Mean volume of the stands is 200 m^3/ha. The higher standing volumes are in state-owned forests as the result of better silvicultural treatment. Latvia’s forests total current annual increment is calculated 16.5 million m^3 (6.3 m^3 per ha annually), including 9.6 million m^3 in conifer stands. Natural die-off is estimated to make up 3.3 million m^3 per year including 1.9 million m^3 in conifer stands.

Around 60 % of the forest are dominated by softwoods, where 2/3 are represented by pine forests and about 1/3 by spruce forests. The main hardwood species is birch representing about 28 % of all forests. Other important species are white alder, aspen and black alder. Oak and ash are represented on small areas about 0.5 % each.

Since the time when Latvia regained its independence, Latvia's **forest ownership model is** facing essential changes. The forest may be owned by the state, local governments and natural or legal persons. After the land reform and the restitution of land (and also forest) ownership rights Latvia has an essential part of privately owned forests:

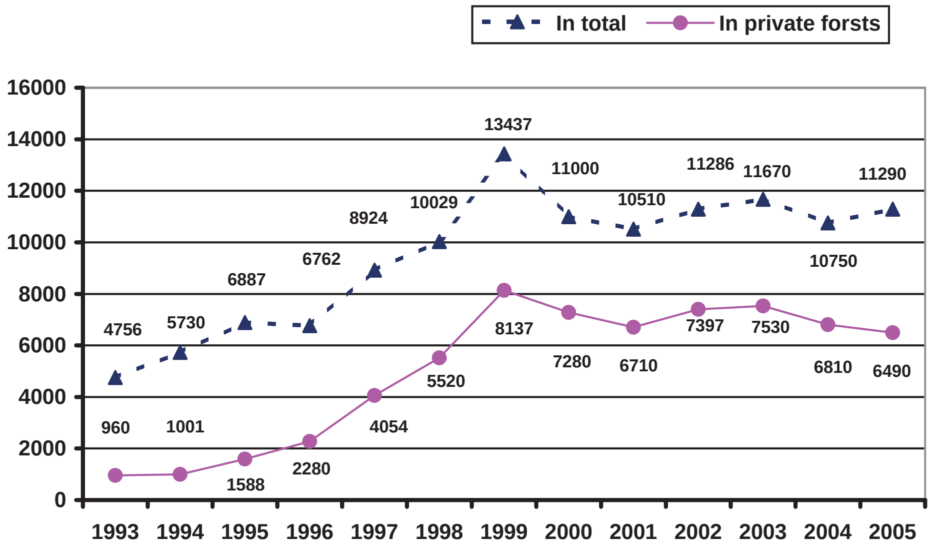
- According to Law on Land reform land which was in private ownership up to 21.06.1940 was returned to previous owners or their inheritors.
- Considering the forest ownership structure before the 21.06.1940 and essential increase of forest covered area since that time it is forecasted that 50 % or 1.5 million ha of the forest will be under state ownership.
- The rest or about 45 % is and will be dispersed among many small private owners.
- Municipalities are playing minor role as forest owners in Latvia, except Riga city.

As a result of land reform the ownership structure as of January 1, 2005, is the following: state forests – 49.9 % of the total area, private – 42.9 %, local governments, private enterprises and other forests take up 7.2 % of the total forest area. At present there are up to 154 400 private forest owners in Latvia; average size of holdings in private ownership is 8.2 ha. To date the average area of holdings is too small, shape and location of some is unsuitable for effective forest management, utilization and protection.

4. Forest production

Basic information to estimate allowable cut is taken from Latvian forest inventory system. The volumes for final and intermediate cuttings are specified in the forest management plans both nationally and at operational levels. They are based on the protection status of the respective stands, the age structure and the dominant tree species. Annually accepted amounts of logging ensure wood processing enterprises with domestic raw materials. Taking into account the experience of the Nordic countries, where a intensive forest management is carried out, the possible allowable cut would be increased up to 12 million m^3 in the near future in Latvia (up to 4 m^3/ha per year).

The implementation of the privatisation programs increased the amount of roundwood and processed timber for sale. As shown in table, since 1993 the volumes of forest harvesting in Latvia were continuously increased. This increase of cuttings attributes mainly to the private forests, where harvesting volume in year 2003 was 7,8 times higher than in year 1993.



* duration of the forest management year 1999 was 15 months.

Figure.2. Forest harvesting volumes in Latvia, 1000 m^3.

4. Long tradition of Wood Processing

The four major periods of Latvian technological advancement are characteristic for the development of Latvian wood processing industries, too.

a. prior to World War I. The first woodworking enterprises – predecessors of wood mechanical processing in Latvia emerged at the beginning of the 17^{th} century. The very first steam powered sawmill in Riga was put into operation at the beginning of the 19^{th} century; there were already six sawmills of that type which were producing for export. As a timber port Riga took a steady lead in the Russian Empire. One third of the Russian timber export went through the port of Riga in the 60-ties and the 70-ties of the 19^{th} century and the major part of the assortments was produced in Riga sawmills. At the turn of the century 40 million cubic feet (1.3 million m^3) of sawn timber was exported from Riga to Western Europe every year.

Along with the sawmilling other wood processing branches developed in the second half of the 19^{th} century – the first paper mill, plywood and match factories were established. 50 000 m^3 plywood or 25 % of the total Russian Empire production capacity were produced in Latvia in 1913. The main points of destination for the export of sawn materials and plywood at the beginning of the 20^{th} century were England, Holland, Germany, France and Belgium.

b. between the World Wars. In coming years the growth of the national economy was interrupted by the World War 1 – for more than four years Latvia was the direct war zone and industrial machinery, including wood processing equipment, was evacuated to Russia. When the War was over and the reconstruction of the national economy was started in Europe, Latvia still suffered from the liberation fights and renovation of the national economy was started only in 1921, in the frames of the first independent Republic of Latvia. Wood processing output became Latvia's main export product. One half to one third of all timber from the annual cut was used to rebuild dwellings, buildings and farms destroyed during the war.

There were 800 frame saws in Latvia in the early thirties and despite their out-of-date equipment they produced up to 750 000 m^3 of export quality sawn materials per year. 445 sawmills with 523 frame saws employed 6603 people and produced 765 207 m^3 of sawn timber in the year 1936. In 1937 Latvia joined the European Timber Exporter's Convention and sawn timber export of 500 000 m^3 per year was applied. In 1939 the Latvian plywood industry comprised 15 mills, produced 83 000 m^3 of plywood annually, which were for the most part exported. The main countries of sale were Great Britain, Germany, the Netherlands, Belgium and Denmark.

c. the post World War 2 era. In 1940 Soviet power was established in Latvia and the destruction process of the national economy was started. It was continued when World War 2 started in 1941. After the World War 2 the national economy of Latvia was totally incorporated into the Soviet planned economy and governed from Moscow. Even at that time wood processing had a strong impact on the national economy and it had acknowledged success. The furniture produced in Latvia was considered the best in the former USSR. Plywood, particleboard, fibreboard and pulp were produced here as well. All enterprises belonged to the State and most of them were under jurisdiction of the Ministry of Wood Processing. In 1960 there were produced 1.25 million m^3 of sawn timber, 120 000 m^3 of plywood, 130 000 m^3 of particleboard and 774 000 standard matchboxes.

Production rates increased every year in accordance with the traditions of the socialistic planned economy and in the early seventies sawn timber production capacity reached 1.55 million m^3. Until the seventies sawn goods were exported only under the USSR trademark through *Exportles* company in Moscow. In the following years sawn timber export from Latvia was stopped and it was used only for domestic consumption, e.g., in furniture production and construction. In 80-ties wood processing as well as all Latvian and Soviet economy entered a period of stagnation.

d. independence (post 1991). Since the establishment of independence in 1991 wood processing started to develop more dynamically in comparison with other industries, where transition from socialistic to market economy was more sophisticated or next to impossible at all. Over recent years the Latvian wood processing industry in the state enterprises privatisation program has been completed and businesses operating in this sector are privately owned. After the Declaration of Independence the structure of the sawmill industry changed considerably. Large production units have been privatised and new sawmill established, partly together with foreign investors. The developments show that these enterprises have mastered conditions in a market economy, enabling further development by attracting investment. Latvian exporters have found good markets for their timber in the UK, Germany, the Benelux countries and in the Near East.

5. Wood Processing industries in Latvia

A large number of people have been employed by the **sawmilling industry**. Relatively small investments are required to convert sawlogs into sawn timber. Furthermore, there is a large (more than 5.7 million m^3 sawlogs annually per one shift) processing capacity already in Latvia. This existing capacity can be utilized in a cost effective way in the short run as the production capital is already there. The output from sawmills has reached nearly the limits of Latvian sawlog resources while there is still opportunity to improve quality and added value of sawmilling products and production efficiency of sawmills. Therefore more and more companies invest in kiln drying and other technologies for the value-added processes. Main problems to be addressed in sawmilling development (especially in small sawmills) are:

debarking; *sorting of logs, sawn timber and quality control*; *drying*; *market for sawmilling residues*.

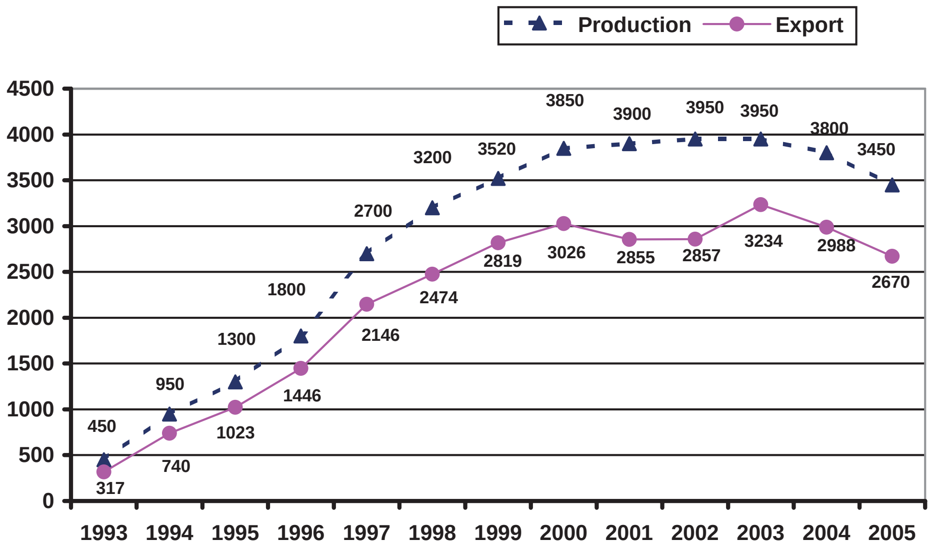


Figure.3. Dynamics of production capacities and export of sawn timber, 1000 m^3.

Plywood production has a long history in Latvia. Activities in this field started in the plant *Latvijas Bērzs,* which was founded in 1873. In October, 1992, on the basis of state enterprise *Plywood Production Union of Latvia*, the joint-stock company *Latvijas Finieris* was established. In the course of years *Latvijas Finieris* has become a multi-profile woodworking company. The assortment offered has increased substantially: plywood of various types of coating, plywood for interior and exterior use, plywood veneered, varnished or painted, etc. From 2000 to 2004 were established 10 product developing trading regional enterprises outside of Latvia (Sweden, Germany, United Kingdom, Spain, USA, France, Finland, Italy, the Netherlands, Japan). Year by year the company keeps to confirm that its operations and produced production are in compliance with the requirements of Latvian and internationally recognized standards by receiving certificates in accordance to its stage of actions.

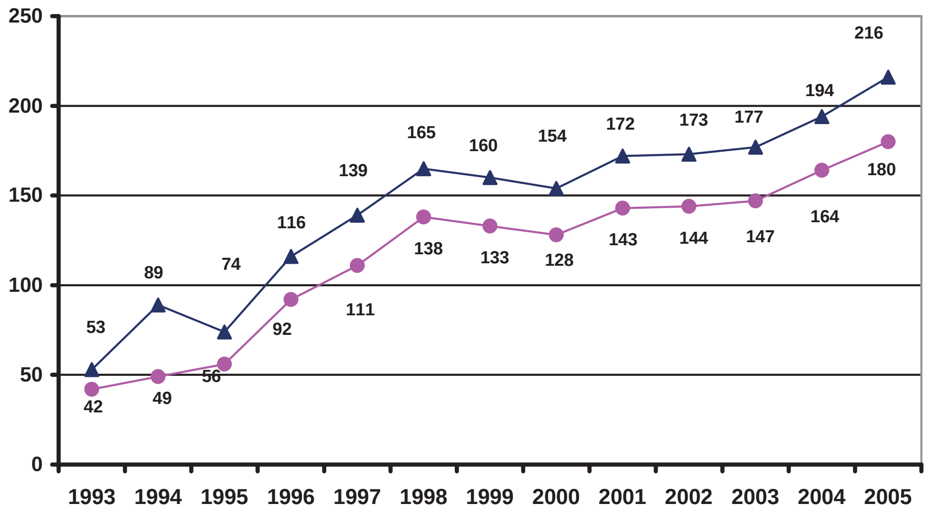


Figure.4. Dynamics of production capacities and export of plywood, 1000 m^3.

During last years interest about birch increases significantly. Management of forests in Latvia that was predominant so far is the main reason to current situation – due to lack of young and middle-aged birch stands we can predict shortage of birch wood resources after 30…40 years. In this case, initiative has been followed from forest industry. Wood processing companies not only invest in new birch plantation establishing projects, but also are paying attention to popularize advantage of planting birch among private forest owners. Interest about planting of birch has increased considering the problem of abandoned agricultural lands. One of the solutions could be afforestation of these lands. Using birch in afforestation is advisable not only from economical point of view. Deciduous tree species are also very valuable to make more diversified amenity forests.

The **furniture industry** was and still is an important branch in the Latvian woodworking industries. The main development problems during the transition period after regaining independence were the lack of customer oriented marketing strategy and a complete new market situation. Privatisation in furniture industry is mainly completed and is considered as an important precondition to attract investment. Number of privatised and newly established private companies have successfully found their new market niches and reoriented their production towards Western markets, local consumers or new Eastern market situation. A rather new direction rapidly developing in Latvia is the production of solid wood furniture. Many enterprises have managed to penetrate Western markets with their solid wood products.

Currently there are slightly more than 300 companies in Latvia producing furniture or furniture components. Among them 10 companies can be considered as medium sized (annual turnover 1 to 4 million USD). Furniture producers are situated mainly in urban areas especially in Riga. Latvian furniture producers are familiar with traditions and demands in potentially huge Eastern (namely CIS) markets but risks there are still high. Now furniture or furniture components exports to Western markets has a tendencies of the growth annually.

6. Forest products market situation and foreign trade

Forest products trade could be characterised as following:

- Week domestic market for forest and wood processing products - main reason is low average income and low level of private long-term investments such as construction.
- Exports accounting about 90 % of all sales.
- Completely changed sales direction - from East to West, mainly EU.
- Relatively high amount of exported unprocessed wood (year 1997 - 2.12 million m^3 of roundwood and 1.031 million tons of fuelwood, year 2000 – 4.19 million m^3 of roundwood and 0.793 million tons of fuelwood, year 2005 – 3,749 million m^3 of roundwood and 2.08 mullions tons of fuelwood, including chips and sawdust).
- High and rising environmental awareness of consumers of Latvian forest products in main importing countries as UK and Germany.

Table 1. Value structure of wood and wood products exported from Latvia

Wood and wood products		Value structure, % Year 1999	Year 2002	Year 2005
Sawn timber		**50.7**	**48.9**	**37.2**
Roundwood		**12.1**	**14.6**	**12.3**
Furniture		**10.7**	**10.3**	**9.8**
Processed wood articles		**5.7**	**8.3**	**11.2**
Plywood		**8.7**	**7.5**	**8.4**
Wood pulp and paper		**2.8**	**2.8**	**6.3**
Fuelwood		**4.0**	**2.3**	**7.7**
Veneer		**1.2**	**1.0**	**0.9**
Particleboard		**1.4**	**1.0**	**1.8**
Hardboard		**0.6**	**0.4**	**0.1**
Matches		**0.3**	**0.3**	**0,3**
Other wood products		**1.5**	**2.2**	**4.0**
In total		**100 %**	**100 %**	**100 %**
Total value of exported wood and wood products	million LVL	**436.3**	**562.3**	**796.85**
	million EUR	**~ 620**	**~ 800**	**1133.82**

Efficient investments in wood processing sector and the available local resources have provided the rapid growth of this field. Wood and wood products are the most important Latvian export products (Table 1). In year 2005 the total value of exported wood based products reached LVL 797 millions (EURO 1134 millions) - 35 % of the total value of exports. If we compare the relative growth dynamics of the value of wood and wood product exports from 1992 to 2005, it has reached a value of more than 48 times higher.

One of the fundamental problems of the wood market in Latvia is the problem of export of unprocessed roundwood. Analyse of the structure of exported roundwood shows, that mainly was exported the pulpwood: 1.691 million m^3 of coniferous (90.5 % of the volume of exported coniferous roundwood) and 1.626 million m^3 of non-coniferous roundwood (86.5 % of the exported volume) - year 2005.

Table 2. Roundwood export from Latvia

Year	1930	1992	1994	1996	1998	2000	2001	2002	2003	2004	2005
Million m^3	0.55	0.51	1.95	1.47	2.76	4.19	3.99	4.22	3.92	4.14	3.75

Gradually is growing the value of wood and wood products imports too; the rate of growing of the imports is lower than the rate of growing of the exports. In year 2005 the total value of forest branch imports reached LVL 285.5 millions (406.2 millions EUR); 41.1 % of that was the value of imported paper and paperboard and 11.9 % - the value of imported furniture (furniture exports value was LVL 77.735 millions or 2.3 time higher than imports value). Roundwood was imported by the value of LVL 36.8 million, sawn timber – by the value of LVL 53.2 million, plywood, particleboards and hardboards by the value of LVL 23.94 million. The value of imported processed wood articles reached LVL 13.9 million in year 2005.

7. Conclusion

Since regaining independence in 1991, the forest industry started to develop more dynamically in comparison with other industries, where transition from socialist to market economy sophisticated. The forest sector is among the most thriving sectors of the national economy, contributing to the stabilisation of the country's foreign trade balance. Forest industry, including wood processing, is the Latvia's only industry, showing a positive export/import balance. Successful utilisation of locally available renewable forest resources has achieved iyt.

Strengths of the Forest sector in Latvia:

- Historically, climate and geographically favourable conditions for forestry with quantitative, diverse and renewable forest resources, providing functioning of harvesting and timber processing enterprises, thus contributing to decrease of employment problems in rural areas.
- Long-standing traditions in forestry and wood processing.
- Major part of requirements regarding forest management partly were in compliance with EU, changes were not so sharp and in some case even became more tolerant.
- Forest products have taken and are maintaining a firm niche in the global forest products market.

- The roles and interests of forest sector institutions, non-governmental and professional organisations, and interest groups have been clearly defined.

Weaknesses of the Forest sector:
- A big number of private owners manage small areas of forests lands.
- There is no working compensation mechanism on considerable relieves for restricted forest management.
- Forest sector is unbalanced because of lack of industrial capacities for processing low-grade wood and industrial residues, also pulpwood.
- Low competitive capacity of the big number of small and medium enterprises, unfavourable situation for investments thus introduction of new technologies is slow.
- Insufficient funding and support for research and education in order to ensure competitiveness in the forest sector.
- Insufficient level of society understanding (knowledge) about forest sector, its priorities and ongoing processes.

References

Domkins A. 2003. Wood processing branch today and tomorrow. - Baltic Timber Journal 4 (15). pp.6-9.

Forest Sector in Latvia 2005. – Forest Sector Information Centre, Riga. 32 p.

Forestry in Changing Societies in Europe: Teaching nodule. 1999. Tuherm H. et al. – Joensuu: University Press. 480 p.

Tuherm H., Silamikele I. 2004. Challenges in strengthening of capacities for Forest Policy development in Latvia. – Forests in transition II: Challenges in strengthening of capacities for forest policy development in Countries with Economics in transition. Tokyo: Umited Nations University. pp.175-194.

Cost and performance management in the sawmilling industry

Torgrim Tunes, Anders Q. Nyrud and Birger Eikenes*

Abstract
Joint costs are costs which cannot be readily identified with individual products. They are especially prominent in extractive, agricultural and chemical industries. In this article we consider methods used by the Norwegian sawmilling industry to allocate joint costs. A survey of joint cost accounting systems in use in Norwegian sawmills was carried out using structured interviews. In order to analyze the results from the interviews we conducted a Cross Case Analysis. According to the results Norwegian sawmills do not allocate joint costs, except from some ad-hoc methods inapplicable for joint cost allocation to products. There are several reasons for this. The problem is perceived as difficult to solve and many of the respondents consider the benefit as limited. There are shortcomings in existing joint cost allocation systems, and finally, there is a lack of interest and knowledge about cost accounting.

***Keywords*:** Joint costs, cost allocation, structured interview, sawmilling

Introduction
The profitability in the Norwegian sawmilling industry has declined over the last couple of decades. There are several reasons for this: the bargaining power of builders' merchant wood sales industry has increased, and impact from international competitive markets has led to declining sales value of sawmilling products. This development has made sawmilling companies to focus on cost efficient production. Means used to gain these goals are for example mergers and acquisitions, outsourcing and implementation of better or more efficient management systems. The purpose of this study is to explore accounting practices in Norwegian sawmills in order to survey the methods used by the industry to allocate joint costs and indirect costs. Drury and Tayles (2005) pointed out that the major role of product costing systems is to provide relevant cost information in order to manage the cost and mix of activities, products, services locations and customers. Relevant information should be generated to ensure that only profitable activities are undertaken.

The term "Sawmill paradox" was coined by Grönlund (1992). It refers to the fact that when processing a sawlog, a range of products (both main products and by-products are produced). This is a typical joint production. Some of the products, such as chips, will have a considerably lower sales value than both raw material price and sales value of other wood products produced from the core of the sawlog. Furthermore, since the raw material price is higher than the net revenue for chips and lowgrade sawnwood, the sawmill is apparently producing these products at negative net value. A profit maximizing sawmill should therefore maximize production of centre boards and minimize the production of chips and lowgrade sawnwood.

