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SYMPOSIUM ON FOREST PRODUCTS AND ROUNDWOOD MARKETS

HANASAARI, FINLAND 14.–16.11.1983



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Editors: Mikko Tervo & J.A. Selby

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This volume contains the nineteen papers presented at a symposium organized by the Scandinavian Society of Forest Economics and financed by Samarbetsnämnden för Nordisk Skogsforskning to bring together Scandinavian researchers and university teachers in the field of forest products and roundwood markets. The papers discuss theoretical, methodological and empirical aspects of the discipline.

It is hoped that the proceedings will act as a stimulus for a continuing exchange of ideas within Scandinavia, as well as with researchers in other countries.

Editors' address: Finnish Forest Research Institute, Department of Forest Economics, Unioninkatu 40 A, SF-00170 Helsinki, Finland.

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F O R E W O R D

This volume contains the papers presented at the Symposium on Research on Forest Products and Roundwood Markets, held at Hanasaari, Espoo, Finland, between 14th and 16th November 1983. The symposium was initiated and organized by the Forest Products and Roundwood Markets Working Group of the Scandinavian Society of Forest Economics. A grant from Samarbetsnämnden för Nordisk Skogsforskning financed the symposium.

The purpose of the symposium was to further the cooperation between scandinavian researchers and teachers in the subject field in order to increase the efficiency and productivity of scarce research resources, and to advance the discpline. The symposium was attended by 27 active researchers representing educational and research institutions in Denmark, Finland, Norway and Sweden. The range of papers presented covers the markets of both forest industry products and roundwood. The proceedings therefore give an idea of the variety of theoretical, methodological and empirical research being undertaken in Scandinavia at the present time.

It is hoped that the proceedings will act as a stimulus for a further exchange of ideas within Scandinavia, but also with researchers in other countries. The Scandinavian Society of Forest Economics intends that specialist meetings will be arranged to consider in more detail the theoretical and methodological problems which came to light during the symposium.

On behalf of the Scandinavian Society of Forest Economics, the editors thank the participants for their active and enthusiastic support at all stages, and the Department of Forest Economics of the Finnish Forest Research Institute for material support and cooperation. Special acknowledgements are extended to SNS for the financial support without which the symposium could not have taken place.

Helsinki, 28th February 1984

J. Ashley Selby Mikko Tervo
Editors

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EXPORT MARKETING STRATEGIES AND FUNCTIONS OF FINNISH FOREST INDUSTRY: Theoretical background and empirical example

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Export marketing strategies and functions of Finnish forest industry are described in this paper. General hierarchical goals of science and research make out a good case for that description. It is argumented that descriptions are starting points for scientific work. On the other hand descriptions are needed as a base for instruction and research and development of export marketing in practice.

After these arguments it is demonstrated how to move from description to comparative description. The demonstration also suggest one practical way to find "a planning gap" in marketing. In the same connection it is possible to consider research co-operation on marketing strategies and functions.

After that the framework of studing the marketing strategies and functions is presented. Operationalization of strategy- and marketing function-concepts are also discussed here.

The export marketing strategies are described by components: product -, customer -, marketing area - and competitive emphasis strategies. As examples of marketing functions marketing intelligence and marketing channels of Finnish sawmill industry are examined.

1. OBJECTIVES OF SCIENCE AND RESEARCH

Generally speaking the objectives of the research and science can be divided into four levels:

1) Description
2) Explanation, understanding
3) Prediction
4) Control

Especially in the early phases of the development process of a discipline there is a need of research aiming to form exact concepts and systems of concepts with which the phenomena of the discipline can be described. This is a necessary prerequisite for the research work on the field. The development of the whole discipline is based on it too. Theoretical concepts and descriptive theories are documents of this type of research.

After description it is possible to move to the second phase. Explanation concentrates on the causal or teleological relationships between certain phenomena on the field. This type of work is documented as explanatory theories, which should form as coherent or systematic structure as possible.

Description and explanation are necessary prerequisites for prediction. The better causal theories we have the better predictions it is possible to make. When predicting we are interested in the events of the future and in the instumental variables having an impact on those events. Predictions are a direct link between fundamental research and practical applications.

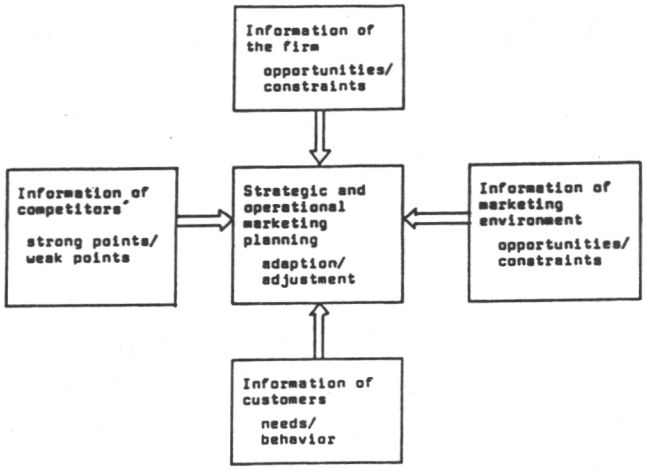
The ultimate goal of research and science is the control over the phenomena in our environment. Description, explanation and prediction are all aiming at this goal. The more relevant is the information produced by the above mentioned three phases the better are the possibilities of control. Qualitative and quantitative increasing of information increases the possibilities of control all the time.

The idea of control is crucial in marketing as it is in all applied sciences.

2. PRODUCING AND USING THE INFORMATION IN MARKETING AND MARKETING SCIENCE

Producing and using the information in marketing can be examined in the framework of Figure 1. The figure shows the task and information sources of marketing planning.

Figure 1. The task and information sources of marketing planning



Marketing (and marketing planning) has a mediatory mission when it adapts the opportunities and constraints of the firm to the opportunities and threats of the environment. Customers are the most important block of the environment.

Generally researchers produce information about the environment for the planners in practice. Planners use or do not use this information. In many cases the researchers do not know the planning systems in which their information should be used. Respectively the planners do not know the bases and starting points of researchers´work. There is lack of contacts and no common language between researchers and planners. It easily happens so that unused results of research get dusty on bookshelves of decision makers and planners.

Besides producing information about the environment of paanning researchers should also critically examine the marketing and marketing planning itself. Knowledge about the planning systems of the firms helps the researchers to produce suitable information about the environment for the planners. Researchers should also criticize the marketing strategies and functions used by the firms. Especially it is the duty of researchers and scientists to adapt the theoretical intelligence cumulated by science to the use of marketing.

What was just said means working in the central block in Figure 1. Later in this paper I shall tell you about some results of a study which has concentrated in describing and criticizing marketing and marketing planning itself.

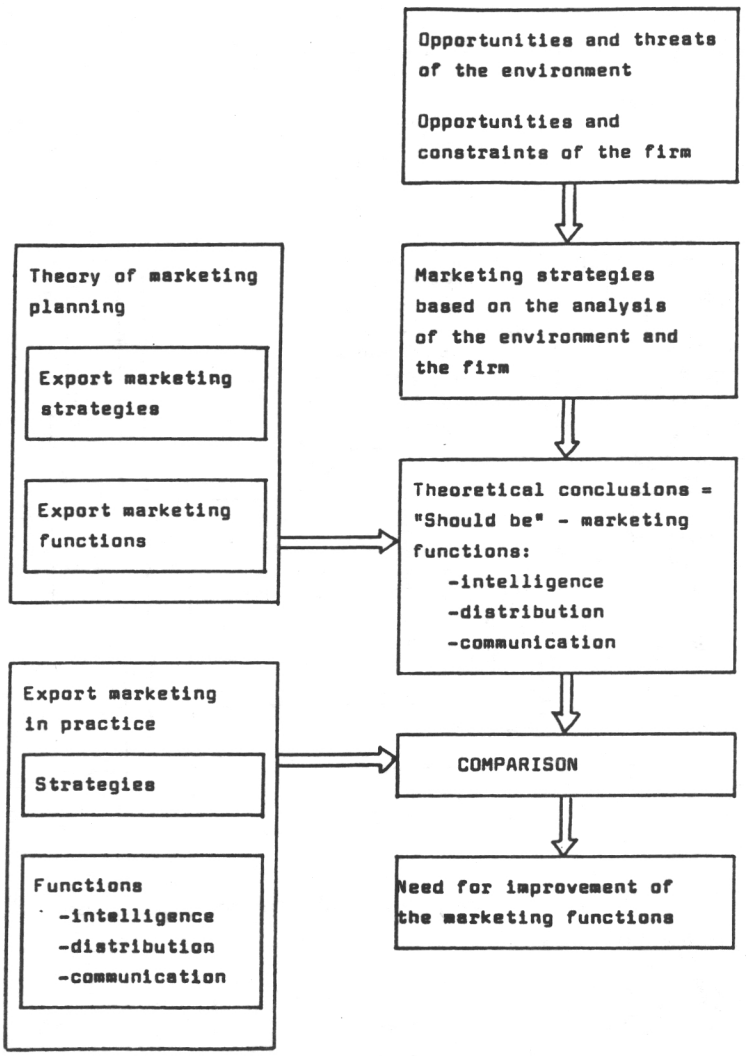
3. IDEA OF ANALYZING THE NEED FOR IMPROVING EXPORT MARKETING FUNCTIONS

The absolute size, quantity or quality of a phenomenon, function or action give minimal direction how to improve the function or action. Only comparison with something shows the need for improvement. Figure 2. points out how the need for improving the marketing strategies and functions can be shown by comparing the prevailing practice with theoretical "should be"-models under certain presumptions.

As far as marketing is concerned it is appropriate to compare our own functions with those of competitors. Sweden and Finland are keen competitors and the comparison between the countries is very interesting for example.

Analyzing the marketing strategies and functions of forest industries in the various Scandinavian countries could be a co-operative project of Scandinavian researchers. Concepts and their operationalizations should naturally be identical in all countries.

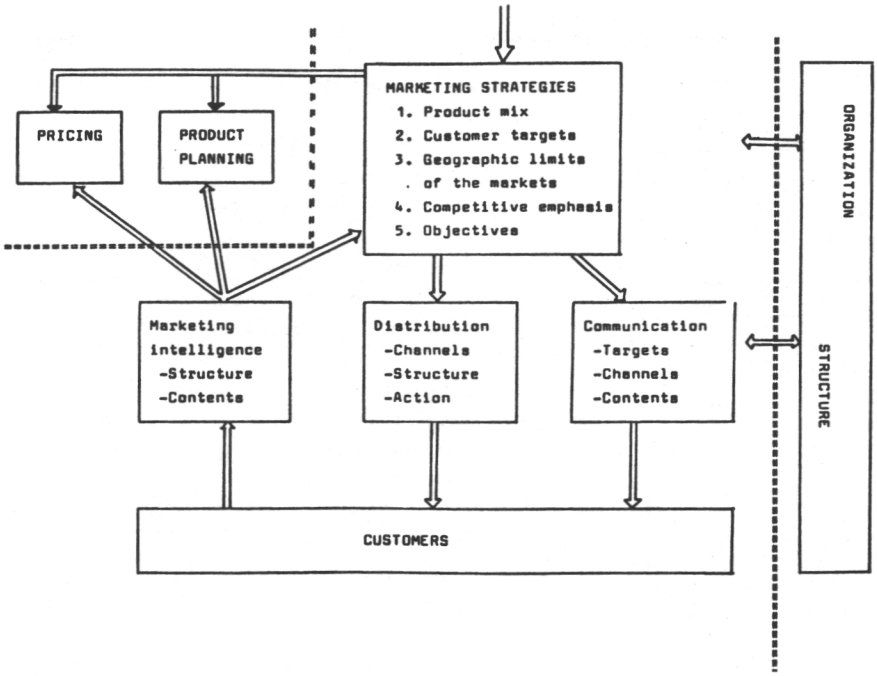
Figure 2. Idea of showing the need for improvement of export marketing functions



4. THE FRAMEWORK FOR ANALYZING THE EXPORT MARKETING STRATEGIES AND FUNCTIONS

The concept of strategy used in this paper and its relationship to marketing functions can be seen in Figure 3.

Figure 3. Analytic framework of marketing



Marketing strategy and marketing function-concept will be operationalized as follows:

Marketing strategies

1. Product mix — Emphasis on:
   1. -bulk products
   2. -special products
   3. -custom-made products
2. Customer targets — Emphasis on:
   1. -as many segments as possible
   2. -few, specified segments
   3. -known end-users

3. Geographical limits of the markets	Emphasis on: 1. -as many countries as possible 2. -few ,specified countries
4. Competitive emphasis	Characters in marketing giving a relative advantage

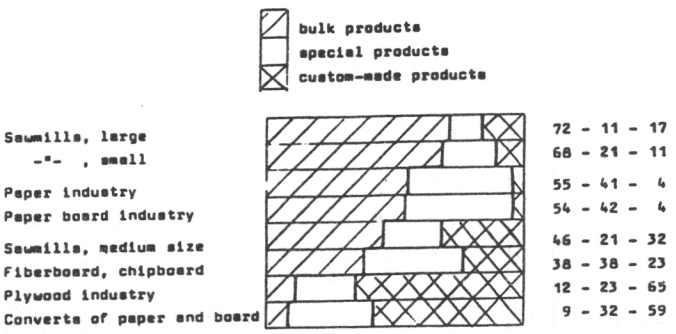
Marketing functions

1. Marketing intelligence	1. Sources of information 2. Deficiency of information
2. Marketing channels	1. Structure of marketing channels 2. Communication in marketing channels
3. Marketing communication	1. Senders 2. Channels 3. Messages 4. Targets

5. MARKETING STRATEGIES OF FINNISH FOREST INDUSTRIES

The most frequent demand made on Finnish forest industry is the one of value added products. In strategic planning this means moving from bulk product -strategies to special product- and custom-made product-strategies. Figure 4 presents what kind of strategies are applied nowadays.

Figure 4. Product strategies of Finnish forest industries

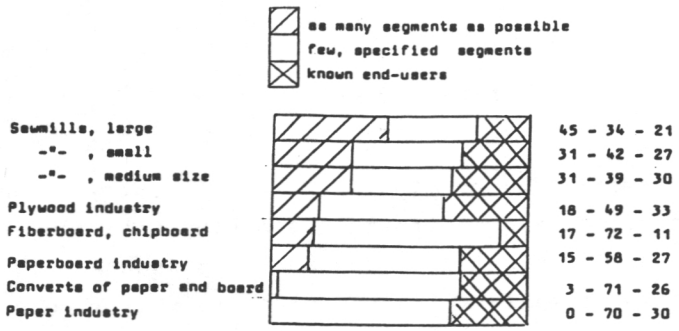


It can be seen that the product strategies of Finnish forest industries vary a lot. About 70 % of large and small sawmills are using bulk product -strategy.It is interesting to see that the more flexcible medium-size sawmills differ from other sawmills. Only about 50 % of medium-size sawmills are stressing bulk product -strategy.

Among paper and paperboard industries a development of product strategies can be observed. These industries that used to rely on bulk products are now moving towards special products. Almost half of these companies apply other than bulk product -strategy. The product strategy of custom-made products is most frequent in the plywood industry, where 65 % of the companies have this strategy.

Product strategies and customer strategies has to be in a very keen connection with each other. Figure 5 bears a certain resemblance to figure 4.

Figure 5. Customer strategies of Finnish forest industries

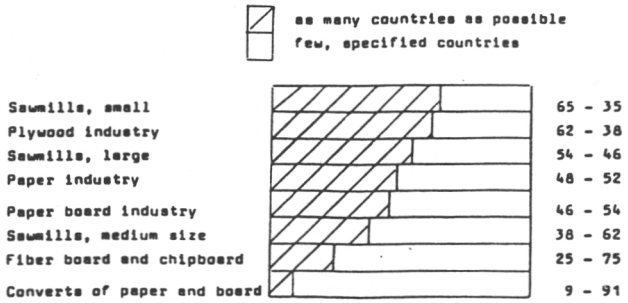


About 50 % of large sawmills are not selecting their customers at all. They are selling to as many segments as possible. Among other industries most common is the stratecy which means concentration on few well specified segments of markets.

Plywood industry has the most specialized strategies. About one third of plywood mills are stressing known end users as targets of their marketing. It is also worth mentioning that paper and converts of paper and board are marketed only to selected groups of customers.

Marketing area strategies have to be planned in accordance with product- and customer -strategies.

Figure 6. Marketing area strategies of Finnish forest industries



Analysis of product and marketing area strategies reveals that the thinking behind strategic planning in sawmill industry differs from that of plywood industry. Both are stressing as many countries as possible. Sawmills are marketing bulk products to those markets whereas plywood mills are marketing custom-made products to this kind of markets.

Great variation can be observed in the marketing area strategies of various sectors of forest industries. Deeper analysis will reveal the causes to this.

The fourth component of marketing strategy concept used in this study is the competitive emphasis.

The whole Finnish forest industry is building its marketing upon high quality of products. The sawmill industry considers also old customer relationships to have high priority as basis for marketing activities. Rest of the forest industries emphasize instead the effective marketing channels. Advertising, PR etc. are least important in all industries.

Figure 7. The competitive emphasis of Finnish forest industry

Emphasis on	Industry (group)	
High quality of products	Sawmills	+ +
	Panel industry	+ +
	Paper and paper board	+ +
Effective marketing channels	Saw	+
	Panel	+ +
	Paper	+ +
Old customer relations	Saw	+ +
	Panel	+
	Paper	+
Effective personal selling	Saw	+
	Panel	+
	Paper	+
Service, technical instruction	Saw	-
	Panel	+
	Paper	+
Innovation	Saw	-
	Panel	+
	Paper	+
Advertising, PR, SP	Saw	-
	Panel	-
	Paper	-

+ + high priority as a basis for marketing activities
+ low -"- -"- -"-
- no -"- -"- -"-

6. MARKETING FUNCTIONS OF THE FINNISH SAWMILL INDUSTRY

61. Marketing intelligence

Some features of marketing activities of Finnish sawmill industry are presented in this and the following chapter as examples of describing the marketing functions of Finnish forest industry.

Table 1 shows through which channels the sawmill industry gets the information for marketing planning.

Table 1. The sources/channels of market information

Source/channel of market information	Proportional share %
Agent	41
Personal contacts to customers	25
Importer	12
Central Associations	10
Journals etc.	4
Own sales office	3
Marketing research	2
Other	3

The sawmill industry relies on information from sources which are outside its control (agents, importers, Central Associations). It is also known that agents are not capable or willing to produce proper information for marketing planning. Marketing research and other active means of obtaining market information are practically speaking non-existent.

The conditions described in table 1 may explain the insufficiency of information needed in planning which can be seen in table 2.

Table 2. The sufficiency of information needed in planning

Information of	Sufficiently %
End-use of products	14
Marketing activities of competitors	22
Needs and buying behavior of customers	30
Regional prospects of demand	39
Development of standards, building instructions etc.	41
Supply of competitors	44
General prospects of demand of products	66
Economic prospects of markets	73

There is lack of information concerning end-use of products, needs and buying behaviour of customers and marketing activities of competitors. This means that the customers and their environments are not known. Real marketing planning is impossible without that kind of information.

62. Distribution

Changes in the structure of marketing channels have a vital interest in professional discussions. The prevailing structure of the marketing channels of Finnish sawmill industry is described in figure 8.

Figure 8. Marketing channels of Finnish sawmill industry

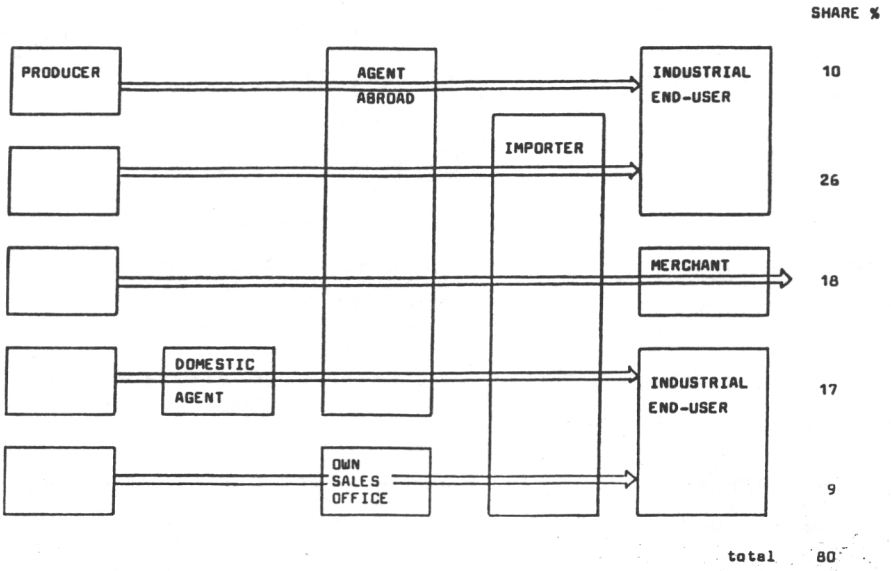


Figure 8 shows that the customers of sawmills are behind one or more channel members. This kind of structure is problematic if the producer has no control over the channel members. In most cases the "channel captain" is the importer. The channel is working according to importers' goals not those of producers'.

As far as the functioning of marketing channels is concerned communication between the members of marketing channels is very important. Table 3 shows the sufficiency of communication between producers and other members of the channel.

Table 3. Sufficiency of communication between producers and other members of the channel.

Member of the channel	Sufficiently %
Domestic agents	78
Agents abroad	59
Own sales offices	44
Importers	27
Merchants	22
Industrial end-users	20
Customers	14

Information is the fuel of the functioning of the channel. On the other hand communication is the means of the management of the channel. If there is lack of communication, the channel is not functioning properly.

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A NOTE ON EXPORT FUNCTIONS FOR FINNISH FOREST PRODUCTS

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Abstract

This paper surveys some models concerning Finland´s forest products exports, particularly those that are estimated for sawnwood industry. Work on Finnish export models has led to a discussion of the importance of especially export prices, costs and profitability in determining the volume of exports. Finland´s traditional sawnwood export´s marketing-area is in Western Europe. In this paper, also an export demand model, derived from an explicit theory of export demand developed by Armington (1969), is estimated for Finland´s sawnwood exports to some countries in the area concerned.

1. INTRODUCTION

This paper briefly presents some models that have been estimated for Finland´s mechanical wood industry exports, especially sawnwood. The models presented here are macro-economic and in them it is assumed, that Finnish firms can be viewed as one supplier.

2. EXPORT MODELS

2.1. Previous studies

When it is assumed, that competition in Finland´s export markets is imperfect, the Finnish export price and world market price (= weighted sum of competitors´ prices) must be both taken into account. It can be put into the model by assuming that it affects Finland´s export demand. So, the price of competitors is exogenous and makes the long-term demand curve shift (Figure 1).

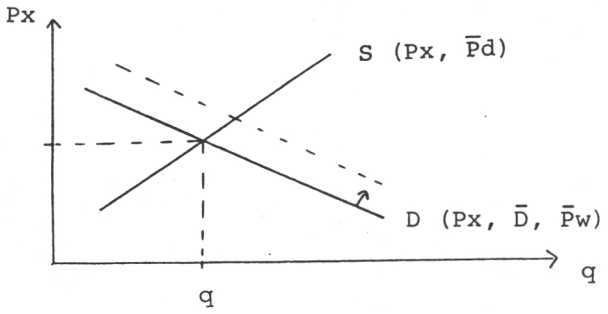

Figure 1. The simultaneous determination of export volume and price.

In this case, the Finnish sawmilling industry has limited market power (at least in the short run) and the Finnish export price can diverge from the world market price. In the long run, the Finnish price probably adjusts to world market price for ex. following some partial adjustment rule.

Aurikko (1975) has estimated this kind of a model for Finland´s sectoral exports. He assumed that Finland´s

exports cannot be disaggregated into as homogenous groups that Finnish export price could be kept exogenous. So, Aurikko spesifies both export demand and export supply equations. According to Tanskanen (1976) Aurikko´s (1975) model can be presented using following variables, which are, in principle, same as in the earlier presented (chap. 1) general export model (Huomo 1982)
demand function:

EX_d = f (D, (Px/Pw)), where

EX = Finland´s exports (value)
D = imports to Finland´s export countries (value)
Px = Finland´s export prices
Pw = import price of the market area concerned

supply function:

EX_s = f (K, Px, Pd), where

EX = Finland´s exports (volume)
Pd = Finland´s domestic costs
K = other explanatory variables

When estimating the model Aurikko has used and inverse form (= price as a dependent variable) of the supply equation. In the estimation results, the parameter of export volume did not differ significantly from zero. Aurikko (1975) has interpreted this result so, that exports has been perfectly elastic during the estimation period 1958-71. However, Tanskanen (1976) has criticized this result, in that the estimation results may have led to incorrect interpretations because the simultaneity has not been taken into account. Aurikko has specified his demand equation according to export demand theory as developed by Armington (1969). This specification will also be used in the present paper to form an export demand model for Finnish sawnwood.

Most models that are formed for Finland´s mechanical wood industry exports are reduced form models that include supply and demand variables. Apart from Aurikko´s (1975) model, many export models (for ex. Holopainen 1960, Saviaho 1975, Kukkonen 1977, Aurikko 1980, Enroth 1982) include the assumption that Finnish export prices are mainly determined by world market prices. In the models of Aurikko (1980) and Kukkonen (1977) demand variable and relative prices affect finnish exports, but in addition, Aurikko and Kukkonen have brought profitability factor into the export demand function.

EX = f(D, (Px/Pw), PR), where

EX = Finland´s exports
D = imports to Finland´s export country
Px/Pw = Finland´s exports prices in relation to foreign prices
PR = profitability in Finnish industry (gross profits)

According to Kukkonen "relative prices affect in large countries and in most product categories". International price is the stronger determinant and the cost increases have only a limited effect on the export prices. Kukkonen assumes, that when costs in Finland increase more than international prices, profitability weakens at aggregate level and marginal enterprises must stop export production. Volk (1981) has critisized the profitability variable in the model. According to her, it would be better to use, for example, cost-variable, because the profitability depends on the strength of export demand. This can cause simultaneity bias in the estimation results of the model.

Enroth (1982) has analyzed Finland´s sawn softwood exports to West-Europe in the light of demand and supply factors during the years 1960-77. The basic assumption of the study was, that Finland´s export prices are mainly determined by demand and competitors´ prices. According

to this, production costs and profitability should have a central role in the determination of export volume. Another hypothesis was, that Finnish sawnwood exports is elastic in relation to price. The estimation results showed, that production costs were significant in explaining sawnwood exports. On the other hand, the estimation of price elasticities showed that sawnwood exports were, on average, inelastic during the years 1960-77. In addition, the price elasticities were negative, which is against the hypothesis. Enroth has interpreted this result so, that the cost pressures in Finland´s sawnwood industry have increased export prices higher than those of competitors´ are, and this has affected Finland´s export quantities.

Saviaho (1975) has estimated an export demand model for Finland´s sawnwood export to England. His export function is in principal similar to the one presented in chapter 1 (function 1) including demand variables and Finland´s export price in relation to foreign price. Also he assumes, that Finnish export prices follow competitors´ prices.

2.2. Estimated model

In the following, an export demand model for Finland´s sawnwood exports to some West-European consumer countries, is estimated. This model-experiment is a part of a larger research project that concerns the development and formation of sawnwood demand and consumption in West-Europe. The purpose of the project is to construct a model that can be used in explaining and forecasting consumption. Recently the research work has concerned Finland´s sawnwood export demand in West-Europe. A further purpose of this work is to form a model than can also be used in forecasting.

It is assumed here, that the competition in West-European sawnwood markets is imperfect and that the products from different countries are near but not perfect substitutes.

In this case, the Finnish sawmilling industry is supposed to have limited market power, at least in the short run, and the Finnish export price can diverge from the world market price.

When estimating an export demand model, the export demand theory of Armington (1969) was applied. He has developed an export demand theory in which the export products are differentiated by their country of origin. Armington derived his theory from consumption theory. In case of sawnwood it must be derived from production theory, because sawnwood is mostly used as an input in end-use sectors. Such an approach has been used for ex. Volk (1983) to derive the demand for Finnish newsprint in the United Kingdom and Germany.