The problem explained above is a typically joint cost problem. Billera *et al*. (1981) described joint costs as "…costs which cannot be readily identified with individual products." They stated that joint costs are usually common in extractive, agricultural and chemical industries, as well in industries where different grades of the same product are obtained. The average Norwegian sawmill is producing approximately 3500 different products, many of them with different qualities and grades. Most of the production costs in sawmilling are raw material costs. Companies have to consider how they best can ascribe joint costs generated up to the splitoff point to particular products. The splitoff point in this case, is where the sawlog is divided into centre boards, side boards, chips and sawdust. If the cost system does not capture the consumption of resources by products, costs will be distorted, and there is a risk that managers decide to produce unprofitable products (Drury and Tayles 2005).

Previous studies

Johansson and Rosling (2002) developed an approach to allocate joint costs in sawmilling based on a linear programming model. This model was further developed by Johansson (2004b) and has been used for cost allocation in a Swedish pine mill. The purpose of this model was to calculate the marginal cost of centre boards. Timber costs (*i.e.* joint costs) included all costs before splitting the logs, less revenue from cellulose chips, bark and saw dust. Johansson (2004a) suggested that marginal cost estimates are useful only for centre products, (*i.e.* for products sold to regular customers at negotiated prices and often further processed). For commercial sideboards sold at fixed market prices, marginal cost estimates are of little use since prices are given and the volumes are consequences of the production of centre boards.

Activity-Based Costing (ABC) in the sawmilling industry has been investigated by Kjesbu *et al*. (2001). They concluded that ABC calculation is possible, but ABC calculation is preferred when the production involves a great share of indirect cost. This is not the case in the sawmilling industry where the amount of direct cost (raw material cost) account for more than 60% of the total cost.

A survey of accounting practices in the European oil and gas industry was conducted by Coe *et al*. (1997). They stated that the accelerating pace of change in the energy industry created uncertainty, and information on the accounting aspects of this dynamic environment was needed. As early as in 1977 Feller highlighted the need for management accounting systems designed for handling joint costs in the oil refinery industry. The oil crisis in 1973/74 had made by-products highly profitable, and other costing systems were needed to allocate joint costs in a more appropriate way.

Billera *et.al* (1981) presented a unique procedure for allocating common costs from a production process. This approach was suitable to allocate joint costs in a production process which yield different products or services, or different grades of the same product. The procedure enabled calculation of marginal unit costs for products produced and finally a relative cost per unit produced of products. This is the procedure implemented by Johansson (2002, 2004a, 2004b) on a Swedish sawmill.

Balachandran and Ramakrishnan (1981) also presented a way of allocating joint costs by assembling earlier joint cost allocation models developed by Moriarity (1975) and Louderback (1976). Balachandran and Ramakrishnan (1981) used a combination of both Moriarity (1975) and Louderback (1976) to provide a new approach called "prosperity to contribute". Divisions' "prosperity to contribute" were calculated as the minimum cost of each division acting independent of the company or together (internally) with the other divisions in the company, minus the internal processing cost of each division. Each division's relative share of the contribution was used as distribution formula when joint costs (*i.e.* purchasing raw material, joint production cost, etc.) should be allocated. Balachandran and Ramakrishnan (1981) also suggested a Shapley Value based scheme to allocate joint costs. A more thorough discussion of game theoretic concepts and Shapley Value based allocation can be found in Hamlen *et al*. (1977). The methods presented by Balachandran and Ramakrishnan (1981) allocated joint costs to divisions and not to products.

Finally Jang *et al.* (2006) proposed a method to allocate joint in the gas industry (*i.e.* liquid and gaseous). The method was called "The design benefit method (DBM)" and joint costs are allocated to products based on an ideal product's utilization of real capital. Jang *et al.* (2006) focused on minimizing the total costs connected to producing a number of products. The joint costs of utilizing specific equipment were allocated to the products using a regression analysis to determine each of the products utilization of the equipment.

Theory and methods

Economic theory

Horngren *et al*. (2006) described four different methods to allocate joint costs:
(1) Sales value at splitoff point: The relative amount of cost is the same as the relative amount of sales value.
(2) Physical measure: The relative physical part of one product at splitoff point is used as cost allocation key.
(3) Net realizable value (NRV): Final sales value for one product minus separable costs (costs connected directly to that product), relative to total net realizable value, is used as an allocative key to allocate joint costs to each product.
(4) Constant gross-margin percentage NRV: The gross-margin is deducted from a products' total revenue using the gross-margin percentage. The remaining amount is total production cost for that product. Then separable cost is deducted, and the cost remaining is the joint cost to each product.

Which method of allocating joint costs should be used?

Horngren *et al*. (2006) stated that the sales value at splitoff point method should be used when the sales price of the products is available (even if further processing is done) and they presented four reasons for this: first, it measures the value of the joint product immediately at the end of the joint process; second, there are no anticipations of subsequent management decisions; third, it is meaningful to allocate joint costs based on relative revenues. The fourth reason is connected to its simplicity compared to the other methods described above.

Kaplan and Atkinson (1989) emphasized the importance of joint cost allocation: first, it can be used in order to provide the product valuations required for financial accounting and regulatory purposes and to determine transfer prices when market prices not are available. In addition joint cost allocation can be used to coordinate the activities of decision makers in a decentralized firm.

Allocating joint costs: an example

The two first joint cost allocation methods presented by Horngren *et al*. (2006) can be explained using an example from the sawmilling industry:

Given that a sawmill is producing 40% centre boards, 10% side boards, 37% chips and 8% sawdust when processing a sawlog. In addition, kiln and drying results in 5% reduced production volume. Inputs are purchased for 450 NOK/m^3. Outputs are sold for 1400 NOK/m^3 (centre boards), 900 NOK/m^3 (side boards), 300 NOK/m^3 (chips) 100 NOK/m^3 (sawdust), the following example is presented:

Table 1: Example of joint cost allocation, physical measure method

	Yield [%]	Timber cost [NOK/m^3]	Share of timber cost [NOK/m^3]	Sales-value [NOK]	Gross-margin [NOK/m^3]
Centre-boards	40	450	180	560	380
Sideboards	10	450	45	90	45
Chips	37	450	166.5	111	-55.5
Sawdust	8	450	36	8	-28
Shrinkage	5	450	22.5	0	-22.5
Sum	100		450		319

Table 2: Example of joint cost allocation, sales value method

	Price in [NOK/m^3]	Yield [%]	Sales value [NOK]	Relative sales value [NOK]	Timber cost [NOK/m^3]	Share of timber cost [NOK/m^3]	Gross-margin [NOK/m^3]
Centre-boards	1400	40	560	0.73	450	328.5	231.5
Side-boards	900	10	90	0.12	450	54	36
Chips	300	37	111	0.14	450	63	48
Sawdust	100	8	8	0.01	450	4.5	3.5
Shrinkage	0	5	0	0	450	0	0
Sum	2700	100	769	1		450	319

Using the physical measure method or the sales value method obviously affects the gross-margin for a single product, but the overall gross-margin is the same for both methods.

When sales prices of all products at the splitoff point not are available, other methods can be used. Two of them are the net realizable value (NRV) method and constant gross-margin percentage NRV method presented above. According to Horngren *et al.* (2006) the NRV method measures products income better than the gross-margin percentage NRV method. Also compared to physical-measure method, the NRV method is perceived as better. However, there are instances when physical measure methods are preferred. Market price based methods are for instance difficult to use in the context of rate and price regulations. In addition, the concepts of future income and costs are of great importance. The idea is that only expected future revenues and costs are taken into consideration when the decisions on whether a joint product or main product should be processed further or sold at the splitoff point. Horngren *et al.* (2006) emphasized that joint costs incurred up to the splitoff point are irrelevant because these costs would have incurred whether the product is sold at the splitoff point or processed further. Joint costs up to the splitoff point are frequently not available (this is not only raw material costs and labor costs, but includes a range of costs such as deprecations, house rent and administration). That is one of the reasons why Horngren *et al.* (2006) suggested that further processing should depend on products revenue attainable beyond the splitoff point.

Data collection

Nine Norwegian sawmills were investigated. Structured interviews with the business manager and the production manager were conducted to acquire exact information about production and management accounting. The interviews were based on a questionnaire containing questions about products, production, management accounting and product costing. A tour through the sawmills visited was used to gain a more thorough understanding of how sawmills do cost allocation.

The nine interviewed sawmills consumed between 55000 m^3 and 330000 m^3 sawlogs with an average of 169222 m^3. The yield of centre boards range between 50% - 55%.The sawmills consumed about 35% (1523000 m^3) of the available amount of sawnwood in Norway in 2005 (Statistics Norway 2006).

Method

The material was analyzed using descriptive case study methodology. Emphasis was placed on the qualitative part, in order to obtain detailed understanding of how these companies are doing their cost accounting and product calculation.

Case studies

Case study methodology is presented in Scapens (1990). Case studies can be descriptive, explorative, illustrative, explanatory or experimental, but distinctions between different types of case studies are not clear and it can be difficult to place a study in one category. According to Drury and Tayles (2005) case studies have the potential to provide richer insight into explaining why, and under what circumstances, some organizations adopt simplistic systems and others do not.

In this analysis, the case study method used is both descriptive and exploratory. Based of the interviews, a description of accounting systems, techniques and procedures currently used was provided. The explorative part represented a preliminary investigation intended to generate ideas and hypotheses for a more thorough research later.

Miles and Huberman (1994) provided approaches for analyzing qualitative data. One of these approaches is Cross Case Analysis (CCA). An advantage with CCA is its generalizability; the researcher would like to know the relevance or applicability of his findings to other similar settings. Furthermore, CCA explain more thorough the investigated cases. Miles and Huberman (1994) emphasized two strategies for analysing cross case data: *case-oriented analysis* and *variable-oriented analysis*. *Case-oriented analyses* focus on differences and similarities between cases or types and families of cases while *variable-oriented analyses* focus on the correlation between variables explaining the cases. Sawmill size and degree of further processed products can be examples of explanatory variables, and subsequently evaluated regarding their significance for cases. A mix of *case-oriented strategy* and *variable-oriented strategy* was used in the further analysis of the interviews. All sawmills were displayed in matrix form (see Miles and Huberman 1994, figure 7.1) and by looking at all the cases (sawmills), patterns and similarities could be revealed, and sawmills could be placed into groups dependent on qualitative properties.

The steps are organized chronological depending on level of detail of information for each step. *Partially ordered displays* are less detailed than *conceptually ordered displays* which are in turn less detailed than *case ordered displays*. The first step was to set up a *partially ordered meta-matrix (partially ordered displays)*. All the information collected were placed into a meta-matrix, defined by Miles and Huberman (1994) as master charts assembling descriptive data from each of several cases in a standard format. The simplest form is a juxtaposition of all sawmills displayed on one very large sheet. Conclusions concerning Norwegian sawmills as one group were made. After all sawmills were assembled on one sheet, the variables were divided into three parts founded on the questionnaire used for interviews, that is, smaller matrices consisting of answers connected to products, production and management accounting and product costing. These three matrices were analyzed individually and statements connected to the three categories, production, products, and management accounting and product costing were provided.

Results

Partially ordered displays

None of the sawmills in the sample allocated joint costs. The interviewed sawmills considered the joint cost problem very interesting, but pointed out that this problem is not easily solved. For example, there is clearly a shortcoming in management systems designed for handling joint cost allocation. Further, the sawmills consider the cost-benefit effect of a joint cost accounting system to be limited compared to benefit received from effort put into other parts of the company management, for example customer relationship and raw material suppliers.

Answers from the questions about accounting and costing indicated that all sawmills registered and allocated costs in cost units. Cost units were defined as sections based on geographical position at the site, or cost centers assembled by production units or simply constructed cost centers. A monthly or quarterly closing of accounts was common among all the interview sawmills.

Sawmills allocate fixed indirect costs, but practices differ. For example, many sawmills use internal determined allocative keys in order to divide fixed indirect cost to cost centers. It is also common to benchmark cost centers, (*i.e.* units within the same company) based on the relative amount of fixed indirect cost. Another method of handling fixed indirect costs is to accumulate all fixed cost and subtract them at the bottom of the management account.

None of the sawmills tried to allocate raw material cost (*i.e.* joint costs) in the way presented by Horngren *et al.* (2006) and Johansson (2002, 2004a, 2004b). Other techniques were used, such as cost per timber class, which is appropriate when using fixed settings (sawing patterns). Another method in use was to subtract raw material costs directly from revenues in the management accounts. One mill used an approximation to the physical measure method to allocate joint costs (*i.e.* the joint production costs of by-products (chips and sawdust) are allocated to the main products. Product costing for sawdust and chips were not made, but by-products' joint costs are allocated to the main products.

Discussion

There are several reasons for calculating product cost, for example profitability analyses of markets, customers and products, to estimate the value of inventories or amount of insurance premiums etc. Sawn products are sold in international markets, and consequently Norwegian sawmilling companies can not affect product prices. In order to be profitable they have to concentrate on the products, customers and markets with best net profit (*i.e.* they have to produce and sell products with the lowest total costs). Sawmills have to offer a range of products to customers and markets which are profitable. The best way to determine profitable markets and customers are to know the exact cost of sold products.

Joint cost allocation by Norwegian Sawmills

Despite of the fact that all the interviewed sawmills see joint cost allocation as important in cost accounting, there is a lack of joint cost allocation in the Norwegian sawmilling industry. The interviewed persons confirm that the joint cost problem is perceived as difficult to solve, and also consider the cost-benefit effect of a joint cost system as limited. Effort in other parts of a company's day to day management is perceived as more cost effective than development of sophisticated costing systems.

There are shortcomings in management systems designed for handling joint cost allocation that presently are in use. Some sawmills have developed accounting systems for cost allocation. For example, sawing pattern calculation for one entire timber class and sawing pattern. In this case the joint cost allocation is not solved.

One should also take into consideration that the staff at most sawmills have general knowledge of accounting systems, but lack expertise in cost accounting. Questions about education were not asked, but theoretic competence and interest are important when adopting new accounting systems and using economic theory to solve problems.

Johansson (2004b) found that the profitability measures differ considerably between cost allocation by his model and the costing system used at the investigated sawmill. Johansson (2004b) investigated five products, the system in use at the sawmill indicated that products with high market price were most profitable. The results from Johansson's (2004a, 2004b) model indicated that these products were the least profitable, implying that the company should be better off if it decreased the sales volumes of these products. Differences in cost allocation and product costing methods are important in sales price determination. In the worst case, a company can, based on misleading cost allocation systems, focus on products with the lowest profitability.

Further research

In order to evaluate similarities among sawmills, the next step of this study is to classify the meta-matrix in groups depending on different properties (for example, cubic meters of lumber produced, whether the mill is a part of a bigger company or perceive themselves as job production units, etc.). Miles and Huberman (1994) called these *conceptually ordered displays*. The point is to focus primarily on the content of a meta-matrix, without reference to specific cases, and to find out if there are any clear distinctions among groups of the investigated sawmills.

The third step, concentrates on more detailed information than the *partially ordered meta-matrix* and the *conceptually ordered displays* and is described by Miles and Huberman (1994) as *case-ordered displays*. Instead of using discrete variables, (*i.e.* part of a bigger company), the sawmills are sorted into groups depending on continuous variables as, for example share of processed products. The gradation will make it possible to see differences between cases.

References

Balachandran, B.V. & Ramakrishnan, R.T.S., 1981. Joint Cost Allocation: A Unified Approach. The Accounting Review 56, 85-96.

Billera, L.J., Heath, D.C., Verrecchia, R.E., 1981. A Unique Approach for Allocating Common Cost form a Production Process. Journal of Accounting Research 19, 185-196.

Bjørnenak, T., 1997a. Conventional Wisdom and costing practices. Management Accounting Research 8, 367-382.
Coe, T.L., Gilbert, K., Heather, M. 1997. Survey of accounting practices in the European oil and gas industry. Institute of Petroleum Accounting, University of North Texas. Denton, Texas 76203. USA.
Drury, C. & Tyles, M. 2005. Explicating the design of overhead absorption procedures in UK organizations. The British Accounting Review 37, 47-84.
Feller, R E. 1977. Accounting for Joint Products in the Petroleum Industry. Management Accounting 59, 43.
Grönlund, A., 1992. Sägverksteknik del II. Processen. Sveriges Skogsindustriförbund Sweden. pp. 293.
Hamlen, S.S., Hamlen, jr. W.A., Tschirhart, J.T., 1977. The Use of Core Theory in Evaluating Joint Cost Allocation Schemes. The Accounting Review 52(3), 616-627.
Hoff, K.G. & Bjørnenak,T. 2006. Driftsregnskap og budsjettering. 4.utgave Universitetsforlaget.
Horngren, Charles T., Datar, Sirkant M., Foster, G., 2006. Cost Accounting. A Managerial Emphasis. Upper Saddle River, N.J. Prentice Hall. Pp. 868
Jang, W.H., Hahn, J., Hall, K. R., 2006. The design benefit method: Allocate joint costs among shared products. Gas processing developments, Special report. Department of Chemical Engineering, Texas A&M University, College Station, Texas
Johansson, M. & Rosling, K., 2002. The Timber Cost of a Board. In: Helles, F. and Strange, N. (Eds.). Scandinavian Forest Economics 39, 229-239
Johansson, M 2004a. Allocating the Timber Cost to Sawn Products – A Case Study. In: Baudin, A., 2004. Industrial and Market perspectives on the Forest Sector. Proceedings from the International Conference on Forest Industry and Markets, May 2003. pp. 17.
Johansson, M. 2004b. Allocating the Timber Cost to Sawn Products – A Case Study. Costing in sawmills for sales management: Thesis for the Licentiate's degree. Vaxjö University 2004.
Kaplan, R.S. & Atkinson. A.A., 1989. Advanced Management Accounting. Prentice-Hall Internatioanl Inc. 1989, Second edition.
Kjesbu, H., Eikenes, B. & Mellem, A., 2001. ABC-kalkyler i trelaslindustrien. Trelastindustriens Landsforening. Norges landbrukshøgskole, Institutt for skogfag.
Louderback, J.G., 1976. Another Approach to Allocating Joint Cost: A Comment. The Accounting Review 51, 683-685.
Miles, M. B. and Huberman, A. M. 1994., Qualitative Data Analysis: An Expanded Sourcebook. 2nd ed. pp. 338. SAGE Publications, Inc.
Moriarity, S., 1975. Another Approach to Allocating Joint Cost. The Accounting Review 50, 791-795.
Scapens, R., 1990. Researching management accounting practice: The role of case study methods. British Accounting Review 22, 259-281
Statistics Norway 2006. Statistisk sentralbyrå (SSB). Commercial roundwood removals. http://www.ssb.no/english/subjects/10/04/20/skogav_en/tab-2006-06-02-02-en.html Accessed: June 28, 2006.

Trade flows, unit prices and roundwood market integration in northern Europe

Jari Viitanen, Anne Toppinen, Surya Bahadur Magar, Bruce Michie & Anders Q. Nyrud*

Abstract
Roundwood markets in Northern Europe have changed significantly due to the enlargement of EU in 1995 and 2004, and the formation of a common currency union between the 12 EU countries in 2001. However, wider research on the larger context of interaction between national markets in European Union is yet largely missing. This study shortly assesses roundwood market development and integration in Northern Europe. First, international roundwood and chips trade is studied by using simple descriptive analyses and annual national data from EFI's and FAO's databases for coniferous roundwood trade in 1980-2004. We classify countries as net importers or exporters of roundwood and examine how the trade flows have evolved over time. Second, we explore how the unit values of the roundwood and chips exports and imports have developed during 1980-2004, and explore signs for deepening integration of the roundwood markets in terms of convergence of unit prices and price variances. The results indicate that coniferous roundwood trade has been mainly moving from east (Russia, Baltic States) to west (Finland, Sweden, Norway), even though there has also been a small trading centre around Austria. The unit price development reveals that national export and import prices have clearly converged during the last decade.

Key words: Roundwood trade, coniferous, Northern Europe, integration, unit prices

Introduction
During the 1990s roundwood trade in Northern Europe increased significantly. This increase is mainly due to the large structural changes in the operational environment of forest industry. Especially, the enlargement of European Union with its harmonised legislation and regulation dealing with international trade of products as well as competition legislation has been among the main factors to affect national roundwood markets in Northern Europe (Toppinen et al. 2005). The forest area and forest industry production of the EU almost doubled when Finland, Sweden, and Austria joined EU in 1995. The integration of national wood markets continued in 2004, when ten more countries joined in EU, and three countries are still in pipeline to join in 2007. Also, the collapse of Soviet Union in the beginning of 1990s resulted in a large increase in roundwood exports especially to Finland and Sweden (Mutanen et al. 2005), along with the investment boom in the sawmilling industry.

In order to understand how these structural changes have affected roundwood markets in Northern Europe, how national roundwood markets in different countries are functioning, and to evaluate the degree of integration between these markets, it is essential to analyse the change in volumes and prices of international roundwood trade. Theoretically, integration of roundwood markets can be analysed with the law of one price (LOP), which address that in competitive markets without trading costs a homogeneous commodity has a single price irrespective of the country of origin. As Silvapulle et al. (1994) and Toivonen et al. (2002) have stated, two regions then belong to the same competitive market if the local price of homogeneous product differs only by transportation costs between the regions.

Recently, only a few studies have been carried out to analyse the international trade of roundwood. Thorsen (1998) and Nyrund (1999) examined the Nordic roundwood markets and found that countries with highest forest industry capacities, i.e. Finland and Sweden, are also price leaders in the markets. Integration of roundwood markets in Austria, Finland and

Sweden was studied by Toivonen et al. (2002) who found that the LOP holds between the two Nordic counties, but a clear price co-movement did not exist between Austria and Nordic countries. Mäki-Hakola (2002, 2004) tested roundwood market integration between Finland, Estonia, Germany, and Lithuania. He found out a strong connection of sawlog prices between Finland and Estonia. Furthermore, using standard convergence tests Toppinen et al. (2005) found only weak evidence for long run equilibrium delivery price levels between different Finnish, Estonian and Lithuanian wood assortments.

Using simple descriptive methods, this study analyses the development of international trade of roundwood in Northern Europe. We focus only on studying the development of exports and imports of coniferous roundwood and chips in terms of their volumes and prices, because coniferous assortments and saw residues are the most important wood articles for the forest industry in Northern Europe. Especially, we analyse which countries have been the main importers and exporters of roundwood in Northern Europe, and how these trade volumes have evolved over the period from 1980 to 2004. As a whole, this paper is a preliminary study as a background for oncoming analyses of roundwood market integration in Northern Europe.

Materials and methods

Annual export and import data of roundwood was obtained from European Forest Institute's (EFI) database (see also Michie & Wardle 1998) and from bilateral trade matrices of FAOSTAT. The time span is from 1980 to 2004. The series contain export and import volumes and unit prices of coniferous industrial roundwood and chips and particles. The countries included in this study are Finland, Sweden, Norway, Russian Federation, Czeck Republic, Poland, Germany, Austria, Belarus, Estonia, Lithuania, Latvia, Ukraine and Slovakia.