For estimation purposes, Aurikko (1975) has simplified the demand relationship derived by Armington (1969). Originally, the demand realationship included many countries and goods. Aurikko (1975) assumed, that only one good exists and that it is differentiated into products according to the country of production. The basic relationships expressing the demand for exports of country i in country k is:

$$(1) \quad X_{ik} = \alpha^{o}_{ik} \; M_k \left(\frac{P_{ik}}{P_k}\right)^{-\delta k}$$

where:

X_{ik} = country k:s demand for imports from country i, in volume terms (i.e. exports from country i to country k)

α^{o}_{ik} = constant

δk = elasticity of substitution in the k:th market (assumed to be constant)

M_k = volume of total imports of the k:th country

P_{ik} = price index of exports X_{ik}

P_k = price index of imports M_k

Total exports of the i:th country are the sum of X_{ik} over countries k. The equation can be linearized for estimation purposes (see Aurikko 1975):

$$(2) \quad X_{ik} = \delta \alpha^{o}_{k} + \alpha^{o}_{ik} M - \delta_{k} \alpha^{o}_{ik} M^{o}_{k} \left(\frac{P_{ik}}{P_{k}}\right)$$

Using the property $\Sigma_i \alpha^{o}_{ik} = 1$ and the definition $P_k = \Sigma_i \alpha^{o}_{ik} P_{ik}$ (see Aurikko 1975) we obtain $\Sigma_i X_{ik} = M_k$ for (2). Summing equation over k thus gives the demand for the exports of the i:th country $\Sigma_k X_{ik} = X_i$. For the purpose of estimation the export demand equation is here written with one import variable and one price ratio for one consumption country and one product.

The function to be estimated is as follows:

EX = f(D, (Px/Pw)), where

EX = export demand
(Finland's soft sawnwood exports to West-European countries (m^3))

D = demand variable
(total soft sawnwood imports of West-European countries (m^3))

Px = export price
(Finnish export unit price for sawnwood (US$) to the country concerned)

Pw = foreign price
(Soviet Union's total export unit price for sawnwood (US$))

In addition, Aurikko (1975) has considered dynamic adjustment and expectation factors, because his spesification is suitable only for a desired equilibrium situations. He assumes lags in price ratios. These arise from the formation of expectations and from decision and delivery lags. Here, in the tentative estimation results, the price ratio (Px/Pw) is lagged by 1 year.

However, the dynamics of the model in this respect is still to be studied.

The export demand model was estimated with regression analysis using logarithmic differences of time series from the years 1962-78. The coefficients of the export function for different West-European countries are:

UK:

$$-0.02 + 0.63D^{*} - 0.94\,(Px/Pw)^{*}_{t-1} \qquad \bar{R}^2 = .79,\ dw = 2.15$$

W-Germany:

$$-0.01 + 1.06D^{*} - 1.65\,(Px/Pw)^{*}_{t-1} \qquad \bar{R}^2 = .57,\ dw = 1.17$$

France:

$$0.01 + 0.59D^{*} - 0.70\,(Px/Pw)^{*}_{t-1} \qquad \bar{R}^2 = .57,\ dw = 2.11$$

Denmark:

$$0.15 + 0.69D^{*} - 1.42\,(Px/Pw)^{*}_{t-1} \qquad \bar{R}^2 = .90,\ dw = 2.41$$

Nertherlands:

$$-0.01 + 0.69D^{*} - 1.33\,(Px/Pw)^{*}_{t-1} \qquad \bar{R}^2 = .76,\ dw = 1.82$$

Belgium:

$$-0.02 + 1.12D^{*} - 0.20\,(Px/Pw)^{*}_{t-1} \qquad \bar{R}^2 = .45,\ dw = 2.21$$

The coefficients of demand variables (D) are statistically significant in the equations of all countries. The changes of this variable (consumer countries' total sawnwood imports) explain alone about half of the variance of the changes of Finland's exports to the country concerned. When the price ratio (Px/Pw) was added into the equations, it raised the $\bar{R}^2$ - values especially in UK, Denmark and Netherland's where it is statistically significant, too.

The negative sign of the export price relation (Px/Pw) means, that when for ex. Finnish price has increased

in relation to the competitor´s price, the growth of Finland´s export quantitites has fallen.

The size of the coefficient of the demand variable show, that for ex. a change in UK:s total sawnwood imports is followed by a change in Finnish exports to UK 63 % as large (in the average). In W-Germany, the respective changes have been about the same size. The coefficients of the price ratios are largest in W-Germany, Denmark and Netherlands. Thus, in these countries Finnish relative price changes have greatest effect on exports.

When thinking that exports is in general determined by supply and demand, the model presented here is also in that sense a simplification of reality. However, the tentative results show, that a demand model alone explains rather good Finland´s sawnwood exports to West-Europe. Because the explanatory variables of the model, especially price ratio, are difficult to forecast, the model can be used mainly in producing conditional forecasts, for Finland´s exports. By changing assumptions made about the development of the explanatory variables, alternative forecasts can be made.

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E N D - U S E O F W O O D P R O D U C T S

I N C O N S T R U C T I O N

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The purpose of this paper is to describe the study on the end-use of sawnwood and wood-based panels in construction in Finland.

The developments and trends in construction, especially in building construction, during the last 10-20 years are first presented.

Secondly, the method and results of an investigation concerning the use of wood products in new building construction by building types and by end-uses are described. The investigation was a sample survey and the population comprised of new buildings and enlargements of old buildings. The material was gathered by analysing building drawings.

Finally, the development of the total use of sawnwood and wood-based panels in new buildings and other construction in the 1970's is presented.

1. INTRODUCTION

The study presented in this paper is part of a research project concerning the end-use of wood products being undertaken at the Finnish Forest Research Institute. The purpose of the whole project is to investigate the end-use of sawnwood and wood-based panels by product type, end-use sector and end-use in Finland. The first task of the project is to make basic studies of the end-use of wood products. This end-use information will later be the basis for forecasts of wood products use, for research in greater detail and for the planning of marketing and production in the wood products industry.

The study continues a preliminary investigation on the need of end-use information (Valtonen 1979). That study determined what kind of data concerning end-use of wood products is needed, and where it is being used in marketing planning and management in sawmill and wood-based panel industries. The study was aimed at enterprises and trade associations of the sawmill and wood-based panel industries. Questionnaires were sent to experts responsible for marketing or marketing planning in the enterprise.

In the preliminary investigation the opinions of the respondents concerning the most suitable classification for products, users, end-use sectors, end-uses and regional distribution were also determined. Continual periodic collection of end-use data directed every year toward a different end-use sector and repetition in each sector every 3-5 years, was considered by the respondents to be the most suitable method for carrying out end-use studies. New building construction, the largest and most significant among the end-use sectors, was considered to be the first priority for further study. The next sectors in order of importance were joinery, building repair and other construction.

2. DEVELOPMENT IN CONSTRUCTION

The average annual growth rate of the construction industry was in the years 1948-65 about the same as the growth rate of GDP total. The development of GDP by sectors in the years 1960-1986 is presented in figure 1. (Kansantalouden... 1982)

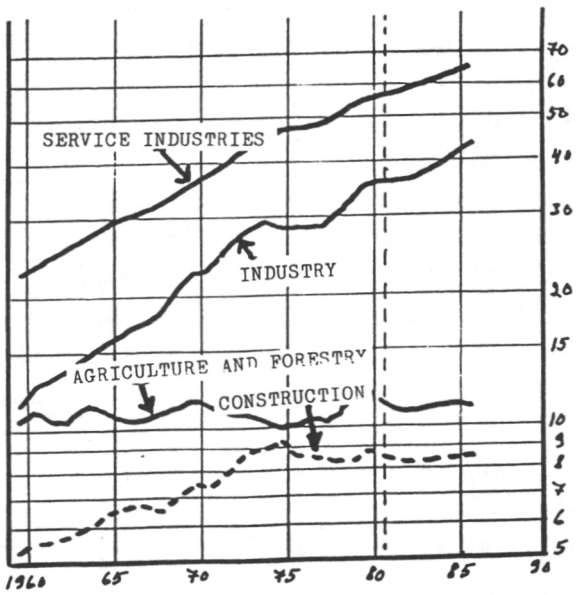

Figure 1. Gross domestic product by sectors, 1960-86, bill. mk at 1975 prices.

The growth in the volume of construction after the middle 1960's has been clearly slower than the growth of GDP and of the greatest sectors, industry and services. In the years 1976-81 the volume of construction has been on average unchanged although the annual changes were big. The share of construction in GDP was 7,9 % in 1981.

The share of building construction was 73 % of the total construction in 1981. Other construction consists of roads, railways and waterways. The development in the volume of building construction and other construction in the years 1970-1983 is presented in figure 2 (Suhdanne, syksy 1982). The growth rate of building construction has been earlier clearly faster than the growth of other construction. The annual changes in the volume of other construction were not so great as in the volume of building construction.

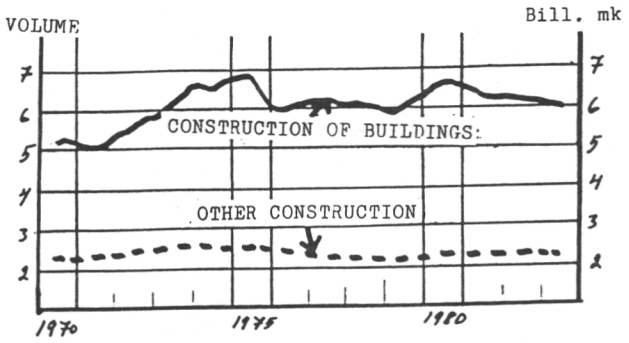

Figure 2. Volume of construction, bill. mk at 1975 prices in 1970-83.

The development of new building construction in the years 1960-1981 is presented in figure 3 (Talonrakennus 1960-1981). The volume of buildings completed includes the volume of new buildings and enlargements of old buildings which have been granted building permission. The new building construction has increased during the 1960's and the first half of the 1970's. After the middle of the 1970's the volume of buildings completed has decreased. The volume of buildings was 22 mill. m^3 in 1960 and 42 mill. m^3 in 1980. The proportion of the wood-framed buildings was 36 % in 1960 and 30 % in 1970. During the 1970's the proportion of wood-framed buildings has increased rapidly being 46 % in 1980.

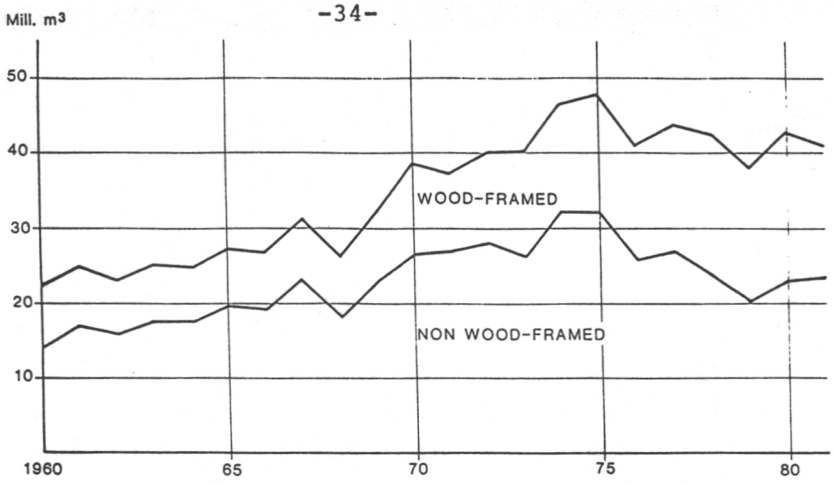

Figure 3. Buildings completed in 1960-1981, mill. m^3.

The development of the production of new dwellings in 1965-1982 is presented in figure 4 (Asuntotuotanto 1965-1982). The production of new dwellings increased rapidly after the middle of the 1960's (40 000 dwellings in 1965) and was at its highest in 1974 (72 000 dwellings). In the latter half of the 1970's the number of dwellings completed has decreased continuously to about 46 000 in 1982.

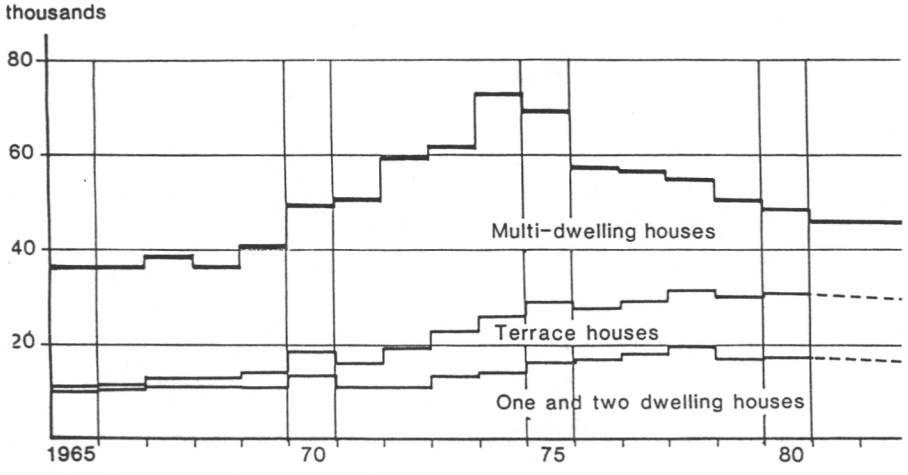

Figure 4. Dwellings completed in 1965-1982 by type of building.

The proportion of one and two dwelling houses and terrace houses was at its lowest at beginning of 1970's (30 %) but has increased rapidly during the 1970's and was 60 % in 1980. The average floor space per dwelling of all dwellinngs has increased during the whole period, being 63 m^2 in 1965 and 80 m^2 in 1980. The average floor space of the multi-dwelling houses and terrace houses has decreased a little during in the same period, but the floor space of one and two dwelling houses has increased rapidly, on average 2 m^2 per year. It was 113 m^2 in 1980.

The building volume of dwellings completed has not decreased so much as the number of dwellings in the latter half of the 1970's. The reason is that the floor space of the one and two dwelling houses has increased year after year during the whole time of the 1970's. The production of buildings other than residential buildings has been uniform. The decrease of new building construction as a whole in the latter half a the 1970's can be explained to a great measure by the decrease of the production of multi-dwelling houses.

The building volume produced between 1970-1980 by building type is presented in figure 5 (Talonrakennus 1970-1980). The building volume produced is calculated in this figure as the average volume of the buildings completed and buildings started. The total building volume produced was 38-39 mill. m^3 at beginning of the 1970's, 47,5 mill. m^3 in 1975 and 44 mill. m^3 in 1980. The building types used in the figure are the same as in the investigation: "The use of sawnwood and wood-based panels in new building construction in the 1970's" (presented in ch. 3).

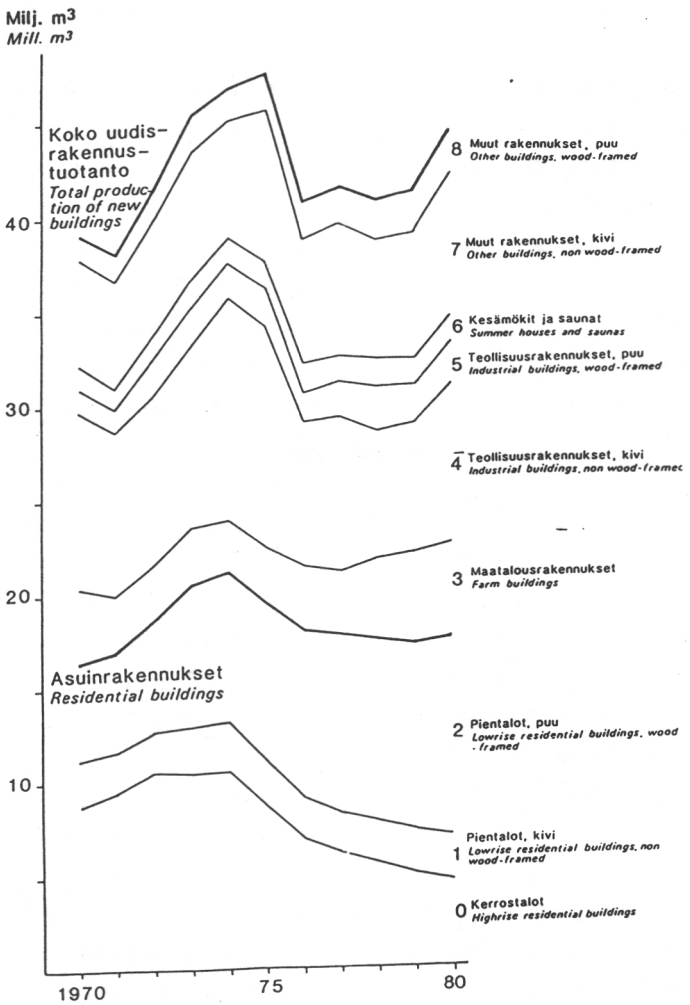

Figure 5. Production of new buildings in 1970-80 mill. m^3, (buildings completed + building works started)/2.

The production of highrise residential buildings (multi-dwelling houses) increased in the early part of the 1970's and was at its highest (10,5 mill. m^3) in 1974 but after that it has decreased very rapidly and was 4,7 mill. m^3 in 1980. The lowrise residential buildings include one and two dwelling houses and terrace houses. The production of the non wood-framed lowrise residential buildings has been rather uniform during the 1970's (2-2,5 mill. m^3 per year).

The building volume of the wooden lowrise residential buildings produced in 1970 was 5,1 mill. m^3 and 10,5 mill. m^3 in 1980. This very fast increase in production of wooden lowrise residential buildings has raised their proportion in the total production of residential buildings from 30 % in 1970 to 60 % in 1980.

The development of production of building types other than residential buildings has been more regular. The production of farm buildings, wood-framed industrial buildings and other buildings has increased a little during the 1970's.

There are no statistics on or estimates of the development of total building repair and modernization work. The basic repair of dwellings has increased rapidly after 1974. The number the basic repair works of dwellings started in the period 1974-1981 with state aid is presented in the following table (Rakennuspuusepän... 1981).

Year	1974	1975	1976	1977	1978	1979	1980	1981
Number of dwellings	1269	3226	3665	3877	4028	4615	5110	5197

The total number of dwelling basic repair works was estimated to be 11 000 in 1976 and 13 000 in 1980. In addition to these basic repair works improvements to the insulation of buildings has been important. The number of repair works of this kind has been estimated to be about 10 000 dwellings per year.

The production of doors, windows and built-in fittings is nearly the same as the utilization of these products in Finland because the share of export (5-6 %) and import (1 %) is very small. The use of joinery products follows the development of building construction very closely, particularly residential building construction (Kaskela 1978). The production

of doors has been rather stable during the 1970's. The production of windows and built-in fittings increased during the first half of the decade following the large increase in production of new dwellings and in the latter half of the decade following the increase of building repair.

3. STUDY OF THE USE OF WOOD PRODUCTS IN NEW BUILDINGS

3.1. The purpose of the study

The purpose of this investigation was to describe the use of sawnwood and wood-based panels in new building construction in Finland by building types and by end-uses in the 1970's (Valtonen 1982). The investigation was divided into the following tasks:

1. to estimate the use of sawnwood and wood-based panels per unit of volume built in 1975, by building types;
2. to estimate the total use of sawnwood and wood-based panels in new buildings completed in 1975, by building types;
3. to investigate the proportional distributions of the use of sawnwood and wood-based panels by end-uses (by building components) in different buildings types, and to calculate the total quantities used by end-uses in 1975;
4. to investigate the distribution of sawnwood used in new building construction by processing grade, quality, dimension and form of use;
5. to investigate the distribution of plywood, particle board and fibreboard used in new building construction by board type, processing grade and thickness.

3.2. The material and methods

This investigation was a sample survey, and the population comprised of the new buildings and enlargements of old buildings completed in 1975 according to house construction statistics of Finland. These statistics included all new buildings and enlargements which have been granted building permission. A sample unit was a building and the sample size was 700 buildings. The sampling method was stratified systematic sampling. The sampling frame was a register of the house construction statistics, in which the buildings are ordered according to their regional situation.

Systematic sampling therefore quaranteed the regional coverage of the sample over the whole country. The population was stratified into nine strata according to building type. The purpose of the stratification was that the use of sawnwood and wood-based panels in a strata would be as homogenous as possible.

The material was gathered by analysing the drawings of the sample building and it was completed by interviewing the owners, builders or building inspectors. The quantities of sawnwood and wood-based panels used in sample building were gathered from drawings, and other available papers relating to the buildings in the offices of building inspectors of the communes. In the interviews, an attempt was made to determine the building material employed where the material was not marked in the drawnings or where the material had been changed after planning.

The consumption of sawnwood and wood-based panels was estimated by the formula of stratified random sampling. As an estimator of quantities used per unit of volume built, the ratio estimator based on the volume of building was used. The consumption of sawnwood and wood-based panels by end-uses were calculated as proportional distributions of the quantities used in the sample buildings in each strata of building type. The total

consumption by end-uses was calculated on the basis of the total quantities used in new buildings completed in 1975. The consumption of sawnwood and wood-based panels by processing grade, dimension, quality, etc. was calculated by the same method.

3.3. The results

In this investigation, sawnwood and wood-based panels use in doors, windows and prefabricated built-in fittings were excluded. Also excluded were quantities lost during the building work. The quantities presented in this study therefore describe the net use of new sawnwood and wood-based panels in new building construction. The total use of sawnwood and wood-based panels per unit of volume built is described by building type in table 1.

Table 1. The use of sawnwood and wood-based panels per unit of volume built by building type.

Building type	Total use m^3/100 m^3 built	
	sawnwood	panels
Highrise res. buildings	0,66	0,15
Lowrise res. buildings, non-wood-framed	3,73	0,82
Lowrise res. buildings, wood-framed	4,78	1,45
Farm buildings	2,60	0,14
Industrial buildings, non-wood-framed	0,37	0,08
Industrial buildings, wood-framed	1,32	0,12
Summer houses and saunas	8,45	0,58
Other buildings, non-wood-framed	0,96	0,13
Other buildings, wood-framed	3,80	0,48

The differences in the use of sawnwood and wood-based panels between the building types were very large. Summer houses and saunas had the largest use of sawnwood per unit of volume built, being nearly two times larger than in wooden lowrise residential buildings. The smallest use of sawnwood per unit of volume built was in the non-wood-framed industrial buildings, highrise residential buildings and other buildings. The wooden lowrise residential buildings had the largest use of wood-based panels per unit of volume built. Other lowrise residential buildings had 60 %, summer houses and saunas 40 % and wooden other buildings 30 % of the use of panels per unit of volume built of the wooden lowrise residential buildings.

The variance estimates of the ratio estimates by building type were relatively large. This implies a considerable variation in the use of sawnwood and wood-based panels in each building type. The 90 % confidence limits were also large in this sample size. However, the confidence limits were smaller for lowrise residential buildings, summer houses and saunas and other wooden buildings types. These were the most important building types in this study because of their relatively large use of sawnwood and wood-based panels.

The total use of sawnwood and wood-based panels in new building construction by building type in 1975 is presented in table 2, and by end-use in table 3.

Table 2. The total use of sawnwood and wood-based panels by building type in 1975.

Building type	Sawnwood		Wood-based panels	
	1000 m^3	%	1000 m^3	%
0. Highrise residential buildings	64	6	15	7
1. Lowrise residential buildings, non wood-framed	99	10	22	11
2. Lowrise residential buildings, wood-framed	400	41	119	59
3. Farm buildings	73	8	4	2
4. Industrial buildings, non wood-framed	42	4	9	5
5. Industrial buildings, wood-framed	27	3	2	1
6. Summer houses and saunas	124	13	9	5
7. Other buildings, non wood-framed	71	7	10	5
8. Other buildings, wood framed	76	8	10	5
Total use	976	100	200	100

Table 3. The total use of sawnwood and wood-based panels by end-use in 1975.

End-use	Sawnwood		Wood-based panels	
	1000 m^3	%	1000 m^3	%
1. Roof	314	38	5	3
2. Uppermost floor	112	13	34	18
3. Intermediate floor	18	2	5	3
4. Ground floor	55	7	10	6
5. External wall	192	23	36	19
6. Internall wall	110	13	87	47
7. Built-in fitting etc.	30	4	7	4
Structural use total	831	100	184	100
8. Temporary use	145		15	
Total use	976		199	

The total use of sawnwood in framework was 453 000 m^3 (46 % of total use) and in facing including roof boarding 348 000 m^2 (36 %). The balance (18 %) was built-in fittings, formwork, scaffolding and other temporary use material (without division to framework and facing material). The built-in fittings included only the fittings fabricated on the site. The total consumption of wood based panels in new buildings in 1975 was 198 600 m^3, of which the proportion of plywood was 17 800 m^3. The use of particle board was 130 000 m^3 and of fibreboard 50 800 m^3.

4. DEVELOPMENT IN THE USE OF WOOD-PRODUCTS IN CONSTRUCTION

The use of sawnwood and wood-based panels in new building construction in 1970-1980 by building type is described in figures 6 and 7. The consumption in different years was calculated, by building type, on the basis of quantities used per unit of volume built and the building volume produced in those years (Valtonen 1982).

The use of sawnwood in new building construction increased very rapidly during the years 1972-74. Since then the increace has been slower. The proportion of residential buildings was over 50 % of the total use and that proportion has increased during the whole 1970's. The proportion of the total use going to wood-framed lowrise residential buildings has increased from 33 % in 1970 to 45 % in 1980. The use of sawnwood in highrise residential buildings has decreased since 1974.

The use of wood based panels in new building construction has increased relative to the use of sawnwood. The proportion of residential buildings in the total use was 75 % in 1970 and 80 % in 1980. The proportion of the wood-framed lowrise residential buildings in the total use has increased from 50 % in 1970 to 70 % in 1980. The total use of plywood has

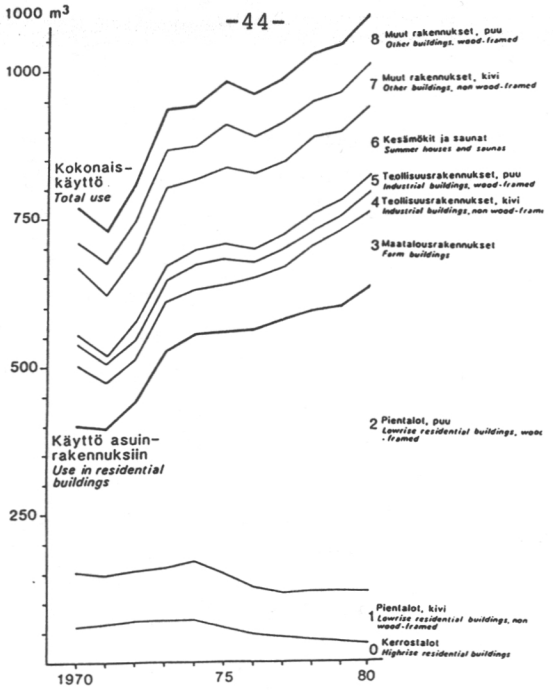

Figure 6. Use of sawnwood in new building construction in 1970-80 by building types, 1000 m^3.

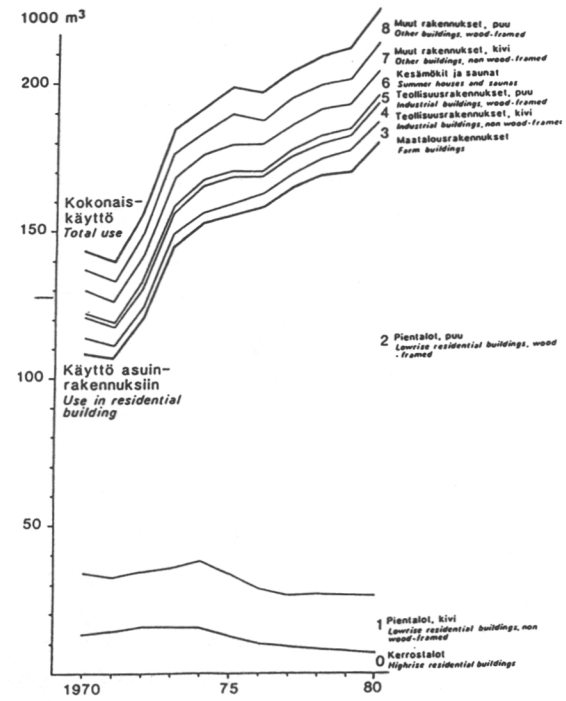

Figure 7. Use of wood-based panels in new buildings in 1970-80 by building types, 1000 m^3.

been very stable during the 1970's. The use of fibreboard has increased a little but the increase of use of particle board has been very rapid in the 1970's.

The total use of sawnwood and wood-based panels in new building construction has increased throughout the 1970's, although the total building volume produced has clearly decreased after the middle of the decade. The reason is that in the latter half of the decade the production of those building types has increased in which the use of sawnwood and wood-based panels per unit of volume built is relatively large.