Results

Exports of Coniferous Roundwood

The drastic societal changes in Europe affected considerably both national and international operational environment of forest industries as well as their wood procurement strategies in Northern Europe. The unification of Germany, the collapse of Soviet Union and the gradual privatisation of the forests of the Baltic States after their declarations of independence integrated the former national forest resources into international markets. Also, the European Union with its harmonised legislation and regulation dealing with international trade of final products and inputs have affected strongly on the internationalisation of roundwood trade.

Fig. 1 illustrates the development of export volumes of coniferous roundwood from 1980 up to 2004.1 As can be seen from the Figure, USSR was the largest exporter of coniferous roundwood before its collapse. While Finland and the Soviet Union had bilateral trade contracts during 1980s, most of the volumes from USSR were exported to Finland as a part of the contracts. Up to 1987, the export trend of all studied countries is rather constant. Annually, USSR exported about 0.75 million cubic meters of coniferous roundwood whereas other countries exported less then 0.2 million m^3. During the period 1988 – 1989 the export volumes of all countries raised. USSR exported almost all 3.5 million m^3 but due to the collapse of the Soviet economy, the exports of coniferous roundwood temporarily decreased.

---

1 Throughout this study, the figures represent only those of documented in FAOSTAT and EFI. The statistics given e.g. in Finnish Statistical Yearbook of Forestry and other national sources can differ slightly from these figures.

However, soon after the collapse of Soviet Union, the export volumes of coniferous roundwood increased significantly. The forest enterprises in Russia were willing to export roundwood to finance their domestic activities and investments and to avoid bankruptcy (see Vinokurova et al. 2005 and Mutanen et al. 2005 for more details). In Northern Europe, Russian Federation has clearly been the most important exporter of coniferous roundwood. In 1999, the exported volume from Russian Federation was above 8 million m^3, and recently the volumes are slightly less than 10 million cubic meters.

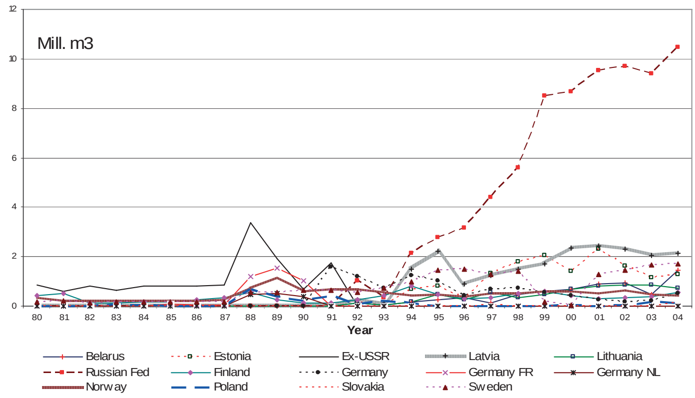


Figure. 1 Export volumes of coniferous roundwood, 1980 – 2004

Also, the Baltic States have participated intensively in international coniferous trade after their declarations of independence. Especially, Latvia and Estonia have exported considerable amounts of coniferous roundwood mainly because a substantial pulpwood based forest industry does not exist in these countries. The annual export volumes of both countries have moved parallel between 1 and 2 million m^3. The export of other countries during the period 1992 – 2004 was below 1 million m^3.

Imports of Coniferous Roundwood

During the period from 1980 to 2004, Scandinavian countries Sweden, Finland and Norway have been the major importers of coniferous roundwood. As can be seen from Fig. 2., the import volumes started to increase in the late of 1980s mainly due to the institutional reasons mentioned above. However, also changes in national operational environments created incentive to increase international trade of roundwood. For example, in Finland the centralised roundwood market contracting, giving strict rules for roundwood prices as well as for volumes of imports was gradually removed between the late 1980s to the mid 1990s. However, the import volumes did not increase significantly until the collapse of Soviet Union. The incentive for the Scandinavian firms, especially in Sweden and Finland, was undoubtedly the relatively cheap wood material and good logistics through close geographical location. Sweden also imported considerably amounts of coniferous pulpwood from the Baltic States.

During the period 1992 – 2004, the imported volume of coniferous roundwood to Sweden and Finland increased in parallel even though the import volumes to Sweden were slightly higher than to Finland. In 2000, Sweden recorded the largest volume of about 8.5 million m^3. From 2000 onward, the imported volumes of coniferous roundwood have slightly decreased mainly due to the decreased supply and increased prices of logs from Russia. After the increase in the early of 1990s, Norway has consumed rather constant import volumes of about 2 to 3 million m^3.

The other countries in Northern Europe have also imported coniferous roundwood, but the volumes have been negligible in comparison to Sweden, Finland and Norway. However, after the year 1995, other countries have also slightly increased their import volumes. Evidently, the main reason for this is the enforcement of competition legislation of European Union with its harmonised rules and regulations dealing with the international trade of products and inputs. In 1999, Germany crossed the threshold of one million cubic meters of imports, while other countries reached the half million m^3 of imports.

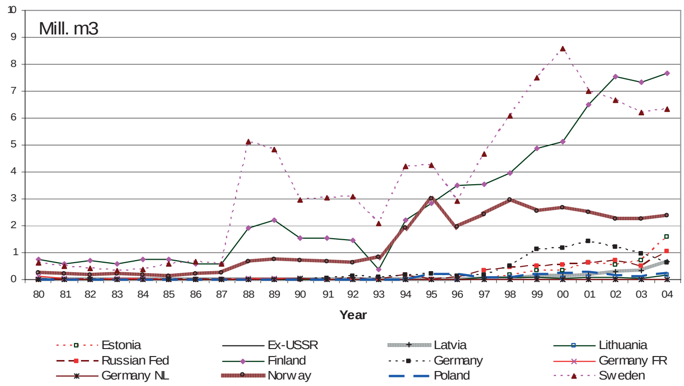


Figure. 2. Import volumes of coniferous roundwood, 1980 – 2004

To get a better understanding about the coniferous trade in Northern Europe, Fig. 3. depicts the trade flows in 2003. From this Figure as well as from the previous Figures, it is clear that the main wood flow originates from Northwest Russian to Scandinavian countries. However, two other concentrations can be found around the Baltic States and in Central Europe, especially around Austria.

The coniferous export from Estonia and Latvia to Finland, Sweden and Norway has been rather significant. As discussed shortly above, these export volumes consist mostly of pulpwood. Because of the investments in sawmilling industry and recent lack of coniferous logs, Estonia has also imported logs from Russia. Traditionally, some border trade of coniferous wood has been from Sweden to Norway. Sweden, Russia and the Baltic States also export smaller quantities to Germany. The marketing of industrial roundwood from Germany, Czech Republic and other neighbouring countries to Austria is also significant in central Europe.

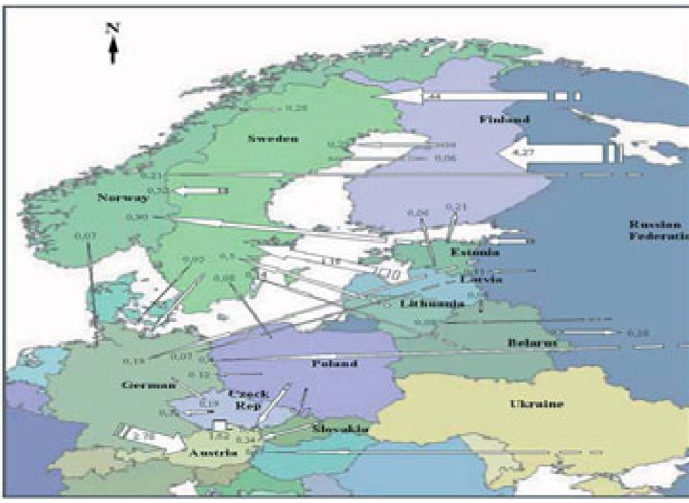


Figure. 3 Trade flow map of coniferous roundwood in Northern Europe in 2003, mill. m3

Germany differs from the other countries by engaging in both exports and imports of roundwood. Though Germany is an exporter of coniferous roundwood, it also imported from Sweden, Czech Republic and other neighbouring countries. At the same time, it is significant exporter to Austria. The reason for this can be understood through the logistics. Because of the location of the wood processing industry and the low custom tariffs, it would be profitable to export coniferous roundwood from some parts of the country rather than consume it in domestic plants which may be able to import roundwood for their own special needs.

Chips and Particles

The trade of chips and particles as a wood residue is closely connected to the location of sawmills and pulp and paper industry. Nowadays, because of the vertical integration strategies of the forest industry and the competition legislation of the European Union, national boarders are no longer barriers to trading raw material from one country to another.

Fig. 4. depicts the development of trade of chips and particles during 1980 – 2004. Prior to the institutional changes in Europe in the beginning of the 1990s, the most important exporter of chips and particles was Sweden. The annual volumes fluctuated around the half million cubic meters until 1990 and after that the trade has averaged approximately 0.3 million m3. Due to the absence of the pulp and paper industry and large investments in sawmilling industry, the Baltic States have become more active in trading chips after the mid of 1990s. Especially, Latvia has increased its export volumes considerably after 1996. In 2003, Latvia exported 1.82 million m3, which was twice as much as exported from Estonia and more than three times higher than exports from other countries. The trend of Estonian exports has been similar to that of Latvia, but the exported volumes have been significantly lower. The exports of chips and particles from Russia grew only slightly up to 1999, but in 2000 it increased its export volumes to about 0.5 million m^3. Exports from Sweden have also been rather constant with annual volumes of about 0.3 million m3. Exports from other countries have been annually less than 0.1 million m^3.

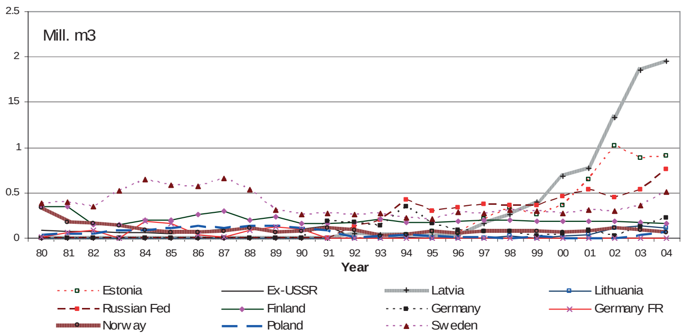


Figure. 4 Export volumes of chips and particles, 1980 – 2004

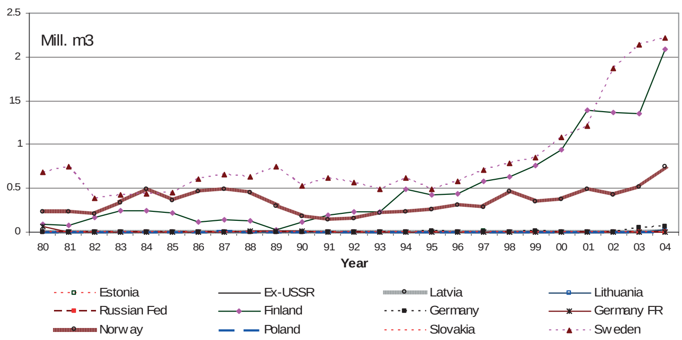


Figure. 5 Import volumes of chips and particles, 1980 – 2004

The total imports of chips and particles in Northern Europe and the Baltic Sea area in 2004 amounted to 10.52 million m^3, which was 13.4% higher than in 2003 and 27.2% higher than in 2000. Thus, the trade of chips and particles is following an upward trend. As can be seen from the Fig. 5., Sweden, Norway and Finland have been the major importers of chips and particles. The other countries have only a negligible role in chips and particles imports. It is however noteworthy that while Sweden and Finland have considerably increased imports of these pulp articles, Norway has only slightly increased the import volumes. The imports of these three countries moved more or less parallel over the period from 1980 to 1998 even though Sweden imported higher amounts than Norway and Finland. The reason for this increase is related to increased export volumes from Latvia. Imports into Finland continuously increased up to about 1.35 million m3 in 2001, and have remained rather constant since then.

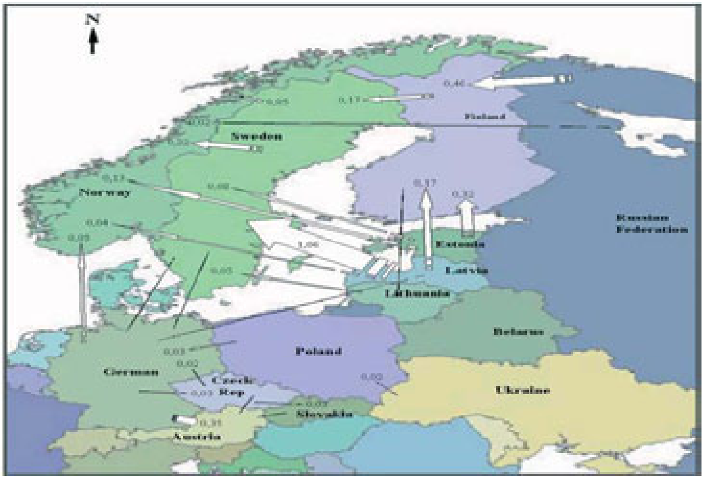


Figure. 6 Trade flow map of chips and particles in Northern Europe in 2003, mill. m3

In the case of chips and particles, trade flows are mainly moving in the Northwest direction, as presented in Fig. 6. Latvia was the most important exporter of chips and particles in 2003. It exported to Sweden, Finland, Norway and also to Germany. The trade from Estonia and Russia to Finland is also considerable. A smaller but locally important trade has occurred around Austria and Czech Republik.

Unit Price Development of Coniferous Roundwood

The simplest way to analyse roundwood market integration in Northern Europe is to observe the development of import and export unit prices of industrial coniferous roundwood. If the unit prices are converging over time, or if the price fluctuations appear with a lower standard deviation, then one can suspect deepening market integration. As lower unit price development typically means more competition between buyers, this would be another sign of increased market integration.

Fig. 7. depicts the development of unit prices of exported coniferous roundwood. As can be seen, prices fluctuated widely until the mid 1990s. However, it is difficult to explain the large peaks in the series other than as errors in statistics. For example, the unit price for exports for BRD in 1983 can be due to the biased observation rather than huge increase in prices. Interestingly, the prices seem to fluctuate more consistently after 1994 with the exceptions of Sweden and Estonia, where the price development can be explained by changes in national market environments. Clearly, prices have followed a decreasing trend until 2001 after which there is a modest increase.

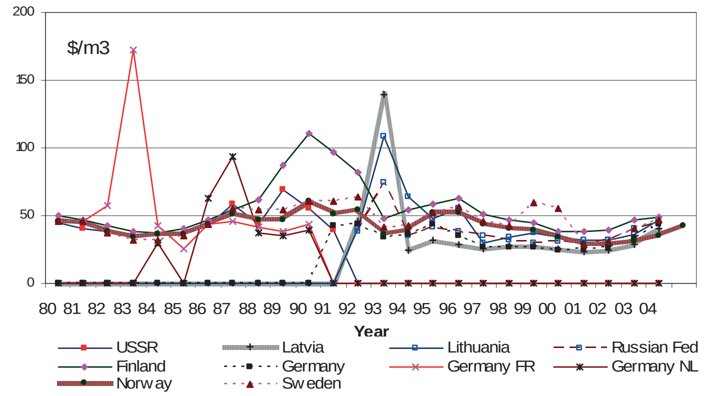


Figure. 7 Unit prices of exported coniferous roundwood, 1980 – 2004

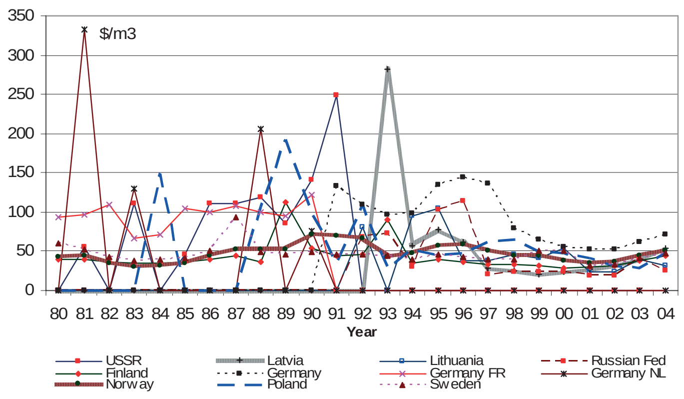


Figure. 8 Unit prices of imported coniferous roundwood, 1980 – 2004

The development of unit prices for coniferous imports is consistent with the behaviour of export unit prices. According to Fig. 8., the convergence of the prices is evident after the mid of 1990s indicating an increased international competition of roundwood and market integration.

Conclusion and Discussion

Along with the general globalisation and structural societal changes in Europe, the operational environment of forest industry has changed remarkably, and international trade of wood has experienced manifold increases. Using simple descriptive analysis and annual data from 1980 to 2004, this study briefly explored the development of coniferous roundwood and chips and particles trade flows, identified major importers and exporters during the last two decades and analysed the direction of market integration in Northern Europe.

Results reveal that imports and exports of industrial coniferous roundwood and chips and particles started increasing in the early 1990s. During the past decade, volumes of both imports and exports have increased continuously. Industrial coniferous roundwood trade flows move mainly from east to west. The largest volumes of coniferous roundwood are imported into Finland, Sweden and Norway especially from the Russian Federation, but also from Latvia and Estonia. Sweden is the main importer of chips and particles in Northern Europe, even though Finland and Norway have increased their import volumes as well. Latvia is the main exporter of chips and particles. Based on trade volumes, the Baltic Sea area constitutes an internal market for roundwood and chips. A small separate market of coniferous roundwood and chips and particles trade is concentrated around Austria.

The price analysis confirms that unit prices of coniferous roundwood and chips in the Northern and Central Europe are co-moving, converging or both, which ultimately indicates that the roundwood markets in Europe are becoming increasingly integrated. This finding is consistent with Nyrud et al. (2004), who found that the prices of forest products in global markets are co-moving. However, even though there are some differences between the national prices of imports and exports, they are likely to be derived from different transportation costs or from differences in wood quality. In the case of coniferous roundwood, the import and export prices between the countries are much closer than in the case of chips and particles prices. Nevertheless, the development of imported unit prices for chips and particles between the major importers seems parallel.

References

FAO. 2005. Forestry Data. FAOSTAT.

Http://Faostat.Fao.Org/Faostat/Form?Collection=Forestry.Primary&Domain=Forestry&Servlet=1&Hasbulk=0&Version=Ext&Language=EN

FAO. 2005. Forestry Trade Flow.

Http://Faostat.Fao.Org/Faostat/Forestry/Jsp/Fytf_QE.Jsp?Language=EN&Version=Ext&Hasbulk=0

Finnish Forest Research Institute (METLA). 2004. Finnish Statistical Yearbook of Forestry.

Michie, B. & Wardle, P. 1998. Unstat Trade Data as Basis for Analysis and Projection of Forest Products Trade Flows. EFI Working Paper 17.

Mutanen, A., Viitanen, J., Toppinen, A. Hänninen, R. & Holopainen P. 2005. Forest Resources, Production and Exports of Roundwood and Sawnwood from Russia. Working Papers of Finnish Forest Research Institute 9.

http://www.metla.fi/julkaisut/workingpapers/2005/mwp009.htm

Mäki-Hakola, M. 2002. Cointegration of Roundwood Markets around the Baltic Sea. An Empirical Analysis of Roundwood Markets in Finland, Estonia, Germany and Lithuania. Pellervo Economic Research Institute. Working Paper No. 55.

Mäki-Hakola, M. 2004. Roundwood Price Development and Market Linkages in Central and Northern Europe. Pellervo Economic Research Institute. Working Paper No. 68.

Nyrud, A.Q., Michie B. & Sande, J. B. 2004. Investigating Globalization: The Case Of Forest Product Markets. Proceedings of The Biennial Meeting of The Scandinavian Society of Forest Economics. Vantaa, Finland. Scandinavian Forest Economics Vol 40: 307-317.

Nyrund, A. 1999. A Multivariate Cointegration Analysis of Relation between Norwegian and International Pulpwood Prices. Paper Presented at Biennial Meeting of Scandinavian Society of Forest Economics. Umeå, Sweden 1998.

Silvapulle, P. & Jayasuriya, S. 1994. Testing of Philippines Rice Market Integration. A Multiple Cointegration Approach. Journal of Agricultural Economics, Vol 45.

Thorsen, B. J. 1998. Spatial integration in the Nordic Timber Market: Long-run Equilibria and Short-run Dynamics. Scandinavian Journal of Forest Research 13:488-498.

Toivonen R, Toppinen A. & Tilli T. 2002. Integration of Roundwood Markets in Austria, Finland and Sweden. Forest Policy and Economics 4: 33-42.

Toppinen, A., Viitanen, J., Leskinen, P. & Toivonen, R. 2005. Dynamics of Roundwood Prices in Estonia, Finland and Lithuania. Baltic Forestry 11: 88-96.

United Nations – Economic Commission for Europe. 2005. Timber Bulletin. Forest Products Annual Market Review. Volume LVIII FAO/UN.

Vinokurova, N., Ollonqvist, P., Holopainen P., Viitanen, J., Mutanen, A. & Gerasimov, Y. 2005. Challenges in Roundwood Trade between Finland and Russia – A Cultural Approach. Working Papers of Finnish Forest Research Institute 7. http://www.metla.fi/julkaisut/workingpapers/2005/mwp009.htm

Carbon pricing through subsidy payment for thinning activities in Japan

Atsushi Yoshimoto

Abstract
Carbon pricing was conducted through the subsidy payment for thinning activities in Japan within the optimization framework for the forest stand management. The optimal forest stand management model called DP-KYSS (dynamic programming model for Kyushu stand simulator) was utilized for the analysis of a sugi (Cryptomeria japonia) forest stand in the Kyushu region, Japan. The analyses showed that the thinning subsidy activated thinning activities with the reduction of carbon sequestered in a forest stand. Considering subsidies as a compensation for carbon loss by thinning, the evaluation of carbon showed that the present net value of cost per unit carbon loss became the highest for the rotation age of 35 years and the minimum for the rotation age of 50 to 65 years dependent upon the subsidy measure. At the rotation age of 100 years, the present net value of cost per unit carbon loss was found to be 44.56 to 110.13 Euro/Ct. The analyses showed that lengthening the period for subsidy would reduce the value of carbon. Subsidy pays more with more thinning reducing carbon sequestered in a forest stand.