The estimated total use of sawnwood and wood-based panels in construction in 1980 by sub-sectors is presented in table 4. The estimates of the use of sawnwood and wood-based panels in building repair, joinery and other construction are based on the estimates made by The Laboratory of Building Economy of the Technical Research Centre (Pajakkala-Lyytikäinen 1981).

Table 4. The estimates of the total use of sawnwood and wood-based panels in building construction in 1980 in Finland, 1000 m^3.

	Sawnwood		Wood-based panels	
New buildings[1]		1 200		240
- structural use	1 040		220	
- temporary use	160		20	
Building repair [2]		300		150
Joinery		220		90
- windows[2]	100		-	
- doors[2]	70		10	
- built-in fittings[1]	50		80	
Glue-laminated wood[2]		50		
Building construction total		1 780		480
Other construction		150		20
Construction total		1 930		500

The use of sawnwood and wood-based panels in building repair has increased very rapidly during the latter half of the 1970's. The estimated use of sawnwood in building repair in 1980 was about 300 000 m^3 of which 200 000 m^3 was used in residential buildings. The most important end-uses were framework for partition walls, external and internal facing of walls and facing boards for floors. The proportion of each was about 20 % of the total use.

The estimated use of wood-based panels in building repair in 1980 was 150 000 m^3 of which nearly all was used in residential buildings. The biggest proportion (over 50 %) was used in the internal facing of walls. Other important end-uses were ceilings and facing boards for floors.

The estimated use of sawnwood in windows was about 100 000 m^3 in 1980, of which 80 % was used in new buildings and 20 % in building repair. The estimated use of sawnwood in doors was about 70 000 m^3 of which 70 % was used in new buildings and 30 % in building repair. The estimated use of wood-based panels in doors was about 6 000 m^3.

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UNIVARIATE STOCHASTIC MODELS AND TRANSFER FUNCTION MODELS FOR SHORTTERM PROGNOSIS OF SAWNWOOD EXPORT PRICES TO WEST GERMANY - SOME PRELIMINARY RESULTS

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ABSTRACT

This paper describes some preliminary efforts of making monthly prognosis models of the f.o.b. prices of spruce sawnwood export from Sweden to West-Germany. The Box-Jenkins procedure is applied to arrive at three univariate stochastic models and two transfer function models. Two of the models are developed based on data from January 1974 to September 1981 and tested as to predictive power for the period September 1981 - July 1983. In addition, prognosis including corresponding probability limits are estimated for the period August 1983 - December 1983.

Of the explanatory variables tried in the transfer function models, only nominal interest rate in West-Germany gives a statistically significant contribution. In the prediction test the univariate transfer function model gives slightly better predictions than the univariate stochastic model. It is concluded that the developed models seem promising, and that other explanatory variables and quarterly instead of monthly models should be tried.

1 INTRODUCTION

This paper aims at describing some preliminary efforts of making short-term (monthly) prognosis models of the f.o.b. prices of spruce sawnwood export from Sweden to West-Germany.

West-Germany is the most important country for the Norwegian sawnwood export, besides England. Our export on this market is small compared to the total, and is not likely to influence prices significantly. Such prognosis models for the spruce sawnwood prices, if good enough, may therefore be of practical interest in Norway in several ways. First, they could indicate for the sawmill owners the preferability of selling today, or wait, on this market, and for the forest owners the preferability in cutting today or wait for higher sawlog prices[1]. Secondly, such models may be of some interest in the annual timber price negotiations between the forest owners' and the sawmill owners' associations. Thirdly, the prognosis may give useful indications as to Swedish competition in the Norwegian sawnwood market.

2 METHOD

2.1 Hypotheses

The Box-Jenkins procedure used in this analysis (cf. Ch. 2.3) is characterized by an iterative approach to model building.

First, major hypotheses are set about what factors influence the output variable. Here, one may use economic theory or other behaviour theory. However, unlike traditional

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[1] Sawlogs account for more than 70 % of the stumpage value in Norway.

econometrics, the Box-Jenkins method does not specify the complete model ex ante. In this approach the data itself play an important role in defining for example the most significant lag structures of the output and the input variables to be included in the model. As such, the Box-Jenkins approach is not suited for testing completely specified hypotheses about, say, lag structures, but to be used for mapping what the actual lag structures most likely are, given the empirical data at hand and the ex ante hypothesis about what causal structures are involved. For prognosis purposes, this is an advantage, as the approach gets the best prediction power out of the given hypothesis and the data at hand.

Regarding factors affecting the price of spruce sawnwood export from Sweden to West-Germany (hereafter referred to as y), many variables could ex ante be classified as important, for example:

- The interest rate (nominal as well as real term) in USA influencing e.g. (a) the building activities and economic growth in USA and then the supply of sawnwood from Canada to West-Europe; (b) the interest rate in West-Germany and then the building activities and economic growth there; (c) foreign exchange rates

- The price and quantity of the supply of sawnwood from Sovjet-Union

The influence of these factors is of considerable interest for further investigations. However, at the present stage, I have not taken them into consideration, partly because of lack of data, and partly because these factors are judged to be quite "far out" in the causal chain influencing y, and other factors being "closer" to y should be investigated first. I have, therefore, concentrated on the following factors as explanatory variables for y (these variables are defined in Ch. 2.2.):

- Building activity in West-Germany
- Interest rate (nominal) in West-Germany
- Interest rate (real term) in West-Germany
- Stock of sawnwood in West-Germany
- Stock of sawnwood in Sweden

A causal diagram illustrating my hypothesis about which factors are important for the monthly fluctuations of y_t is presented in Figure 1. Because univariate transfer models are being used, the implications indicated by the dotted arrows are not included in the analysis (cf. Ch. 2.3). It should be emphasized that time lags are assumed important for most of the causal relationships described in Figure 1.

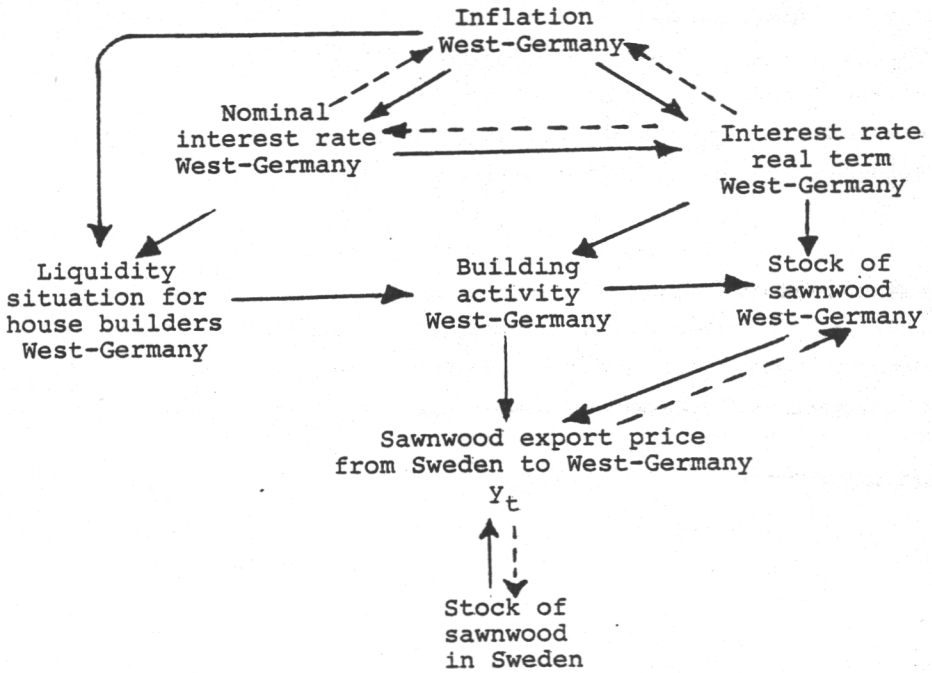

Figure 1. Hypothesis about factors influencing monthly price of sawnwood export from Sweden to West-Germany.

As this work concentrates on monthly prognoses (possibly quarterly), changes in income or industrial production is not likely to influence y in addition to what is already embodied in the interest rates.

2.2 Data input

The output variable y which is to be forecasted, is the monthly price in Sw.kr per m^3 (deflated to 1970 price level) of spruce (Picea abies) sawnwood exported from Sweden to West-Germany. Actual observations of this variable from January 1974 to July 1983 is obtained from the National Central Bureau of Statistics, Stockholm under the CCN classification 44.05.106, by dividing the value of the total monthly sales f.o.b. with the corresponding total volume of sawnwood. The observed time series is shown in Figure 2.

This price is deflated by using the consumer price index of Sweden as reported in CBS a, Table "Int".

Quarterly[1] account of the change in stock volume of sawnwood in Sweden is obtained from CBS b.

Quarterly[1] account of the stock of sawnwood in West-Germany is obtained from STATISTISCHES BUNDESAMT a.

Building activity in West-Germany is covered by two separate monthly time series, both taken from STATISTISCHES BUNDESAMT b, Table "Erteilte Baugenehmigungen für Bauvorhaben des Hochbaus":

1. "Genehmigte Wohngebäude"
2. "In den genehmigten Bauvorhaben geplante Wohnungen in Wohnbauten"

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[1]Monthly data have not been obtainable.

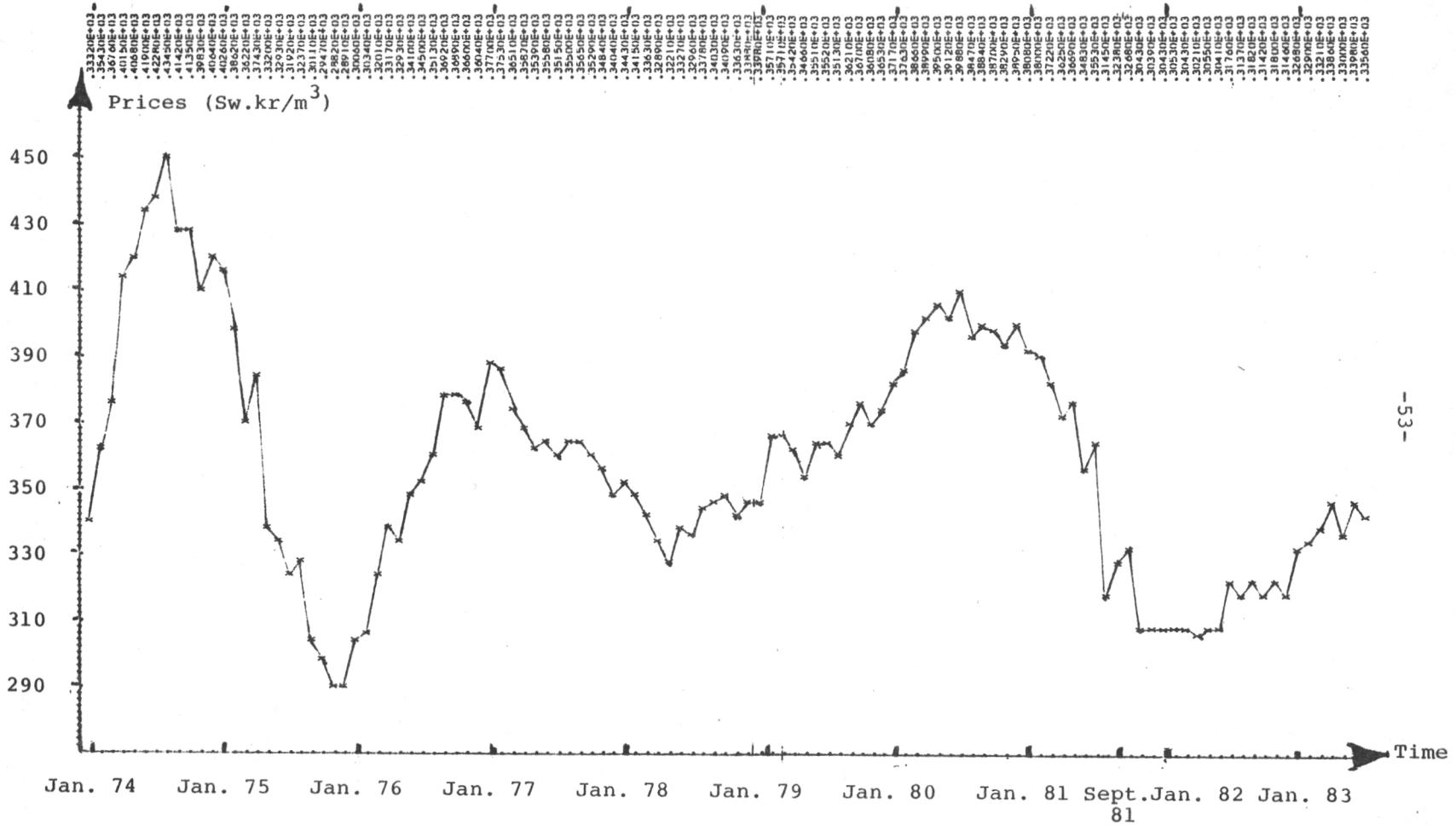

Figure 2. Monthly prices of spruce sawnwood export from Sweden to West-Germany for the period January 1974 to July 1983 (Sw.kr/m^3, 1970 prices, each price observed written at top of figure).

Monthly data for the nominal interest rate in West-Germany is taken from BUNDESBANK, Table 6, "Sollzinsen, Kontokorrentkredit unter 1 Mio DM".

Monthly data for the real term interest rate in West-Germany are arrived at by adjusting the above mentioned nominal interest rate with the 12 month consumer price increase for West-Germany as recorded in CBS a, Table "Int".

2.3 Statistical method

The statistical analysis is based on the Box-Jenkins modelling approach as described e.g. in BOX & JENKINS (1976) and JENKINS (1981).

A model which describes the probability structure of a sequence of observations is called a stochastic process. A time series of N successive observations $\underline{z} = (z_1, z_2, \ldots, z_n)$ is regarded as a sample realization, from an infinite population of such samples, which might have been generated by the process. A major objective of statistical investigation is to infer properties of the population from those of the sample. To make a statistical forecast may be viewed as to infer the probability distribution of a future observation from the population, given a sample $\underline{z}$ of past values. For this, the Box-Jenkins approach differentiates between 5 classes of models (JENKINS op.cit.): Univariate stochastic models, univariate transfer function models, intervention models, multivariate stochastic models and multivariate transfer function models.

The univariate stochastic models represent the simplest forecasting situation to forecast the future of a time series from a knowledge of its past history only. Univariate transfer function models forecast one output time series based on the past history of this series and of other related input variables. It is assumed that the input

variables are not influenced by the output variable. Intervention models are models which incorporate the influence of exceptional external events (for example strikes, trade regulations, changes of foreign exchange rates). Multivariate stochastic models forecast several time series simultanously assuming they have mutual interactions or feedback over time. Finally, multivariate transfer function models are used when it is necessary to relate several mutually interacting output variables to several input variables.

The types of models used in this analysis are the univariate ARIMA (Autoregressive Integrated Moving Average) model, and the univariate transfer model.

The ARIMA (p, d, q) model of time series may be defined as (BOX & JENKINS 1970:88-92):

$$(1) \quad \phi(B)\nabla^d z_t = \theta(B)a_t$$

where

z_t is the value of z at time t

$\phi(B)$ is the autoregressive operator defined by
$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 \ldots \phi_p B^p$

$\nabla^d z_t = z_t - z_{t-d}$

$\theta(B)$ is the moving average operator defined by
$\theta(B) = 1 - \theta_1 B - \theta_2 B^2 \ldots \theta_q B^q$

a_t is the residual at time t

$B^s z_t = z_{t-s}$

p, d, q are integers greater than zero

ϕ_i and ϕ_j are coefficients i=1,p and j=1,q

BOX & JENKINS (op.cit.:137) shows that, for at least 50 observations the $1-\varepsilon$ profitability limits for the k steps ahead forecast done at time t, is given by:

$$(2) \quad z_{t+k}(\pm) = \hat{z}_t(k) \pm u_{\varepsilon/2} \left\{1 + \sum_{j=1}^{k-1} \psi_j^2\right\}^{1/2} s_a$$

where

$u_{\varepsilon/2}$ is the deviate exceeded by a proportion $\varepsilon/2$ of the unit Normal distribution

s_a is the estimated standard deviation of the residual a_t

the Ψ weights are defined by:

$$\varphi(B)\ (1 + \Psi_1 B + \Psi_2 B^2 + \ldots) = \theta(B)$$

$$\varphi(B) z_t = \theta(B) a_t \quad \text{(cf. (1))}.$$

all other variables are as defined under (1).

A single output transfer function model relates in general an output variable z_t to several related input series x_{1t}, x_{2t}, ..., x_{nt}, it being assumed that the inputs affect the output but that the output does not affect the inputs. To the extent that the inputs do not fully explain the output it is necessary to add a noise model or error model which describes the discrepancies.

A single output single input transfer function may be written as:

$$(3) \quad z_t = v(B)x_t + N_t$$

where

$v(B)$ is a transfer function with rational lag structure applied to the explanatory variable x_t

N_t is a noise model which is a seasonal ARIMA model

This model may be parsimoniously parameterized in the form (BOX & JENKINS 1976:378):

$$(4) \quad z_t = \delta^{-1}(B)\omega(B)x_{t-b} + N_t$$

where

$\delta(B) = 1-\delta_1 B - \delta_2 B^2 \ldots \delta_r B^r$

$\omega(B) = \omega_0 - \omega_1 B \ldots \omega_s B^s$

b, r and s are integers greater than zero

δ_i and ω_j are coefficients i=1,r and j=1,s

B is defined as in (1)

In similar way as with (2), one can use (4) to estimate the $1-\varepsilon$ probability limits for the k steps ahead forecast (op.cit.:405).

In practice we have the finite time series $z_1, z_2, \ldots, z_N$ and $x_1, x_2, \ldots, x_N$ of N observations from which we can only obtain estimates of the model (4). To get the best estimates, the minimum mean square error procedure of BOX & JENKINS (1976:208-284) is used.

Each of the 5 explanatory variables defined in Ch. 2.2 are analysed to find any significant correlation with y. For multivariate transfer analysis possibly done later, it is postulated that if one variable does not show any statistical significant connection with y in a univariate transfer model, it will neither be of interest as explanatory variable in a multivariate transfer model for y.

The final criterion for judging a model is the accuracy of its prediction. The predictive power of the univariate stochastic and transfer models arrived at is tested by dividing the empirical data in two groups - before and after September 1st, 1981. The models are calculated based on the data from January 1974 to September 1981, and are tested for the period September 1981 to July 1983.

In addition prognoses are made for the period August 1983 - December 1983 with corresponding probability limits.

3 RESULTS

3.1 Univariate analysis

3.1.1 Estimated models

The univariate model arrived at based on data for the time period January 1974 - September 1981 is the ARIMA model:

(5) $(1+0.53B)\ (1-B)^2 y_t = (1-0.52B)a_t$

with residual standard deviation 10.65

where

y_t is average price per m^3 (Sw.kr f.o.b.) of sawnwood export from Sweden to West-Germany in month t

B is backward operator defined as $B^s y_t = y_{t-s}$, s=1,2,..,t-1

a_t is the residual in month t

Based on the data from January 1974 to July 1983 the estimated model changes slightly by introducing 22 more time periods. The new model is:

(6) $(1+0.45B)\ (1-B)^2 y_t = (1-0.58B)a_t$

with same symbols as in (5) and a residual standard deviation of 10.20.

There is a slight seasonal variation in the data. Taking account of this, the following model is arrived at (based on the data from January 1974 to July 1983):

(7) $(1+0.45B)\ (1-B)^2 y_t = (1-0.58B)\ (1+0,30B^{12})a_t$

with same symbols as in (5) and a residual standard deviation of 9.94.

3.1.2 Test of predictive power

Model (5) was tested for the 22 periods from September 1981 to July 1983 by comparing the model's prognosis with the actual empirical data. The result is shown in Table 1. It is for example seen from the first column that the prognosis for the first, second and third month after September 1st, 1981 are respectively 302, 296 and 282 Sw.kr/m^3. From the next column it is seen, first, that the actual export prices for these three periods were

Table 1. Prediction test of model (5) for the 22 months from September 1981 (Sw.kr/m^3, 1970 prices).

Months ahead of Sept. 1981	Updated forecasts after 3, 6, .., 22 months ahead (below dotted line) and actual values (above dotted line)								
	0	3	6	9	12	15	18	21	22
1	302	327							
2	296	304							
3	282	304							
4	272	292	304						
5	261	286	305						
6	250	276	304						
7	239	269	303	302					
8	228	260	302	306					
9	216	252	301	304					
10		244	300	305	318				
11		236	299	305	314				
(Sept.82) 12		228	298	305	318				
13			297	305	319	314			
14			296	305	322	318			
15			295	305	325	315			
16				305	327	316	327		
17				305	329	316	329		
18				306	332	316	332		
19					334	316	336	339	
20					337	316	340	330	
21					339	316	343	340	
22						316	347	338	336
23						316	350	342	340
(Sept.83) 24						316	354	343	340
25									342
26									343
27									344

respectively 327, 304 and 304 Sw.kr/m^3. Secondly, it is seen that the model's prognosis for the 6 months ahead of December 1st, 1981 are respectively 292, 286, 276, 269, 260 and 252 Sw.kr/m^3. The corresponding actual prices are shown in the third column (304, 305, 304 Sw.kr/m^3) for the first three months and in the fourth column (302, 306, 304) for the last three months.

It is seen that the prognosis from September 1st, 1981 (first column) predicts the actual price fall at the end of 1981, but is not capable of mapping the price stabilization at the beginning of 1982 (period 4 to 9), as the prognosis just shows a steady lowering of prices. The predictions presented in Table 1 have the following mean errors and corresponding standard deviations:

	Mean prediction error	Standard deviation of mean prediction error
Prediction 1 month ahead	- 7.0	10.0
" 2 " "	- 5.6	9.9
" 3 " "	- 9.9	13.7
" 4 " "	- 14.9	16.4
" 5 " "	- 22.0	18.6
" 6 " "	- 26.7	22.0
" 7 " "	- 33.5	28.0

3.1.3 Prognosis

The prognosis with model (7) for the 5 months ahead of last observation (July 1983) is shown in Table 3, together with the 50 %, 70 % and 95 % confidence intervals, estimated by using (2). In brackets are shown the corresponding prices in July 1983 prices.

It is for example seen (from the third line) that the most likely estimate for the October price is 342[1] (1098[2])

---

[1] In 1970 prices

[2] In July 1983 prices

Sw.kr/m^3, and that it is a 25 % probability of the price being higher than 356[1] (1143[2]) Sw.kr/m^3, a 12.5 % probability of the price being higher than 365[1] (1172[2]) Sw.kr/m^3, and a 2.5 % probability of the price being higher than 382[1] (1226[2]) Sw.kr/m^3. Following the same line to the left, it is seen that it is a 25 % probability of the price being lower than 328[1] (1053[2]) Sw.kr/m^3, a 12.5 % probability of the price being lower than 319[1] (1024[2]) Sw.kr/m^3 and a 2.5 % probability of the October price being lower than 302[1] (969[2]) Sw.kr/m^3.

3.2 Transfer model results

3.2.1 Estimated models

At the present stage only the following 6 explanatory variables have been tried for transfer modelling[3]: Building activity (2 series) in West-Germany (based on quarterly data), stock of sawnwood in West-Germany (based on quarterly data), stock of sawnwood in Sweden (based on quarterly data), interest rate real term (monthly data deflated by the consumer price index) in West-Germany, and nominal interest rates in West-Germany (monthly data).

It has not been possible to find any significant correlation between y and any of the first 5 of these variables. Only the nominal interest rate in West-Germany gives a statistically significant contribution to the explanation of the variation in y.

Based on the data from January 1974 to September 1981 the following transfer model was calculated:

---

[1] In 1970 prices

[2] In July 1983 prices

[3] Cf. Ch. 2.2 for a definition of the variables.

$$(8)\quad (1-B)^2 y_t = (-12.86 + 9.78B)\ (1+0.74B)^{-1}(1-B)x_{t-3} + (1-0.77B)a_t$$

where y_t, a_t and B are as defined in (5), and x_t is nominal interest rate in West-Germany in month t as defined in Ch. 2.2. Residual standard deviation of this model is 10.05.

When the estimation was done for the period January 1981 to July 1983 - i.e. including 22 more periods - the following model was arrived at:

$$(9)\quad (1-B)^2 y_t = (-6.51 + 4.13B)\ (1+0.88B)^{-1}(1-B)\,x_{t-3} + (1-0.72B)a_t$$

with the same symbols as in (8). Residual standard deviation of this model was 9.97. It is seen that x_t has some less influence in (9) than in (8).

3.2.2 Test of predictive power

Model (8) was tested for the 22 periods from September 1981 to July 1983. The result is shown in Table 2, which should be interpreted as described in Ch. 3.1.2 for Table 1.

It is seen from Table 2 that the same pattern as in Table 1 emerges. The price stabilization at the beginning of 1982 is better covered in Table 2 than in Table 1. The predictions presented in Table 2 have the following mean errors and corresponding standard deviations:

	Mean prediction error	Standard deviation of mean prediction error
Prediction 1 month ahead	- 3.3	10.7
" 2 " "	- 1.7	7.1
" 3 " "	- 3.0	9.4
" 4 " "	- 5.0	15.3
" 5 " "	- 9.3	17.8
" 6 " "	- 12.0	20.0
" 7 " "	- 16.3	26.5

Table 2. Prediction test of model (8) for the 22 months from September 1981 to July 1983 (Sw.kr/m^3, 1970 prices)

Month ahead of Sept. 1981	Updated forecasts after 3, 6, .. 22 months ahead (below dotted line) and actual values (above dotted line)								
	0	3	6	9	12	15	18	21	22
1	311	327							
2	306	304							
3	295	304							
4	289	301	304						
5	279	293	305						
6	272	291	304						
7	263	284	300	302					
8	255	280	299	306					
9	247	274	296	304					
10		270	294	308	318				
11		264	292	310	314				
(Sept.82) 12		259	290	311	318				
13			287	313	320	314			
14			285	314	322	318			
15			283	316	329	315			
16				317	330	312	327		
17				319	337	325	329		
18				320	338	329	332		
19					344	338	337	339	
20					346	344	339	330	
21					351	351	345	340	
22						357	347	352	336
23						364	353	351	331
(Sept.83) 24						370	355	359	335
25								361	333
26									
27									

3.2.3 Prognosis

The prognosis with model (9) for the 5 months ahead of last observation (July 1983) is shown in Table 3, together with the 50 %, 70 % and 95 % confidence intervals. The figures should be interpreted as described in Ch. 3.1.3.

4 DISCUSSION

The mean prediction errors and corresponding standard deviations presented in Ch. 3.1.2 and Ch. 3.2.2 of respectively the univariate stochastic model (5) and the transfer function model (8) indicate that the latter has a lower mean prediction error, but that regarding uncertainty, indicated by the standard deviations, the two models seems fairly equal. One should be careful in drawing conclusions based on so few observations. However, the relatively small difference regarding predictive power between model (5) and model (8) could illustrate that in forecasting like this, the last price observed is a good indicator of the future price, short time ahead. It could also indicate that a better explanatory variable than nominal interest rate might be found, for example monthly data on the stock of sawnwood in Sweden and West-Germany. The quarterly data used at present on these variables, smooth the monthly variation too much to explain the monthly variations in y. It might also be that the rate of inflation alone would be a better explanatory variable than the nominal interest rate, as the former according to Figure 1 might be said to have a stronger influence on y than the nominal interest rate.

From Table 3 it is seen that the confidence intervals - i.e. the uncertainty - of model (7) and model (9) are about equal. Table 3 shows that a half confidence interval at 75 % probability limit is about 11, 18, 26, 33 and 40

Table 3. Ex ante prognosis of sawnwood export price (y)[1] from August to December 1983 with corresponding probability limits (Sw.kr/m^3 in 1970 prices)[2]

Model	Period	Value at low (1-ε) fractile			Most likely estimate	Value at high (1-ε) fractile		
		ε=0,05	ε=0,25	ε=0,5		ε=0,5	ε=0,25	ε=0,05
Model (7)	August 1983	320 (1027)	328 (1053)	333 (1069)	340 (1091)	347 (1114)	352 (1130)	360 (1156)
	September "	312 (1002)	324 (1040)	330 (1059)	340 (1091)	350 (1124)	356 (1143)	368 (1181)
	October "	302 (969)	319 (1024)	328 (1053)	342 (1098)	356 (1143)	365 (1172)	382 (1226)
	November "	291 (934)	313 (1005)	325 (1043)	343 (1101)	361 (1159)	373 (1197)	395 (1268)
	December "	277 (889)	305 (979)	321 (1030)	344 (1104)	367 (1178)	383 (1229)	411 (1319)
Model (8)	August 1983	311 (998)	319 (1024)	324 (1040)	331 (1063)	338 (1085)	343 (1101)	351 (1127)
	September "	302 (969)	316 (1014)	324 (1040)	335 (1075)	346 (1111)	354 (1136)	368 (1181)
	October "	290 (931)	308 (989)	318 (1021)	333 (1069)	348 (1117)	388 (1245)	376 (1207)
	November "				not calculated			
	December "				- " -			
Model (9)	August 1983	315 (1011)	323 (1037)	327 (1050)	334 (1072)	341 (1095)	345 (1107)	354 (1136)
	September "	306 (981)	319 (1024)	326 (1046)	337 (1082)	348 (1117)	358 (1149)	369 (1184)
	October "	293 (937)	311 (998)	322 (1034)	337 (1082)	352 (1130)	363 (1165)	380 (1220)
	November "	283 (908)	306 (982)	320 (1027)	339 (1088)	358 (1149)	372 (1194)	396 (1271)
	December "	269 (863)	299 (960)	318 (1021)	339 (1088)	379 (1217)	375 (1204)	409 (1313)

[1] As defined in Ch. 2.2

[2] In brackets are prices referring to July 1983 price level

Sw.kr/m^3 (1970 prices) for forecasts respectively 1, 2, 3, 4 and 5 months ahead for both models. This indicates that their accuracy decreases considerably with the length of the prognosis period.

It is somewhat surprising that the building activity in West-Germany cannot explain more of the fluctuations of y. One explanation could be that repair and maintenance and smaller investments using sawnwood are not recorded in the observed time-series, and are of significant size. Another explanation is that the variable used in this analysis for building activity - number of house building permits - does not adequately describe the actual building activity. A more relevant explanatory variable should be tried - e.g. the actual number of houses being under construction.

It may be of interest to test the preferability of using an intervention model (cf. Ch. 2.3) for incorporating impacts of changes in foreign exchange rates, for example the two strong devaluations of the Swedish kroner in September 1981 (about 12 % devaluation) and in October 1982 (about 15 % devaluation).

In the work ahead it would be of considerable interest to try quarterly models in addition to the monthly approach described in this paper. Quarterly based models could be an advantage because one might utilize better the information in the available sawnwood stock data described in Ch. 2.2. Some of the random monthly variations might also be reduced (for example the situation that the time lag from ordering to delivery of sawnwood varies with the business cycle). Quarterly prognosis might also be of higher interest than monthly ones for decision makers, depending of course on the size of the confidence intervals of the prognosis. However, the number of observations of y must be considerably expanded if going on quarterly models.

5 CONCLUSIONS

The Box-Jenkins approach seems promising. The prognosis models developed so far are better than one may expect, but should in general not be used for prognosis more than 5-6 months ahead.

The univariate stochastic model and the univariate transfer function model tried seem to about equal regarding predictive power and uncertainty.

Other explanatory variables than nominal interest rate in West-Germany should be tried - e.g. monthly data on stock of sawnwood in Sweden and West-Germany, rate of inflation, and records on the actual house building activity.

When more univariate transfer function models have been tested, a multivariate transfer model could be developed based on the information gained in the univariate transfer modelling and on further contacts with potential users of such forecasts. It should be kept in mind that prognosis models like those discussed in this paper, can only be useful when put into a planning context where decision makers adjust the forecasting model's results with their "inside" knowledge of the sawnwood market.

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DETERMINANTS OF SWEDISH MARKET SHARES OF PULP AND PAPER IN THE COMMON MARKET.

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ABSTRACT

There are two alternative theoretical approaches to the analysis of the development of a country's market share of forest products. One is to assume that products from different exporting countries are imperfect substitutes. Demand for a country's exports and its market share, will then depend on relative prices. If, on the other hand, products from different countries are perfect substitutes, export prices will be identical, and market shares will depend on relative unit costs of labor, raw materials and other inputs.

In this paper costs and prices are used as alternative explanatory variables together with GDP and a measure of the North American market situation, to explain the development of Swedish market shares of pulp and paper in the EEC in the period 1960-1980.

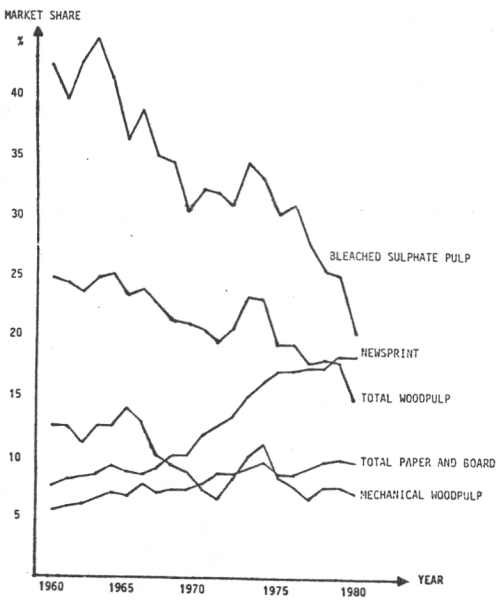
In general, the explanatory power of the cost factors, which in this study are unit labor costs and unit pulpwood prices in US$, is as high or higher, than that of relative export prices. The best results for the cost variables are found for the homogenous groups rather than for the corresponding aggregates.

1. INTRODUCTION

The EEC is the main market for Swedish exports of pulp and paper. In 1980 it accounted for 66% of total Swedish exports of pulp and 69% of the exports of paper and paperboard. The importance of the EEC, is likely to hold for the future. The annual growth of consumption of pulp in Western Europe in 1980-2000 has been estimated to 2%, and the dependence on imports of the region is expected to increase (FAO 1982). In order to explain the historical development of Swedish exports to EEC of pulp and paper, and to make export forecasts, we have also to analyze the principal determinants of the Swedish market shares. This paper contains an econometric analysis of that question.

A look at the historical development of market shares in fig 1 reveals that Swedish market shares in the Common Market have been continuously falling for mechanical and bleached sulphate pulp since the beginning of the 1960's. For total paper and paperboard as well as for newsprint there is an increasing trend for the Swedish market shares.

Figure 1 Swedish market shares in the Common Market



Which factors may account for this development? To analyze this question empirically we have to develop a theoretical framework or model.

2. TWO MODELS FOR DETERMINATION OF MARKET SHARES

There are essentially two alternative theoretical approaches to the analysis of market shares. According to the first, forest products from different countries are assumed to be near but not perfect substitutes. Such an approach, based on consumption theory, was used by Armington (1969) as the basic assumption for a model of international trade flows in manufactured goods. Since we deal with forest products, which are not consumed directly but used as inputs in other activities, consumption theory in a strict sense is not applicable. Instead, demand for forest products must be derived from the theory of production. Such an approach has been used by Buongiorno, Chou and Stone (1979) to derive the demand for US imports of forest products.

The first model may be derived in the following way. Let

$$y = f(x_1..x_n, z, k, l) \qquad (1)$$

be a production function where exports from different countries of a forest product, $x_1..x_n$, are used as inputs together with other materials (z), capital (k) and labor (l) in the production of y. Exports from different sources are thus assumed to be imperfect substitutes. For a particular forest product the function f(x) might denote a certain activity: for pulp, y is paper production, for newsprint and other printing paper, y is the output of the printing and publishing industry, for other paper y may be the activity in the retail trade. Let us assume that prices of forest products are equal to variable unit costs, which are constant and independent of output. If f(x) is a generalized Cobb-Douglas production function, and if we assume cost minimization by producers, eq (1) can be solved for the demand for exports from any country, x_i, in terms of the relative prices and the level of activity in the user sector (all other prices are assumed equal to one).

$$x = f_i(p_1..p_{n-1}, y) \qquad (2)$$

The market shares will also be functions of the activity level and relative prices.

$$s_i = \frac{x_i}{\sum_{j=1}^{n} x_j} = \phi_i(p_1 .. p_{n-1}, y) \qquad (3)$$

If the elasticity of demand for exports with respect to the level of activity are the same for all suppliers (including the domestic industry), market shares will be functions of relative price only. If this is not the case, market shares will change with the growth of production in the user sector, at unchanged prices.

The second model assumes that forest products from different countries are perfect substitutes. Export supply from each region depends on market price and (marginal) costs, which in turn is determined by the unit costs of labor (w_i), roundwood (r_i), energy and other variable factors of production (in the short run capital costs are fixed) in that region. The equilibrium condition for a particular import market is that demand equals the sum of supply from all sources, including domestic production.

$$D(y,p) = \sum_{i=1}^{n} S_i(p, w_i, r_i) \qquad (4)$$

Demand for a forest product used as an input may be assumed to depend on the activity in the user sector y and the price of the forest product (p). By solving eq (4) we can express demand for exports from each country as a function of the exogenous variables, i.e. the activity level and the relative costs of labor and roundwood in all regions.

$$x_i = x_i(w_1 .. w_{n-1}, r_1 .. r_{n-1}, y) \qquad (5)$$

The market shares will be determined by the same factors.

$$s_i = \mu_i(w_1 .. w_{n-1}, r_1 .. r_{n-1}, y) \qquad (6)$$

If the price elasticities of export supply are identical in all exporting countries, market shares will depend on relative costs only.

Otherwise, the growth of the activity in the user sector will affect market shares.

Relative export prices have been used in a large number of econometric studies of international trade to explain exports and market shares (for a survey see Stern, Francis & Schumacher 1976). In the field of forest products, Chou and Buongiorno (1982) used relative export prices to explain US exports of forest products to the EEC. In an other study Chou and Buongiorno (1982) explain United States demand for hardwood plywood imports with relative import prices. In a study of Swedish forest products exports Horn (1979) estimated the effects of current and lagged relative export prices on Swedish market shares of six groups of forest products in four countries. Relative unit labor costs have commonly been assumed to affect a country's overall competitive position and its share of world exports. To our knowledge, however, there are no studies that have used relative costs to explain changes in market shares of forest products on a disaggregated level.

3. DATA AND METHODS

We have attempted to test the explanatory power of the two alternative approaches by estimating two basic equations, where the Swedish market shares in the EEC in the period 1960-1980 were related either to the relative export prices of Swedish products, according to eq (3), or to the relative costs of the Swedish industry (eq 6). This was done for three homogenous products - mechanical pulp, bleached sulphate pulp and newsprint - and for two broad aggregates - total pulp and total paper and paperboard.

The dependent variables s_{it} are annual data for Swedish exports to EEC in per cent of apparent consumption in the EEC. The price data for different products (i) and exporters (j), p_{ijt}, are export unit values. To represent the production cost in international comparison we have used unit labor cost (w_{jt}) and the unit cost (u_{jt}) of pulpwood. The first is defined as hourly wage cost in US$ divided by production per man-hour, the second as the pulpwood price in US$. If this is divided by wood requirement per ton pulp we get the per unit pulpwood cost u_{jt}. As a proxy for the activity variables y in eq:s (7) and (8) we have used GDP in US$ in constant prices in the EEC countries.

Relative prices and costs may be obtained by dividing Swedish costs (prices) of all other exporters. However, in this paper we have chosen to relate Swedish costs (prices) to the costs (prices) of the Finnish exports of the same products. One reason for this was that the Swedish and Finnish forest industries for the three products considered are among the largest exporters to the EEC, and traditionally have been regarded as the main competitors on this market. Another reason was that empirically the Swedish wage costs relative to Finland generally seem to explain the market shares better than Swedish costs relative to any other major exporter.

To the models described in eq:s (3) and (6) we have added another explanatory variable. Since exports from the US and Canada is but a marginal part of production, one may argue that export supply is determined not so much by costs and prices relative to the European competitors, but mainly as a residual by domestic demand and supply. A fall in demand on the North American market, caused for instance by a general economic recession, will then result in an increase of the export supply from Canada and USA to the European market, a downward pressure on prices and falling market shares for other suppliers, among them Sweden. (For a discussion of this mechanism, see Lundberg and Wiberg 1981 and Brännlund, Lundberg and Wiberg 1982). To represent the state of the North American market we have used the ratio of domestic apparent consumption to capacity, m_t.

Expressed in log-linear form, the following regressions were estimated for each of the five product groups:

$$s_{it} = a_0 \cdot w_{it}^{a_1} \cdot u_{it}^{a_2} \cdot m_t^{a_3} \cdot y_t^{a_4} \qquad (7)$$

$$s_{it} = b_0 \cdot p_{it}^{b_1} \cdot m_t^{b_2} \cdot y_t^{b_3} \qquad (8)$$

where s_{it} is the Swedish market share of product (i) in year t, p_{it},w_{it} are, respectively, the Swedish relative price of product (i), and the Swedish unit costs for labor and pulpwood relative to Finland, m_t is the ratio of North American consumption to capacity, y_t is GDP in the EEC countries. (Sources: see Appendix 1).

4. RESULTS

The coefficients and the corresponding t-values in parentheses of the estimated regressions on the Swedish market shares according to eq:s (7) and (8) are shown in table 1.

Table 1 The coefficients and the corresponding t-values in parentheses of the determinants of Swedish market shares of forest products in the EEC.

Table 1a Cost equations - Exogenous variables

	w	u	m	y	Adj.R^2	DW	
S_{MP}	-1,232** (2,31)	-0,193 (1.28)	1,178** (2,54)	-0,833*** (3,21)	0,73	1,62	
S_{BS}	-0,765** (2,80)	-0,026 (0,33)	0,123 (0,51)	-0,619*** (4,66)	0,83	1,67	
S_{TWP}	-0,384 (1,44)	-0,086 (1,15)	0,357 (1,53)	-0,348** (2,70)	0,74	1,00	
S_N	-0,210** (2,43)	-0,032 (0,60)	-0,246 (1,21)	0,370*** (6,24)	0,97	1,49	
S_{TPP}	-0,126 (0,59)	0,027 (0,37)	0,795* (2,11)	0,216*** (3,12)	0,84	1,28	D_L = 0,78 D_U = 1,90

Table 1b Price equations - Exogenous variables

	p	m	y	Adj. R^2	DW	
S_{MP}	-0,642** (2,31)	1,163** (2,30)	-0,146 (1,59)	0,63	1,44	
S_{BS}	-0,118 (0,58)	-0,056 (0,16)	-0,218*** (4,22)	0,70	0,91	
S_{TWP}	-0,741 (0,73)	0,395 (1,54)	-0,128** (2,29)	0,59	1,08	
S_N	-0,067 (0,24)	-0,179 (0,54)	0,498*** (10,74)	0,96	1,21	
S_{TPP}	0,183 (0,75)	0,534 (1,48)	0,251*** (9,30)	0,86	1,40	D_L = 0,90 D_U = 1,71

* = Statistically significant at the 10% probability level
** = Statistically significant at the 5% probability level
*** = Statistically significant at the 1% probability level
MP = Mechanical pulp
BS = Bleached sulphate pulp
N = Newsprint
TWP = Total wood pulp
TPB = Total paper and board

The relative unit labor cost variable has the expected negative sign in all cases, and is significant (on the 5 % level) for bleached sulphate pulp, mechanical pulp and newsprint. The relative cost of pulpwood also seems to have the expected negative effect on market shares, except for paper and paperboard, but it is not significant in any case.

The relative price variable shows the expected negative sign in all cases except one, but is significant only for mechanical pulp. The adjusted R^2:s which measure the proportion of the variation in s_i explained by the regression, are lower for all products except total paper and paperboard in the price equations. The results indicate that the development of Swedish market shares of forest products may be explained by relative labor and pulpwood costs, alternatively by relative prices, but that the cost factors perform somewhat better than the price variables. Clearly, the wage costs of the Swedish industry relative to Finland, which in turn depends on hourly wage costs, productivity and exchange rates, seem to affect the market share of the industry much stronger than relative pulpwood costs. Not unexpectedly, the best results for the cost variables are found for the homogenous product groups rather than for the corresponding aggregates.

An increase of North American consumption relative to capacity is expected to divert exports from Europe to the home market and increase market shares of the Nordic producers in the EEC. This effect seems to be present in most product groups, but is significant only for mechanical pulp and total paper and paperboard.

The coefficient of the income variable is negative and strongly significant for all three groups of pulp except for mechanical pulp in the price equation, but positive and significant for newsprint and total paper and paperboard. The negative sign of this coefficient may indicate a relatively low price elasticity of export supply in the Swedish pulp industry. However, other interpretations are possible. Since the income variable contains a strong time trend, it may reflect various long run tendencies in the industry. One such tendency is the integration of the pulp and paper production. In the Swedish pulp and paper industry, the share of pulp production for exports has declined, and pulp is to a greater extent processed to paper and exported.

Before deriving any far-reaching conclusions about the market mechanisms and the key determinants of Swedish international competitiveness in the pulp and paper industry, based on these simple calculations, we must consider some complications not mentioned so far. First, costs and prices will obviously not be independent. In the model where products are imperfect substitutes, and firms have some scope for individual pricing, in the short run prices will vary with variable costs (as well as with demand, if firms face non-constant cost curves). This model, then, should consist of eq 8 plus an additional equation for price formation, where price is determined by wages and pulpwood prices. In fact, when we estimate eq 7 this could be interpreted as the reduced form of that model.

Second, eq:s 7 and 8 are purely static. In reality, however, one should expect a considerable inertia in the reaction of market shares on changes in prices and costs. This should be true for both models: in the first there is likely to be a lag in the supply side adjustment by different exporters to cost changes, in the second one we would expect a lagged response on the demand side by users of pulp and paper to price changes. To capture the dynamics of changing international competitiveness, the equations would have to contain lagged variables.

Third, pulpwood prices cannot strictly be treated as exogenously given. Rather, they are determined by supply and demand for pulpwood, where the latter is influenced by demand and price of pulp and paper. This calls for a model where production of pulpwood, pulp and paper, as well as pulpwood prices, are determined simultaneously by exogenous factors such as demand in the EEC, wage costs etc (For an outline of such a model see Brännlund, Lundberg & Wiberg). This may be one explanation for the poor regression results for the pulpwood price variable.

Finally, there are some statistical problems remaining that require further work. There are strong correlations between some of the independent variables, giving rise to multicollinearity. The estimated coefficients and their standard errors will therefore be sensitive to exclusion of other variables. For instance, if the income variable is dropped from the equation for paper and paperboard, the significance of both cost variables increases. Furthermore, in some of the equations, in particular for pulp, the values of the Durbin-Watson statistic indicate the presence of serial correlation and thus of a possible misspecification of the equations.

APPENDIX 1

American Paper Institute (API)	Wood pulp and fiber statistics, New York
Dominion bureau of statistics	Statistics Canada, Ottawa
FAO	Yearbook of forest products, Rome
Finnish Forest Research Institute	Yearbook of forest statistics, Helsinki
OECD	The pulp and paper industry, Paris
Skogsstyrelsen	Skogsstatistisk Årsbok, Jönköping
Svensk Officiell Statistik (SOS)	Industri, Stockholm
Swedish Employers Confederation (SAF)	Wages and total labour costs for workers, Stockholm
UN	Growth of world industry, New York
UN	Yearbook of industrial statistics, New York
UN	Yearbook of national account statistics, New York

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PRESENT STRUCTURE OF THE SWEDISH ROUNDWOOD MARKET AND LIKELY FUTURE TRENDS

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ABSTRACT

- Most private holdings are owned by non-farmers. Net income from forestry is a marginal contribution to the owner's economy.
- Private owners sell as stumpage or in combination with the buying of a logging contract, offered by the wood purchasing company.
- Most wood is in trade between consumers to secure the proper assortment for each mill and the lowest transport cost. Thus you might be both "seller" and "buyer" and pricing includes vested interests.
- Supply is highly dependent on the land-owner's expectations. He sells rather seldom and awaits the proper year.
- The key to an efficient market and a sufficient supply is the purchasing strategy in which the service for logging is an integrated part.

MAIN FEATURES OF THE MARKET

Let me first state that this is not a scientific paper. I will only describe the market on the basis of my own experience from the business.

Ownership structure

One fourth of the forest area is in the hands of pulp manufacturing companies. They also run sawmills, in which they consume a timber quantity roughly equal to what is produced on their own forest land. Their pulpmills in average consume about double as much pulpwood as produced within the company. Differencies between companies are considerable. Some get half their amount of wood from own land, while others get only 5-10%.

Companies running only sawmills, the so called "purchasing sawmills", normally have to buy all their wood as they rather seldom have got any forest land. These sawmills are dominating the wood purchasing in the south of Sweden. In the north pulpmills dominate.

About 10% of our wood come out of state owned land. Here, as well as on the company land, forestry is based on long term plans and the forest owner keeps a modern large-scale harvesting organization.

Wood from state land is sold to forest industries in rather big quantities under separate contracts, where prices are kept confidential. A slight decrease in out-put from state forests is foreseen.

The supply out of this "large scale forestry" is rather easy to forecast.

However, about 60% of the harvesting potentials comes out of about 240 thousands privately owned holdings. The average size is about 50 ha. To a great extent they are mutually owned by relatives and in total some 300 thousands individuals own forest land.

These people have no facilities to harvest the wood. They may do some silvicultural work themselves, sometimes also felling, but skidding or more mechanized harvesting has to be done by a larger organization. Thus, the forest owner has to buy this service in combination with his sales of wood. This is a very important feature in the roundwood market - the integration of purchasing wood and selling logging contracts.

The net annual income out of such a private forest would be in the order of SEK 10-15 thousands to be taxed on the margin, say by 70%. This means a marginal contribution to a family economy. The basis for the private economy is the land owner's main activity. A rather large group are farmers, but they are nowadays in minority. About 1/6 of the forest land is under the same management as some agriculture. This was a large share in former times. Nowadays most of the owners live out of salaries, wages, pensions or small sized enterpricing.

You find almost all sorts of economic situations and emotional aspects among these people and you cannot look at the forest part of the economy exclusively. All actions in forestry are highly dependent on the total economy and the general attitude of the land owner.

Land owners, combining forestry with agriculture use to put a rather stable total quantity of wood on the market every year. Individual variations are considerable, but the group as a whole normally harvest about the annual growth. The economy of these types of traditional enter-price is fairly well described in litterature.

Other forest owners - the heterogeneous majority - are much more difficult to analyze. They have to sell as stumpage or to sign a harvesting contract parallel to the sales contract. For biological reasons they cannot harvest every year, maybe every 10th or 20th. These owners, among which many live far away from their holdings, are the key factor when we judge the total supply on the market. They can be influenced upon through the purchasing strategy of the industry and there are reasons to discuss their situation a bit further.

Decisions on sales

Their decision on whether to harvest and sell or not is a very complicated one. It is highly influenced by the landowner's future expectations. Will it be better or worse to wait? Will prices increase more than costs? He can always wait if he thinks it pays. If cash is needed the land will provide enough security for loans.

If you look entirely on price/cost expectations the market provides ample opportunities for speculations as prices use to fluctuate a lot. However, you can only sell to someone who has got logging facilities on the spot. This is one of the facts that will curtail speculations.

As net income from forestry is on the margin it is also marginally taxed and Sweden has the toughest marginal taxation in the world. Net revenues from one cutting can be distributed on a series of fiscal years, but it still is marginally taxed the day you draw money out of the special account.

Purchasing in focus

A dozen purchasers/consumers of pulp wood operating regional and some 500 sawmilling companies create the total demand. They direct their purchasing over a group of some 300.000 owners of forest land trying to find those who are in the mood to make a deal on a spot where logging can be managed. Thus the availability of logging capacity is a key factor for the purchaser. Each industry will have to cover the quantity needed to keep the mills going.

Extensions of mills causing a higher wood consumption are controlled by government. You need a sort of permission or licence. Wheter or not such a permission should be issued is a tricky political decision. However, the total frame of maximum demand is settled by authorities.

About one third of the wood from the private forest owners is chanelled over Forest Owners' Associations. Their market share is traditionally higher on pulp wood than on saw logs. About half of their wood crop is logged under the management of the Association. Most of their wood is tied in long term agreements to industries, now or previously owned by the cooperatives. Associations offer the same prices on wood to all their members. Their price list is public, indicating a market price or "lowest market price".

The proper assortment

Forest industries cannot exclusively buy the assortment they need. If you consume say spruce pulp wood you have to purchase quite a lot of pine, birch and saw logs in order to cover your entire needs. This necessitates a considerable exchange of quantities between the mills. Another example is that saw mills have to sell the pulp-wood they get out of stumpage which is often done in exchange for saw logs.

Another reason for exchange of wood is that transport cost can be reduced if wood goes to the nearest mill.

Thus we notice that almost all wood will have to change owner after the first sale from the land owner. This creates a definite need for some sort of pricing and uniformed definitions on quality in order to establish an adequate value for the wood.

Logging facilities

Industries holding forest land get a basis for a harvesting organization operating on a large scale. This is used for service to the small private holdings.

To a great extent logging is carried out by contractors. These work more or less exclusively for one consumer of wood, from which they even might have a financial support. Often they are a sort of "glorified employees". This system, however, will encourage work incentives and give good machine care. This structure constitutes a strong dependence between the mills and the contractors which will stop independent trading in wood. This is one of the reasons why we have got very few separate traders of wood in the round.

To-day the access to an efficient logging organization is a necessity for the purchasing of wood.

Pricing

It may sometimes be difficult to know who represents the seller's and the buyer's interest. Saw mills buy saw logs, but sell pulp wood and chips. A pulping company might be net seller of saw logs. Forest Owners' Associations run saw mills, but sign market agreements on saw logs as sellers.

Groups of "sellers" and "buyers" use to come to annual regional agreements on prices for round wood delivered at truck road. By tradition the market forms a price at truck-road that is almost independent of the distance to the mill.

Net revenue per cu mtr at truck-road is to-day about five times as big for a final (clear) cutting as for thinnings. There might be reasons to level this out a bit. This would encourage thinnings and imply a better silviculture.

The northern part of Sweden is covered by just one agreement, including pulp wood as well as saw logs. Sellers' interest is represented and signed by the Forest Owners' Associations. Buyers' interest is represented by pulp companies and saw mills although they mostly are net sellers of one of the assortments. This agreement serves as a tool to regulate the very large exchange of wood between consumers.

In the southern half of Sweden there are regional agreements on pulp wood and saw logs separately.

Technical development of logging now indicates a more frequent harvesting of the entire stem, first of all in thinnings. So far there are no price agreements on this assortment, containing both pulp wood and fuel wood in a mixture.

It is important to notice that there are no market agreements on logging service nor on stumpage. Consequently we have no adequate statistics on average wood costs or net revenues to the land owner.

If you want to use pricing as an incentive for higher supply on a short notice, it is logical to act by increasing prices on stumpage or by decreasing prices on logging services. You might even offer some silviculture free of charge. Measures of this kind can be adjusted to local or individual situation. However, they might cause reluctancy from potential supplyers, waiting for even better terms.

An official price increase might lower the supply for similar reasons. It might indicate an even better situation to come. On the opposite expectations on lower prices or higher costs might push more wood on the market, as it will not pay to wait.

In a long term statistics you find a correlation between official wood prices and totally harvested quantity. One reason for this is that you produce more and need more wood during a year with high lumber or pulp prices. Good gross revenues mean that you can afford higher prices and you pay, as you lack arguments and strength to meet the preassure. In the opposite situation - low lumber or pulp prices - you get more of arguments and the strength. You restrain for obvious reasons better and at the same time you purchase less as you need less.

These examples illustrate that the efficiency of pricing as a tool to influence supply is a very complicated matter to analyse.

It is adequate to characterize this market by describing the purchasing strategy of mills in a certain region rather than sellers actions. Purchasing organizations are the active parts and it is not quite adequate to talk of a marketing of round-wood. Thus the key to a sufficient supply is basically a matter of purchasing strategy.

The strategy will include pricing of stumpage, of wood at road side and of logging services. It also contains decisions on how to influence on land owners expectations. Stock holding policy is another important part of the strategy.

You can hardly expect the land owner to invest in silviculture unless he can pay it out of contemporary revenues from wood sales. Thus a legislative preassure on say cleaning of young stands will push some wood onto the market. This effect on supply is counteracted if state subventions are payed for silviculture.

Regional variations

Given so far is a very rough picture of market structure. Regional variations are considerable. E.g. in parts of western Sweden the Billerud company is purchasing all pulp wood mixed, independent of species. This was established as a defence towards Norwegian companies purchasing spruce pulp wood.