Key words: Carbon evaluation, carbon pricing, thinning subsidy, dynamic programming, calculus of variation

Introduction

During the 1960's, the large scale of artificial forests were established by the lead of Japanese Forestry Agency with plantation subsidy to encourage forest owners for plantation activities. Since then, the subsidy payment has continued for plantation as well as thinning activities. This is to let private forest owners sustain their forestry practices including tending, weeding and thinning to satisfy the future domestic timber demand as well as multiple purpose benefits from forest resources under management at the same time. The recent decrease in timber price, is however discouraging them, and impinges on the sustainable forest management for a large amount of artificial forests. Current phenomena regarding the forest management is such that thinning tends to cease while final harvest tends to be postponed longer than we expected.

Several policy measures have been proposed with subsidies for thinning activities within the framework of the sustainable forest management in Japan. The current thinning subsidy is provided for forest stands with the age older than 10 years and younger than or equal to 35 years. Since the fiscal year of 2000, as a remedy for non-thinned or unmanaged forest stands older than 35 years, an additional subsidy as an emergency political action was proposed to forest stands up to age younger than or equal to 45 years from the fiscal year of 2000 to 2004. Currently, extending the subsidy period is under consideration.

While much of attention has been paid to the sustainable forest management, the global warning issue also became one of the serious environmental concerns internationally as well as domestically. After forests under management were considered as carbon sink by Article 3.4 of the Kyoto Protocol (UNFCC 2005), Japanese Forestry Agency has started to look for an opportunity to enhance thinning activities as well as other management activities required. At the same time, the emission trading under the Kyoto Protocol became active with carbon credits issued to forests. This trading is one of alternatives for a nation to meet the target of emission reduction.

In this paper, carbon pricing is conducted through subsidy payment for thinning in Japan within the forest stand optimization framework. Since thinning activities affect the amount of carbon sequestered by a forest stand, the subsidy payment for thinning can be regarded as a compensation for changing the amount of the credits. We evaluate how much is paid for the unit carbon change from a forest stand at the rotation period. The optimal forest stand management model called DP-KYSS (dynamic programming model for Kyushu stand simulator) is utilized for the analysis with a sugi (Cryptomeria japonia) forest stand growth simulator in the Kyushu region, Japan. The growth simulator is the stand density management diagram. The MSPATH (multiple stage projection alternative technique) algorithm is implemented in the optimization phase.

The dynamic programming approach has been developed and extensively applied due to its dynamic nature of forest stand growth (Arimizu 1958a, b; Amidon & Akin 1968; Schreuder 1971; Kilkki & Väisänen 1970; Adams & Ek 1974; Brodie et al. 1978; Brodie & Kao 1979; Chen et al. 1980; Martin & Ek 1981; Riitters et al. 1982; Brodie & Haight 1985; Haight et al. 1985; Valsta & Brodie 1985; Arthand & Klemperer 1988; Torres & Brodie 1990). While the curse of dimensionality had been the main problem for these early applications of dynamic programming, Paredes & Brodie (1987) introduced a new dynamic programming algorithm called PATH (Projection Alternative Technique) within the framework of both network theory and the theory of the Lagrange multipliers to resolve the problem. The shortcoming of PATH was pointed out by Yoshimoto et al. (1988) in considering a long-term effect of thinning activities on the objective function. The MSPATH (Multiple Stage PATH) algorithm was developed to overcome the problem by considering all possible future path combination.

The paper is organized as follows. In the second section, the MSPATH algorithm is mathematically elaborated, followed by the description of a growth simulator for sugi forest stands in the Kyushu region, Japan in the third section. In the fourth section, carbon pricing is conducted with DP-KYSS using the data collected from our study plot. Some concluding remarks are provided in the last section.

Dynamic Programming Modeling

The DP formulation by PATH and MSPATH can be described by a canonical problem of the calculus of variations (Intriligator 1971). Let x(t) be a state variable representing a forest stand at time t, and $\dot{x}(t)$ be its first derivative with respect to time t. Introducing a marginal function of the objective for the management over time, $\pi(\cdot)$, an optimal solution is sought by maximizing its integral from the initial state (plantation) x0 at time t0, to the ending state (final harvest) xn at time tn with respect to a control variable, $\dot{x}(t)$.

$$\max_{\{\dot{x}(t)\}} J = \int_{t_0}^{t_n} \pi(x(t), \dot{x}(t), t)\, dt$$
$$x(t_0) = x_0$$
$$x(t_n) = x_n \qquad (1)$$

For the thinning management problem, only thinning intensity, T(t) at time t affects x(t) and $\dot{x}(t)$, so that the control variable in the above equation (1) can be replaced by thinning, T(t) as follows,

$$\max_{\{T(t)\}} J = \int_{t_0}^{t_n} \pi(x(t), T(t), t)\, dt$$
$$x(t_0) = x_0$$
$$x(t_n) = x_n \qquad (2)$$

where T(t) is the intensity of thinning at time t. In order to convert the objective function into the discrete thinning problem for $(t = t_0, t_1, \cdots, t_n)$, we have,

$$\max_{\{T(t_i)\}} J = \sum_{i=1}^{n} \int_{t_{i-1}}^{t_i} \pi(x(t), T(t_{i-1}), t)\, dt$$
$$x(t_0) = x_0$$
$$x(t_n) = x_n \qquad (3)$$

Defining

$$\Pi(x(t), T(t), t) = \int \pi(x(t), T(t), t)\, dt \qquad (4)$$

the objective function of equation (3) becomes,

$$\begin{aligned}\max_{\{T(t_i)\}} J &= \sum_{i=1}^{n} \int_{t_{i-1}}^{t_i} \pi(x(t), T(t_{i-1}), t)\, dt \\ &= \sum_{i=1}^{n} \{\Pi(x(t_i), T(t_{i-1}), t_i) - \Pi(x(t_{i-1}), T(t_{i-1}), t_{i-1})\}\end{aligned} \qquad (5)$$

Let us introduce the contribution value of thinning, $T(t_i)$, to the objective by $V(T(t_i))$ defined by,

$$V(T(t_i)) = \Pi(x(t_i), T(t_{i-1}), t_i) - \Pi(x(t_i), T(t_i), t_i) \qquad (6)$$

The first term of the right-hand side is the contribution value of a forest stand, $\Pi(\cdot)$, at time ti after having thinning $T(t_{i-1})$ at time ti-1 and the second term is that just after having thinning $T(t_i)$ at time ti, so that the difference, $V(T(t))$, is the contribution of thinning to the objective or the return from thinning. Inserting equation (6) into equation (5), we have

$$\begin{aligned}\max_{\{T(t_i)\}} J &= \sum_{i=1}^{n} \{\Pi(x(t_i), T(t_{i-1}), t_i) - \Pi(x(t_{i-1}), T(t_{i-1}), t_{i-1})\} \\ &= \sum_{i=1}^{n} \{\Pi(x(t_i), T(t_{i-1}), t_i) - \Pi(x(t_{i-1}), T(t_{i-2}), t_{i-1}) + V(T(t_{i-1}))\} \\ &= \sum_{i=1}^{n} \{\Pi(x(t_i), T(t_{i-1}), t_i) + V(T(t_{i-1})) - \Pi(x(t_{i-1}), T(t_{i-2}), t_{i-1})\}\end{aligned} \qquad (7)$$

By assuming that thinning at time (ti-1) only affects the objective value until time ti over one stage, the optimality equation within the DP optimization framework becomes

$$\begin{aligned} f_i^* &= \max_{\{T_{i-1}\}} \{f_i(T_{i-1})\} \\ f_i(T_{i-1}) &= \Pi_i(T_{i-1}) + V(T_{i-1}) - \Pi_{i-1}^*(T_{i-2}) + f_{i-1}^* \end{aligned} \qquad (8)$$

where $T_i = T(t_i)$ is the intensity of thinning at time ti, $\Pi_i(T_{i-1}) = \Pi(x(t_i), T(t_{i-1}), t_i)$ is the contribution value of a forest stand at time ti after having thinning Ti-1 at time ti-1, $V(T_i) = V(T(t_i))$ is the contribution value of thinning Ti at time ti, $\Pi_i^* = \Pi_i(T_{i-1}^*)$ is an optimal contribution value of a forest stand at time t after having optimal thinning T_{i-1}^* at time ti-1.

The PATH algorithm assumes that thinning only affects the objective value until the next possible thinning period, i.e., one stage look-ahead. By considering influence of thinning over multiple periods, i.e., multiple stage look-ahead, on the other hand the optimality equation of MSPATH becomes,

$$\begin{aligned} f_i^* &= \max_{\{T_{i,i-j}, j\}} \{f_{i,i-j}(T_{i,i-j})\} \\ f_{i-j}^i(T_{i,i-j}) &= \Pi_i(T_{i,i-j}) + V(T_{i,i-j}) - \Pi_{i-j}^* + f_{i-j}^* \end{aligned} \qquad (9)$$

This is to search for an optimal intensity of thinning as well as an optimal elapse of the stage, j, for two sequential thinning over multiple stages. Note that Ti,i-j is the intensity of thinning at time ti-j with the elapse of the stage j from the i-th stage, $\Pi_i(T_{i,i-j})$ is the contribution value of a forest stand at time ti after having thinning Ti,i-j at time ti-j, V(Ti,i-j) is the contribution value of thinning Ti,i-j implemented at time ti-j, j* is an optimal elapse of the stage from the i-th stage, $T^*_{i,i-j}$ is an optimal intensity of thinning at time ti-j targeting time ti, $\Pi^*_i = \Pi(T^*_{i,i-j})$ is the contribution value of a forest stand at time t_i after having thinning $T^*_{i,i-j}$ at time ti-j. Unlike PATH, MSPATH searches for not only an optimal intensity of thinning but also an optimal elapse of the stage for two sequential thinning activities. Nonetheless, both algorithms search for an optimal solution by maximizing the sum of the contribution value of a forest stand and thinning. Figure 1 shows the dynamic programming network for MSPATH for the four stage case. All combinations of thinning intervals are also compared for an optimal solution.

algorithm

Growth Simulator for Sugi Forest Stands

A growth simulator used here is the stand density management diagram for sugi (Cryptomeria japonica) forest stands in the Kyushu region, Japan. The main concepts of the model is in Ando (1966). The current number of trees per ha, N, and the dominant height, H are required to determine other elements of a forest stand as follows. Note that parameters were site specific to the Kyushu region and determined in Rinyacho (1980).

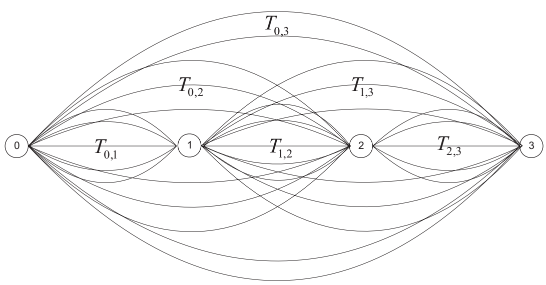


Figure 1. Dynamic programming network for the MSPATH

1) An average individual tree volume

$$v(N,H) = \frac{1}{0.068509N \cdot H^{-1.347464} + 2658.2 \cdot H^{-2.814651}} \quad (10)$$

2) An average forest stand volume per ha

$$V(N,H) = v(N,H) \cdot N \quad (11)$$

3) A forest stand height

$$HF(N,H) = 0.791213 + 0.244012H\sqrt{N}/100 + 0.353895H \quad (12)$$

4) A basal area per ha

$$G(N,H) = \frac{V(N,H)}{HF(N,H)} \quad (13)$$

5) An average diameter for a given basal area

$$\overline{D}g(N,H) = 200\sqrt{\frac{G(N,H)}{\pi \cdot N}} \quad (14)$$

6) An average DBH (diameter at breast height) for the dominant trees

$$\overline{DBH}(N,H) = -0.048940 - 0.034814H\sqrt{N}/100 + 0.98937\bar{D}g(N,H) \quad (15)$$

7) The maximum tree density per ha in the log-transformed expression

$$\log_{10} N_{Rf}(H) = 5.3083 - 1.4672\log_{10} H \quad (16)$$

8) The volume at the maximum tree density

$$V_{Rf}(H) = \frac{N_{Rf}(H)}{0.068509N_{Rf}(H)\cdot H^{-1.347464} + 2658.2H^{-2.814651}} \quad (17)$$

9) Self-thinning relationship as a function of an average individual tree volume and the number of trees planted, N0

$$\frac{1}{N} = \frac{1}{N_0} + \frac{v(N,H)}{3.47089\times 10^6 N_0^{-0.9184}} \quad (18)$$

As can be seen from the above set of equations to describe a forest stand, the current number of trees per ha, N, and the dominant tree height, H, are enough to predict future growth of a forest stand. The dominant tree height in this paper was assumed to follow the Richards function (Richards 1958) with a time component.

Parameters of the Richards function were estimated with the field data collected from our study plot in Hoshino Village, Fukuoka Prefecture, located in the Kyushu region of Japan. Our study plot was a 23 years old sugi (Cryptomeria japonica) stand without previous thinning. The number of trees in the plot was 136 per 0.0466 ha. Thirty trees were thinned for the stem analysis. The average DBH of all sampled trees was 15.66cm with a standard deviation of 2.25cm, the average height was 14.82m with a standard deviation of 1.22m, and the average individual tree volume was 0.15m3 with a standard deviation of 0.055m3. Using the results of the stem analysis on the height growth, we estimated parameters of the Richards function with the following

$$H = 24.95(1 - e^{-0.064\cdot t})^{1.97} \quad (19)$$

The amount of carbon sequestered in a forest stand was estimated by the following equation (see Matsumoto, 2001),

$$Wc = \rho_0 \times V \times E \times Coef \quad (20)$$

where Wc (Ct) is the amount of carbon sequestered, ρ0 is wood density (g/cm2), V is stem volume (m3), E is an expansion factor (here specified by 1.7), and Coef is a coefficient of carbon content (g/Ct: here specified by 0.5). Based on wood density estimation for the study plot, we obtained an average of 0.3372, so that carbon sequestered in trees was calculated by

$$Wc(Ct) = 0.3772 \times V \times 1.7 \times 0.5 \quad (21)$$

Table 1. Basic Settings for Optimization by DP-KYSS

1. A forest stand condition	
Stand Age	0 (year)
Plantation Density	3000 (trees/ha)
Discount Rate	1 %
Felling Costs	70 Euro/m3
Thinning Costs	84 Euro/m3
Utility Ratio for log	65 %
2. Carbon Related	
Wood Density	0.3372 (g/cm3)
Expansion Factor	1.7
Carbon Content Coef	0.5 (gC/g)
3. Management Constraints	
Minimum Thinning Age	15 year
Minimum TPH for Felling	300 trees/ha
4. Optimization Inputs	
Objective	maximization of PNV
Thinning Interval	50 trees/ha
Stage Interval	5 years
Planning Period	100 years

Carbon Pricing Through Thinning Subsidy

Carbon pricing was conducted by investigating effects of subsidy payment on change in the objective value along with change in the amount of carbon sequestered in a forest stand at the final harvest period. The basic settings in Table 1 were used for optimization. The initial forest stand age was set to 0 year old with plantation of 3,000 trees/ha. One percent interest rate was used as the discount factor. Thinning costs were set to be 84 Euro/m3, while 70 Euro/m3 was for final harvest based on the general forest management practice in Fukuoka prefecture, Japan. Utility ratio for a log converted from a stem was assumed to be 64%. Two management constraints were set; the minimum thinning age of 15 years and the minimum trees per ha for final harvest by 300 trees. The objective for the management was to maximize the present net value of the total profits from thinning and final harvest over one rotation. As for optimization parameters, the time interval was set to 5 years and the thinning interval was set to 50 trees. Also 100 years was used as the maximum management time horizon. A tree price was assumed to be a function of DBH (diameter at breast height) given in Table 2.

Table 2. A tree price function of DBH

Range of DBH (cm)	0 - 9	10 - 13	14 - 16	17 - 22	22 or more
Price (Euro/m3)	66.20	78.87	89.44	95.07	103.52

The thinning subsidy was added to benefits from thinning activities with the present net value of thinning, Ti,i-j, at time ti-j by,

$$V(T_{i,i-j}) = [P(\overline{DBH}_{i-j}) \cdot v(N_{i-j}, H_{i-j}) \cdot N^T_{i,i-j} - C_{thin} \cdot v(N_{i-j}, H_{i-j}) \cdot N^T_{i,i-j} + Subsidy_{i-j}(N^T_{i,i-j})] / (1+r)^{t_{i-j}} \quad (22)$$

where $P(\overline{DBH}_{i-j})$ is a price per tree volume as a function of an average DBHi-j at time ti-j, Cthin is thinning cost per tree volume, and $Subsidy_{i-j}(N^T_{i,i-j})$ is the applied subsidy for thinning as a function the number of trees removed, $N^T_{i,i-j}$ at time ti-j targeting the state at the i-th stage. The discount factor is r. The present net value of harvesting a forest stand was calculated in the same way as the value of thinning without the subsidy part.

$$\Pi_i(T_{i,i-j}) = [P(\overline{DBH}_i)\cdot v(N_i, H_i) - C_{fell}\cdot v(N_i, H_i)]/(1+r)^{t_i} \quad (23)$$

where Cfell is final harvesting cost per tree volume.

Three types of thinning subsidy used here are given in Table 3. The first one is called the current subsidy implemented from age 11 to 35 every five years, while the second is from age 11 to 45 every five years as the emergency subsidy. The last is from age 11 to 90 every five years as the extended subsidy. Subsidy is provided per unit area basis (ha) only with 10 to 20 % of standing trees for thinning. Thinning less than 10 % or more than 20 % is not considered for subsidy.

Table 3. The amount of subsidy (Euro/ha)

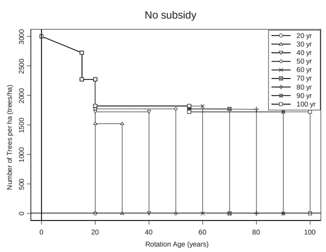
Age class	Current Subsidy	Emergency Subsidy	Extended Subsidy
10<Age≤15	1,331	1,331	1,331
15<Age≤20	1,331	1,331	1,331
20<Age≤25	1,331	1,331	1,331
25<Age≤30	1,894	1,894	1,894
30<Age≤35	1,894	1,894	1,894
35<Age≤40	1,894	1,894	1,894
40<Age≤45		3,345	3,345
45<Age≤50		3,345	3,345
50<Age≤55			3,345
55<Age≤60			3,345
60<Age≤65			3,345
65<Age≤70			3,345
70<Age≤75			3,345
75<Age≤80			3,345
80<Age≤85			3,345
85<Age≤90			3,345

Information Source: Fukuoka Prefectural Office, Japan

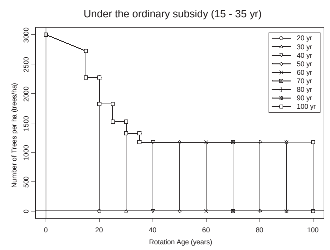
Optimal thinning regime and efficient level of subsidy

Figure 2 shows the optimal thinning regime under no subsidy and three different subsidy payments in terms of change in the number of trees over time. With no subsidy (Figure 2-a), thinning was implemented at age 15 and 20 up to the rotation age of 60 years, and additional thinning at age 55 up to the rotation age of 100 years. The thinning intensity was the same at age 15 across different rotation ages until 60 years, while less thinning intensity was observed at age 20 and more thinning intensity at age 55 for the longer rotation age than 60 years. The number of trees for final harvest with thinning activities varied from 1,322 under the rotation age of 25 years to 2,272 under the rotation age of 20 years along with 1772 trees/ha felled at final harvest in most cases. The optimal rotation age was found to be 50 years with 1,772 trees/ha for final harvest.

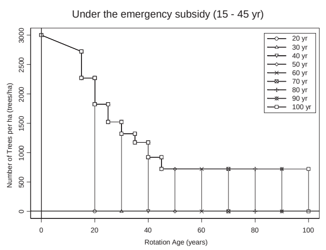
a)



b)



c)



d)

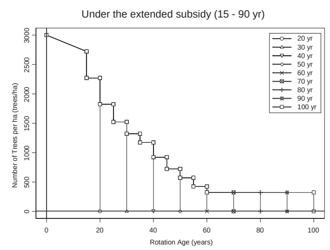


Figure 2. Optimal thinning regimes under different subsidies
a) no subsidy, b) ordinary subsidy, c) emergency subsidy, d) extended subsidy

With the current subsidy payment, thinning was implemented every 5 years whenever subsidy was provided (Figure 2-b). The same thinning regime was obtained up to age 35 with the emergency subsidy. With the emergency subsidy payment, thinning continued until age 45 years (Figure 2-c). Likewise with the extended subsidy payment, there was additional thinning until age 60, then thinning ceased afterwards due to the requirement of the number of trees for final harvest (Figure 2-d). As can be expected, the thinning subsidy payment emphasized thinning activities during the period eligible for subsidy.

The above optimal solutions were derived with the full amount of the subsidy provided. In order to investigate an effect of subsidy payment, it is necessary to search for an efficient level of the subsidy for change in an optimal thinning regime. In other words, redundant subsidy payment should be avoided to evaluate carbon through the subsidy payment. This was done by changing the level of the payment from 0% to 100% of the current amount with 10% increase. Figure 3 shows optimal thinning regimes with different subsidy payment and different percentage of the payment. From Figure 3, twenty percent of the current amount in Table 3 under all subsidy payments became efficient in terms of change in the optimal thinning regime. That is, more than twenty percent would not make any difference and became redundant for the optimal thinning regime. Thus, the following analysis applied only 20% of the payment in Table 3 to investigate effects of subsidy payment on change in the objective value.