In general, possibilities for a company to increase its market share are limited by the strength in the traditional structure, reinforced by agreements and strong traditions.

Seasonal variations

Parts of the summer period saw logs are not cut as damages would be too costly.

Necessary re-planting and other silviculture will absorbe labour force during some months and so will sometimes agriculture and tourism.

These variations will have to be absorbed by storage, normally in wood yards.

In order to level out quantity over time prices are slightly adjusted through bonuses etc.

Efficiency

Is this an efficient market? This paper shall not deal with possible criterias on efficiency in this connection, but I will give some illustrations of the complexity in an evaluation of the market mechanism.

This market has certainly been efficient in the sence that industries normally have had enough wood and the proper assortment. Whether or not this has been achieved with too high costs for damages etc I do not know. A sort of total optimum would probably include situations with local "wood shortages", but to what extent?

In 1981 we had an exceptional year. Storage of pulp wood was at a minimum which forced some mills to stop or to curtail production. Let me line up some of the reasons why this happened. This is partly indicative to features of this very market.

- Inflation rate was high and had been so for some years. Why cut a growing inventory and get a small part of the gross value as net cash money, if you can borrow money?
- All political parties promised a lower marginal taxation within a near future. They have been wrong so far, but if you believed it you were likely to delay cuttings.
- A high demand of pulp wood was combined with low demand of saw logs. Net revenues is mainly out of the saw timber and many land owners forecasted a better demand and a later increase in saw timber prices. They delayed their decisions to cut and they were right!
- We had recently got a ban on the usage of DDT for dipping coniferous plants to avoid insect damages. Why not postphone a clear cutting until new and efficient measures are available? Possibly you then favour a thinning, which will lower the output per man-day and machine hour. With modern logging technique and work safety regulations you cannot increase these resources on a short notice. Once the logging organization is fully occupied you cannot push more wood on the market by prices or other lures.
- Delivery time on new machinery was more than a year due to structural problems in that sector of machinery industry.
- Some of the Forest Owners' Associations were in deep economic troubles, some in bankruptcy. For obvious reasons land owners were afraid not to be properly paid. This caused postphonements and reluctancy.
- Low production in the saw mills decreased the output of chips, thus increasing the need for pulp wood in the round which was already in low supply.
- Interest rates were high and many industries were short of cash. They therefore curtailed the purchasing in 1978-80 in order to minimize storage. For cash flow reasons they took a risk, "loosed" in a way and paid by high additional costs to cover an accute shortage in 1981.

During the past two years market has recovered and to-day's supply is sufficient. This is mainly due to a more active purchasing (to higher costs), price increases, expanding of logging resources etc. It is interesting to notice an entire different situation to-day in Sweden and Finland, where supply is extremely low. To explain this is not within the scope of my paper, however.

Main features

This presentation on the Swedish market is certainly rather fragmentory. However, I hope it will raise some questions and encourage further research. Let me summarize some of the most important features.

1 Total supply is mainly given by the response from purchasing activities within the large group of private owners, most of them being "non-farmers". This group is extremely heterogenous from the decision making point of view.

2 Main actors on the market are the purchasing organizations and their strategy is the key to the short-time or regional supply.

3 Signing of a logging contract and a wood sales contract are normally in an integrated decision.

4 Public price lists are only found on wood delivered at truck roads, although stumpage sales are frequent. Nor are there any public prices on logging and silvicultural services.

5 You have to purchase the entire crop including assortments you don't need. Most wood is exchanged between mills.

6 Long term delivery agreements from large forest holdings and exchange agreements between mills are frequent and so is traditional behaviour. The market has a remarkable resistance to changes.

7 Most purchasing organizations operate almost entirely within a given region, established by tradition or by agreements.

8 Availability of logging facilities and silvicultural service is an important key to successful purchasing.

You may consider this presentation of mine as a rather conservative one in the sence that I point out a number of stabilizing factors and complications. Theoretically it might be easy to suggest improvements, but in practice any change will move a great amount of money somehow. I end my paper by recommending any economist trying to analyse this very market to check every assumption with utmost care.

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M A R K E T F O R T I M B E R A N D F O R E S T P R O D U C T S I N N O R W A Y

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ABSTRACT

The Norwegian timber market has been strongly restricted.

Prices were negotiated between the buyer and seller organizations, and were the same country-wide. The forest owner had complete information, but essentially no power to influence the price of his timber.

To try to clarify how some of the regulations and restrictions on the marked forces have influenced the Norwegian timber market is an aspect of an upstarting project at the Department of Forest Economics. We also know very little about which forces influence the land owner in his decision to harvest or not. I will in this paper discuss the timber market in Norway as it is today, and outline what we will try to do in this field.

1. INTRODUCTION

Work has just started on a project at the Department of Forest Economics, NLH, Norway, which is going to look at the timber market and markets for forest products in Norway. This is a fairly broad and undefined subject, and to narrow it down the main part of the project will concentrate upon looking at the short-run movements in the timber market trying to use econometric methods. This was

chosen, because there is a long time since the last thorough study of timber supply in 1964 done by Rolf Sæther (Sæther 1964). In addition there has been forces working for a revitalization of the roundwood market in Norway. Some people feel that this is long overdue, while others think that the present situation is ideal. It is important to note, however, that there is an increasing interest in how the market works, in the forest owner as a decision-maker and as a person working in an economic environment.

To understand why this is quite a radical change in thinking, it is necessary to look at how the roundwoodmarket works. The purpose of this paper is thus to describe some sides of the Norwegian timber market as of today. Since we have not yet got to the point of doing any empirical work, the rest of the paper will discuss variables and indicators which seem important to include in a study like this one.

2. THE NORWEGIAN TIMBER MARKET

There are two groups with primary, though differing, interest in the timber market: forest owners and forest industry. Forest industry is often characterized by large economies of scale, and thus significant power in the market. Sawmills are usually smaller, but they can still obtain local monopsony in buying roundwood.

The number of forest owners are large - approximately 120,000, and the average holding is small. As an individual each and everyone has very little power to influence anything in the market. The conditions are thus present for monopoly-power exploration by forest industries. To organize a seller organization is the only way to avoid this. This is a well-known scenario in the other Scandinavian countries, but the number of regulations and the kind of organizational power seen in the Norwegian timber market is quite remarkable.

2.1. Price negotiations

Prices are negotiated independently for pulpwood and sawntimber between the Norwegian Forest Owner's Association and the respective buyer organizations. This is a "collective timber price negotiation" system covering the entire country, and prices are equal country-wide. The negotiations did not, and still do not in the case of pulpwood, allow local adjustments. Essentially this is a well-known system of bilateral monopoly situation as shown in Figure 1. Bargaining power has been the main parameter deciding the price-level within the price-range P_A to P_B (Høsteland 1982).

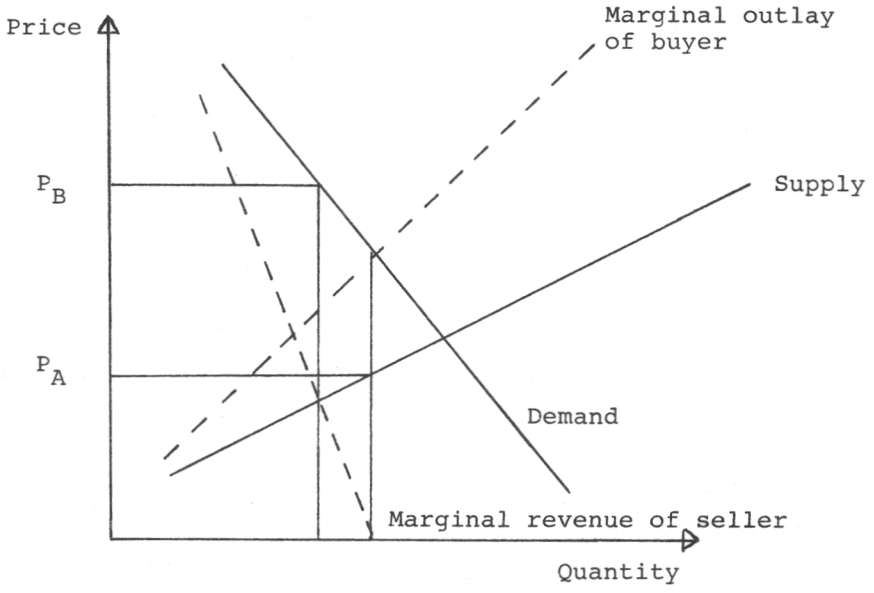

Figure 1. Bilateral monopoly situation.

However, once prices have been decided, more of a perfect market situation existed for most forest owners. Everyone had complete knowledge, and very little power to influence the price level. The forest organizations have, and have occationally used, the power to collectively reduce the quantity offered if the contracting process indicate higher supply than demand at the currect price. The price has thus functioned as a minimum price.

Normally prices have been negotiated for 1 year periods, and this created a sense of stability in a volatile business. It does make the market unflexible to changing conditions on the export market, however. The price of sawntimber this year has thus only been determined from August 1983 to January 1984.

2.2. Hovedavtalen

"Hovedavtalen" is a treaty/contract signed by both the seller and the buyer organizations. It describes formalities around how timber is supposed to be traded. However, one paragraph in this treaty also makes the price a maximum price. It says (free translation): All buyers must respect the negotiated price, and any overbidding are not allowed. This stimulates import in the sense that marginal quantities are very expensive, but it also stops any buyer from exploring monopoly power.

As has already been mentioned there are more sawmills than pulp mills, and this had made the sawntimber market less controllable. Overpricing has probably taken place at times. Stumpage sales have been an important "valve" in the market if the centrally negotiated prices has failed to find the "right" price level.

These sales also have to obey the given price, but the cost-level is a matter of negotiations. Low logging costs have been a way of giving price-increases to some of the sellers in the market. Very little is known about these contracts and other irregularities in the market, however, and bias in the data is a possible result.

2.3. Virkesforbruksloven

In addition to "hovedavtalen", the Norwegian "Storting" regulated the quantity each buyer could purchase in the domestic market by "virkesforbruksloven" from 1977. Quotas are calculated on the basis of quantities purchased in previous years. Strategic buying of roundwood might have taken place at times. The buying of old run-down industries

and then closing them down afterwards, indicate that the quota has a price-tag on its own.

2.4. Finished products

The lumber and finished products markets for paper have been and are dominated by Norwegian products although competition from imports are increasing. Lumber prices have been regulated by maximum prices untill just recently (October 1.), and this has very likely had a stabilizing effect on the prices for sawntimber.

3. PREVIOUS STUDIES

Rolf Sæther (1964) conducted the last study using econometrics as a method to analyze "the supply of industrial softwood in Norway". This is a very interesting and thorough study, and concludes that price is the main explanatory variable. However, the problem and weakness in the study is that the ordinary least squares technique is used to estimate linear relations through equilibrium points between quantity and price. This ignores the fact that prices are a result of both demand and supply. This leads into the possibility of using simultaneous equation method.

Adam and Haynes (1980) attempted this approach in the part of their TAMM study looking at the supply of stumpage. They were not very successful, at least not for the "other private" (non-industrial) sector part. They even got negative correlation in certain regions when price and timber inventory at the beginning of each period was used as the sole explanatory variables. Using only price and inventory as explanatory variables thus seem to be an oversimplification of the problem in this case.

4. ROUNDWOOD SUPPLY

4.1. Classification of owners

Forest owners are, as is the case for most countries allowing private ownership, far from being a homogenous

group. A study of the supply of roundwood will thus have to analyze which groups etc. might respond similarly to exogenous changes. This is especially important if the results are used to analyze how various forest owner categories react. A crude division is between:

1. State and Industrial ownerships
2. "Other" private

State and Industrial ownerships are grouped together because they are similar in the meaning that both have social and industrial considerations to acknowledge in their forestry decisions. This will make this group more constrained in their forest management decisions than are persons belonging to the "other" private group.

4.1.1. Area-classes

Høsteland (1982) shows that quantity-price relationships differ with the size of the forest property (Figure 2).

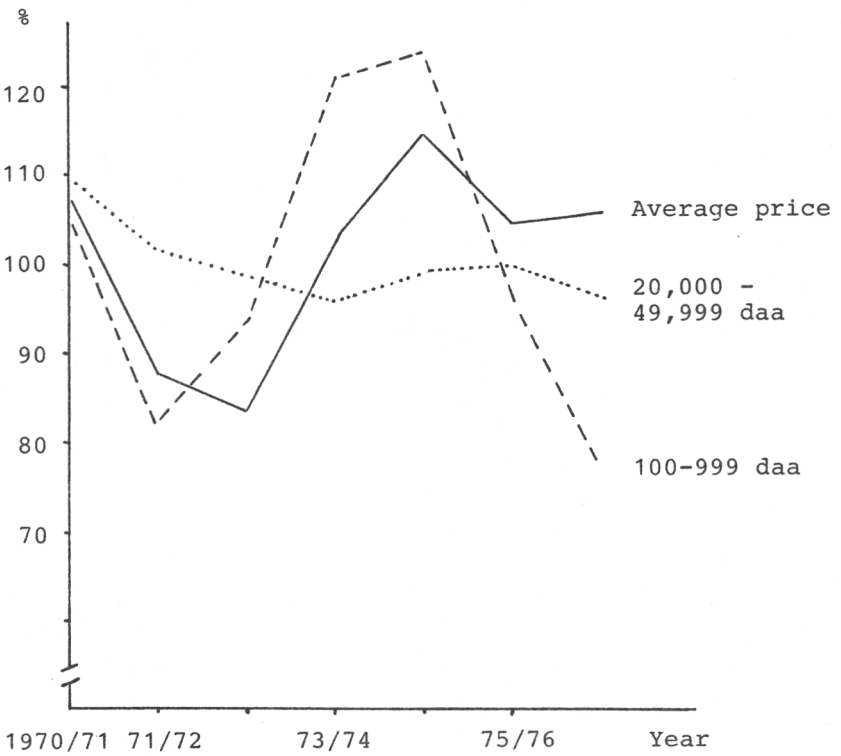

Figure 2. Indexes showing average price movements and movements in harvest in the two size-classes 10-99.9 ha and 2,000-4,999.9 ha.

This indicate that the "other" private group should be subdivided into area-classes. The number of groups necessary are probably not more than 3-4, and will also depend upon the capacity of the estimation method used.

4.1.2. Primary vs. secondary income from forestry

Income in other occupations - agriculture or any other occupation - possibly has an effect upon harvesting decisions. Farmers in Norway have received an increasing amount of subsidies from the government in the last decade, and the hypothesis is that as the farm receives more attention, the forest gets second priority.

The productivity- and cost-development have reduced the size of each forest holding in the sense that fewer people can be employed for each m^3 harvested. This together with abundant oportunities of alternative jobs, have reduced forestry to a secondary income-source for many owners. The forest holding might be looked upon as a savings account, where harvests take place if or when the owner needs money.

4.2. Price

Price has already been mentioned as an important explanatory variable for the cut - not cut decision. Anything, but a positiv correlation would be surprising. It is important to note, however, that a number of other variables can affect the strength of the correlation. Some were discussed in chapter 4.1, and others will be discussed later.

Pulpwood and sawntimber are competing, although they are necessarily complements to a certain degree, products in forestry. Høsteland (1982) also shows that forest owners think in those terms. Operating with two prices thus seems interesting.

4.3. Logging costs

The net price received from harvesting timber is the interesting parameter to the forest owner. However, finding net price on both pulpwood and sawntimber is hard, because they are a result of the same operation. Including logging costs as an explanatory variable might be a solution.

4.4. Interest rates

The last decade has been one of extremely low and even negative interest rates in the western world (Wall Street Journal 1981). This has made the costs of holding land and high investories of standing timber low, and thus have had a negative effect on the amount cut.

5. DEMAND FOR ROUNDWOOD

As has been mentioned pulpwood and sawntimber are considered different products. Although there are major differences between sawmills and pulp and papermills in economies of scale, capital and labour intensity etc., demand will be discussed together here.

5.1. Derived demand

Demand for roundwood is a derived demand, and is dependent upon market conditions for final products. There are, of course, other factors influencing demand, but this is something forestry cannot deny. Price of the most important final products are thus important explanatory variables. The maximum price regulations on Norwegian lumber might create some difficulties in choosing price in years where this regulation has been effective. Approximately 90 % of the lumber production is sold on the domestic market (TSF 1982), and the home market is obviously the primary market.

Forest industry, even on the international markets, has had tendencies toward organizing cartells (Bergendorff and Glenshaw 1980). This will reduce the value of price on finnished products as an explanatory variable to roundwood demand. In times of low demand for final products, the producers have rather reduced quantity produced than price (or a combination of the two). This cannot be done without a reduction in profits in the forest industry sector. Annual profit in the industrial sector is thus possibly an explanatory variable to movements in roundwood demand.

5.2. Substitutes to Norwegian roundwood

The price of imported rawmaterial is an important indicator to the Norwegian timber market. This is especially true in the case of pulpwood where imported roundwood and chips and chips from Norwegian sawmills limit the price-movements of pulpwood. Most pulp and papermills in Norway are positioned along the coast, and they can easily receive imported raw-material.

5.3. Stocks of roundwood

The stocks of roundwood at the beginning of a price-negotiation are very likely to influence the bargaining power of the organizations and thus the price of roundwood. It has already been mentioned that the 1 year price-periods are unflexible to changes in the economic conditions. A build-up of stocks are thus hard to avoid at times when demand for final products change to the worse.

5.4. Lags

The presence of lags are obvious for most of the variables on the demand side. An instantaneous reaction to a changing environment is theoretical. An analysis of the length of lags will thus have to be a part of the study.

6. CONCLUSION

As was mentioned in the introduction, the project is at the starting point. This was thus meant to be a brief dismission of things to consider. I feel relatively certain that the list will increase in length before the process of exclusion starts.

The work up till now has made me aware of the problems and biases which might be present due to regulatory constraints. Forced reduction of cut indicate that price was higher than equilibrium price should have been. In cases where mills have filled their quota of domestic roundwood indicate than price was too low, and that they wanted to buy more. This

is important to clarify before the actual estimation process starts. Biased parameters due to regulatory constraints will probably have very little chance of giving good estimates of how the market responses will be in a "revitalized" market.

The availability of data is probably also a problem. Hopefully this can be solved through cooperation with the organizations.

The project is a challenge, and the work will hopefully yield useful results. Being the only one working full-time with these problems at the Department of Forest Economics, I do, however, feel the need to establish contact with people working in the same field in Scandinavia.

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THE DANISH MARKET FOR CONIFEROUS ROUNDWOOD

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ABSTRACT

The present paper gives an outline of the structure and the price formation on the Danish market for coniferous roundwood.

The main actors on the market are introduced, i.e. the forests, the sawmills and the chipboard industry.

Further, the trading channels are explained.

The central timber price negotiations are described, and factors affecting the price setting and the power relationship between the negotiants are discussed.

1. MARKET STRUCTURE

1.1 Consumption and production

In Denmark, wood products which correspond 7 mill. roundwood equivalents are consumed annually (Helles 1983). The annual cutting in the Danish forests is approx. 2 mill. m^3. The rest, which accordingly corresponds 5 mill. roundwood equivalents, is based on foreign wood resources.

The foreign suppliers, mainly Scandinavia, predominantly refine their own raw materials. Accordingly, the import is dominated by semi-manufactures and finished goods (e.g. timber, pulp and paper, boards, furniture).

The Danish primary - i.e. roundwood manufacturing - industry is obliged to provide raw material almost exclusively from the Danish forestry.

1.2 The roundwood market

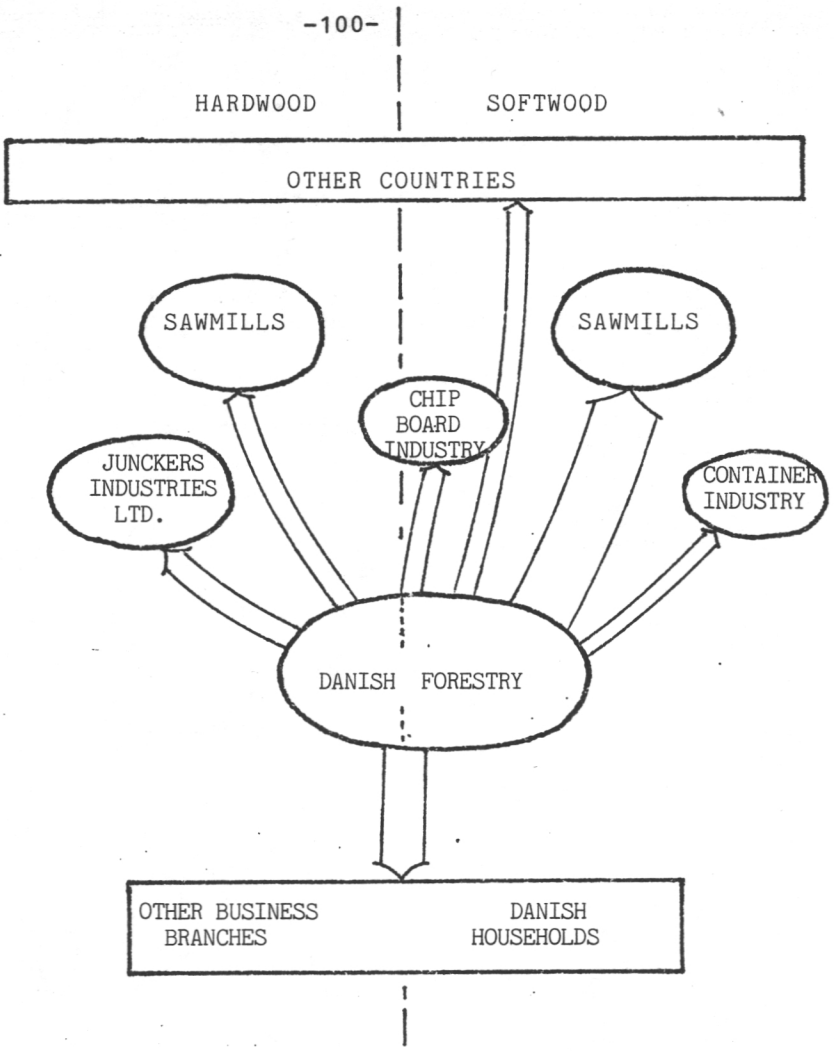
In Denmark with few exceptions the forest districts undertake the felling and terrain transport to the roadside, and the roundwood consuming industries hire trucks for the road transport. Thus, the trade normally takes place between the forest owners and the wood industry and concerns roundwood delivered at the roadside.

Unit 1ooo m^3	Production 1981	Production 1982	Import 1981	Import 1982	Export 1981	Export 1982
Softwood:						
timber	684	1548	7	6	28	297
pulp wood	273	848			179	391
chip board wood	191	145				
container wood	132	194				
fire wood	108	145				
Hardwood:						
logs	480	468	32	42	16	22
pulp wood	70	62	2	2	23	26
fire wood	234	242				
sum:	2172	3641				
Total Cut	2256	3697				

Source: Stat.Dept.

The table is a survey of the traded quantities on the Danish roundwood market in 1981 and 1982. 1981 is typical of the preceeding five years, when exception for firewood is made. 1982, however, is strongly influenced by the greatest windthrow in history, 24th November 1981, where approx. three mill. m^3 of conifers were overthrown.

Since 1975, the firewood market has shown a strongly increasing trend.



The figure is a structural model of the Danish roundwood market, showing the actors and the main channels of trade. The division into channels is to some extent coinciding with a division into the various roundwood assortments, and the competition for raw materials between the different channels is limited.

The division of the markets for soft- and hardwoods is almost total, as the vast majority of the industries have specialized and can only rationally manufacture one of the raw materials.

The following paragraphs concern the softwood market only.

1.3 The actors on the market.

The forestry: Danish forestry is the only supplier of roundwood, as foreign supplies are negligible. 34 % of

the Danish forest area which totals 493.ooo ha are owned by the National Forest Service, and the main part of the rest concists of numerous private estates. The National Forest Service represents approx. 25 % of the annual cut. (Landbrugsstat. 1981:317).

The forest owners are organized in Danish Forest Society ("Dansk Skovforening") to which the National Forest Service is an associated member. The chairmen of the Society's 11 local forest constituencies ("skovkredse") form The Trade Committee of Danish Forests ("Danske Skoves Handelsudvalg") which represents the forests in the central price negotiations with the industry.

The Forest Society has a limited roundwood trade through its Trade Office of Danish Forests ("Danske Skoves Handelskontor").

Beside the roundwood, Christmas trees and greenery are important sources of income to the forestry, representing about 2o % of the total income.

Moreover, it is characteristical for the market situation that the main part of the forest area is run together with farm land, so that the owners' economies are not entirely depending on the sale of forestry products.

The sawmills: The Danish sawmills are mostly small, measured by an international scale. They have small chances of competing with large-scale, highly automatic production plants as regards manufacture of standard products. Thus, the production today is, as has always been the case, after buyer's specifications. According to Kring (1977) there were in 1977 18o softwood-manufacturing sawmills in Denmark. A total capacity of 828.2oo m3 roundwood per year was estimated, which compared to the total annual cut means an overcapacity of some 2o %. The overcapacity is more or less evenly distributed throughout the country.

The main products of the sawmills are unseasoned timber and planks for heavier constructions, especially in farm- and house-building. As a result of the common stagnation in the economic activity in Denmark - especially the decline of the house-building - the wood industry has increasingly oriented itself towards foreign markets. The Danish ability to compete has mainly been based on flexibility - the ability to deliver products in accordance with the buyer's specifications.

The association of Danish Wood Industries ("Danske Træindustrier") undertakes negotiations with the Trade Committee of Danish Forests concerning suggested prices of timber and other assortments.

The chip-board industry: The chip-board industry is dominated by two concerns, representing the main part of the production. They are producing for the home market and for export. The raw material consists partly of wood refuse from wood industries of all kinds and partly of un-

regular, damaged or small dimensioned roundwood of practically all species, the main part being softwoods. There is competition with the wood container industries and firewood consumers for roundwood of some size and quality and with Swedish and Norwegian pulp industries for the smaller dimensions. Within this framework of the raw material situation, the chip-board industry follows its own price policy.

The container industry: Consists of an amount of smaller units. The dominating products are wooden containers, pallets and wood wool. The majority are members of Danish Wood Industries which negotiates the suggested prices with the Trade Committee.

1.4 Channels of trade

In Denmark, the roundwood has traditionally been traded directly between industry and forest district, and this pattern is - unlike our Nordic neighbouring countries - still predominant. (The sale from the small forests is normally directed through the Danish Heath Society or one of the 15 associations of small-forest owners. This amounts to 12 % of the annual cut). Traditions and personal sym- and antipathies play a role in the pattern of trade relations (Troldtoft 1976).

A questionnaire by Hoeck (1980) among the softwood manufacturing sawmills shows that about 40 % of their roundwood buys are procured within a radius of 15 km from the industry, and about 70 % of the total within 35 km from the industry.

Trade Office of Danish Forests: The object of the Trade Office is to improve the selling possibilities for the products of the Forest Society members. Though, the Office's share of the home market is negligible. Nearly 90 % of the circulation are exported. (Dansk Skovforening, Report 1981). The most important item is the arrangement of the pulp-wood export to "Södra Skogsägarna" and "Sydsvenska Massaveds AB" in Sweden and "UNION" in Norway. The Trade Office arranges about 50 % of the total pulpwood export. Further, the Office has contact to a number of customers (sawmills) in Germany, to whom export of softwood timber occasionally takes place. However, the Trade Office is not dominating in this field. The home market trade is increasing, as certain wood industries have started to buy through the Office.

The National Forest Service has a trade office of its own. Through this greater orders, concerning several forest districts, are arranged, whereas normal deliveries are negotiated directly between local districts and industries.

Moreover, the trade office coordinates the total activity of the National Forest Service in accordance with the established trade policy.

The office arranges the National Forest share of the pulpwood export. Price and delivery conditions are negotiated in concert with The Trade Office of Danish Forests.

The Danish Heath Society has started a trade office, undertaking export orders too, and besides a few other private roundwood exporters are found on the Danish roundwood market.

1.5 Conditions of delivery and payment

Presubscriptions of deliveries to the industry are normal, but rarely binding. It is regularly seen that size and time for deliveries from the forests are more dependent on internal conditions or conditions of the farming operation than consideration of the industry's needs. The industry has a need for an even flow of roundwood throughout the year, but the cutting in the Danish forests is seasonal. The activity is heaviest in winter and lightest in the harvest and greenery season (autumn).

Thus, the supply situation can change radically in few months, which is a drawback for the production planning of the sawmills. It is costumary - with a background in these seasonal fluctuations - that a three months' interest-free credit to the sawmills is granted.

Some industries pay rewards for deliveries in the autumn.

2. THE PRICESETTING OF TIMBER

2.1 The central price negotiations

Danish timber from private forests is almost exclusively invoiced according to the suggested prices, which are agreed between "Danish Wood Industries" and "Trade Committee of Danish Forests".

When a desire is expressed from either of the organisations, they meet and negotiate suggested prices for all dimensions and qualities. If an agreement is reached, a common price list is issued. If not, each party issues its own suggested price list, socalled "green prices". Green prices for longer periods are uncostumary.

Efforts are made to set a price level, which assures a reasonable balance between supply and demand. The fixed prices are, however, often apparent, as - unlike our Nordic neighbouring countries - there is no impartial organisation who measures the roundwood and valuates the quality.

In the individual trade operation, the supply/demand mechanism functions through the assessment of the quality, so that an average price of the party according to the actual market situation is obtained. Moreover, the central price agreement normally contains a special paragraph which determines that special specifications from the buyer means a higher price for the entire party.

References to this are often made when prices above normal level are agreed, in order not publicly to break the solidarity within the sawmill association.

Through a current registration of all invoices of roundwood from a number of forest districts, the Trade Committee of Danish Forests follows the pulse of the market.

When unbalance occurs, negotiations with Danish Wood Industries are called for. In this way, the suggested price lists despite the above mentioned imperfections can be considered as more or less up to date.

The timber prices East and West of the Great Belt (Storebælt) are set independently, as the market situation differs some.

2.2 Factors affecting the price setting.

The central price negotiations are characterized by an atmosphere of concensus, as both parties realize their mutual dependence. Both parties agree in general that the level of the Danish timber prices must follow the prices on the world market. As for the softwood timber, this means the Swedish and North German markets.

The Forest Society - and hereby the Trade Committee - keeps up to date on the foreign roundwood markets and the international sales conditions for the sawmills through the operations of the Trade Office, through international market reports and through contacts to sister organisations in the neighbouring countries.

A number of other factors are contemplated in the negotiations, among which for instance previews of the (cereal) harvest, as the value of this is experienced to influence the roundwood supply (e.g. Nielsen 1974) considerably.

2.3 The power relationship

Firstly, it is important that the Danish forestry as a group more or less holds a monopoly: The industry will hardly be able to substitute the Danish roundwood supplies by imports in any greater scale. On the other hand, the forestry has a potential possibility - and established contacts - to increase its export operations.

Secondly, as forest operations demand considerable capital and very often are run together with economically dominating farming activities, most forest owners are sufficiently well consolidated to retain timber supplies, say for a three months' period, in case of unsatisfying prices, whereas this will often be fatal to the Wood Industry.

Thirdly, most forest districts are suppliers of both softwood and hardwood, and therefore more flexible than are the industries. When prices are not satisfying on one of the product groups, emphasis can for a period be transferred to the other group.

On this background the forestry must definitely be considered the stronger party, when it acts as a unity.

The National Forest Service supplies the market with one fourth of the total roundwood supply. Through this, the State has a considerable potential for influencing the price setting. However, it is politically settled that the National Forest Service must not be price leading. Within this and a few other limitations, the NFS trade policy should none the less be aimed at the commercial optimum. This comes to expression in the common practice according to which the National Forest Service adjusts its prices to the suggested prices agreed between the Danish Wood Industries and the Trade Committee of The Danish Forests. In case of "green prices", the NFS usually form a united front with the private forestry and follows the price list issued by the Trade Committee. As the National Forest Service also has an obligation to ensure sufficient supplies to the industry, the unity, however, is not unbreakable, if it should come to extremes.

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The presentation in this paper is mainly based on yearly reports to the general assembly of the Danish Forest Society and on interviews with representatives from the Danish Wood Industries, Danish Forest Society and the National Forest Service, trade department.

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BUYER CONCETRATION IN THE ROUNDWOOD MARKETS OF NORTHERN FINLAND

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ABSTRACT

The purpose of this paper is to analyze the roundwood market structure in Northern Finland with the aid of some discrete and cumulative measures of concentration. Measurement of concentration is first briefly discussed and the measures used in the empirical analysis are presented. Areal concentration indexes of the buyers of coniferous saw log and pulpwood are then calculated using the four northernmost forestry board districts. As a general rule appears that the level of concentration is highest in the Lappi forestry board district whereas the lowest values yielded by different measures exist in the markets of Pohjois-Pohjanmaa forestry board district. The level of concentration in the market area defined by the four forestry board districts together is lower than in each subarea.

1. INTRODUCTION

According to the data of commercial roundwood research (Aarne, 1981) there were one hundred buyers in operating the roundwood markets of the four northernmost forestry board districts in 1979. The four giant firms purchased nearly 70 percent of the total volume of roundwood exchanged during the year. Accordingly the dominant role of the largest buyers in the timber markets of Northern Finland is indisputable.

By the theory of imperfect competition, the degree to which activity in a market is dominated by a few large firms, in other words market concentration, is the basis on which the hypotheses concerning, for example, firms' pricing conduct may be constructed. If there are no data constraints, appropriate measurement devices and types of measures of concentration are to be utilized when detailed quantitative information is needed. However, as is stressed by Hay and Morris (1979; 101), it is important to remember that concentration measures are statistical devices: they only derive meaning from the theoretical justification for constructing them in a particular way.

The main purpose of this presentation is to analyze the structure of roundwood markets in Northern Finland from the buyer side with the aid of some specific measures of concentration. The presentation is divided into three parts. In the first we descuss some methodological aspects of concentration measurement and present the types and specific measures of concentration used in this paper. In the second detailed resultas of the calculation and finally brief concluding remarks are presented.

2. MEASUREMENT OF CONCENTRATION

2.1. Some properties of measures of concentration

Business concentration, being the most important element of market structure, has received considerable attention among economists and problems of concentration measurement have been discussed extensively during the last 20 years. (The majos lines of thought in measuring industrial concentration, see Marfels, 1971.) According to most researchers the basic premise underlying the development of a concentration measure is that monopoly performance is more likely when a large share of output (of some other variable) is controlled by

a small number of firms. Accordingly the concept of concentration measurement is associated with two measurable phenomena, namely number and size distribution of firms.

Hall and Tideman (1967; 163) and also Hannah and Kay (1977) has proposed that a measure of concentration ought to have certain properties.

1. If one concentration curve lies entirely above another it represents a higher level of concentration. The concentration curve (Hay and Morris, 1979; 102) is constructed by plotting cumulative shares of market output attributable to the largest 1, 2, 3,... in firms in the market as shown in Figure 1. With this critetion A is more concentrated since a given number of firms accounts for a higher proportion of output in A than in either B or C. The comparison of B and C is ambiguous. According to Hall and Tideman a measure of concentration should be unambiguous.

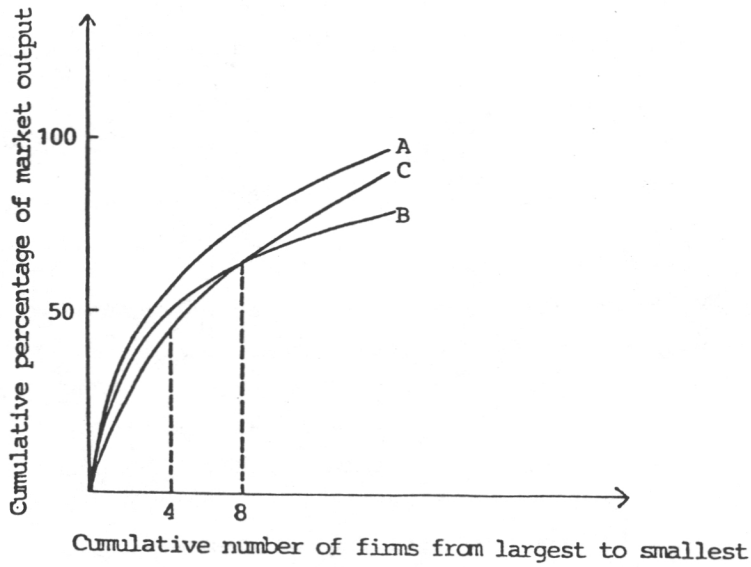


Figure 1. Concentration curves.

2. Concentration in a market is independent of the size of the whole; it is some function of the relative shares of firms in the market.

3. A measure of concentration should be affected by a change in any firms's market share, with concentration increasing if (for a small change) there is a shift from a lower ranked firm to a higher ranked firm, and vice versa.

4. If market A had K times the number of firms in market B, $K > 1$, and the market shares in A are distributed such that corresponding to each share in B there are K firms of size the share/K then the measure of concentration for A should be 1/K times the measure for B.

5. When a market is divided into N equal-sized firms, a measure of concentration should be a decreasing function of N.

6. A measure of concentration should have a range of 0 to 1. While this property is not strictly necessary, it makes the measure easier to use, and it is always possible to perform a transformation on a measure that will give it this range without changing its order properties.

2.2. Types of concentration measures

There are a number of alternative measures of concentration and they follow somewhat similar patterns, but with varying weighting schemes of firms market shares and their sensitivity towards changes in the number of firms. In the literature of industrial economics the measures are often divided into three general classes, i.e., measures of inequality and discrete and cumulative measures of concentration. The first mentioned class, measures of inequality, is not discussed in this presentation.

Discrete concentration measures show the percentage of the total markets accounted for by the largest firms. Illustrated with the aid of the concentration curve (see, p. 3) the

discrete measure of concentration shows the height of the cumulative concentration curve above the point on the horizontal axis. According to Bailey and Boiley (1971; 702) discrete measures of concentration are the most commonly used measures in the empirical analysis of concentration because of the low level of requirements concerning the data.

Dicrete measures placing emphasis on the largest firms only ignore most of the firm size distributions from the tail, whereas summary measures take the whole size distribution into account. Summary measures differ from each other by the different weighting schemes of the firms' market shares and by their sensitivity towards cahnges in the number of firms. There are a lot of various summary measures, but it doesn't necessarily mean that each has economic significance. According to Marfels (1971; 764) the choice for a measure may be made dependent on their weighting schemes of firm's market shares and their sensitivity towards changes in the number of firms.

2.3. Specific measures used in this study

The choice of the measure that will be used in empirical analysis is often determined by the extent to which detailed firm data is available. In our case the data concerning the number and market shares of roundwood buyers in Northern Finland was complete and did not set limitations on the choice of the measures. Accordingly some measures proposed by Marfels (1971; 758) were used in the calculations. The measures presented below represent various weighting schemes of firms' market shares.

I $CR = \sum_{i=1}^{4} p_i$

Concentration ratio with weights of unity to the shares of four top firms ranked in descending order.

II $C = \sum_i p_i^2$

Hirchman-Herfindahl index with shares of individual firms as weights. This index takes all firms into account.

III $I = 1/(2\Sigma i p_i - 1)$

Rosenbluth index. Ranks of firms as weights, with the firms ranked in descending order and the i-th firm receiving rank i. Again this index takes all firms into account but assigns greater weights to smaller firms because of its ranking device.

IV $CCI = p_i + \sum_{j=2}^{n} p_j^2 / 1 + (1-p_j) /$ $\quad (i=1;\ j=2;\ldots,n)$

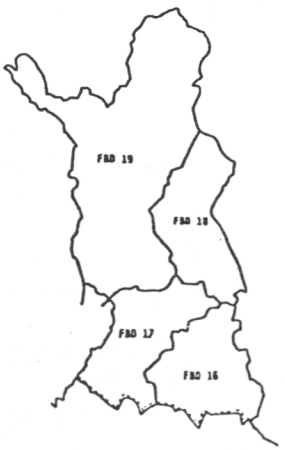
Horvath index, Combination of aspects of both discrete and summary measures. The discrete part is represented by the market share of the largest firm, p_i, the summary part is split up into a C-index of the shares of all but the largest firms, $p_2,\ldots,p_n$, and a multiplier which slows down their rapid decline owing to the weighting seheme of the C-index.

3. RESULTS

3.1. Preliminaries

Regional concentration indexex were calculated considering each of four northernmost forestry board district as a separate market area and alternatively considering Northern Finland as a whole, one market area.

Figure 2. Market areas



Forestry Board districts

FBD 16	Kainuu
FBD 17	Pohjois-Pohjanmaa
FBD 18	Koillis-Suomi
FBD 19	Lappi
NORFIN	FBD 16 - FBD 19

Similarly coniferous sawlog, pulpwood and their assortments are assumed to have their own markets in the geographical areas in question. Justification of these assumptions is problematical, but mostly in empirical analysis; just as in our case concerning the geographical market areas, limitations are imposed by the available data. The second assumption was made because of a desire to render pulp and sawlog markets comparable to each other with regard to specific measures of concentration.

The data used in the empirical analysis originates from the commercial roundwood research in 1979 (Removals and flows of commercial roundwood in Finland in 1979 by districts, Aarne 1981). Accordingly the purpose of the analysis is to answer cross sectional questions concerning the level of concentration and the variations in concentration among markets in 1979. Also questions concerning results obtained using different measures are dealt with.

Results are presented with the aid of tables for the part of each market concerning different roundwood assortments. For the sake of comparability the markets of coniferous sawlog and pulpwood are presented first and then markets of their assortments. Later, the following abbrevations and symbols are used:

Kainuu forestry board district,	FBD 16
Pohjois-Pohjanmaa forestry board district,	FBD 17
Koillis-Suomi forestry board district,	FBD 18
Lappi forestry board district,	FBD 19
Northern Finland	NORFIN

CR_4, C, I and CCI, as defined before
s, percentage share of markets
n, number of buyers

3.2. Concentration in the coniferous sawlog and pulpwood markets in Northern Finland in 1979

There were one hundred roundwood buyers operating in the coniferous sawlog markets in Northern Finland in 1979.

The four leading firm accounted for 57 % of the total volume exchanged. In the pulpwood markets the four leading firm purchased 79 % of the total volume exchanged and the total number of buyers was 65.

Table 1. Concentration in the coniferous sawlog markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	34	35	0.69	0.16	0.14	0.43
FBD 17	13	49	0.65	0.12	0.10	0.35
FBD 18	22	25	0.68	0.18	0.15	0.46
FBD 19	31	52	0.76	0.18	0.13	0.46
NORFIN	100	100	0.57	0.10	0.08	0.30

According to the values of C and I the level of concentration in the coniferous sawlog markets is low. Correspondingly values of CR_4 assign a relative high level of concentration and values of CCI a kind of mid-position between them. In spite of the parallel values of C and I the weighting schemes of the indexes are different. Accordingly in the case of C, the low level of concentration is due to equality among the shares of leading firms and in the case of I due to the number of little firms. The values obtained by CR_4 and CCI are in accordance with the definitions of the indexes.

Ranks of the regional markets with regard to level of concentration is not unambiguous. In the following composition markets are ranked in descending order with regard to level of concentration

CR_4	FBD 19	FBD 16	FBD 18	FBD 17	NORFIN
C	FBD 18	FBD 19	FBD 16	FBD 17	NORFIN
I	FBD 18	FBD 16	FBD 19	FBD 17	NORFIN
CCI	FBD 18	FBD 19	FBD 16	FBD 17	NORFIN

In the case of CR_4 the argument for the order is clear. As to order defined by C what is said above applies. Equal distribution among the shares of leading firms means a low

level of concentration and vice versa. In the case of I the basic premise is fewness i.e. the number of firms. CCI emphasizes the share of the leading firm.

A comparison among the markets of forestry board districts in reference to the most concentrated market and to the least concentrated market indicates that the first mentioned is according to C, I and CCI, FBD 18 and according to CR_4 FBD 19. Due to all indexes market of FBD 17 is least concentrated. The level of concentration in the market area defined by the four forestry board districts together is lower than in each subarea.

Table 2. Concentration in the pulpwood markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	30	23	0.81	0.26	0.22	0.56
FBD 17	15	21	0.81	0.19	0.20	0.48
FBD 18	17	17	0.74	0.20	0.19	0.49
FBD 19	38	27	0.93	0.28	0.28	0.61
NORFIN	100	65	0.79	0.16	0.15	0.43

Pulpwood markets are more concentrated than coniferous sawlog markets. However, also according to values of C and I the level of concentration is relative low. CCI again shows a kind of mid-value and CR_4 - especially in the case of FBD 19 - quite a high level of concentration.

Ranks of firms with regard to level of concentration are not clear in spite of the two most concentrated markets.

CR_4	FBD 19	FBD 16	FBD 17	NORFIN	FBD 18
C	FBD 19	FBD 16	FBD 18	FBD 17	NORFIN
I	FBD 19	FBD 16	FBD 17	FBD 18	NORFIN
CCI	FBD 19	FBD 16	FBD 18	FBD 17	NORFIN

Arguments for the different rank concerning the results obtained by different indexes are similar to those in the

the case of coniferous sawlog markets. According to each index the most concentrated markets are FBD 19 and FBD 16. It is worth noticing that pulpwood market of FBD 18 is the least concentrated market according to I and CR_4 while the coniferous sawlog market of FBD 18 is the most concentrated market among the forestry board districts.

3.3. Concentration in the markets of coniferous sawlog and pulpwood assortments in Northern Finland in 1979

A Comparison of the level of concentration in the coniferous sawlog market and that of pine sawlog markets reveals that values yielded by different concentration indexes are parallel in spite of some exceptions. However, variations concerning the number and size distribution of roundwood buyers of each assortments may as, for example, in the spruce sawlog markets in comparison with coniferous sawlog markets be a source of relatively large differences as to level of concentration and ranks of forestry board districts with ragard to level of concentration.

As to the level of concentration in the markets of coniferous sawlog and pulpwood assortments with regard to results yielded by different measures, what is said before applies. The extremes of values are again produced in one way by I and C, in another way by CR_4. Respectively values yielded by CCI lie between the extremes.

Table 3. Concentration in the pine sawlog markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	35	35	0.75	0.19	0.14	0.47
FBD 17	14	48	0.69	0.13	0.11	0.37
FBD 18	17	25	0.62	0.13	0.12	0.37
FBD 19	34	52	0.76	0.17	0.12	0.44
NORFIN	100	100	0.58	0.10	0.08	0.31

The level of concentration in the pine sawlog markets follows the same pattern as that of coniferous sawlog markets. However

pine sawlog market of FBD 18 is not as concentrated as the market of coniferous sawlog especially according to CCI.

Ranks of forestry board districts with regard to level of concentration are clear in spite of the results yielded by CR_4 and some equalities of values.

CR_4	FBD 19	FBD 16	FBD 17	FBD 18	NORFIN
C	FBD 16	FBD 19	FBD 18	FBD 17	NORFIN
I	FBD 16	FBD 19	FBD 18	FBD 17	NORFIN
CCI	FBD 16	FBD 19	FBD 18	FBD 17	NORFIN

The most concentrated markets among the forestry board districts are FBD 16 and FBD 19 according to C, I and CCI. Definition of the least concentrated market is not clear because of equalities of the values.

Table 4. Concentration in the spruce sawlog markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	31	19	0.63	0.13	0.13	0.37
FBD 17	14	30	0.54	0.10	0.11	0.31
FBD 18	36	24	0.81	0.36	0.21	0.63
FBD 19	19	22	0.88	0.27	0.25	0.59
NORFIN	100	73	0.56	0.12	0.09	0.37

A comparison of the level of concentration in the spruce sawlog market in NORFIN with that of pine sawlog market reveals that values yielded by different measures are towards similar. However, there are differences among the forestry board districts. The level of concentration in the spruce sawlog markets of FBD 18 and FBD 19 especially are higher than that of pine sawlog markets.

Ranks of forestry board districts with regard to level of concentration is clear only in the case of FBD 16.

CR_4	FBD 19	FBD 18	FBD 16	FBD 17	NORFIN
C	FBD 18	FBD 19	FBD 16	NORFIN	FBD 17
I	FBD 19	FBD 18	FBD 16	FBD 17	NORFIN
CCI	FBD 18	FBD 19	FBD 19	NORFIN	FBD 17

The most concentrated markets are FBD 18 and FBD 19, mutual rank depending on the index used. The rank of FBD 17 as the least concentrated market among the forestry board districts is unambiguous.

Table 5. Concentration in the pine pulpwood markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	22	22	0.79	0.22	0.19	0.52
FBD 17	16	19	0.83	0.20	0.21	0.50
FBD 18	19	17	0.79	0.26	0.22	0.55
FBD 19	43	26	0.93	0.29	0.29	0.62
NORFIN	100	61	0.79	0.18	0.16	0.45

Similarly as in the case of coniferous sawlog markets the level of concentration in the pine pulpwood markets follows the same pattern as that of pulpwood markets. Accordinly rank of the northernmost forestry board district as the most concentrated market is quite clear.

CR_4	FBD 19	FBD 17	FBD 16	FBD 18	NORFIN
C	FBD 19	FBD 18	FBD 16	FBD 17	NORFIN
I	FBD 19	FBD 18	FBD 17	FBD 16	NORFIN
CCI	FBD 19	FBD 18	FBD 16	FBD 17	NORFIN

A comparison of the regional values of concentration yielded by different indexes indicates a relative low variance. Accordingly the ranks of the regional markets others than FBD 19 are quite ambiguous.

Table 6. Concentration in the spruce pulpwood markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	44	17	0.85	0.33	0.26	0.61
FBD 17	13	19	0.77	0.18	0.19	0.46
FBD 18	14	17	0.70	0.15	0.16	0.41
FBD 19	29	17	0.92	0.31	0.32	0.65
NORFIN	100	48	0.75	0.16	0.15	0.44

Spruce pulpwood markets of FBD 17 and FBD 18 are less concentrated than those of pine pulpwood. Correspondingly in the case of FBD 16 the order is reverse.

CR_4	FBD 19	FBD 16	FBD 17	NORFIN	FBD 18
C	FBD 16	FBD 19	FBD 17	NORFIN	FBD 18
I	FBD 19	FBD 16	FBD 17	FBD 18	NORFIN
CCI	FBD 19	FBD 16	FBD 17	NORFIN	FBD 18

Rank of forestry board districts with regard to level of concentration is clear only in the case of FBD 17. Rank of FBD 18 as the least concentrated market is worth noticing.

Table 7. Concentration in the hardwood pulpwood markets in Northern Finland in 1979

Markets	s	n	CR_4	C	I	CCI
FBD 16	23	15	0.88	0.31	0.28	0.62
FBD 17	15	14	0.84	0.23	0.23	0.54
FBD 18	17	11	0.87	0.24	0.25	0.56
FBD 19	45	12	0.95	0.29	0.31	0.63
NORFIN	100	35	0.84	0.23	0.21	0.54

According to the values of CR_4 the level of concentration in the hardwood pulpwood markets is high. In addition variance of the values yielded by CR_4 is relative low.

Ranks of regional markets with regard to level of concentration is not unambiguous.

CR_4	FBD 19	FBD 16	FBD 18	FBD 17	NORFIN
C	FBD 16	FBD 19	FBD 18	FBD 17	NORFIN
I	FBD 19	FBD 16	FBD 18	FBD 17	NORFIN
CCI	FBD 19	FBD 16	FBD 18	FBD 17	NORFIN

The most concentrated markets are FBD 19 and FBD 16. Rank of FBD 17 and FBD 18 as the least concentrated market is clear.

4. CONCLUSION

The analysis has shown that the level of buyer concentration varies in the coniferous sawlog and pulpwood markets in Northern Finland by forestry board districts and by roundwood assortments. In addition values yielded by different measures are quite inequal. The extremes of values are produced in one way by Hirchman-Herfindahl index (C) and Rosenbluth index (I) in another way by Concentration ratio (CR). Respectively values yielded by Horvath index (CCI) lie between the extremes.

Ranks of the forestry board districts with regard to level of concentration is not unambiguous in spite of some exceptions. However, as a general rule appeares that the level of concentration is highest in the Lappi forestry board district, whereas the lowest values yielded by different measures exist in the markets of Pohjois-Pohjanmaa forestry board districts. Instead mutual rank of Kainuu and Koillis-Suomi forestry board districts is not so clear. The level of concentration in the market area defined by the four forestry board districts together is lower than in each subarea.

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THE RANKING OF DIFFERENT BEHAVIORAL MODES FOR A FIRM FACING AN UNCERTAIN SUPPLY CURVE*

by Karl-Gustaf Löfgren and Bo Ranneby

The paper contains a theoretical investigation of behavioral modes for a monopsonistic firm facing an uncertain supply curve. Different behavioral modes are ranked according to the mathematical expectation of profit. The theoretical results are applied in an attempt to explain the functioning of the Swedish roundwood market.

1 INTRODUCTION

The decision problem for a firm facing an uncertain demand curve has been studied by many authors. Some attention has also been paid to the fact that the firm under such conditions can choose between different behavioral modes. The reader is referred to Baron (1971), Leland (1972), and Weitzman (1974). One of the first times different behavioral modes were analysed in a setting such that they could be properly compared was in a paper by Lim in 1980. However, the assumptions in Lim's paper are very restrictive. The results will, roughly speaking, hold true only for cases when the demand curve is linear and risk is additive or for probability distributions, that are compact and concentrated. Furthermore, he seems to have overlooked one (the best) behavioral mode.

The analysis of the present paper modifies the analysis in Lim's paper. The main differences being that the firm in the present paper faces an uncertain supply curve for one (a vector) of its inputs, while the demand curve is uncertain in Lim's paper, and that we rank behavioral modes under condsiderably weaker assumptions. Nevertheless,

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we are able to rank behavioral modes to the same extent as in Lim's paper. Our results are also easily modified to the case of an uncertain demand curve.

The criterion we use for our comparisons is the mathematical expectation of profit (Π) and we say that a behavioral mode A dominates another mode B if $\sup E[\Pi_A] \geq \sup E[\Pi_B]$. In a concluding section we hint at an application of the results reached in the theoretical sections of the paper.

2 DEFINITIONS OF BEHAVIORAL MODES

Let us assume that the firm is facing a given price, p, of its product, which is produced by a concave production function

$$q = f(c) \tag{1}$$

where

q = the output of goods
c = the input of the production factor[1]

The supply conditions are described by the implicit supply function

$$H(r,c,\theta) = 0 \tag{2}$$

where

r = the price of the production factor
c = the supply of the production factor
θ = a random element with distribution function $F(\theta)$ (the distribution function could be apprehended as being subjective)

The fact that the firm faces a supply curve, and not a market price, means that it has a monopsonistic power in the market for its input. The supply function has the property that, for each outcome $\theta(w)$ of θ, there is a one to one correspondence between r and c, i.e.

$$\begin{aligned} c &= c(r,\theta) \\ r &= r(c,\theta) \end{aligned} \tag{3}$$

The functions are continuous on a bounded set of R^2.

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1 Nothing changes in the analysis if c is a vector of inputs $c = (c_1,\ldots,c_n)$.

2.1 c-behvior

Under c-behavior the firm decides the magnitude of the input of the production factor before the supply curve is revealed. The ex post profit be written

$$\Pi_c(c) = pf(c) - r(c,\theta)c \tag{4}$$

The expected profit is

$$E[\Pi_c(c)] = pf(c) - E[r(c,\theta)]c \tag{5}$$

If c* is the optimal choice under c-behavior it holds per definition that

$$E[\Pi_c(c^*)] \geqq E[\pi_c(c)] \quad \text{all } c \tag{6}$$

2.2 r-behavior

Under this behavioral mode the firm adjusts demand for production factors and, hence, production to meet supply at the chosen price. The ex post profit under r-behavior can be written

$$\Pi_r(r) = pf(c(r,\theta)) - rc(r,\theta) \tag{7}$$

The expected profit is

$$E[\Pi_r(r)] = pE[f(c(r,\theta))] - rE[c(r,\theta)] \tag{8}$$

Given that r^o is the optimal input price under r-behavior it holds that

$$E[\Pi_r(r^o)] \geqq E[\Pi_r(r)] \quad \text{all } r \tag{9}$$

Next we define two behavioral modes under which the firm makes both the input decision and the pricing decision before the revelation of the supply curve.