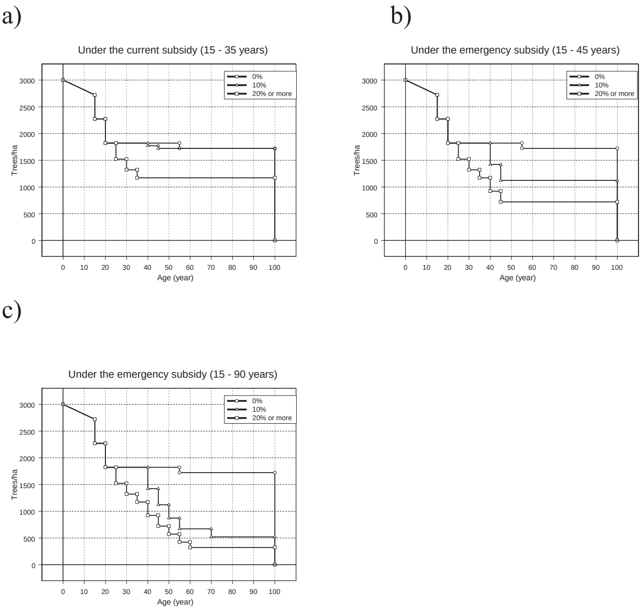


Figure 3. Effect of subsidy on an optimal thinning regime
a) current subsidy, b) emergency subsidy c) extended subsidy

Carbon pricing

Figure 4 depicts the objective value change over different rotation ages. As Figure 4 shows, the optimal rotation age became 50 years with no subsidy, the current subsidy and the emergency subsidy, while it was 60 years with the extended subsidy. Figure 5 is the amount of carbon sequestered in a forest stand at final harvest. The amount of carbon sequestered in a forest stand became the largest with no subsidy over all rotation age except 25 year rotation age. This was due to more thinning than those with subsidies. The second largest was that with the current subsidy, followed by that with the emergency and extended subsidy. The amount of carbon sequestered gradually increased over time with no subsidy and the current subsidy, while with the emergency subsidy it reached to the first peak at age 45, decreased till age 50, then increase afterwards. The same increasing and decreasing trend was observed with the extended subsidy till age 65. These decreases in the amount with the emergency and extended subsidy were due to thinning activities at rather older thinning periods stimulated by the subsidy payment. While the amount recovered more than the first peak with the emergency subsidy after age 55, it had never occurred with the extended subsidy. That is, the first peak was the maximum amount of carbon sequestered in a forest stand with the extended subsidy. At age 100, the amount became 155.59 Ct/ha, 144.22 Ct/ha, 126.22 Ct/ha, and 89.92 Ct/ha with no subsidy, the current, emergency and extended subsidy, respectively.

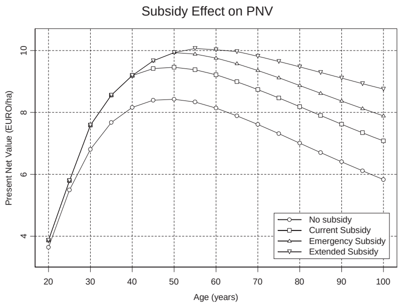


Figure 4. Present net value over different rotation ages

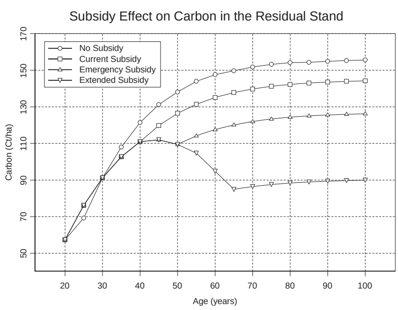


Figure 5. Total carbon sequestered in a forest stand at final harvest period

As was observed above, thinning subsidies could result in reduction of carbon sequestered in a forest stand at the final harvest period. At the same time, monetary benefits were provided as subsidies, so that we next evaluate carbon through subsidy benefits as follows. The cost of unit carbon loss, or shadow price of carbon, Cco2, over different rotation ages was first estimated on the basis of the derived optimal solution without any subsidy by,

$$C_{CO2} = -\frac{\partial J}{\partial Carbon} = -\frac{PNV(No\,Subsidy) - PNV(Subsidy)}{CBN(No\,Subsidy) - CBN(Subsidy)} \qquad (24)$$

where $PNV(\cdot)$ is the present net value of the optimal thinning regime and $CBN(\cdot)$ is the amount of the corresponding carbon sequestered at final harvest period. We also estimated the annual payment, APT, over the given rotation age, T, by equating Cco2 to the sum of present net value of the annual payment over the given rotation age as follows,

$$C_{CO2} = AP_T \frac{1-(\frac{1}{1+r})^T}{1-(\frac{1}{1+r})} \qquad (25)$$

Table 4. Payment for carbon

Rotation Age (years)	Cco2 (Euro/Ct)			APT (Euro/Ct/yr)		
	Current Subsidy	Emergency Subsidy	Extended Subsidy	Current Subsidy	Emergency Subsidy	Extended Su
35	167.23	167.23	167.23	5.63	5.63	5.63
40	98.16	98.16	98.16	2.96	2.96	2.96
45	88.95	65.98	65.98	2.44	1.81	1.81
50	89.07	52.65	52.65	2.25	1.33	1.33
55	83.43	52.36	44.27	1.96	1.23	1.04
60	85.36	53.58	35.42	1.88	1.18	0.78
65	92.36	56.76	32.23	1.92	1.18	0.67
70	94.25	58.27	33.95	1.86	1.15	0.67
75	95.60	60.02	35.59	1.80	1.13	0.67
80	98.12	62.64	37.70	1.77	1.13	0.68
85	105.50	65.14	39.78	1.83	1.13	0.69
90	107.55	66.92	41.23	1.80	1.12	0.69
95	108.69	68.55	43.23	1.76	1.11	0.70
100	110.13	70.03	44.56	1.73	1.10	0.70

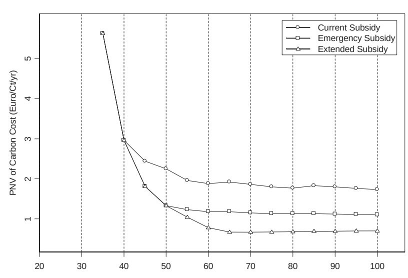


Figure 6. Annual payment for carbon loss

Calculation results are in Table 4. The current subsidy induced the most payment for the unit carbon loss. At the rotation age of 100 years, it was 110.13 Euro/Ct, while that with the emergency and the extended subsidy was 70.03 and 44.56 Euro/Ct. Figure 6 depicts annual payment for unit carbon loss. The annual payment at different rotation ages with different subsidies for the rotation age longer than 30 years. There existed such a tendency that the longer the rotation age, the less the annual payment was. The lowest was 0.67 Euro/Ct/yr for the rotation age of 65 to 75 years with the extended subsidy. The highest increased to 5.63 Euro/Ct/yr for all subsidy policies at the rotation age of 35 years. For such a rotation age over 60 years, the annual payment ranged from 1.73 to 1.92 Euro/Ct/yr with the current subsidy, from 1.10 to 1.18 Euro/Ct/yr with the emergency subsidy, and from 0.67 to 0.78 Euro/Ct/yr with the extended subsidy.

Concluding Remarks

Thinning subsidy has been utilized to activate forestry practices for artificial forest stands toward the sustainable forest management. While the subsidy keeps forest owners to continue the regular thinning to maintain forests, it also induces reduction of carbon sequestered in a forest stand at the final harvest period. In this paper, carbon pricing was conducted through subsidy payment within the optimization framework for the forest stand management. The optimal forest stand management model called DP-KYSS was utilized for the analysis of a sugi forest stand in the Kyushu region, Japan. A field data from our study plot was used to develop the growth simulator in DP-KYSS.

The analyses showed that the thinning subsidy activated thinning activities with the reduction of carbon sequestered in a forest stand. Over the different rotation age, the amount of carbon sequestered in a forest stand gradually increased as the rotation age became longer in the case of no subsidy and the current subsidy payment. On the other hand, with the emergency and extended subsidy payment, a peak of carbon sequestered was observed. The amount decreased due to thinning activities at rather older thinning periods stimulated by the emergency and extended subsidy.

Considering subsidies as a compensation for carbon loss, the evaluation of carbon showed that the present net value of cost per unit carbon loss became the highest for the rotation age of 35 years for all subsidies and the minimum for the rotation age of 55 years with the current subsidy, 50 years with the emergency subsidy, and 65 years with the extended subsidy. The current subsidy induced the most payment for the unit carbon. At the rotation age of 100 years, the present net value of cost per unit carbon loss was 110.13 Euro/Ct with the current subsidy, while that with the emergency and the extended subsidy was 70.03 and 44.56 Euro/Ct, respectively. This implies that lengthening the period for subsidy to some point would reduce the value of carbon. Subsidy pays more with more thinning which reduces carbon sequestered in a forest stand. For the amount of carbon sequestered in a forest stand, the annual payment became as low as 0.67 Euro/Ct/yr for the rotation age of 65 to 75 years, while the highest increased to 5.63 Euro/Ct/yr at the rotation age of 35 years.

Currently, the emission markets have been paid a great deal of attention. The price of carbon dioxide was sometimes priced at 10 to 20 Euro/tCO2 which is more or less equivalent to 2.72 to 3.27 Euro/Ct. If this price were applied to the amount of carbon sequestered in a forest stand, forest owners would still stay with the current thinning subsidy. In other words, unless the price of CO2 at least exceeds the induced price with the subsidy, no incentive would be created for forest owners.

Acknowledgement

This research was supported partly by a Grant-in-Aid for Scientific Research (No. 15330048) from the Ministry of Education, Culture, Sports, Science and Technology of Japan, and by Global Environment Research Fund (No. S-4).

Literature Cited

Adams, D.M. & Ek, A.R. 1974. Optimizing the management of uneven-aged forest stands. Canadian Journal of Forest Research 4: 274-287

Amidon, E.L. & Akin, G.S. 1968. Dynamic programming to determine optimum levels of growing stock. Forest Science 14: 287-291

Ando, T. 1966. The stand density management diagram and its use. Norin Press, Tokyo. (in Japanese)

Arimizu, T. 1958a. Regulation of the cut by dynamic programming. Journal of the Operations Research Society of Japan 1: 175-182

Arimizu, T. 1958b. Working group matrix in dynamic model of forest management. Journal of the Japanese Forest Society 40: 185-190

Arthaud, G.J. & Klemperer, W.D. 1988. Optimizing high and low thinnings in loblolly pine with dynamic programming. Canadian Journal of Forest Research 18: 1118-1122

Brodie, J.D., Adams, D.M. & Kao, C. 1978. Analysis of economic impacts on thinning and rotation for Douglas-fir, using dynamic programming. Forest Science 24: 513-522

Brodie, J.D. & Haight, R.G. 1985. Optimization of silvicultural investment for several types of stand projection systems. Canadian Journal of Forest Research 15: 188-191

Brodie, J.D. & Kao, C. 1979. Optimizing thinning in Douglas-fir with three descriptor dynamic programming to account for accelerated diameter growth. Forest Science 25: 665-672

Chen, C.M., Rose, D.W. & Leary, R.A. 1980. Derivation of optimal stand density over time - a discrete stage, continuous state dynamic programming solution. Forest Science 26: 217-227

Haight, R.G., Brodie, J.D. & Dahms, W.G. 1985. A dynamic programming algorithm for optimization of lodgepole pine management. Forest Science 31: 321-330

Intriligator, M.D. 1971. Mathematical optimization and economic theory. Prentice Hall, Inc.

Kilkki, P. & Väisänen, U. 1970. Determination of the optimum cutting policy for the forest stand by means of dynamic programming. Seloste: Metsikön optimihakkuuohjelman määrittäminen dynaamisen ohjelmoinnin avulla. Acta Forestalia Fennica 102: 1-23

Martin, G.L. & Ek, A.R. 1981. A dynamic programming analysis of silvicultural alternatives for red pine plantations in Wisconsin. Canadian Journal of Forest Research 11: 370-379

Matsumoto, M. 2001. The amount of carbon storage and sequestrated by Japanese forest. Shinrin Kagaku 33:30-36. (in Japanese)

Paredes V., G.L. & Brodie, J.D. 1987. Efficient specification and solution of the evenaged rotation and thinning problem. Forest Science 33: 14-29

Richards, F.J. 1958. A flexible growth function to empirical use. Journal of Experimental Botany 10: 290-300

Riitters, K., Brodie, J.D. & Hann, D.W. 1982. Dynamic programming for optimization of timber production and grazing in ponderosa pine. Forest Science 28: 517-526

Rinyacho. 1980. The guide book of the stand density management diagram for sugi artificial forests (Northern Kinki, Chugoku, Southern Kinki, Shikoku and Kyushu regions), Rinyacho. (in Japanese)

Schreuder, G.F. 1971. The simultaneous determination of optimal thinning schedule and rotation for an even-aged forest. Forest Science 17: 333-339

Torres-Rojo, J.M. & Brodie, J.D. 1990. Demonstration of benefits from an optimization approach to the economic analysis of natural pine stands in Central Mexico. Forest Ecology and Management 36: 267-278

UNFCC. 2005. Kyoto protocol to the United Nations framework convention on climate change, http://unfccc.int/resource/docs/convkp/kpeng.pdf, 23p.

Valsta, L.T. & Brodie, J.D. 1985. An economic analysis of hardwood treatment in loblolly pine plantations - a whole rotation dynamic programming approach. The 1985 symposium on system analysis in forest resources (Dress, P.E. & Field, R.C. eds), Georgia Center for Continuing Education, Athens, Georgia, USA. pp. 201-214

Yoshimoto, A., Paredes V., G.L. & Brodie, J.D. 1988. Efficient optimization of an individual tree growth model. The 1988 symposium on systems analysis in forest resources (Kent, B.M. & Davis, L.S. eds), USDA Forest Service. General Technical Report RM-161, pp. 154-162

Timber demand/supply analysis of east Asian timber trade - trade among eight Japanese regions, China, Korea

Kiyoshi Yukutake & Atsushi Yoshimoto*

Abstract
Because of increasing supply of the imported wood at low price, the rate of wood self-sufficiency in Japan has dropped further below 20%. This resulted in abandoning the reforestation activities after harvesting, which could impinge on the sustainable forest management. In this study we first overview the current state of Japanese forestry with a focus on relationship between the timber market and the sustainable forest management. Secondly, we estimate price elasticity of lumber supply and demand for eight Japanese regions (Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku, and Kyushu), China and Korea. With the estimated price elasticities for these regions, we finally analyze the characteristics of the supply and demand structure through the spatial and inter-temporal partial equilibrium market model called JAFSEM (Japanese Forest Sector Model). Our results show the following; 1) at the present price level Japan would face to difficulty to continue the sustainable forest management, 2) Japanese regional lumber demand except Kyushu would increase, and 3) the additional demand for lumber would be met by Korea and China.

Key words: Timber trade, sustainable forest management, domestic harvest, price elasticity, JAFSEM

Introduction

Since the Kyoto Protocol was adopted as global warming preventive measures in 1992, it is admitted that forest contributed to atmospheric CO2 reduction by absorbing CO2 from the atmosphere and the storage function. Wood use such as biomass, forest product, wood housing and furniture is effective in preventing the increase of atmospheric CO2, in place of non-wood material and non-wood housing which mainly depend on fossil fuel and large energy consumption. Forest resource management and the wood use have been revaluated as an important substitution for preventing global warming. On the other hand, free trade could affect this situation adversely, impinging on the sustainable forest management. Japanese timber market has been dominated by the imported timber under the free trade since World War II with price decrease of the domestic timber, which discourage forest owners from reforesting after harvest.

Regarding the substitution between these foreign and domestic timber, Mori (1972) and Yukutake (1977) estimated the import price elasticity of North American timber from a supply and demand model based on quarter data from 1960 to 1971 and on annual data from 1960 to 1973, respectively. They found that the elasticity was more than unit, and that import of North American timber was remarkable to increase. Tachibana (1997) pointed out that the main product of the U.S. timber export shifted from logs to lumber by the model based on annual data from 1979 to 1994. Based on the simulation analysis on North American, Russian and New Zealand timbers with the annual data from 1970 to 2002, Yukutake et al.(2006) pointed out that changes of North American timber supply factors, e.g. the increase of the U.S. housing units, fossil fuel wholesale price and labor wages, would affect the Japanese timber market by increasing demand for New Zealand and Russian timber with less demands for domestic timber.

Other econometric supply and demand models on the timber trade have been developed by McKillop(1973), Gallagher(1980), Yukutake(1984), Mori(1991), Flora and Lane(1994), Nilsagard (1999) and so forth until now. However, all these models deal with national level aggregate data. First regional market model for Japanese forest sector model(JAFSEM) was developed by Yukutake & Yoshimoto(1996), which was a equilibrium model of Koopmans-Hitchcock type (Labys 1989). Then spatial regional model of the Samuelson type(Samuelson 1952) called JAFSEM (Japanese forest sector model) was developed by Yoshimoto et al.(1999) and Yoshimoto & Yukutake (2002).

In this study we first overview the current state of Japanese forestry with a focus on relationship between the timber market and the sustainable forest management. Secondly, we estimate price elasticity of lumber supply and demand for eight Japanese regions (Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku, and Kyushu), China and Korea. With the estimated price elasticity for these regions, we finally analyze the characteristics of the supply and demand structure through JAFSEM (Japanese Forest Sector Model) with some modification.

Forest resources and harvesting

Sixty-seven percent of the land in Japan, 25.1 million ha estimated in 2002, is covered by forests. Artificial forest area is around 10.3 million ha. But the age distribution of plantation forest is not uniform. Most are from 30 to 50 years old which covers 67%. Forest stands older than 30 years are harvestable and the share of it is 97% in the total artificial forest stock of 2,330 million m3. Artificial forests mainly consist of sugi (Cryptomeria japonica) (57%; 1,336 million m3 on the stock level) and hinoki (Chamaecyparis obtusa) (21%; 492 million m3). They are the main species for softwood lumber in Japan. Annual increment of the total forest stock is around 800 thousand m3 (Rinyacho 2001). Sustainable forest management is basically possible if the amount of annual increment was harvested. It would be able to supply more than 50 million m3 at least, given that the recovery rate is 70% from forest stand to log. The peak of annual harvest was observed in 1960 with 75 million m3. Since then, annual harvest has been declining and it became 20 million m3 in 2002. Roughly speaking from the viewpoint of the forest stock level, we can supply approximately 3 times more than the current level.

Japanese timber markets

In 1964 the liberalization of timber import in Japan was almost completed. The foreign timber has occupied 51% of the total timber supply, 95.6 million m3, in 1969. Foreign timber increased remarkably afterwards, and the share of foreign timber in Japanese market rose to over 60% in 1973, and 70% in 1987. The share became 80% of the total wood supply, 112million m3 in 1996. The largest foreign timber suppliers are the U.S. and Canada, which produce hemlock (Tsuga heterophylla) and Douglus-fir (Pseudotsuga menziesii) for construction material along with sugi(Cryptomeria japonica), the major Japanese timer. More than 40% of the total timber supply until 1996 was from the U.S. and Canada. Due to the harvest regulation by the societal conservation movement for the spotted owl in the U.S., North American timber export had begun to decrease in 1989. The North American timber occupied only 21% of 87.2 million m3 total timber supply in 2003(Figure-1).

In place of North American timber, the domestic timber supply could increase. But the self-sufficient rate of the domestic timber decreased to 19%, and its amount became 16 million m3. Instead of North American timber, the increase of import from Russia and Europe timber, especially from Finland, Sweden and Austria, was remarkable(Yukutake & Yoshimoto 1999). Imported timber from Europe in ‘others’ category in Figure-1, was next to

Russian with 8% and occupied the same rate of 6% as the import from Indonesia and Malaysia in 1996.

In spite of increasing the available forest stock, the supply of domestic timber does not increase. Figure-2 shows log price tendency of sugi, hemlock and Douglus-fir. From Figure-2, we can see that the price of Miyazaki sugi and national average sugi became less than that of hemlock and Douglus-fir after 1989 when the spotted owl protection issue emerged.

The Japanese timber market was mainly dominated by foreign timber suppliers, because the domestic timber was insufficient in volume to satisfy demands in Japanese market and it was more expensive than the imported timber. However, even if the domestic lumber price dropped below prices for imported timber, its demands did not aim at the domestic timber. This implies that the price is not the

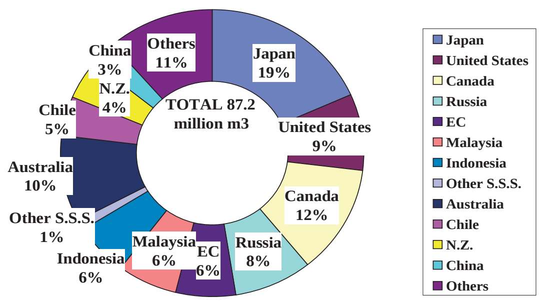


Figure.1 SOURCES OF WOOD SUPPLY (2003)
SOURCE:Foerstry Agency,"Table of Wood Demand and Supply"

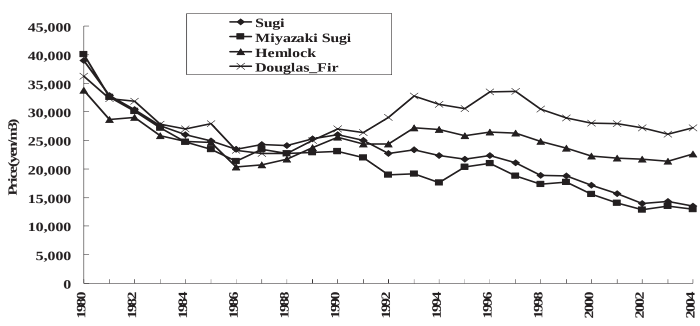


Figure 2 LOG price of sugi, hemlock and Douglus-fir
SOURCE:Ministry of Agriculture, Forestry and Fisheries, "Wood Price" and Miyazaki Prefecture,"Annual Report of Timber Statistics"

sole factor to determine timber supply. It's often pointed out that imported timber is preferred because 1) it's available just in time, 2) its supply is more stable, and 3) its wood quality is also more stable than domestic timber.

Sustainable forest management and production cost

The following is the comparison of the siliviculture costs between different countries(Yukutake & Yoshimoto 1999). Cost in Japan is represented by a major forestry prefecture, Miyazaki. The total siliviculture costs in Japan are approximately 1,500 thousand yen/ha, while those in Canada are 200 thousand yen/ha, in Sweden 300-400 thousand yen/ha, and those in New Zealand and China are both 100 thousand yen/ha. As can be seen, the silviculture costs in Japan are five to ten times higher than those in other countries except Korea, where silvicultural management costs are as high as 800 thousand yen/ha. One of the reasons for this difference is high weeding costs in Japan. Weeding costs are around 600-700 thousand yen/ha because of Asian monsoon climate zone with vigorous growth of understory vegetation. The weeding costs in Korea are 264 thousand yen/ha, and the costs are almost zero in other countries. Regarding the harvesting and logging costs, the Japanese forestry agency, Rinyacho estimates at 7,000 yen/m3 in Japan, 15,000 yen/m3 in Sweden, 14,000 yen/m3 in Finland and 31,000-36,000 yen/m3 in Austria (Rinyacho 2005).