2.3 r-c-behavior[2]

The firm makes both the input decision and the pricing decision before the revelation of the supply curve. If the ex post supply is below the quantity the firm has planned to use the firm is constrained and has to take whatever volume it gets. On the other hand, if actual supply exceeds what the firm wishes to buy the firm buys its planned input, and no more. The ex post profit can be written

$$\Pi_{r\text{-}c}(r,c) = \begin{cases} pf(c(r,\theta)) - rc(r,\theta) & \text{if } c \geq c(r,\theta) \\ pf(c) - rc & \text{if } c(r,\theta) > c \end{cases} \tag{10}$$

If we define

$$\tilde{c}(r,\theta) = \begin{cases} c(r,\theta) & \text{if } c \geq c(r,\theta) \\ c & \text{if } c < c(r,\theta) \end{cases} \tag{11}$$

The expected profit can be written as

$$E[\Pi_{r\text{-}c}(r,c)] = pE[f(\tilde{c}(r,\theta))] - rE[\tilde{c}(r,\theta)] \tag{12}$$

Moreover, if r',c' is the optimal choice under r-c-behavior it holds that

$$E[\Pi_{r\text{-}c}(r',c')] \geq E[\Pi_{r\text{-}c}(r,c)] \quad \text{for all } (r,c) \tag{13}$$

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2 This is the analogy to the behavioral mode called q/p behavior in Lim [1980].

2.4 c-r-behavior

Finally we define a behavioral mode in which the firm determines an input quantity c and a maximum price r. If the planned input quantity c can be obtained at a lower price than r the firm buys at this lower price. If on the other hand, the quantity c can only be bought at a price higher than r, the firm buys whatever input volume it can obtain at the maximum price r. Hence, the ex post profit is

$$\pi_{c\text{-}r}(r,c) = \begin{cases} pf(c) - r(c,\theta)c & \text{if } r \geq r(c,\theta) \\ pf(c(r,\theta)) - rc(r,\theta) & \text{if } r < r(c,\theta) \end{cases} \tag{14}$$

If we define the sets A(r,c) and B(r,c) as

$$A(r,c) = \{\theta;\ r \geq r\ (c,\theta)\}$$

$$B(r,c) = \{\theta;\ r < r(c,\theta)\} \tag{15}$$

the expected profit under c-r-behavior can be written

$$E[\Pi_{c\text{-}r}(r,c)] = \int_{A(r,c)} (pf(c) - cr(c,\theta))\, dF(\theta) + \int_{B(r,c)} (pf(c(r,\theta)) - rc(r,\theta))dF(\theta)$$

If $\bar{r},\bar{c}$ is the optimal combination it holds that

$$E[\Pi_{c\text{-}r}(\bar{r},\bar{c})] \geq E[\Pi_{c\text{-}r}(r,c)] \quad \text{for all } (r,c) \tag{17}$$

3 THE RANKING OF DIFFERENT BEHAVIORAL MODES

In this section we prove four propositions, which to some detail enable us to compare the different behavioral modes defined in Section 2. In Proposition 1 we show that r-c behavior always dominates r behavior in the sense that the mathematical expectations of profits is higher under r-c behavior than under r behavior. The reason being that

r behavior is just a restrictive case of r-c behavior. By the same reason c-r behavior dominates c-behavior. In Proposition 2 we show that the introduction of a natural monotonicity requirement on the supply function enables us to show that c-r behavior dominates r-c behavior. In other words the maximum price - quantity strategy defined under 2.4 turns out to be the best behavioral mode for a firm trying to maximize expected profit.

In Proposition 3 we show that under conditions similar to Lim's c-behavior is better than r-c behavior, and finally in Proposition 4 we give a condition under which r-behavior dominates c-behvaior.

Proposition 1. It always holds that

a) r-c-behavior dominates r-behvaior
b) c-r-behavior dominates c-behavior

Proof: Proposition 1a: If we in the definition of r-c behavior put $c = \sup_r \sup_\theta c(r,\theta)$ (this sup exists as $c(r,\theta)$ is continuous on a bounded set) then r-behavior becomes r-c-behavior q.e.d.

The proof of Proposition 1b follows similarily.

If we are willing to assume that supply $c(r,\theta)$ is a nondecreasing funtion of θ the following claim can be shown to hold true.

Proposition 2. If $\theta > \theta_1$ implies that $c(r,\theta) \geq c(r,\theta_1)$ for all r, then c-r-behavior dominates r-c-behavior.

Proof: Let r',c' be the optimal choice under r-c-behavior, We then have

$$\Pi_{r\text{-}c}(r',c') = \begin{cases} pf(c(r',\theta)) - r'c(r',\theta) & \text{if } c' \geq c(r',\theta) \\ pf(c') - r'c' & \text{if } c' < c(r',\theta) \end{cases}$$

and

$$\pi_{c-r}(r,c) = \begin{cases} pf(c) - cr(c,\theta) & \text{if } r > r(c,\theta) \\ pf(c(r,\theta)) - rc(r,\theta) & \text{if } r \leqq r(c,\theta) \end{cases}$$

Since $C = \{\theta;\ c' \geqq c(r',\theta)\} = \{\theta; r' \leqq r(c',\theta)\} = R$

(from monoticity of $c(r,\theta)$) and

$pf(c') - c'r(c',\theta) \geqq pf(c') - c'r'$, if $r' \geqq r(c',\theta)$

it follows that

$\Pi_{c-r}(r',c') \geqq \Pi_{r-c}(r',c')$ for all θ

Thus, for $\bar{r},\bar{c}$ optimal under c-r-behavior we have that

$$E[\Pi_{c-r}(\bar{r},\bar{c})] \geqq E(\Pi_{c-r}(r',c')] \geqq E[\Pi_{r-c}(r',c')]$$

where the first inequality follows from (17) and the last inequality follows from the equality of the sets C and R and the definition of Π_{r-c} and Π_{c-r} q.e.d.

As a simple corollary it now follows from Proposition 1 and 2 that c-r-behavior dominates r-behavior under the assumptions in Proposition 2.

We will presently prove a claim, the validity of which is built on the same restrictive assumption which were used by Lim (1980). The proposition is the analogy of Proposition 2 in his paper, although the proof is a bit different, due to the particular features of the uncertain supply problem.

Proposition 3. If the funtions $c(r,\theta)$ are linear functions of θ with an additive random component, and the production function is concave, then c-behavior dominates r-c behavior.

Proof: Assume that

$c = ar + b + \theta$, when $E(\theta) = 0$ and let (r^0, c^*) be the values of (r,c) which correspond to the optimal r-c-behavior.

Define

$$\tilde{c}(r,\theta) = \begin{cases} c(r,\theta) \text{ if } c^* > c(r,\theta) \\ c^* \text{ otherwise} \end{cases}$$

Then

$$\tilde{c}(r,\theta) \leqq c(r,\theta)$$

Moreover $\sup_{r,c} E[\Pi_{r-c}(r,c)] = E[\Pi_{r-c}(r^0,c^*)]$

$= pE[f(\tilde{c}(r^0,\theta))] - r^0 E[\tilde{c}(r^0,\theta)]$

Let $\hat{c}$ be the value of c which is optimal under c-behavior and define

$$c_0 = E[\tilde{c}(r^0,\theta)]$$

Clearly

$$E[\pi_c(\hat{c})] - E[\pi_{r-c}(r^0,c^*)] \geqq$$

$$E[\pi_c(c_0)] - E[\Pi_{r-c}(r^0,c^*)] =$$

$$pf(c_0) - c_0 E[r(c_0,\theta)] - pEf(\tilde{c}(r^0,\theta)) + r^0 E[\tilde{c}(r^0,\theta)]$$

Since $c_0 = E[\tilde{c}(r^0,\theta)] \leqq E[c(r^0,\theta)] = ar^0 + b$

Thus $E[r(c_o,\theta)] \leqq r^o$

and $r^o E[\tilde{c}(r^o,\theta)] - c_o E[r(c_o,\theta)] = c_o(r_o - E[r(c_o,\theta)]) \geqq 0$

If we can show that also

$$f(c_o) - E[f(\tilde{c}(r^o,\theta))] \geqq 0$$

we are through. However, this inequality follows by invoking Jensen's inequality and the definition of c_o as $E[\tilde{c}(r^o,\theta)] = c_o$ q.e.d.

We will end this section by proving a result which shows under what circumstances r-behavior dominates c-behavior.

Proposition 4. If, for each θ the supply function $c = g(r) + \theta$, with $E(\theta) = 0$, is strictly increasing and concave and the production function is linear, then r-behavior dominates c-behavior.

Proof: Assume that $f(c) = ac + b$ and let c^* denote the optimal input combination under c-behavior.

The maximum expected profit under c-behavior is then

$$E[\pi_c(c^*)] = pf(c^*) - c^*E[g^{-1}(c^*-\theta)] =$$
$$= apc^* + bp - c^*E[g^{-1}(c^*-\theta)]$$

The expected profit under r-behavior is

$$E[\Pi_r(r)] = pE[f(c(r,\theta))] - rE[c(r,\theta)] = pag(r) + bp - rg(r)$$

Now choose $\bar{r} = g^{-1}(c^*)$ then

$$E[\Pi_r(\bar{r})] - E[\Pi_c(c^*)] = c^*(E[g^{-1}(c^*-\theta)] - \bar{r})$$

Since, $g^{-1}(c^*-\theta)$ is a convex function of θ it follows from Jensen's inequality that

$$E[g^{-1}(c-\theta^*)] \geq g^{-1}(c^*-E(\theta)) = g^{-1}(c^*) = \bar{r}$$

and the proposition follows by invoking (6) q.e.d.

This result shows, although r-behavior in most instances is an inferior behavioral mode, that its competiveness in relation to c-behavior seems to depend on the curvatures of the revenue and cost functions. Even if the revenue function (production funciton) is strictly concave r-behavior could dominate c-behavior provided that the supply function is, loosely speaking, "enough concave".

4 A FEW COMMENTS

Most of the results derived in this paper would carry over to the case of an uncertain demand curve, which in turn means that the results in Lim's paper could be sharpened a great deal. In particular as Lim seems to have overlooked the best behavioral mode. If we use the notational conventions of this paper, a q-p-behavioral mode[3] in the case of an uncertain demand curve would give the following ex post profit

$$\Pi_{q\text{-}p} = \begin{cases} qp(q,\eta) - c(q) & \text{if } p \leq p(q,\eta) \\ pq(p,\eta) - c(q) & \text{otherwise} \end{cases}$$

where $p(q,\eta)$ is the realization of the price given the supplied volume q, $c(\cdot)$ is the cost funcion and $q(p,\eta)$ is the demand function. The above behavioral mode means that the firm ex ante chooses a minimum price p and a quantity supplied q. If ex post this quantity can be sold at the minimum price or at an even higher price this is indeed

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3 What Lim (1980) calls q/p-behavior is in our terminology a p-q-behavior.

done. On the other hand, if not the firm sells whatever quantity it can sell at the minimum price. Using the idea in the proof of proposition 1 it is easily shown that q-p-behavior dominates q-behavior. This also explains the casual empiricism, mentioned by Lim, that firms are often observed to set both price and quantity.

5 AN APPLICATION OF THE RESULT

The above discussion on the ranking of different behavioral modes for a firm facing an uncertain supply curve is written in general terms, but the investigation of the problem originates from attempts to understand the functioning of the Swedish roundwood market. The firm discussed in sections 1-3 can, hence, be viewed upon as (the representative firm within) the Swedish forest industry, and the supply curve can be apprehended as an aggregate expression of the individual behavior of private forest owners.

People familiar with the institutional setting in the Swedish roundwood market know that the prices of timber and pulpwood are set on a yearly basis every fall in negotiations between one organization representing the sellers and one organization representing the buyers. No doubt, however, the buyer is the stronger party, and the market is best described by a model containing monopsonistic features. The price setting does of course not take place independently of the production plans of the industry, and the negotiation process could therefore be viewed upon as determining both price and quantity before the revelation of the cutting plans of the private forest owners.

Which of the two behavioral modes, r-c-behavior or c-r-behavior, that best describes the actual behavior of the forest industry is not selfevident. From the results in propositions 1 and 2 one would from a normative stand point be inclined to suggest c-r-behavior. It should, however, be reminded that c-r-behavior presupposes rather weak sellers. A realization $\bar{r} > r(c,\Theta)$ - i.e. a situation where excess supply forces the sellers to sell the wood at prices lower than the announced price - seems a bit unlikely when sellers are well organized. On the other hand, r-c-behavior has the unattractive feature of being dominated by both c-r-behavior and c-behavior.

Any reasonable model of the Swedish roundwood market must also be able to explain why wood sometimes is bought as standing timber for sale or imported from the international market at prices above the price level relevant for the proper roundwood market. It can be demonstrated that given the optimal price-quantity combination under a c-r-mode (as well as under a r-c-mode) there exists realizations of Θ such that $\Theta < \Theta^*(\bar{r}, \bar{c})$, where Θ^* is the lower bound of Θ in the set $A(\bar{r}, \bar{c})$, when the firm is willing to buy more wood at the ruling price $\bar{r}$. Note that $\bar{r} < r(\bar{c},\Theta)$ implies that $c(\Theta,\bar{r}) < \bar{c}$ from monoticity with respect to Θ, and, hence, that the theory is able to explain the rationing tendencies that have been prevalent in the late seventies and early eighties. We can talk about rationing in the ex post sense, as the firm ex ante realizes that outcomes $\Theta < \Theta^*$ are distinct possibilities.

An ex post market is, however, an interesting possibility also under a c-mode. An advantage of a c-r-mode (r-c-mode) over the c-mode in this respect is that a firm under a c-r-mode can plan production without placing any ex ante bids in other markets. There is a positive probability that there will be no ex post market, and an engagement in price equalizing arbitrage is a risky business. Uncertainty combined with the time dimension can, therefore, be used to divide the market into segments in which different prices are charged[1].

To sum up, the comparison of different behavioral modes for a firm facing av uncertain supply curve has hinted at an explanation of certain characteristic features of the Swedish roundwood market: The forest industry's actual behavior could be viewed upon as a rational attitude towards a stochastic environment. There are of course alternative explanations, and it should be kept in mind that the results are derived under an assumption of risk neutrality. The Swedish forest industry is, however, only one, possibly good, example of the applicability of the particular approach. The analysis of this paper are, of course, of some relevance for an analysis of the behavior of any monopsonistic firm facing a stochastic supply, of for an analysis of a monopolist facing a stochastic demand curve.

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1 For an attempt to model intertemporal price discrimination in another context see Löfgren (1971).

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EFFECTS FROM SUBSIDIES TO FORESTRY ON TIMBERPRODUCTION AND REGIONAL EMPLOYMENT

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A B S T R A C T

Subsidies are today given to the silvicultural activities in forestry in order to maintain a high level of long- and short-run timber supply.

Forest land with inferior quality and less profitability receive a large share of the forest subsidies. These lands are mainly situated in regimes with unemployment problems. Thus the forest subsidies become interesting also from the point of view of regional policy.

If the increase in forestry activities leads to a more efficient forestry, then the subsidies will be "refunded" by the social benefit they create, and thus any employment effects will be "free of charge". Consequently, subsidies to forestry could be a profitable way to reduce unemployment in the depressed areas.

Goals of Forest Policy[1]

The purpose of forest policy in Sweden is, roughly speaking, to attain a high level of sustained yield, in order to make a high level of production in forest industry possible. This is also the government's idea of the best way of using forest land. Behind this statement we find the opinion that a long- and short-run intensive forestry will improve on options in the future.

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1 SOU 1978:6

In some cases the goals of forest policy, in particular the recommended long-run intensive forestry, can diverge from the forest owners' views of the profitability of the fellings. This difference in opinion force the government to find instruments to stimulate or force the forest owners to perform according to the goals of forest policy.

Examples of instruments (means) are

- Silvicultural laws
- Financial support
- Information and consulting activities from the state silvicultural organization
- Service of county Forestry Board
- Taxes

These instruments are together supposed to realize the goals of forest policy although each instrument has effects on different parts of forestry. The silvicultural law, for example, is an efficient way of recieving a sustained yield as it forces the forest owners to make regeneration measures after fellings.

The forest policy can also be transformed into a forest production program which shows how much timber "should" (could) be felled. Some restrictions on how to run forestry are set by the silvicultural law. Sometimes these restrictions make the fellings unprofitable for the forest owners. These stands could, from a broader point of view, be desirable to cut.

Normally, forestry should of course be able to, all by itself, pay the measures set up by the silvicultural law. The regeneration measures, for instace, should be appropriately considered in the felling calculations. But different kinds of market imperfection induces differences between social and private profitability. Subsidies to forestry can be used as an instrument to correct for such differences.

An other goal of forest policy is to make forestry collaborate with other public sectors. Forestry and forest industry should take a part to fulfil other goals as full employment, economic growth, regional balance, balance of foreign trade. These, the second category of goals, from employment and regional policy point of view, are supposed to create job opportunities. The reason why forestry should be particularly suitable to create job opportunities is that one believe in silviculture as a "cheap" employment policy measure.

Subsidies to silvicultural activities

Economic support to forestry is the government's "carrot" to the forest owners in order to realize forest policy while the silvicultural law more has the character of a whip. The subsidies are given in order to stimulate the timber production and in some cases partly pay the overhead tending costs. How much the forest owners get, depends on the economic profitability of the fellings which in turn depends on the character of the forest land.

Due to the biological and economic differences in producing timber the government has introduced a "forest subsidy area" in the north of Sweden. This area overlaps the subsidy area of regional policy (see figure 1) and makes the forest subsidies interesting also from the point of view of regional policy.

Financial support to forestry can both be given from employment point of view or merely in order to correct for differences between private and social profitability. This fact makes the subsidies of different kinds. We have subsidies given in order to increase the long-run timber supply. These subsidies are often the same in the entire country. Other subsidies are given only in the subsidy area. We also have subsidies designed so that it is given independently of location but the highest subsidy is given in the subsidy area. To stimulate private forest

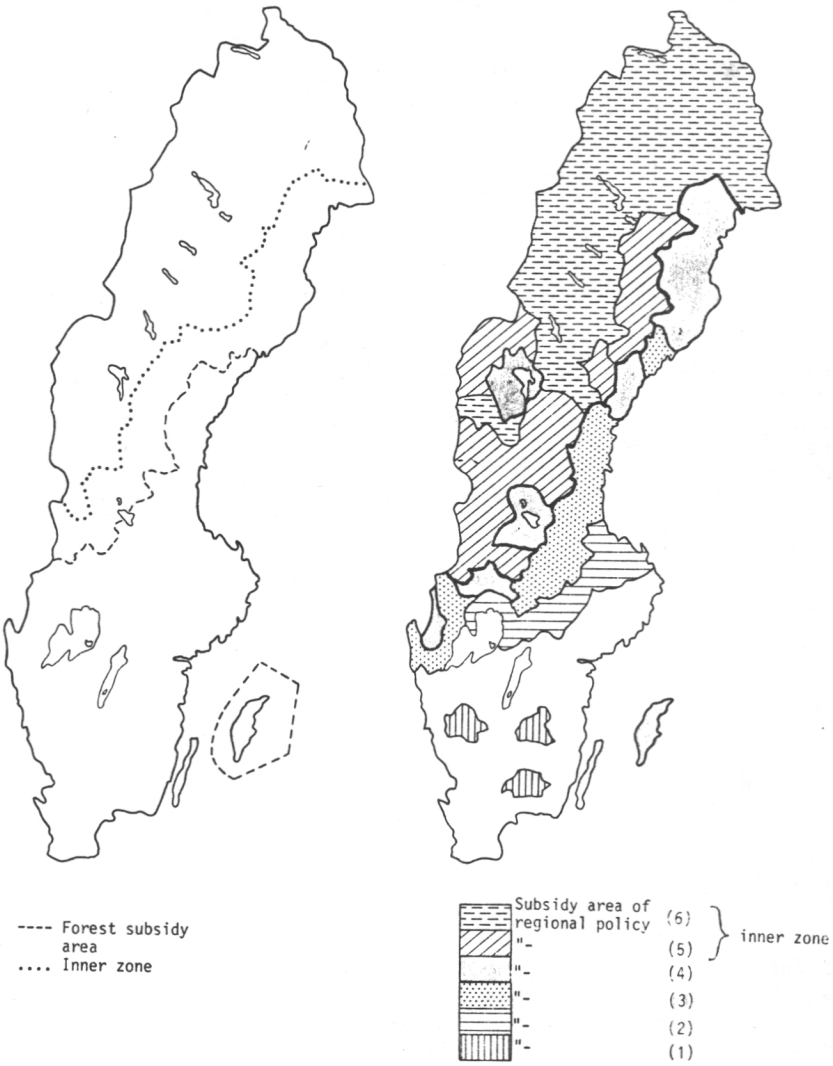


Figure 1 The forest subsidy area and the subsidy area of regional policy (1981)

owners to a higher level of felling, the level of some subsidies depend on the kind of forest owner. In some cases, small scale forestry, gets a higher percentage in subsidies for a certain kind of measures than large scale forestry.

The financial support to forestry is divided into different appropriations due to the kind of activity and/or regions. The fact that there

Table 1 Subsidy entitled measures within different appropriations and per cent of the cost the subsidies cover. The percentage vary dependent on kind of forest owners and part of the country. (Is applicable to July 1983.)

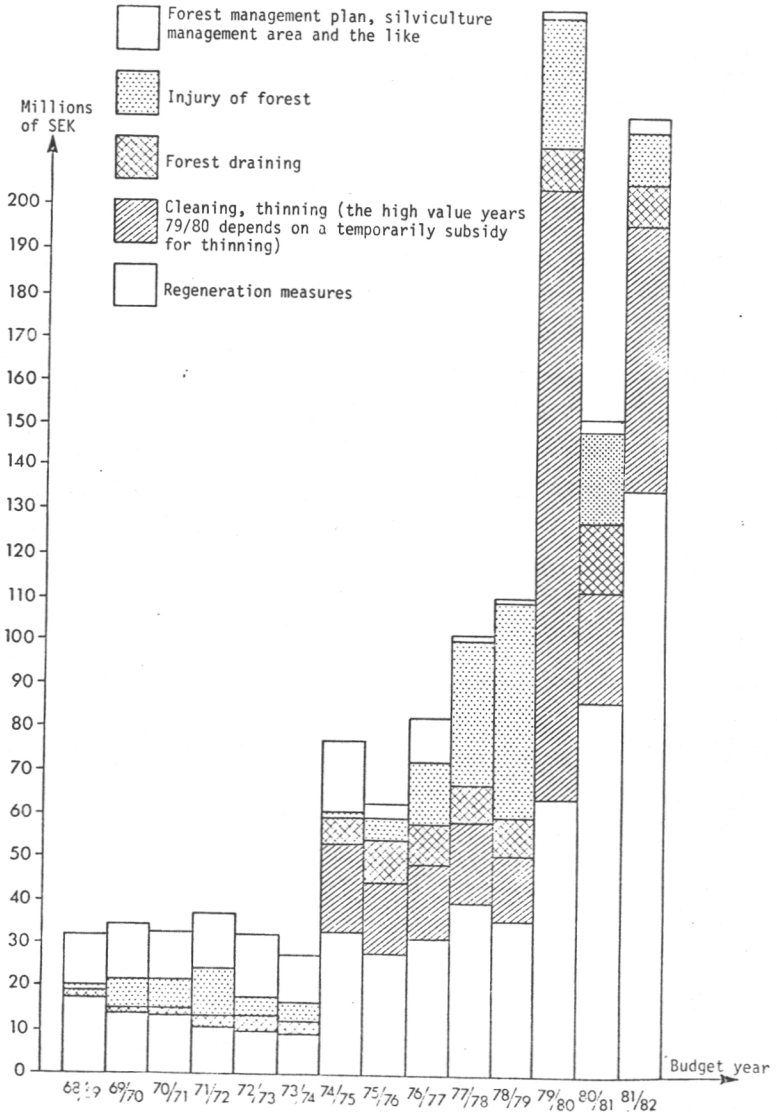
Measures	Applications: Silvicultural measures	Injury of forest	Forest management plan	Forest roads	Intensified silviculture in northern Sweden *)
REGENERATION MEASURES					
- normal stands	50%				
- difficulties of forestation	30-90%	70-90%			60-70%
STAND TREATMENT AND FELLING					
- cleaning	30-60%				60-70%
- thinning	felling defict				
- taking charge of smallwood	600:-/ha				
- final fellings, thin or inferior quality of forest land	felling defict				
- insect combating		varies			
FOREST DRAINING	40%				
FOREST MANAGEMENT PLAN			800:-/ plan		50-60%
FOREST ROADS				30-75%	

(The National Board of Forestry)
*) Until June 30th 1984

are two reasons for giving subsidies makes it possible for the forest owners to get subsidies for the same measure in different appropria-

tions. This makes the support to forestry complicated and difficult to evaluate. In table 1 we can see the appropriations, support entitled measures, and how much of the costs the subsidies cover as of today.

The support has changed during the later years. The total sum given in subsidies to forestry has increased (see figure 2) and the appropriations have changed from 1 January 1980. As the subsidies has



National Board of Forestry

Figure 2 Total financial support to silvicultural activities in forestry during 1969-1982 (fixed prices at the level of budget year 1980/81)

increased even more in northern Sweden (about 50 % of total sum in 1968/69 and 70 % 1981/82) one can ask if the regional policy goal has increased in importance within forest policy.

We will concentrate our analysis on the support to regeneration measures. We are in particular interested in whether these subsidies are motivated from a cost-benefit view point, and whether they have had any positive effects on timber supply and regional employment.

The profitability of investments in regeneration means on low-productivity areas

The effect on forestry from the duty of regeneration is that the alternative to cut and then leave the forest land to its own destiny, is not allowed, and that the regeneration cost might be apprehended as a compulsory harvesting cost rather than an investment cost.

Thus the regeneration duty has its effect on those foresters who otherwise would choose to cut and then do nothing more. If the regeneration duty makes the forester cut and regenerate it has a positive effect on the longrun timber supply. But, in case the duty of regeneration makes the forester give up the cut, then it rather has a negative effect on the short-run (and long-run) timber supply.

Any negative effect on the short-run timber supply could be counteracted by a financial support to the regeneration cost.

Consequently, subsidies to regeneration means do affect those foresters who give up the harvest of today's forest stand due to the regeneration duty.

Let us define:

$\underset{t}{\text{Max}}\ \pi = \bar{\pi} = p_s \cdot q_s(\bar{t})$ = the net present value at the time t_0 (the time of harvest) from cutting the present forest stand at the optimal age $\bar{t}$.

$C =$ The minimum cost of regeneration i.e. the cost necessary to attain the minimum demands of regeneration means after clear-

cutting, according to the forest legislation. The forester is free to choose a more extensive (and expensive) regeneration program, but not a less extensive (and expensive) one.

When there is a duty of regeneration the forester will always cut and regenerate when

$$\bar{\pi} - C > 0$$

As cutting and regenerating is the only way to obtain the profits from the present stand the forester will choose this alternative whatever future value the new stand will take. It does not matter if the forester is a long-run or short-run profit maximizer, the behaviour will be the same, except that a long-run profit maximizer might choose a more extensive regeneration programme in order to raise the future profit. The duty of regeneration has a positive effect on the future volume of timber, and there is no need for a financial support in order to stimulate the forester's actions.

If the net present value, on the contrary, is less than the minimum regeneration cost, but greater than zero i.e.

$$0 < \bar{\pi} < C$$

there is a risk that the duty of regeneration makes the forester give up cutting the old forest stand.

In case the forester give up the cutting, regarding it unprofitable, a financial support to the regeneration cost could make him change his decision.

The cutting of these stands is obviously profitable as the net profit from cutting is positive. Whether the investment in regeneration means is economically justified or not depends on the present value of the future timber production of the new stands.

The economic criteria for making an investment in establishing a new stand is

$$\pi^* > [\max: \pi_n, 0]$$

π^* = the maximum present value of all future stands when regeneration measures has been taken.

π_n = maximum present value of all future stands when the stands have been established by natural regeneration.

i.e. the value of future stands when regeneration measures has been taken must be positive, or greater than the value of naturally grown up forest stands if that value is positive.

As it is quite difficult, or rather impossible, to make a general statement of the value of wild grown forest stands we will leave out that alternative and investigate only the the minimum requirement, i.e.

$$\pi^* > 0$$

Let us define the net revenue when the new stand is harvested as:

$$R_F = P_0(q_F, d_F) \cdot e^{iT^*} \cdot q_F(T^*)$$

$P_0(q_F, d_F)$ = the net revenue per m^3f as a function of the volume of the stand (q_F) and the diameter of the trees (d_F). (The diameter decides the distribution between saw-timber and pulpwood.) The net revenue is calculated in the prices of the year t_0 which is the year when the investment takes place.

e^{iT^*} = the change in prices during the rotation period (T^*) where i is the rate of change in prices.