Log purchase costs and lumber processing costs in sawmills of production scale of 10,000m3/year in 1995 were 16,000-20,000yen/m3 and 13,000-20,000yen/m3, respectively in Japan. Costs in Germany were 8,200yen/m3 for log purchase and 7,400yen/ m3 for processing in the case of the production scale of 6,000-20,000 m3/year. Costs were 6,000-7,000yen/m3 for log purchase and 3,500-4,900yen/m3 for processing in Austria, and 13,330yen/m3 and 5,860yen/m3 in Norway.

Transportation costs from the US, Canada, Chili and New Zealand to Japan by ship were 3,000-4,000 yen/m3 in 1995. These costs were almost half of the cost from Miyazaki to Tokyo, which was 7,000yen/ m3. In the beginning of 2000s, the costs fell to 5,000 yen/m3 with an improvement of transportation method from Miyazaki to Tokyo. However, transportation costs from foreign countries were also reduced, and from North America, it was 1,000 yen/m3, and was 3,000 yen/m3 even from North Europe. In the above case of German sawmill, the freight from Belgian port, Ante Rose, to Tokyo costed 5,900-7,080yen/m3. In the case in Austria, the cost to Tokyo was 5,000yen/m3 including the transportation cost, 1,760yen/m3, for 500km between Italy(Yukutake 2003).

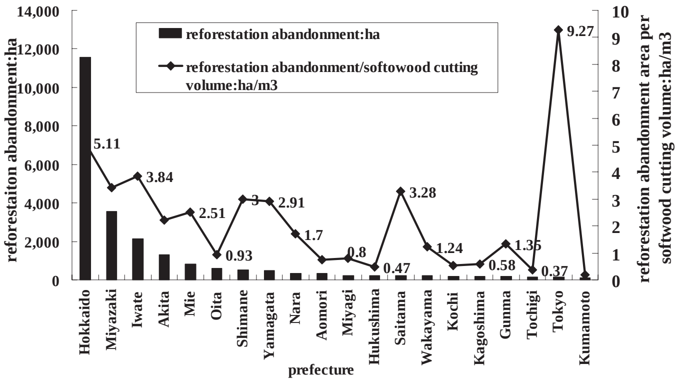


Figure.3 Top 20 prefectures of reforestation abandonment area more than 3years
SOURCE: Forest Agency

The market price of Miyazaki sugi log in 2005 fell to 7,000-8,000 yen/m3. The price cannot cover the reforestation costs, which results in the recent abandonment of reforestation. The area where reforestation is not taken place more than three years after clear cut, was 22,000 ha in 1999 and 25,000 ha in 2003, according to the investigation by Forestry Agency. Figure-3 shows the worst twenty prefectures in 2003. Hokkaido which has the largest land area in the country was the top. The second place was Miyazaki, followed by Iwate, Akita, Mie and Oita. Note that in these prefectures from the second to sixth, forestry is actively operated. That is, such a prefecture with active forestry area tends to have larger reforestation abandonment.

Equation (1) shows the relationship of the clear cutting area with lags for five years(AMHA t to AMHAt-5) and reforestation(REFAt) area in Miyazaki(Nakada 2006).

□Model of time lag 5 years

$$REFA_t = \beta_0 \cdot AMHA_t + \beta_1 \cdot AMHA_{t-1} + \beta_2 \cdot AMHA_{t-2} + \beta_3 \cdot AMHA_{t-3} + \beta_4 \cdot AMHA_{t-4} + \beta_5 \cdot AMHA_{t-5} \quad (26)$$

□Almon lag model

$$REFA_t = \gamma_0 \cdot Z_t + \gamma_1 \cdot Z_{t-1} + \gamma_2 \cdot Z_{t-2} \quad (27)$$

$$Z_0 = AMHA_t + AMHA_{t-1} + AMHA_{t-2} + AMHA_{t-3} + AMHA_{t-4} + AMHA_{t-5} \quad (28)$$

$$Z_1 = AMHA_{t-1} + 2 \cdot AMHA_{t-2} + 3 \cdot AMHA_{t-3} + 4 \cdot AMHA_{t-4} + 5 \cdot AMHA_{t-5} \quad (29)$$

$$Z_2 = AMHA_{t-1} + 4 \cdot AMHA_{t-2} + 9 \cdot AMHA_{t-3} + 16 \cdot AMHA_{t-4} + 25 \cdot AMHA_{t-5} \quad (30)$$

Where,
parameterβi can be interpreted as the ratio of the area replanted i years after clear cutting to the total clear cut area. Equation (2)-(5) show a further specification of the model (1) using Almon lag, which we used to estimate β0□□□β5. Note that we don't use a constant term in this equation. We used the panel data of 1989 to 2003 for towns in Miyazaki prefecture. From the estimated values of Table-1, around 60% of harvested areas would be reforested by one year after, but the remaining 40% abandoned.

Table-1 Estimated parameters of reforestation ratio

current year of clear cutting area	β0	0.45
before 1 year of clear cutting area	β□	0.18
before 2 year of clear cutting area	β□	0.02
before 3 year of clear cutting area	β□	-0.05
before 4 year of clear cutting area	β□	-0.01
before 5 year of clear cutting area	β5	0.13

Comparing the trend of wage for harvesting and logging with that of the stumpage price (Rinyacho 2005), we were able to employ loggers for 11.8 person-day if we sold 1m3 at the stumpage in 1961. However, 1m3 at the current stumpage was equivalent to 3.7 person-day in 1975, to 1.8 person-day in 1985 and only to 0.4 person-day in 2003.

Spatial and Temporal Market Equilibrium Modeling

We added China and Korea to 8 region (Tohoku, Kanto, Hokuriku, central part, Kinki, China, four countries, Kyushu) of a Japanese Lumber market of JAFSEM by Yoshimoto & Yukutake (2002). Figure-4 shows the network the trade. We used three difference types of lumber, i.e., domestic lumber processed from domestic forest resources, lumber processed in Japan from the US imported logs and imported lumber. Since Korea and China does not have enough available resources and data, we used the domestic lumber processed from imported logs and imported lumber as substitute. In order to construct JAFSEM, we need to estimate the price elasticity of the supply and demand for three type lumber in each region. The following supply/demand functions of logarithms are used to estimate the elasticity.

Equation (6) is a total lumber demand(QiD) function and is explained by lumber price(PiW) and wood construction start area(Hi) in 8 region in Japan. In the case of Korea we used GDP(KGN) instead of wood construction start area. In China it is explained by population(CN), because data of demand factor are not available. The coefficient, a2, is the price elasticity estimated of the total demand. Equation of (7) is an own country product lumber supply(QiDS) function. It is explained by an own country product lumber price(Pi□) and harvesting and logging wage(CiH) or manufacture wages(WiP). b2 is the own country product materials sawing product supply price elasticity value. Equation (8) is a supply function of lumber processed in Japan(QiUS) from the US imported logs. Korea and China are not included in this. c2 is the price elasticity of lumber processed in Japan from the US imported logs. We used equation (9) to estimate the price elasticity of import lumber supply function. Owing to a lack of price data in each Japanese 8 regions, for all of 8 regions, the same function was used. In addition, China uses a time trend(year) because there are not wage data.

□Total Lumber Demand Function

$$\log(Q_i^D) = a_1 + \underset{-}{a_2} \cdot \log(P_i^W) + \underset{+}{a_3} \cdot \log(H_i, KGDP, or\ CN) \quad (31)$$

□Domestic Lumber Supply Function

$$\log(Q_i^{DS}) = b_1 + \underset{+}{b_2} \cdot \log(P_i^D) + \underset{-}{b_3} \cdot \log(C_i^H\ or\ W_i^P)\ \ or\ Year \quad (32)$$

□US-JP Lumber Supply Function

$$\log(Q_i^{US}) = c_1 + \underset{+}{c_2} \cdot \log(P_i^U) + \underset{-}{c_3} \cdot \log(W_i^P) + \underset{-}{c_4} \cdot \log(Q_i^L) \quad (33)$$

□Supply Function of Imported Lumber

$$\log(Q_i^{MS}) = d_1 + \underset{+}{d_2} \cdot \log(PMS_i) + \underset{-}{d_3} \cdot \log(WA_i) + \underset{-}{d_4} \cdot \log(EXJA_i) \quad (34)$$

Variables are defined as follows.

QiD:Lumber Demand(103m3) of i region, PiW:Lumber Price(103yen) of i region, Hi:Wood Construction Area(103m2) of i region, KGDP:GDP(109won) of Korea, CN:Population (106people) of China, QiDS:Domestic Lumber Supply(103m3) of i region, PiD:Domestic lumber price(103yen) of i region, PiU:US-JPN lumber price(103yen) of i region, QiUS:US-JPN Lumber Supply(103m3) of i region, CiH:Harvesting wage(yen/m3) of i region, WiP:Manufacture Wage(103yen) of i region, QiL□US imported log supply(103m3) of i region, QiMS:Imported Lumber Supply of i region (103m3 of Japan and m3 of Korea & China), PMSi:Imported lumber price (103yen) of i region(Japan, Korea & China), Year:time trend, WA:Wage index of Exported countries(US, Canada, or New Zealand), EXJAi: Exchange Rate(yen/$)

(Data Source) The data of QiD, PiW, QiDS QiUS PiD and PiU are from "forest Product Demand & Supply" (Ministry of Agriculture, Forestry and Fisheries, 1975-2003), CiH and WiP from "Ministry of Health, Labour and Welfare"(1975-2003), Hi from "Annual Statistical Report of Construction"(Ministry of Construction, 1975-2003), QiL from Cooperation of Imported Timber in Japan, QiMS and PMSi from "FAOSTAT Database" provided by FAO on their Internet Homepage. The data of KGDP, CN, WA, and EXJA are from "International Financial Statistics Yearbook"(International Monetary Fund 2003). Annual data from 1974 to 2002 were used for estimating coefficients of equation (6), (7) and (8). As for the imported lumber, annual data from 1970 to 2002 were used.

Estimated value of equation (6), (7) and (8) by three stage least-squared method (3SLS) shows and a result of equation (9) is expressed in Table-2. It can be pointed out, especially, that the price elasticity of the total lumber demand in Japanese region is very elastic except Kyushu, which is the most important production region of the domestic timber, China and Korea. Tohoku and Kanto were comparatively elastic about the price elasticity of lumber processed in Japan from the US imported logs, and Kyushu was less than others elastic. China was supposed to have 1, because a desirable estimated value was not provided. Tohoku is comparatively high about the supply price elasticity of own country produced lumber, but Kyushu is low. Korea was supposed to have 1, again because a desirable elasticity was not estimated.

Table-2 Estimated value of demand/supply function

		Region									
	3sls	Tohoku	Kanto	Hokuriku	Chubu	Kinki	Chugoku	Shikoku	Kyushu	Korea	China
Total Lumber Demand	a_1	-4.1686	-5.3059	-5.7917	-9.7870	2.6704	-1.18924	-2.834	-2.235	7.0452	-
		(-.236)	(-.099)	(-2.488)	(-.203)	(0.915)	(-0.998)	(-1.251)	(-2.828)	(6.381)	-
	a_2	-2.6122	-2.1466	-2.6222	-1.8148	-1.7038	-1.28764	-3.286	-0.73836	-.4804	-
		(-5.786)	(-.838)	(-4.405)	(-.755)	(-3.498)	(-5.067)	(-2.891)	(-3.946)	(-.932)	-
	a_3	2.4403	3.2455	2.6889	2.7812	1.3473	1.6651	2.9858	1.4702	0.2087	-
		(8.916)	(4.544)	(7.641)	(6.346)	(3.857)	(12.318)	(4.328)	(10.234)	(3.019)	-
	R^2	0.5678	0.3890	0.5991	0.5261	0.3333	0.807696	0.3901	0.8094	0.9014	-
	DW	1.0884	1.0538	1.2905	1.2835	0.3382	1.5906	1.6283	1.5726	1.9801	-
	SE	0.2319	0.2442	0.2134	0.2084	0.249503	0.1249	0.2354	0.0858	0.2026	-
Domestic Lumber Supply	b_1	9.7597	7.4930	6.0026	6.5550	7.1187	8.1107	5.6590	6.6676	-	30.2410
		(14.284)	(14.987)	(6.348)	(7.965)	(10.204)	(11.16)	(9.364)	(16.633)	-	(-4.324)
	b_2	0.6307	0.4090	0.6736	0.6416	0.5432	0.0823	0.408804	0.2763	-	0.5192
		(3.582)	(3.649)	(3.041)	(3.379)	(3.276)	(0.500)	(3.304)	(3.300)	-	(3.423)
	b_3		-0.9515		-.80557	-1.06791	-0.75908	-0.23941	0.0007	-	-0.0078
			(-8.606)		(-0.122)	(-15.375)	(-1.4405)	(-3.770)	-0.0136	-	(-2.206)
	b_3	-0.8526		-1.0252						-	
	(W_i^P)	-14.742		(-14.454)						-	
										-	
	R^2	0.8224	0.9316	0.8685	0.8078	0.8960	0.8215	0.6602	0.3099	-	0.2350
	DW	0.3639	0.6843	0.6081	0.2332	0.4689	0.3048	0.4093	0.4465	-	0.4832
	SE	0.1133	0.0778	0.1111	0.1168	0.0955	0.0962	0.0751	0.071804	-	0.3209
US-JP Lumber Supply	c_1	-1.6335	-0.0670	2.2300	1.2323	-0.69072	2.4501	-0.23111	1.0371	-	-
		(-0.996)	(-.055)	(3.750)	(1.799)	(-1.007)	(4.650)	(-0.242)	(1.792)	-	-
	c_2	0.9335	0.7669	0.1351	0.4960	0.6164	0.1348	0.9295	0.1844	-	-
		(2.626)	(3.370)	(0.808)	(4.048)	(4.626)	(1.009)	(4.295)	(1.498)	-	-
	c_3	0.7491	0.6806	0.6248	0.7091	0.7785	0.763301	0.6926	0.7446	-	-
		(9.588)	(12.985)	(9.808)	(18.590)	(27.644)	(11.825)	(9.596)	(31.120)	-	-
	c_4		-0.0991		-0.1704		-0.2136	-0.24976		-	-
			(-.959)		(-.395)		(-3.113)	(-2.984)		-	-
	c_5			-0.226918						-	-
	DM2			(-2.445)						-	-
	R^2	0.7657	0.9306	0.9126	0.9721	0.9776	0.7590	0.8179	0.9781	-	-
	DW	0.5215	0.7049	1.1449	1.4007	1.7487	0.6212	1.4040	1.3157	-	-
	SE	0.1726	0.1258	0.0826	0.0746	0.0663	0.9618	0.0945	0.0653	-	-

(Note) c_5 of Hokuriku is dummy variable of 2002=1

Table-3 estimated vale of price elasticity for imported lumber

	d_1	d_2	d_3	d_4	d_5	R^2	DW	SE
Japan								
	9.6949	0.4739	-0.0380	-1.1544		0.9300	1.7674	0.1327
	(2.605)	(1.570)	(-0.142)	(-16.404)				
Korea								
	-09.4420	3.4344	66.5285	-4.7010	5.5245	0.9018	1.7829	0.5617
	(-2.840)	(2.288)	(2.717)	(-2.363)	(3.277)			
China								
	-35.9597	0.5696	9.4229	1.8360		0.9055	1.5395	0.5027
	(-2.030)	(2.251)	(2.465)	(10.006)				

(Note) d_5 of Koea is GDP of Exported Country

From Table-3, the supply price elasticity of the imported lumber in Korea is the most elastic with 3.45. That of China was 0.57 and in Japan was 0.47. Owing to a
lack of price data in each Japanese 8 regions, all of 8 regions were set to have the same elasticity of imported lumber. Thus, the imported lumber supply function for each region was determined with the assumption that each supply function is a portion of the derived imported lumber supply function for the nation. Accordingly, the imported lumber supply(QiMS) of each region was set from the proportion of imported lumber in each region of total imported lumber（Yoshimoto & Yukutake 2002）.

$$\underset{[\{d_i\},\{s_j\},\{q_{i,j}\}]}{\text{maximize}}\ NSP = (Consumer\ Surplus) + (Producer\ Surplus) - (Transportaiton\ Costs)$$

$$= \sum_{i=1}^{m}\{\int_0^{d_i} PD_i(x)dx - PD_i(d_i)\cdot d_i\} + \sum_{j=1}^{n}\{PS_j(s_j)\cdot s_j - \int_{S_0^j}^{s_j} PS_j(x)dx\} - \sum_{i=1}^{m}\sum_{j=1}^{n} T_{i,j}\cdot q_{i,j}$$

$s.t.$

$$d_i = \sum_{j=1}^{n} q_{i,j} \quad \forall i$$

$$s_j = \sum_{i=1}^{m} q_{i,j} \quad \forall j$$

$$\{d_i\},\{s_j\},\{q_{i,j}\} \geq 0 \qquad (10)$$

where PDi( ) and PSi( ) are the demand and supply function of the i-th region, Ti,j is the transportation costs from the i-th to j-th region, sj is the supply quantity at the j-th region, di is the demand quantity at the i-th region, and $q_{i,j}$ is the quantity delivered from the i-th region to j-th region.

Demand and supply functions are derived with one set of price and quantity by using price elasticity. The price and quantity was from the data in 2002. Table-4 shows the transportation costs necessary to solve the proposed problem, based on our hearing survey in Japan, China and Korea. Figure–4 shows the equilibrium solution in comparison to the current demand/supply quantities in 2002. The total amount of the domestic lumber demand was estimated at 33.7million m^3 and increased to 3million m^3 more than the actual amount in 2002. China and Korea decreased by 2～3million m^3 than the actual amount. All region of Japan area

Table-4 Transportaion costs among region(Yen/m3)

Region	Tohoku	Kanto	Hokuriku	Chubu	Kinki	Chugoku	Shikoku	Kyushu	Korea	China
Tohoku	2000	3500	4000	4500	6000	7000	7000	7000	12000	13000
Kanto	-	2000	3500	3000	3500	3500	4000	5000	10000	11000
Hokuriku	-	-	2000	3000	2800	4000	4000	7000	10000	11000
Chubu	-	-	-	2000	3000	4000	4000	5000	10000	12000
Kinki	-	-	-	-	2000	3000	3000	4000	9000	12000
Chugoku	-	-	-	-	-	2000	2500	4000	9000	12000
Shikoku	-	-	-	-	-	-	2000	4000	9000	12000
Kyushu	-	-	-	-	-	-	-	2000	7000	10000
Korea	-	-	-	-	-	-	-	-	2000	5000
China	-	-	-	-	-	-	-	-	-	2000

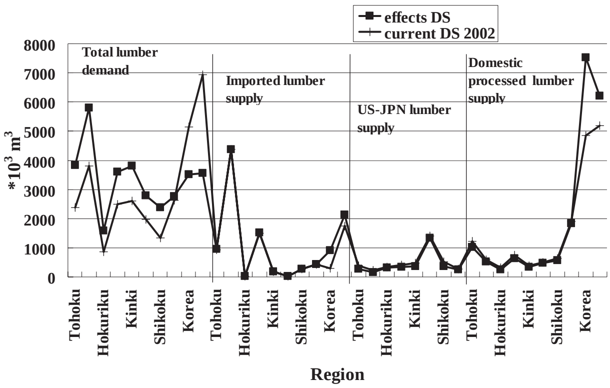


Figure.5 Simulation effects of lumber demand/supply

except Kyushu showed increase by 1□2million m^3. The total amount of imported lumber supply estimated at 10.8million m^3, and increased by 1million m^3 more than the actual amount in 2002. Increase in Japanese 8 region was observed from the actual amount, as well as in Korea and China. The total amount of lumber processed in Japan from the US imported logs was estimated at 3.4million m^3. The total amount of domestic processed lumber supply was 19.4million m^3 and increased by 2.1million m^3. In particular, Korea and China increased by 1□2million m^3, while all regions in Japanese showed decrease.

Discussion and Conclusion

Our findings are as follows.

(1) In a view point of only forest stock level, it would be possible for Japan to increase the self-sufficient rate. However, it might not be possible for Japan to be self-sufficient to supply timber due to high production costs, i.e., costs of silviculture, harvesting and logging, lumber processed, distributing and so forth, which are too expensive compared to imported foreign countries.

(2) One of the major environmental problems regarding forest management has been that artificial forests have been left unmanaged, resulting in unhealthy forests and reforestation abandonment possibly leading to such natural disasters as soil erosion.

(3) From a simulation result by JAFSEM, it would be difficult for Japan to continue the current lumber supply at the present price level, and Japanese regional lumber demand except Kyushu would increases. Additional demand increase might be met by the supplies from Korea and China.

Free trade could affect adversely the sustainable forest management. It could make the maintenance of healthy forest resources difficult. Production cost differences, e.g., the differences of silvicuture costs, which are inherit to natural and geographical characteristics, should be reconsidered in the trade agreements. Some of the costs cannot be avoided. In such a case, the commonly applied financial measures, e.g. subsidy, have to be introduced to stimulate competition and sustainability of the forest management through the fair competitive markets.

Acknowledgement

This research was supported partly by a Grant-in-Aid for Scientific Research (No. 15402003) from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Literature Cited

Flora, D. & Lane, C. 1994. Equilibrium modeling of Pacific rim trade in logs and lumber, Journal of Forest Economics, The Japanese Forest Economic Society, 126: 9-11

Gallagher, P. 1980. An analysis of the softwood log trade between the United States and Japan. Technical bulletin, 330, Agricultural Experiment Station, University of Minnesota, Forestry Series No 34, pp.2-19.

Labys, W.C. 1989. Spatial and temporal price and allocation models of mineral and energy markets, Quantitative methods for market-oriented economic analysis over space and time. Avebury(in Labys, W.C., Takayama, T. & Uri, N.D. ed.), Vermont, 17-47

McKillop, W. 1973. Structural analysis of Japanese-North America trade in forest products, Forest Science, Vol.19: 63-74.

Mori Y. 1972. Econometric analysis about a change of the economic structure of timber import, Research of agriculture and forestry issues 32,135-145 (in Japanese)

Mori, Y. 1991. Timber market in Japan -An econometric analysis-. Memoirs of the College of Agriculture, Kyoto Univ., pp.179-191.

Nakada, T. 2006. Regression analysis of reforestation abandonment, Graduation thesis, 34

Nilsagard, H. 1999. Modelling Japanese Import Demand for European Construction Lumber, In Global concerns for forest resource utilization (Yoshimoto & Yukutake ed.), Kluwer Academic Publishers 62, 287-294

Rinyacho 2001. The forest and forestry basic plan, Forestry Agency (in Japanese)

Rinyacho 2005. Annual report on trend of forest and forestry white paper Fiscal Year 2004, Forestry Agency, Japan Forestry Association, 270 (in Japanese)

Samuelson, P.A. 1952. Spatial price equilibrium and linear programming, The American Economic Review 42, 283-303

Tachibana, S. 1997. An analysis on the structure of Japanese softwood timber market: an econometric study, Bulletin of the Tokyo University Forests 97, 298 (in Japanese)

Yoshimoto, A., Kajita, J. & Yukutake, K. 1999. Japanese forest sector modeling - Possibility of increasing domestic timber production -, In Global concerns for forest resource utilization (Yoshimoto & Yukutake ed.), Kluwer Academic Publishers 62, 183-200

Yoshimoto, A. & Yukutake, K. 2002. Japanese forest sector modeling through a partial equilibrium market model, Journal of Forest Research 7, 41-48

Yukutake, K. 1977. Demand and supply structure analysis of forest products for construction, Econometric analysis of lumber, plywood and pulp/paper, Kohansha, 269-279 (in Japanese)

Yukutake, K. 1984. Econometric analysis of South Sea and USSR log Market in Japan. Japan Agricultural Research Quarterly 17(4), 269-279

Yukutake, K. 2003. States of world's forestry and Japan's forestry, Forest Economy 56 4, 1-16 (in Japanese)

Yukutake, K., Fukushima, K. & Fujikake, I. 2006. Econometric analysis of North American timber Imports influence to demand/supply model of tomber in Japan, Forest Resource Management and Mathematical Modeling-FORMATH KYOTO 2005- (Yoshimoto, Kondo & Hiroshima ed.), Japan Society of Forest Planning Press, 127-141 (in Japanese)

Yukutake, K. & Yoshimoto, A. 1996. Effects of timber export from North America to Japan on regional timber production: A quantitative analysis using the Koopmans- Hitchcock type market equilibrium model, Transactions of the Japanese Forestry Society 107, 413-414 (in Japanese)

Yukutake, K. & Yoshimoto, A. 1999. Current States of Japanese Forestry and Timber Trade, In Global concerns for forest resource utilization (Yoshimoto & Yukutake ed.), Kluwer Academic Publishers 62, 183-200

Creative Learning in Vida AB: A Case to describe organizational learning as a function of management style

Peter Österberg

Abstract
Research in general suggests management style to be an important determinant for organizational adaptability in order to learn how to cope with new situations; this is important when major environmental changes encounters an organization, as the organization need to keep pace in order to staying competitive on the market. Other research suggests that this kind learning take place in an implicit communications process. It is also suggests clear and challenging super ordinate goal setting to be a strong determinant to explain individual and organizational commitment and performance in general, and to mediate organizational creativity to be market-based.

During the weekend of 8-9 January 2005, a storm, Gudrun, hit south of Sweden with hurricane-force. The impact of the storm was devastating across society as it destroyed large areas of forest. According to the Swedish National Board of Forestry, 75 million cubic meters was destroyed or damages. In this situation, the C.E.O. of Vida AB decides to buy 1 million cubic meters of the trees that had fallen due to the impact of Gudrun. In reality C.E.O. committed himself to buy 3.5 million cubic meters of fallen trees, and to take the cost for those parts that would proved to be damages.

The decision made by the C.E.O. is obviously clear and challenging, suggesting it to make members of the organization to commit themselves to fulfill that decision. But how they learned, or develop, abilities to cope with this major change is unclear.

Key words: Management style, climate, super ordinate goals, organizational performance.

Introduction

It is easy to imagine that most organizations during there lifecycle encounters situations that could be characterized as barriers. Barriers that demanding organizations to change; it could be the product portfolio or down-sizing the organization. The cause of change in both cases is due to changes in the surrounding world, calling for reorganization of thinking within an organization; on both super ordinate goal setting and on strategies to reach such goals. But whereas goals could be developed and communicated through either assignment from C.E.O. or by organizational participation, all depending on the organizations socio-cultural structure (Erez, 1986), there are other rules to explain effectiveness on strategies to reach goals; If changes happens by surprise, an organization should be prepared to encounter such changes. One such situation of change will be described in this paper; a sawmill company where management and organization was forced to change their way of thinking concerning the handling of raw material intake after a stormy winter during January 2005. The line of argument is built on a model for creative learning within organizations called Generative Learning Management, were the climate for learning, or maybe the learning-orientation, within an organization is thought to be explained by two management abilities; (1) a managers ability to create a cognitive climate within the organization that favor innovative thinking when needed, and (2) a managers ability to formulate a super ordinate goal in order to direct the organizations innovative thinking in a certain direction. The effect of such a management style is concluded to be generative learning (Österberg, 2004).

The concepts of change, generative learning, creativity, innovativeness, all has a strong interrelation and throughout the text the reader should think of them representing the same construct.

Management style and organizational climate and performance

For members of an organization to be innovative in thinking, they need a manager that can create a creative climate. In the model for Generative Learning Management, creative thinking is explained as parallel distribution of knowledge, that is, network communication. Simplified: when employees has a need for support, it could be support in decision making or just lack of knowledge on a specific task, he or she seeks contact with other co-workers who posses the demanded item of knowledge. The process is parallel as each person theoretically communicates with several co-workers simultaneously. These actions could also take place in several projects at the same time, providing a model that is hard to explain other than by its result. To compare, regular companies which are still organized as bureaucracies in order to maintain control over processes, has a hierarchical structure where workers should turn to middle managers when they need support for their actions. Where hierarchies are purposed to maintain control, networks (those with parallel distribution) are purposed to not maintain control, that is, to set the process of thinking free. In order to further understand the importance of creative thinking, an explanation of creativity should be brought about. Kirton (1987) arguing that a creative climate influences individual style of thinking and that this could be measured in a dimension which has adaptive and innovative thinking in each extreme. According to Kirton:

> ” *Adaption is the characteristic behavior of individuals who, when confronted with a problem, turn to the conventional rules, practices and perceptions of the group to which they belong ... when there is no ready made answer provided by the repertoire of conventional responses, then the adaptor will seek to adapt or stretch a conventional response until it can be used in the solution of the problem*.”

> “*Innovation is the characteristic behavior of individuals who, when confronted with a problem, attempt to reorganize or restructure the problem, and to approach it in a new light ... innovators thus produce answers that are less predictable and thereby sometimes less acceptable to the group*.”

Kirton arguing, with reference to Weber (1970), Merton (1957) and Parsons (1951), that larger organizations with large budgets tend to desire conformity in order to maintain control and discipline. Opposite to that, the model of ‘Generative Learning Management’ opens communication in order to take away control of processes, by applying parallel knowledge distribution. Brunsson (2000) argues that successful management deals with the process of motivating people and creating a good working climate as well in creating suitable social networks of powerful organizational ideologies. Ekvall (1996) describes climate as: ”a conglomerate of attitudes, feelings, and behaviors which characterizes life in the organization, and exists independently of the perceptions and understandings of the members of the organization”, and arguing that: ”the climate has this moderating power because it influences organizational processes such as problem solving, decision making, communications, co-ordination, controlling, and psychological processes of learning, creating, motivation, and commitment.”

But, in order to work properly on the marked this creative process must be directed. This is fulfilled by the manager’s second ability: to formulate and to communicate super ordinate goals to the organization, that are clear and challenging. Other results within management research give indication that managers' ability to be clear reduces the risk of conflict within the organization; Consensus among members of the organization implies symbolic convergence to occur (Bormann, 19985), that is, members of the organization perceive the super ordinate goal in a consistent way. If it's not possible to establish symbolic convergence, members of the organization interpret meaning differently, then spending time to convince each other about the correct interpretation. The importance of being clear seems obvious. To be clear does not only imply lack of conflict, it also implies increased general performance for both individuals and organizations (Locke & Latham, 1985; Unnikrishnan Nair, K. 2001). Therefore, the interaction between parallel knowledge distribution and super ordinate goal setting will result in market-based generative learning within the organization (Österberg, 2004, figure 1).

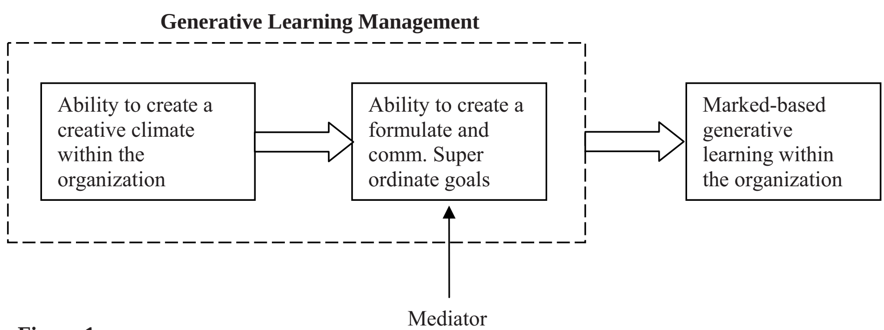


Figure 1

To conclude and repeat, a manager's ability to create a climate that supports generative learning increases the organization ability to be creative. And a manager's ability to direct this creativity increases the organizations ability be creative on specific tasks, i.e., market-based generative learning.

Vida AB and Generative Learning Management

The storm came in from southwest, and hit south of Sweden with hurricane force. It was named "Gudrun". When she passed on, 75 million cubic meters meter of trees was damages or destroyed. And instantly, the geographical picture of this part of Sweden was changed for a long period of time. It's easy to imagine a local landowner's feeling of hopelessness. On the other hand there where the sawmill companies, that now had to change their logistics in order to cope with this new situation. Vida AB is one such sawmill, the largest private owned in Sweden, with a turn over exceeding 200 000 000 Euros, having 600 personnel. Head Quarter is located in Alvesta in Småland, with approximately 10 subsidiaries located not far from there.

In an interview with C.E.O. on 11 of January 2006, I got the impression that the handling of timber at Vida AB was marked by deep-routed routines. The raw material had looked the same since the dawn of time. Even so, minor changes were constantly executed in order to rationalize processes within the company. During the interview, C.E.O. returned to the issue of change several times. I therefore assumed, but could not confirm empirically, that C.E.O. had established some kind of climate for change at Vida AB. With change comes the opportunity for generative learning, that is, to be creative or innovative in problem solving by communicating your fellow co-workers in a parallel fashion.

When the effect of the storm came clear, C.E.O. decided to buy 1 million cubic meters of timber due to the impact of Gudrun (The final amount of timber actually exceeded 3.5 million cubic meters). The decision contained two strong rhetorical characters. The decision was not only (1)clear, it was also (2) challenging; the investment should be fulfilled what ever the cost, that is, Vida AB should fulfill the buy even if the timber turned out to be damaged. There are good reasons to suggest that the C.E.O. of Vida AB has the ability to communicate clear and challenging decisions to the organization, exemplified by his statement to buy 1 (3.5) million cubic meters timber even if the timber later would turn out to be damaged.

The interview also gave some indication of the occurrence of a climate within Vida AB open for change, which also could be a climate for generative learning (creative thinking). In accordance with the theoretically description of Generative Learning management above, I will therefore argue that this sawmill organization was able to sustain its operations on a normal level after Gudrun, partly because C.E.O. had established an organizational climate that allowed individuals within the organization, and therefore the organization as a whole, to instantly comply with changes which enables them to be creative in thinking.

As the interview with C.E.O. of Vida AB did not give any indication that he had a desire to maintain control over processes of the organization, it seemed that he had a holistic perspective about the organization. Exactly how things where done was not the most important, rather what the organization achieved on general goals. This way of thinking is consistent with papers written about creative problem solving as a function of parallel distribution. Parallel distribution is said to be used mostly on complex matters, and the process is sometimes described as procedural or implicit learning (Seger, 1994). The reason for learning to be implicit is that a specific problem space contains so many rules for decisions that it will be impossible to explicitly maintain control over each one of them. This is especially true in large organization, where many people work parallel on solving different kinds of problems. By setting the process of problem solving free, a manager optimizes the probability that the organization solves complex and new problem in the most cost-efficient way. But as the presence of such a climate was not confirmed empirically, further research must be conducted in order to fully answer that question.

Conclusion

For managers in general, organizational working climate is the key to long term success. This proposition is general, and therefore also true for the forest industry. The reason for this is that the cognitive function is general among individuals. Humans in general perceive and processes messages the same way; the members of an organization will follow the manager’s directives about intra-organizational communications style. If the message is that members of an organization should only speak to middle managers in case they need to ask something, they all will become adaptors, with the characteristic behavior of individuals who, when confronted with a problem, turn to the conventional rules, practices and perceptions of the group to which they belong. In case the manager has a holistic management style, members of an organization will turn innovators who, when confronted with a problem, attempt to reorganize or restructure the problem, and to approach it in a new light. I argue that this is the case in Vida AB, even though I can’t prove it empirically. That is yet to come.

Goals setting triggers the individuals mind or cognition function, creating a mental image that could be either unambiguous or ambiguous, depending on the rhetorical characters of the message. Unclear messages like: -this year we should improve sales, could mean different things for different people. This is also true when using descriptions like: -we shall not do this and that. If many people only know what they should not do, could there possible emerge a situation with symbolic convergence?

The message sent, to instantly buy 1 million cubic meters of timber, is unambiguous. It means what it says. And to add that this will be done even if it turns out that the trees are all damages, gives the goal a challenging character; there's risk Vida AB fails to accomplish this task.

I finally conclude that Vida AB and its CEO has the prerequisite to generative learning established within the organization, due to the fact that the CEO – Santhe Dahl is a Generative Learning Managers.

References

Bormann, E. (1985). Symbolic Convergence theory: A communication formulation. *Journal of communication*, autumn, 128-138.

Brunsson, N. (2000). The Irrational Organization: Irrationality as a Basis for Organizational Action and Change. Fagbokforlag. Bergen.

Ekvall, G. (1996). Organizational Climate for Creativity and Innovation. European journal of work and organizational psychology, 5(1), 105-123.

Erez, M. (1986). The Congruence of Goal-setting strategies with socio-cultural values and its effect on performance. *Journal of Management*, 12(4), 585-592.

Kirton M.J. (1987). Cognitive Style and Personality. In S.G. Isaksen (ed.), Frontiers of Creativity research: Beyond the basics (pp. 282-304). Buffalo, NY: Bearly Limited.

Locke, E.A., Latham, G.P. (1985). The application of goal settings to sports, *Journal of Sport Psychology*, 7, 205-222.

Österberg, P. (2004). Generative Learning Management – A hypothetical model. *The Learning organization*, 11 (2), 145-158.

Seger, C.A. (1994). Implicit Learning. *Psychological Bulletin*, 115(2), 163-196.

Unnikrishnan Nair, K. (2001). Adaptation to creation: progress of organizational learning and increasing complexity of learning systems. *Systems Research and Behavioral science*, 18 (6), 505-521.

Appendix A - List of authors

Appendix B – Participants

Participants SSFE-Conference in Uppsala 8-11 May 2006

Name	University	Contact information	E-mail
Andersson, Mats	SLU	Mats Andersson Dep. of forest economics Swedish University of Agricultural Science, 901 83 Umeå Sweden tfn. +46 90-786 85 74	mats.andersson@sekon.slu.se
Anthon, Signe	KVL	Signe Anthon Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1757	sia@kvl.dk
Baardsen, Sjur	Norwegian University of Life sciences	Sjur Baardsen UMB, Postboks 5003 1432 Ås Norway tfn.+47 64 96 57 40	sjur.baardsen@umb.no
Backman, Riitta	TTS Institute	Riitta Backman P.O.Box 28 Melkonkatu 16 A FIN-00211 Helsinki, Finland Tfn. +358 9 2904 1435	riitta.backman@tts.fi
Bhaskar, G	Kakatiya University	G. Bhaskar Department of Economics Kakatiya University Warangal - 506 009 Andhra Pradesh India	bhaskar_gaddam@yahoo.co.in
Christensen, Morten	KVL	Morten Christensen Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1752	moc@kvl.dk
Clarke, Majella	Metla	Clarke, Majella Metla Helsinki Unit, Unioninkatu 40 A, 00170 Helsinki Finland tfn. +358 10 211 2051	majella.clarke@savcor.com

Eriksson, Ljusk Ola	SLU	Ljusk Ola Eriksson Dep. of Forest Resource Management and Geomatics Swedish University of Agricultural Science, 901 83 Umeå Sweden tfn: +46 90-786 83 07	Ljusk.Ola.Eriksson@resgeom.slu.se
Haltia, Emmi	University of Helsinki	Emmi Haltia Department of Forest Economics Univerity of Helsinki, P.O. Box 27 Latokartanonkaari 7, FIN-00014 University of Helsinki, Finland	emmi.lehtonen@helsinki.fi
Hartebrodt, Christoph	Forest Research Institute of Baden-Württemberg	Dr. Christoph Hartebrodt, Forest Research Institute of Baden-Württemberg Wonnhalde 4, D-79100 Freiburg Germany tfn. +49 761 4018 262	christoph.hartebrodt@forst.bwl.de
Helles, Finn	KVL	Finn Helles Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1738	fh@kvl.dk
Holding, Christine	SLU	Christine Holding Dep. of Forest products and markets Swedish University of Agricultural Science, Box 7060 750 07 Uppsala Sweden	christine_holding@yahoo.co.uk
Hultåker, Oscar	SLU	Oskar Hultåker Dep. of Forest products and markets Swedish University of Agricultural Science, Box 7060 750 07 Uppsala Sweden tel. +46 18 67 25 44	oscar.hultaker@spm.slu.se
Hurtado, Eduardo Antonio Sandoval	KVL	Sandoval Hurtado Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	
Ingmarsson,	SLU	Fredrik Ingmarsson Dep. of Forest products	Fredrik.ingmarsson@spm.slu.se

Fredrik		and markets Swedish University of Agricultural Science, Box 7060 750 07 Uppsala Sweden tfn. +46 18 67 38 45	
Jacobsen, Charlotte	KVL	Charlotte Jacobsen The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	cja@kvl.dk
Jacobsen, Jette Bredahl	KVL	Jette Bredahl Jacobsen The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1746	jbj@kvl.dk
Jellesmark Thorsen, Bo	KVL	Bo Jellesmark Thorsen The Royal Veterinary and Agricultural University, Hoersholm Kongevej 11 DK-2970 Hoersholm Denmark tfn. +45 3528 1700	bjt@kvl.dk
Jensen, Anders	KVL	Anders Jensen The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg Denmark	
Kaimre, Paavo	Estonian University of Life Sciences	Paavo Kaimre Estonian University of Life Sciences, Kreutzwaldi 5 Tartu 51014 Estonia	paavo.kaimre@emu.ee
Karppinen, Heimo	University of Helsinki	Heimo Karppinen, Department of Forest Economics, University of Helsinki, P.O. Box 27 Latokartanonkaari 7, FIN-00014 Finland tfn. +358 9 191 57974	heimo.karppinen@helsinki.fi
Kärhä, Kalle	Metsäteho Oy	Kalle Kärhä, Metsäteho Oy, PL 194, 00131 Helsinki Finland	kalle.karha@metsateho.fi
Laaksonen, Susanna	University of Toronto	Susanna Laaksonen-Craig Faculty of Forestry University of Toronto, Toronto, ON M5S 3B3 Canada	susanna.laaksonen.craig@utoronto.ca
Leppänen, Jussi	Metla	Jussi Leppänen Metla Helsinki Unit, Unioninkatu 40 A	Jussi.Leppanen@metla.fi

		00170 Helsinki Finland tfn. +358 10 211 2240	
Linden, Mikael	University of Joensuu	Mikael Linden Department of Business and Economics University of Joensuu, Yliopistokatu 7, Box 111 FIN-80101 Finland	mika.linden@joensuu.fi
Lund, Jens Friis	KVL	Jens Friis Lund Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1767	jens@kvl.dk
Lund, Dorte Hedensted	KVL	Dorte Hedensted Lund Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	
Lähtinen, Katja	Metla	Katja Lähtinen Finnish Forest Research Institute Joensuu Research Unit, P.O. Box 68 FIN-80101 Joensuu Finland tfn: +358 10 211 3179	katja.lahtinen@metla.fi
Lönnstedt, Lars	SLU	Lars Lönnstedt Dep. of Forest products and markets Swedish University of Agricultural Science, Box 7060 750 07 Uppsala Sweden tfn: +46 18 67 24 96 Fax: +46 18 67 34 90	Lars.Lonnstedt@spm.slu.se
Meilby, Henrik	KVL	Henrik Meilby Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University, Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1740	heme@kvl.dk
Mikkilä, Mirja	University of Joensuu	Mirja Mikkilä Faculty of forestry University of Joensuu, Leppärinne 5 D 33 55800 Imatra Finland	mirja.mikkila@joensuu.fi

Mohammadi, Soleiman	SLU	Soleiman Mohammadi Dep. of forest economics Swedish University of Agricultural Science, 901 83 Umeå Sweden tel. +46 90-7868173	soleiman.mohammadi@sekon.slu.se
Mustalahti, Irmeli	KVL	Irmeli Mustalahti Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg Denmark	irm@kvl.dk
Nord, Tomas	University of Luleå	Tomas Nord Luleå tekniska universitet 971 87 Luleå Sweden	Tomas.nord@ltu.se
Nouro, Paul	Metla	Paul Nouro Metla Helsinki Unit Unioninkatu 40 A 00170 Helsinki Finland	Paul.nouro@metla.fi
Nylund, Jan-Erik	SLU	Jan-Erik Nylund Dep. of Forest products and markets Swedish University of Agricultural Science Box 7060 750 07 Uppsala Sweden tel. +46 18 67 13 71	jenylund@swipnet.se
Nyrud, Anders Q	Norwegian University of Life sciences	Anders Q Nyrud INA, UMB Postboks 5003 1432 Ås Norway tel. +47 64 96 57 15	Anders.qvale.nyrud@umb.no
Olsen, Carsten Smith	KVL	Carsten Smith Olsen Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tel.+45 3528 1763	cso@kvl.dk
Owari, Toshiaki	Hokkaido University	Toshiaki Owari Graduate School of Agriculture, Hokkaido University Kita 9, Nishi 9, Kita-ku, Sapporo 060-8589 Japan tfn. +81-11-706-2522	owari@uf.a.u-tokyo.ac.jp
Pajot, Guillaume	Université Bordeaux	Guillaume Pajot GRAPE-Centre Environnement Economie	pajot@u-bordeaux4.fr

		Publique Université Bordeaux Avenue Léon Duguit 33 608 Pessac France tfn. (33) (0)5-56-84-29-66	
Pajuoja, Heikki	Metsäteho Oy	Heikki Pajuoja Metsäteho Oy P.O. Box 101 Snellmaninkatu 13 FI-00171 Helsinki Finland tfn +358 20 765 8801, Fax +358 9 659 202	heikki.pajuoja@metsateho.fi
Ponce, Juan Edgar	KVL	Edgar Ponce Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn: +45 3528 1749	edg@kvl.dk
Préget, Raphaële	UMR ENGREF/INRA	Raphaële Préget Laboratoire d'Economie Forestière, UMR ENGREF/INRA, 14 rue Girardet, 54042 Nancy France tfn.+33(0)383396864	preget@nancy-engref.inra.fr
Price, Colin	University of Wales	Colin Price School of Agricultural and Forest Sciences University of Wales, Bangor, Gwynedd LL57 2UW United Kingdom	c.price@bangor.ac.uk
Rijal, Arun	KVL	Arun Rijal Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	
Rico, Alvaro	KVL	Alvaro Rico The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn. +45 3528 1765	ari@kvl.dk
Rohde, Lizzie Marie	KVL	Lizzie Maria Rohde Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	lmr@kvl.dk

		tfn. +45 3528 1749	
Roos, Anders	SLU	Anders Roos Dep. of Forest products and markets Swedish University of Agricultural Science Box 7060 750 07 Uppsala Sweden tfn. +46 18 67 15 64	anders.roos@spm.slu.se
Rosenquist, Björn	SLU	Björn Rosenquist tfn. 073-825 97 32	W02bjro1@stud.slu.se
Saito, Moeko	KVL	Moeko Saito-Jensen Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	
Sirgments, Risto	Estonian University of Life Sciences	Risto Sirgments Institute of Forestry and Rural Engineering, Estonian University of Life Sciences Kreutzwaldi 5 Tartu 51014 Estonia	
Stendahl, Matti	SLU	Matti Stendahl Dep. of Forest products and markets Swedish University of Agricultural Science Box 7060 750 07 Uppsala Sweden tfn. +46 18 67 12 99	matti.stendahl@spm.slu.se
Strange, Niels	KVL	Niels Strange Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn. +45 3528 1753	nst@kvl.dk
Tarp, Peter	KVL	Peter Tarp Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark tfn. +45 3528 1755	peta@kvl.dk
Teder, Meelis	Estonian University of Life Sciences	Meelis Teder Department of Forest Management Estonian University of Life Sciences, Kreutzwaldi	meelis.teder@emu.ee

		5, 51014 Tartu, Estonia tfn. +372 731 3148 Fax: +372 731 3156	
Toppinen, Anne	Metla	Anne Toppinen Metla Joensuu Research Unit, PL 68, 80101 Joensuu Finland tfn. +358 10 211 3181	Anne.Toppinen@metla.fi
Tunes, Torgrim	Norwegian University of Life sciences	Torgrim Tunes UMB Postboks 5003 1432 Ås, Norway	torgrim.tunes@umb.no
Tuherm, Henn	Latvia University of Agriculture	Henn Tuherm Forest Faculty Latvia University of Agriculture Dobeles iela 41 Jelgava, LV 3001 Latvia	henn@cs.llu.lv
Vahter, Tarmo	Estonian University of Life Sciences	Tarmo Vather Institute of Forestry and Rural Engineering, Estonian University of Life Sciences Kreutzwaldi 5 Tartu 51014 Estonia	
Vedel, Suzanne E.	KVL	Suzanne Vedel Danish Centre for Forest, Landscape and Planning The Royal Veterinary and Agricultural University Rolighedsvej 23 DK-1958 Frederiksberg C Denmark	sve@kvl.dk
Viitala, Esa-Jussi	Metla	Esa-Jussi Viitala Helsinki Unit, Unioninkatu 40 A, 00170 Helsinki Finland tfn. +358 10 211 2231	esa-jussi.viitala@metla.fi
Viitanen, Jari	Metla	Jari Viitanen Metla Joensuu Research Unit PL 68 80101 Joensuu Finland tfn. +358 10 211 3033	jari.viitanen@metla.fi
Yoshimoto, Atsushi	Tohoku University	Atsushi Yoshimoto Graduate School of Environmental Studies Tohoku University 6-6-20 Aoba-Aramaki, Aoba Sendai, JAPAN 980-8579 tfn/fax: 81-22-795-4508	yoshimoa@mail.kankyo.tohoku.ac.jp
Yukutake,	University of Miyazaki	Kiyoshi YUKUTAKE Dept. of Agriculture &	yukutake@cc.miyazaki-u.ac.jp

Kiyoshi		Forest Sciences Faculty of Agriculture Miyazaki University tfn. 0985-58-7190 Fax: 0985-58-5110	
Österberg, Peter	SLU	Peter Österberg Department of Economics Swedish University of Agricultural Science Box 7013 750 07 Uppsala Sweden tfn.+46 18-671786	Peter.osterberg@ekon.slu.se

Appendix C – Programme

PROGRAM (version 2006-05-03)
THE SCANDINAVIAN SOCIETY OF FOREST ECONOMICS (SSFE)
May 8-11, 2006 in Uppsala, Sweden

Each presentation has 30 minutes incl. answering questions.

MONDAY 8th

8.00-10.00	**R e g i s t r a t i o n**		
10.00-10.30	**C O F F E**		
10.30-11.30	**O p e n i n g (Hall Linné)** **"Results and implications from a comparative study of Swedish and Finnish forest sectors"** **by Skogforsk (Sweden), Metla, Metsäteho and Ministry of Agriculture and Forestry (Finland)** Presentation by Paul Nouro		
	Hall: Linné	**Hall: Party**	**Hall: Aspen**
11.30-12.00	**BUSINESS session: Chairman: Anders Roos** # Consumer research for product development, product placement and customization Anders Qvale Nyrud and Anders Roos	**FOREST POLICY-session Chairman: Jan-Erik Nylund** # Promoting of reforestation by different policy tools in Estonia Kaimre, Paavo, Sirgmets, Risto and Vahter, Tarmo	**NON-INDUSTRIAL PRIVATE FOREST OWNERS session Chairman: Sjur Baardsen** # Profit efficiency among Norwegian forest owners Sjur Baardsen, Gudbrand Lien and Ståle Størdal
12.00-13.00	**L U N C H**		
13.00-15.0013.0013.3014.0014.30	**BUSINESS session cont.**# Economic success in small-scale joinery industry in Finland Riitta Backman and Pertti Hourunranta# Acceptability of operations, corporate responsibility, sustainability or what? - Many faces of responsibility within the global pulp and paper industryMirja Mikkilä# Superficial citizens and sophisticated consumers: what questions do respondents to stated preference surveys really answer?Colin Price# DISCUSSION	**FOREST POLICY session, cont.**# Desired structure of family forestry? Forest taxation policy and holding fragmentation control in Finland and SwedenJussi Leppänen# Towards National Ownership in Forestry Sector Development: Possibilities and ConstrainsIrmeli Mustalahti, Tomi Tuomasjukka and Anniina Kostilainen# Welfare effects of increasing forest conservation in Finland: Preliminary resultsEmmi Lehtonen # DISCUSSION	**NIPF: NON INDUSTRIAL PRIVATE FOREST OWNERS session, cont.**# Nonindustrial private timber supply: changes in ownership objectives in Finland.Kuuluvainen, J., Karppinen, H., Mikkola, J. & Stavness, C. # Norwegian land owners' income strategies and their characteristicsGudbrand Lien, Ståle Størdal and Sjur Baardsen# Forest owners' divestment and investment strategiesMarkku Penttinen, Kari Hyytiäinen, Arto Latukka, Antrei Lausti, Jarmo Mikkola and Esa Uotila# DISCUSSION
15.00-15.30	**C O F F E**		

15.30-17.00	**BUSINESS session cont.**	**FOREST POLICY session, cont.**	**NIPF: NON-INDUSTRIAL PRIVATE FOREST OWNERS session**
15.30	# Business strategies of woodworking companies in Northwest Russia: results from pilot study in Leningrad and Vologda regions Anne Toppinen, Ritva Toivonen, Antti Mutanen, Vadim Goltsev and Natalia Tatti	# Decentralization of forest resources, taxation and public finance: empirical evidence from Tanzania Jens Friis Lund and Finn Helles	# Perceived risk sources and strategies to cope with risk among forest owners in Eastern Norway Ståle Størdal and Gudbrand Lien
16.00	# Integrating long-term and medium-term forest planning – computational experiences Ljusk Ola Eriksson	# The use of a scaffolding model to increase interaction and learning in web based teaching in tropical forestry Carsten Smith Olsen, Anita Monty and Thorsten Treue	# Targeting the poor: A critique of taxation of smallholder natural resources utilization in developing countries Anthon, S and Lund, J. F.
16.30		# DISCUSSION	# DISCUSSION
17.00-18.00	17.30 Buss leaves for Ultuna		
18.00-	**GET TOGETHER** at the department of forest products and markets, Ultuna **DINNER** at Ultuna restaurant		

THE SCANDINAVIAN SOCIETY OF FOREST ECONOMICS (SSFE
May 8-11, 2006 in Uppsala, Sweden

TUESDAY 9th

	Hall: Linné	Hall: Party	Hall: Aspen
8.00-10.00	**TIMBER MARKETS Session** **Chairman: Heimo Karpinen**	**NTFP: NON TIMBER FOREST PRODUCTS session** **Chairman: Finn Helles**	**FOREST AND CARBON-session** **Chairman: Jette B. Jacobsen**
8.00	# Timber Demand/Supply Analysis For East Asian Timber Trade - Trade Network among Eight Japanese Regions, China and Korea Kiyoshi Yukutake and Atsushi Yoshimoto	# The scramble for cash: income flows from harvest and trade of a commercial NTFP Anders Jensen	#The value of carbon credits from the forest sector Guillaume Pajot
8.30	# Dynamic of the tropical saw timber market in the State of Acre-Brazil Zenobio Abel Gouvêa Perelli da Gama e Silva	# The Good, the Bad and the Ugly: income determinants and typology in commercial NTFP harvesting Anders Jensen	#Carbon Pricing Through Subsidy Payment for Thinning Activities in Japan in Northern Europe Atsushi Yoshimoto
9.00	# Timber appraisal from French public auctions: How to set the reserve price when there are	# Analysis of the South Asian medicinal plant market conduct and performance Carsten Smith Olsen and Finn Helles	
9.30		# The importance of non-timber forest	

	unsold lots? Raphaële Préget and Patrick Waelbroeck # A game theory approach to the Iranian forest industry raw material market Soleiman Mohammadi Limaei and Peter Lohmander	products (NTFP) to the livelihood of rural poor in Nepal. a case study of the chepang people Rijal, A., Helles, F. and Olsen, C.S.

10.00-10.30	**C O F F E**
10.30-11.30	**G u e s t s p e a k e r: Staffan Brege, Linköpings universitet (Hall: Linné)**
11.30-12.30	**L U N C H**
12.30-15.00	Touring Uppsala (Linné garden, Gustavianum and cathedral) Staffan Elmgren and Åsa Holmstad
15.00-15.30	**C O F F E**

	Hall: Linné	Hall: Party
15.30-17.00	**Nordic-Balticum research**	**Information about programs:**
15.30	**Chairman: Anders Quale Nyrud**	**Chairman: Christoph Hartebrodt**
	# Trade Flows, Unit Prices and Roundwood	# COFOSODE: Communities Forestry &
16.00	Market Integration in Northern Europe Jari Viitanen, Anne Toppinen, Surya Maga, Bruce Michie and Anders Nyrud # Timber trade in the Baltic countries Meelis Teder # Locating Feasible Routes from Forest Management Units to the Nearest Road in the Novgorod Region of Russia Bruce Michie #Development of Forest	Social Development Organization A presentation given byLeticia Aidoo (acting exucutive director) # Collaborating to improve teaching - the example of a joint European MSc programme in tropical forestry Carsten Smith Olsen

	Industries in Latvia Henn Tuherm, Sanita Ludvigsone-Rudzite
17.00-18.00	
18.00-	**CONFERENCE DINNER** at the Association of students from Småland county (Smålands nation)

THE SCANDINAVIAN SOCIETY OF FOREST ECONOMICS (SSFE
May 8-11, 2006 in Uppsala, Sweden

WEDNESDAY 10th

	Hall: Linné	Hall: Party	Hall: Aspen
8.00-10.00	**BUSINESS session cont. Chairman: Anna Toppinen**	**FOREST POLICY session, cont. Chairman: Christine Holding**	**FOREST MANAGEMENT session Chairman: Colin Price**
8.00	# Management systems in the sawmilling industry Torgrim Tunes, Anders Q. Nyrud and Birger Eikene	# Grants for advisory services in the private Danish forestry sector – a principal-agent approach Dorthe H. Lund, Suzanne E. Vedel, Jette B. Jacobsen and Finn Helles.	# An Early Contribution of Martin Faustmann to Natural Resource Economics Esa-Jussi Viitala
8.30	#The Effects of Value-added Creation and Cost Efficiency Strategies on the Financial Performance of Finnish Privately Owned Sawmills Katja Lähtinen & Anne Toppinen	# Promoting Natural Resources Management with Community Driven Development Approach: Challenges and Policy Options Moeko Saito-Jensen	# Creaming: a fast track to continuous cover forests? Colin Price
9.00	# Product development in the Swedish and Finnish Nordic Pine Sawmilling Industry – qualitative study of managerial perceptions Matti Stendahl, Anders Roos and Mårten Hugosson	# Biodiversity and community forestry - can national conservation goals be reached through decentralisation? Morten Christensen	# Profitability of pre-clearance in first-thinning Scots pine stands Kalle Kärhä
9.30	# Multidimensional Management Systems - A Promising Approach for the Management of Larger Forest Organizations? A case study on the use of modern Performance Measurement Systems in the context of Evaluation- and Performance Measurement-Theory Christoph Hartebrodt, Kathleen Herbohn, John Herbohn	# Implementing International Standards for Phytosanitary Measures: Impacts and Challenges Majella Clarke	# The temporal aspect of the counselling for small-scale forest owners after the storm in Sweden 2005 Fredrik Ingemarson and Mårten Hugosson
10.00-10.30	**C O F F E**		

10.30-12.0010.3011.0011.30	**BUSINESS session cont.**# Collective initiatives on improving work environment in Swedish mechanised forestry – A case of institutional entrepreneurship and change.Oscar Hultåker# Creative learning in Vida ABPeter Österberg# DISCUSSION	**FOREST POLICY session, cont.**# Assessing buffer zone management in Bolivia using soft systems analysis Alvaro Rico# Influence of information in stated preference valuation methods - a comparison of methods based on an empirical study of valuation of heath in DenmarkJette Bredahl Jacobsen, Bo Jellesmark Thorsen and Alex Dubgaard,# DISCUSSION	**FOREST MANAGEMENT session, cont.Chairman: Susanna Laaksonen**# Economic optimal conversion of European beechHenrik Meilby and Peter Tarp# Sustainability of Bolivian tropical dry forest applying multiple objectives managementJ. Edgar Ponce# Testing for Forest Investment Stock Growth - Effects with Finnish Regional Data Mikael Linden
12.00-13.00	**L U N C H**		
13.00-15.00	**NIPF: NON INDUSTRIAL FOREST OWNERS session, cont.**	**CERTIFICATION session Chairman: Toshiaki Owari**	**FOREST MANAGEMENT session, cont.**
13.00	**Chairman: Henrik Meilby** # Maximising profit in small scale forest plantation in the lowland of Bolivia Eduardo Sandoval	# Buying certification: warm glows, pigs in pokes, and unexploded bombs Colin Price	# DISCUSSION
13.30	# To plant or not to plant – analysis of Tanzanian households' tree planting behaviour Jens Friis Lund and Henrik Meilby	# Chain of custody certification and certified forest products markets in Japan Toshiaki Owari and Yoshihide Sawanobori	
14.00		# Barriers to Forest Certification in Developing Countries Maia S. Becker and Susanna Laaksonen-Craig # DISCUSSION	
14.30	# Marketing of Forest Products: Income and Employment Perspective – An Analysis Dr. G. Bhaskar and Dr. M. Yadagira Charyulu # DISCUSSION		
15.00-15.30	**C O F F E**		
15.30-16.00	**B U S I N E S S M E E T I N G**		

Thursday 11th: EXCURSION, 7.30-16.00

Morning	Visit to Nyby sawmill located some kilometres north of Uppsala
Afternoon	Visit to Sätuna estate, also located some kilometres north of Uppsala. We will pass the corps de logi and the owner, Agneta Borgenstierna, will shortly present the history behind the estate. Lunch will be served as catering. We will visit some interesting plantations on field areas and also take a look at spruce stands. Probably we will see quite a number of deer thus maybe you should bring your rifle? Our guide will be forester Per Mård and Lennart Eriksson from our department. On its way to Arlanda airport the bus will pass Uppsala.

Appendix D - Faustman Song

SSFE-song
By Peter Lohmander

Economic society
deep in the forest
We are all gathered here
In the honour of Faustmann

Scandinavia we represent
And the gold that is green
Which we then transform to money
In the optimal way

Appendix E

***the best of times*[i]**

There once was a time, told in story and rhyme,
before our historians wrote down the facts,
when the Vikings' behaviour throughout Scandinavia
fell short of the protocols Strasbourg enacts,
and they came, not as tourists and not with the purest
civility, over to Britain and France
to give us their cult-yure, with this sad result: [ii]Eur-
ope faltered in kindly religion's advance.
So let us reflect on the mutual respect
and the peace with which Europe is nowadays blessed,
in which it is written that Sweden and Britain
and Denmark and Finland agree with The Rest
(though Norway is sure independence is best).

There once was a period, of which our inferior
descriptions deny scope to get to its pith;
when people whose kin were called Matti and Finn
were the heroes of forests in folk-lore and myth.
They were times when that dragon – distributed lag on
adjustment of timber price – slept, unassessed;
and cash-flows accrued undiscounted, and pseud-
o-wise wizards told land-owners how to invest.
So let us rejoice that economists' voice
has been heard by the forest profession today,
and ecologists' lies about timber supplies
are displaced by the truth, in the usual way.
(And if you believe *that* … what more can I say?)

There once was an era when fellings were clear – a
sure reason for biodiversity lost;
when low NPVs were not fatal to trees,
which replanted themselves without overhead cost;
when the price of new plants was not covered by grants,
nor did those who *removed* plants receive special aid;
when no preference study would needlessly muddy
the waters when land use decisions were made.
So let us be glad that the damage which *had*
been an accident, now can be carefully planned,
and forest economy, *cum bono homine*[iii],
scatters enlightenment over the land
(although pressure groups *still* want all harvesting banned).

There shall come a time when corruption and crime
in the forest will end, and all profits accrue
without overchargin' – and costs at the margin
will equal the marginal revenue too.
And the small woodland owners will cease to be moaners
concerning their taxes, and low price of wood;
silviculturists take the prescriptions we make,
and ecologists listen to sense, like they should.
On that day pigs will fly, and the krona will buy
just as much as it did in the previous year.
BUT
economics ignoring dynamics is boring;
a time without change is a future to fear.
So let us be glad we live *now* and meet *here*!

[i] Transcribed by Colin Price, from some sheets found on the pavement on his way to the Scandinavian Society of Forest Economics's Conference Dinner in Uppsala 2006.
[ii] Here is one, very serious footnote. Through the conference, and in all SSFE conferences, and throughout the world, we are very merry about the generalised atrocities of the Dark Ages of history. These include the conversion to Christianity of Finns by Erik, king and martyr, who killed those who would not convert to "kindly religion": this is the history that we were told in Uppsala Cathedral. These deaths happened to real people, but at such a distance of time that they no longer seem important to us. So also, we treat the well-being of people who may be born 1000 years in the future.
[iii] A Latin phrase roughly translatable as "with goodwill to all people". Actually, I guess that the anonymous poet was searching for a rhyme, and understandably didn't want to touch "agronomy".

The Society's list of publications:

Svendsrud, A. (ed) 1969. Readings in Forest Economics. Universitetsforlaget, Oslo, 360 pp.
Huttunen, T. 1971. Who's who in the Nordic Forest Economics Seminar. Helsinki, 55 pp.
Saastamoinen, O., Hultman, S.-G., Koch, N.E. and Mattsson, L. (eds) 1984. Multiple-Use Forestry in the Scandinavian countries. Comm. Inst. For. Fenn. 120: 1-141.
Helles, F. (ed) 1985. Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics. Skjoldenæsholm, Denmark, December 1984, 214 pp.
Hänninen, R. and Selby, J.A. (eds) 1987. Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics. Porvoo, Finland, May 1987. Scandinavian Forest Economics 29, 284 pp.
Mattsson, L. and Sødal, D.P. (eds) 1988. Multiple Use of Forests - Economics and Policy. Proceedings from a conference. Oslo, Norway, May 1988. Scandinavian Forest Economics 30, 184 pp.
Lohmander, P. (ed) 1989. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Visby, Sweden, 1989. Scandinavian Forest Economics 31.
Palo, M. and Mery, G. (eds) 1990. Deforestation or Development in the Third World? Scandinavian Forest Economics 32, 189 pp.
Solberg, B. (ed) 1992. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Gausdal, Norway, April 1991. Scandinavian Forest Economics 33, 599 pp.
Linddal, M. and Naskali, A. (eds) 1993. Valuing Biodiversity - on the Social Cost and Benefits from Preserving Endangered Species and Biodiversity of the Boreal Forest. Scandinavian Forest Economics 34, 152 pp.
Helles, F. and Linddal, M. (eds) 1994. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Gilleleje, Denmark,. November 1993. Scandinavian Forest Economics 35, 426 pp.
Saastamoinen, O. and Tikka, S. (eds) 1997. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Mekrijärvi, Finland, March 1996,. Scandinavian Forest Economics 36, 487 pp.
Lohmander, P. (ed) 1999. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Umeå, Sweden, May-June 1998. Scandinavian Forest Economics 37.
Solberg, B. (ed) 2001. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Gausdal, Norway, April 2000. Scandinavian Forest Economics 38, 336 pp.
Helles, F. and Strange, N. (eds) 2002. Proceedings the Biennial Meeting of the Scandinavian Society Forest Economics. Gilleleje, Denmark, May 2002. Scandinavian Forest Economics 39, pp 286.
Pajuoja, H. and Karppinen, H. (eds) 2004. Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics. Vantaa, Finland, May 2004. Scandinavian Forest Economics 40, pp 361
Lönnstedt, L. and Rosenquist, B. (eds) 2006. Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics Uppsala, Sweden, 8^{th}-11^{th} May, 2006, pp 470.

ISSN 0355-032X