$q_F(T^*)$ = the volume of the new stand measured in m^3f, as a function of the rotation period (the production function).

T^* = the optimal rotation period of the new stand.

We can now write the maximum present value of all future stands as

$$\pi^* = \frac{R_F \cdot e^{-rT^*} - C}{1 - e^{-rT^*}}$$

At the time t_0 when the investment in a new stand takes place, we cut the growing stock and obtains the net revenue

$$\bar{\pi} = P_0(q_s, d_s) \cdot q_s(\bar{t})$$

On those forest lands where the net profit from the present stand does not cover the regeneration cost, (those who obtain subsidies), the net present value from cutting the new forest stand do cover the cost only if the new stand is improved with respect to volume and/or value compared to the old stand.

We have tried to make a rough calculation of how much the net value of a forest stand on a specific area of forest land and under very favourable circumstances, could increase. In other words, we have tried to find an upper limit of increases in value and volume.

The volume of the future forest stand

We could assume that the volume of the old stand is less than potentially possible, when the forest land's ability to produce timber is optimally utilized. This assumption is reasonable due to the fact that "intensive" forestry is a fairly young discipline. Today's growing stock has probably not been established by using silvicultural means in order to raise quality and volume. The total volume of biological substances might be at maximum but the volume of timber useful for industrial purposes is less than potentially possible.

The silvicultural law describes and defines what is to be considered as extremely bad forest stands (so-called 5:3-forests, the name comes from the number of the section of the law which describes this kind of forests). If the growth of the forest stand is less than 50% of what is potentially possible, according to the site quality index of the land, then the forest stand is a 5:3-forest stand.

As these stands are in a minority, forest stands normally have a better growth and volume than 50 % of what is potentially possible. We could then roughly say that the upper limit for an increase in timber volume is doubling the quantity i.e.

$$\text{Max } q_F(T^*) = 2q(\bar{t})$$

The net revenue at constant prices from cutting the future forest stand

The net revenue at constant prices is determined by the volume, quality and dimension of the forest stand and the trees. The cost of cutting decreases as the total volume of the stand increases (due to the fixed costs of each cutting object) and as the volume of the single trees increases (due to the fixed costs of cutting each tree).

The price of timber increases with better quality, larger diameter (more saw timber and less pulpwood). Thus the net revenue increases when the total volume and the dimension (the volume of each tree) increase.

According to calculations of the net revenue from clearcutting made within this project[1] the net revenue is greater than zero but less than the regeneration cost when the average diameter of the stand is 13-16cm.

In order to double the total volume of the stand the average diameter has to increase from 13-16 cm to 19-22 cm, if the number of trees is constant. It should be pointed out that we have used a volume-dimension relation that holds for single trees[2]. So, it is a very rough approximation.

Forests which give an extremely low net value when cut down are likely to be found in the interior of northern Sweden. An average diameter of

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1 M Göransson, Inst för skogsek. Jan 1983 Stencil.
2 According to tables by Åke Cernold "Praktisk skogshandbok" Sveriges Skogsvårdsförbund.

19-22 cm is an average final felling diameter of forest stands in northern Sweden[1]. So, this assumption could be interpreted in the manner that bad forest stands in northern Sweden could by maximal improvements reach the average level.

The net revenue from cutting a stand with the average diameter of 19-22 cm is about 40-50 SEK/m^3f i.e. (at the price level of 1979).

$$P_0(q_F, d_F) = 50 \text{ SEK/m}^3\text{f}$$

The increase in net revenue does not only depend on an increase in volume but also in quality. In the figure 50 SEK/m^3 f we have included a change in the distribution between saw timber and pulpwood. The new stand gives a higher share of saw timber (which has a higher price) than the old stand.

Real change of market prices

Making a forecast of the change in prices during a period of 100 years or more is a very difficult task. We will assume that prices and the net revenue will follow the inflation rate, i.e. they will be constant in real terms. An assumption which is neither better nor worse than any other forecasts[2], thus

$$i = 0$$

and

$$e^{iT^*} = 1$$

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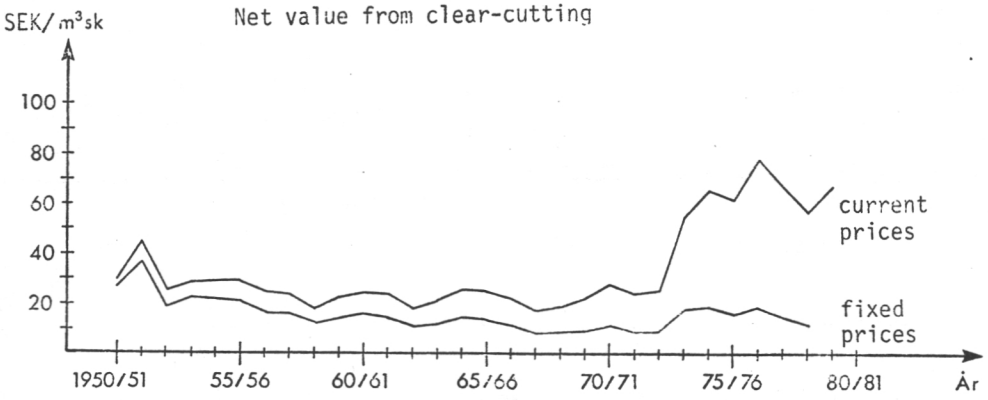
1 Forsknings Stiftelsen Skogsarbeten, Redogörelse 1978/4
2 Löfgren & Johansson, Chapter 8

If we look at the development of the average net revenue from cutting during the latest thirty years we find that it has steadily been falling.



Skogsstatistisk Årsbok

The decrease has occured in spite of the very extensive efficiency improvements that have taken place during this particular period. So, if this development tends to continue then the assumption of a constant real revenue is quite optimistic.

The rate of return on the investment when the timber production on low profit forest areas is maximally improved

The net present value of future stands

$$\pi^* \geq 0$$

can be written

$$\frac{R_F \cdot e^{-rT^*}}{1 - e^{-rT^*}} \geq \frac{C}{1 - e^{-rT^*}}$$

and

$$R_F > C \cdot e^{rT^*}$$

According to the assumptions made about the maximum value of the future stand, the function is

$$R_F = 50 \cdot 2\, q_s(\bar{t}) > C \cdot e^{rT^*}$$

The regeneration cost (an average cost for northern Sweden at the same level of prices (1979) as the net revenue from cutting) expressed as the cost per m^3 timber harvested at the clearcut, is 20 SEK/m^3f.

$$\frac{C}{q(\bar{t})} = 20 \text{ SEK/m}^3\text{f}$$

then the above inequality becomes

$$50 \cdot 2 > 20 \cdot e^{rT^*}$$

or

$$e^{rT^*} < 5$$

and

$$rT^* < 1{,}7$$

If the rotation period is about 100 years then the rate of return of the investment in regeneration means, under favourable circumstances, could reach about 1,5%. If the optimal rotation period is shorter, the rate of return is higher and vice versa, which means that the rate of return is likely to be higher in southern Sweden than in northern Sweden. Still, the results from this brief calculation hints that subsidizing forest stands where

$$0 < \bar{\pi} < C$$

in order to get a new stand established is hardly justified by the value of future timber production. However if we do not give subsidies, these stands will not be cut. So, it seems that financial support to the regeneration cost have more importance for the regional employment than for the value of the future timber production.

Employment effects

One of the subsidies to regeneration measures pays 50 % of regeneration costs in cases when the yield from felling does not cover cost. (This subsidy is only valid for the inner zone of the subsidy area.) We have made a rough estimation of the effects of this subsidy on timber supply and employment.

First, we have to determine the area and volume of forests which have the relevant shape (i.e. profitable to cut when 50 % of regeneration costs are paid). This has been done by collecting information from several forest owner associations. In the National Forest Survey we find that about 18 millions m^3 sk are of this actual kind in the inner zone of the subsidy area. These stands are old enough to be cut within a 10 years period which means 1,8 millions m^3 per year. Counted as job opportunities the subsidy implies about 900 annual job opportunities in forestry. If, indirect effects[1] are included we obtain the estimate 1300-1400 jobs.

The total government expence for 50 % of regeneration costs at 1,8 millions m^3 makes 18 million SEK[2] or 13 000-14 000 SEK per job opportunity. This figures compares favourable with the bang for the "buck" in regional policy in general which amounts to 1 job/45 000 SEK[3].

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1 In Anderstig & Lundberg, "Näringsliv och sysselsättning: Norrbotten en regional input-output studie" 1979 the indirect effects are estimated by using the employment multiplier for the branch of industry forestry and agriculture.

2 Prices of 1979

3 Bångman, G. Behövs regionalpolitiskt stöd till skogsbruket (prices of 1979)

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SOU 1978:47 Att främja Regional utveckling (en utvärdering av det regionalpolitiska stödet till industrin).

Sveriges Skogsvårdsförbund Praktisk skogshandbok.

ON THE TIMBER SUPPLY BEHAVIOUR OF PRIVATE NONINDUSTRIAL FOREST OWNERS IN FINLAND

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The paper presents some of the results of an econometric study on the timber supply behaviour of private nonindustrial forest owners in Finland. The data consists of interviews of 2899 forest owners in Finland during the mid-1970s.

Econometric methods using qualitative dependent variables are briefly discussed. The results of three different model types are presented. In the logit models, the "timber sales - no sales" dichotomy in the interview year is the dependent variable in order to investigate the determinants of the probability of cuttings. Next, the determinants of the volume of cuttings for sale in the interview year are studied by using linear regression models, with those who sold as data. Finally, the "average supply models", where the dependent variable is the product of the volume of cuttings for sale and the sales probability as predicted by the logit model, are discussed.

According the results, various socio-economic factors affect the sales probability and also the "average supply". The volume of sales seems to be almost solely dependent on the size of the holding and the type of owner. Other socio-economic factors being equal, farmers sold more often but less at a time than non-farmers. There is no difference, however, in the average supplies of the two groups.

1. INTRODUCTION

This paper presents results of a pilot study which has employed econometric methods to model qualitative choices in investigating the timber supply behaviour of private forest owners in Finland. The data is based on the interviews of 2899 forest owners in the cutting year 1974/75 in Southern Finland and 1975/76 in Northern Finland. Both time series (cf. Tervo 1981, Korpinen 1981) and cross-sectional data (cf. Virta 1971, Seppälä 1974, Järveläinen 1974, 1981, 1983a, 1983b) has been used in the empirical research of the Finnish roundwood supply. The present study uses econometric methods for cross-sectional data (specially those of qualitative choices) in modelling the socio-economic factors that affect timber supply from private nonindustrial forests. Similar methods in modelling timber supply have been used earlier by, for example, Binkley (1981) and Knapp (1981). The results presented here are based on Kuuluvainen, Loikkanen and Salo (1983).

2. METHOD OF STUDY

We estimate different types of econometric supply models in which the dependent variables and the model types vary but the independent socio-economic variables remain the same. In our logit models we model the "timber sales - no sales" dichotomy in the interview year in order to find out the determinants of the probability of selling timber. Independent socio-economic variables are categorical in nature (farmers - nonfarmers) or are categorized (owner's age). At this stage we want to identify those socio-economic variables in our data, which have statistically significant and theoretically justified effects on probability of cuttings for sales (average sales frequency). From the estimated model it is then possible to derive the quantitative effects of different factors affecting the sales probability per period.

With this model it is possible to get answers such as over 50 year old farmers in Northern Finland sell timber during a year with the probability of 0.2. More intuitively, this means that average sales interval with these farmers is 5 years (=1/0.2), or that out of 100 forest owners with above qualifications 20 sell timber every year.

Briefly, the idea behind the logit models used may be demonstrated by showing their relation to the normal linear regression model. Consider a relative frequency of (in this case) timber sales (probability of sales per period) in the i:th of n replicated samples

$$0 \leq P^i \leq 1; \quad i=1,\ldots,n.$$

Frequencies are influenced (in this case) by socio-economic variables $X_1,\ldots,X_n$. One problem of using normal linear regression analysis to explain P is that predicted frequencies may not be between 0 and 1. One way to avoid this is to use a logit transformation of the linear regression model.

$$(1) \quad \ln (P/(1-P)) = b_1X_1 + \ldots + b_nX_n + b_0 + v,$$

v is the stochastic disturbance.

This specification is possible if reliable (micro) information on relative frequencies P is available. In our data this information is the forest owners' own opinions on their average sales interval (MV; P=1/MV). Models of this type were estimated in the study, but are not presented here.

Often, however, this kind of information does not exist, or is considered unreliable, or one wants to compare the results of different explained variables describing the same phenomenon. In such cases it is possible to use the "sales - no sales" dichotomy as the dependent variable in a discrete choice model. The logit model will be used in this

study. The depended variable is then

$$Y^i = \begin{cases} 1 & \text{(sales)} \\ 0 & \text{(no sales)} \end{cases}$$

per period and the model predicts the probabilities of selling (P^i (= Prob Y^i=1)). An estimable logit equation may be obtained directly from the above logit transformation by setting the stochastic disturbance term equal to zero and solving (2) for P (cf. Intriligator 1978;174). This leads to the logit equation

$$(2) \quad P^i = 1/(1+\exp(-(b_0+b_1X_1^i+ \ldots +b_mX_m^i))),$$

$$= 1/(1+\exp(-t^i)),$$

where $b_0,\ldots,b_m$ are the parameters to be estimated. For detailed discussion see cf. Goldberger (1964), Theil (1971), Goldfeld and Quandt (1972), Maddala (1977) and Pindyk and Rubinfeld (1981). A survey discussion on the econometrics of qualitative choices is provided by Amemiya (1981).

According to equation (2) the probability of selecting alternative 1 increases and $P^i \longrightarrow 1$, when $t^i \longrightarrow \infty$. Accordingly, $P^i \longrightarrow 0$, when $t^i \longrightarrow -\infty$. The cumulative distribution funtion is a sigmoid as depicted in figure 1.

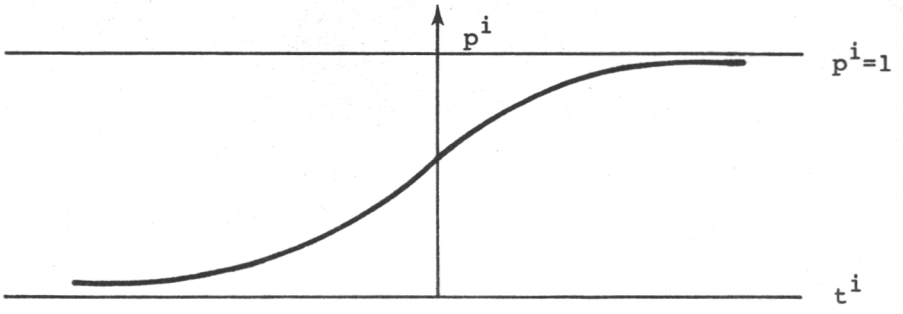

Figure 1. Sigmoid cumulative distribution function.

At this stage the determinants of the volume of cuttings for sale in the interview year are studied by using linear regression models with those who sold as the data. Thereafter, we estimate "average supply models" using linear regression analysis in which the dependent variable is the product of the volume of cuttings for sale and the probability of selling as predicted by the logit model. Independent variables are the same as above except that the forest area is now continuous. The results of these models are affected by the fact that there was a marked recession in the forest industries during the interview years. To obtain results which are independent of the economic situation in the interview year, we estimated linear regression models in which the dependent variable was the product of P=1/MV (MV = the average sales interval inquired in the interview) and the volume of cuttings.

3. THEORETICAL FRAMEWORK

The available cross-sectional data does not contain observations of prices, nor the income of the forest owners. Therefore we do not formally present the timber supply decision making process, but we do discuss the inclusion of the socio-economic variables and there expected signs. Most of our variables can be considered to affect the timber supply decisions by affecting the constraints of the forest owners utility maximizing problem which implicitely lie behind our models (cf. Binkley 1981). The independent variables used in our three types of models, and their expected signs, are presented in table 1.

TABLE 1. The expected effects of exogenous variables on the probability of selling timber (P), on the quantity (Q) (during the year of selling) and on the average supply per year (PxQ).

	P		Q	PxQ
The woodlot is owned by the household (family)	+		-	+/-
The woodlot has a forestry plan	+	and/or[1]	+	+
The owner has received vocational forestry training	+	and/or	+	+
District - Northern Finland compared to other parts of country	-		+	-
Owner's age	-		-	-
Period of ownership	-		-	-
Forest land area of the holding	+		+	+
Arable area (farmers)	-		+	-
The nonfarmer resides permanently on the holding	+		-	+
The owner is a nonfarmer	-		+	+/-

[1] The variable is expected to positively affect probability or quantity or both.

4. ESTIMATED RESULTS

4.1. Sales probability models

According to the results of our logit models several socio-economic factors have statistically significant effects on the probability of selling timber in the interview year. The probability of selling timber increases in the interview year when the ownership of the forest holding is within the family, a forestry plan exists, the owner has had vocational training in forestry and when the size of the holding increases. Young owners sell more probably than the old ones. The sales probabilities are highest in Southern and Western Finland, at intermediate levels in Central and Eastern Finland and smallest in Northern Finland. The ownership period and the arable area of farmers do not obtain significant coefficients. The farmers differ, however, from non-farmers in that the former have a higher sales probability than the latter.

The results of logit sales probability model are presented in table 2. The table also reports probabilities of selling timber for each independent variable solved from the coefficients of the logit model by using the cell means of other variables. Therefore, the probabilities given to each category of the independent variables in question must be considered as ceteris paribus figures. The average sales intervals given by the probabilities are also presented.

4.2. Volume of cuttings during the year when timber is sold

As our second set of models we estimate linear regression models using the volume of timber cuttings (in cubic meters) as the dependent variable. Now, only ownership structure, forest holding size and owner type variables obtain significant coefficients. The volume of sales increases not only with the holding size, but also when the ownership is

TABLE 2. Logit sales probability model

EXOGENOUS VARIABLE	COEFF.	ASYMPT. t-VALUES	SALES[1] PROB.	AVERAGE[2] SALES INTERV.
CONSTANT	-0.906	2.810		
OWNERSHIP				
- alone or with family members	0.408	3.456	0.463	2.15
- other (0-case)			0.364	2.74
FORESTRY PLAN				
- yes	0.484	3.242	0.553	1.80
- no (0-case)			0.433	2.30
VOCATIONAL FORESTRY TRAINING				
- yes	0.290	2.867	0.498	2.00
- no (0-case)			0.426	2.34
DISTRICT				
- Southern Finland	1.314	9.125	0.572	1.74
- Western Finland	1.316	9.695	0.573	1.74
- Central and Eastern Finland	1.106	9.425	0.521	1.91
- Northern Finland (0-case)			0.265	3.77
OWNER'S AGE				
- under 40 years	0.636	4.343	0.504	1.98
- 40-49 years	0.662	5.127	0.511	1.95
- 50-60 years	0.440	3.753	0.455	2.19
- over 60 years (0-case)			0.350	2.85
PERIOD OF OWNERSHIP				
- under 10 years	-0.048	-0.365	0.458	2.18
- 10-25 years	-0.216	-1.945	0.416	2.40
- over 25 years (0-case)			0.470	2.12
FOREST LAND AREA				
- under 25 hectares	-1.348	-9.296	0.281	3.55
- 25-49 "	-0.794	-5.900	0.405	2.46
- 50-100 "	-0.238	-1.885	0.542	1.84
- over 100 " (0-case)			0.601	1.66
OWNER IS				
1) a nonfarmer	-1.760	-5.167	0.322	3.10
2) a farmer with arable area				
- under 5 hectares	-0.302	-1.760	0.429	2.33
- 5-11 "	0.070	0.484	0.521	1.91
- 12-17 "	0.098	0.564	0.528	1.89
- over 17 " (0-case)			0.504	1.98

Percentage of correctly predicted choices	67.8
Number of observations	2717
Mean of the dependent variable	0.455

[1] Sales probabilities for each cell are calculated using means of all other variables.

[2] Average sales interval for each cell is the reciprocal of sales probability.

within the family or when the owner is a non-farmer instead of a farmer. The estimated results are presented in table 3.

TABLE 3. Linear regression model for volume of cuttings for sales

EXOGENOUS VARIABLE	COEFFICIENTS	t-VALUES
CONSTANT	3.101	
OWNERSHIP		
- alone or with family members	66.972	2.047
- other (0-case)		
FORESTRY PLAN		
- yes	18.666	0.598
- no (0-case)		
VOCATIONAL FORESTRY TRAINING		
- yes	33.805	1.401
- no (0-case)		
DISTRICT		
- Southern Finland	-14.483	-0.422
- Western Finland	-44.511	-1.356
- Central and Eastern Finland	11.382	0.376
- Northern Finland (0-case)		
OWNER'S AGE		
- under 40 years	-6.237	-0.165
- 40-49 years	-6.816	-0.205
- 50-60 years	13.599	0.445
- over 60 years (0-case)		
PERIOD OF OWNERSHIP		
- under 10 years	50.997	1.511
- 10-25 years	-14.610	-0.518
- over 25 years (0-case)		
FOREST LAND AREA		
- hectares (continuos variable)	2.176	19.445
OWNER IS		
1) a nonfarmer	90.230	2.607
2) a farmer with arable area		
- under 5 hectares	54.498	1.283
- 5-11 "	-15.738	-0.495
- 12-17 "	-34.825	-0.937
- over 17 " (0-case)		
R^2	0.293	
F-statistics	31.63	
Number of observations (those who sold during the interview year)	1238	

4.3. Average annual supply

Next, we construct an (annual) "average supply" dependent variable by multiplying the probability predictions of the above logit model with the volumes of sales for those owners who had sold during the interview year (sales information per year for other years was not available). In our linear "average supply" regression model the signs of variables are the same as in our logit model. Also, the same variables become significant except for the age and owner type variables which are now insignificant. Referring to the latter variable, the evidence this far suggests that farmers sell more often but less at a time than non-farmers. There is no difference, however, in their "average supply". Also these results must be considered ceteris paribus results. The results of the model are presented in table 4.

To reiterate, the above results are based on data concerning the interview years, i.e. years during which a recession prevailed. To obtain results which are independent of the economic conditions of the interview year we utilize the answer to a question concerning the average sales interval (MV). Now, average annual sales probability (P) for each forest owner is 1/MV.

Finally, we construct "average supply" models in which the dependent variable is the product of the inverse of the sales interval (1/MV = P) and the volume of sales during the interview year. Of the statistically significant variables, ownership structure, forestry plan, regional location, owner type and forest holding size each have the same signs as they have in our previous "average supply" model, in which the sales probabilities were predicted by the logit model. Vocational training in forestry has now a significant positive effect only in the first model, whereas ownership period now has a significant effect only in the second variant. The average annual volume supplied is greatest for those whose ownership period is the shortest. The owner

TABLE 4. Linear regression models for average supply
Model 1: Dependent variable PxQ
Model 2: Dependent variable (1/MV)xQ

EXOGENOUS VARIABLE	MODEL 1 COEFF.	t-VALUES	MODEL 2 COEFF.	t-VALUES
CONSTANT	-96.783		-166.838	
OWNERSHIP				
- alone or with family members	51.187	2.738	90.358	4.115
- other (0-case)				
FORESTRY PLAN				
- yes	55.926	3.161	45.110	2.171
- no (0-case)				
VOCATIONAL FORESTRY TRAINING				
- yes	33.031	2.420	17.562	1.095
- no (0-case)				
DISTRICT				
- Southern Finland	78.403	4.033	88.730	3.886
- Western Finland	56.299	3.010	41.891	1.907
- Central and Eastern Finland	87.700	5.109	64.558	3.202
- Northern Finland (0-case)				
OWNER'S AGE				
- under 40 years	11.389	0.533	-5.711	-0.228
- 40-49 years	23.458	1.249	-7.672	-0.348
- 50-60 years	20.663	1.200	-4.606	-0.228
- over 60 years (0-case)				
PERIOD OF OWNERSHIP				
- under 10 years	32.166	1.686	67.559	3.014
- 10-25 years	-14.224	-0.896	10.062	0.539
- over 25 years (0-case)				
FOREST LAND AREA				
- hectares (continuos variable)	1.523	23.619	1.930	25.478
OWNER IS				
1) a nonfarmer	-7.011	-0.357	26.355	1.143
2) a farmer with arable area				
- under 5 hectares	-5.431	-0.227	52.515	1.865
- 5-11 "	-17.184	-0.959	8.114	0.386
- 12-17 "	-27.213	-1.297	-16.808	-0.682
- over 18 " (0-case)				
R^2	0.385		0.403	
F-statistics	47.115		50.769	
Number of observations	1219		1219	

type variable does not receive a significant coefficient in either model, implying that there is no difference in the average supply of farmers and non-farmers.

5. DISCUSSION

Despite the fact that most of our results are in accordance with our expectations they must be regarded to be somewhat tentative due to the nature of our data. Instead of information concerning supply behaviour in a given year only, we would like to have time series data on individual forest owners. Furthermore, information on the price of timber and some other additional socio-economic variables related to owners and their forest holdings would evidently enable the construction of better models. The testing of present results with new data sets is left for future work.

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S T U M P A G E A N D L A N D R E N T T H E O R Y

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As a basic economic category, stumpage belongs to rent. It is considered here whether the traditional land rent theory still provides useful tools for the study of stumpage. First, the present position of land rent theory in modern "mainstream" economics is discussed. Then the classical case of Ricardian increasing rent is presented. Finally, the concepts of differential and absolute rent in stumpage price formation are discussed. It is recognized that the former is price-determined while the latter is price-determining. This difference may be of importance in the study of stumpage prices.

1. ANY ROOM FOR THE THEORY OF LAND RENT?

The classical economists divided the productive factors into three familiar groups: labour, capital and land. The return on labour is called wages, the return on capital is usually termed interest and the return on land is called rent. Land as an economic category, it may be recalled, includes all free gifts of nature such as land, forests, minerals etc., commonly called natural resources. The theory concerning the return on land is traditionally known as the theory of land rent.

However, the position of the "independent" land rent theory has weakened much in development of economics. For the most part, modern economics has abandoned the notion that there is any need for a special theory of ground rent. In the long run stationary equilibrium, the total product is resolvable into wages and interest on labor and capital - there is no third factor of production (Blaug, 1977; 87). The theory of rent is interesting only because it marks the appearance of the marginal principle in economic theory.

This development is apparently due to the prevailing concept, which treats land and other natural resources as capital. The general definition of capital considers it to be anything which yields a flow of productive services over time and which is subject to control in production processes. Thus land is included in capital since it meets both of the definition's requirements (Herfindahl and Kneese, 1974; 68). Accordingly, the role of rent has changed, too. It is no longer considered only as the payment for the use of land but has been generalized as a term of surplus payment on any factor of production over and above what is necessary to keep it in its present use. Thus, also from a point of view of distribution and the problems of pricing, there is no need to handle land and other natural resources with a specific land rent theory.

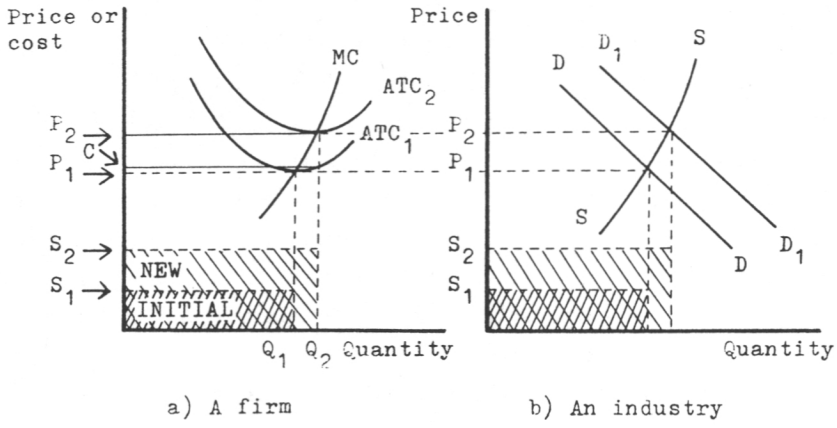
One purpose of this paper is to question whether the land rent theory is only of historical interest, worthy of no more than a passing comment in the economic textbooks. More specifically, the paper is based on the view that many important roots of the problems connected with the stumpage prices lie in the foundations of land rent theory. It tries to develop further some very preliminary thoughts on stumpage presented earlier (Saastamoinen, 1978).

2. STUMPAGE AND RICARDIAN INCREASING RENT

To consider the role of rent in the forest sector, the familiar basic model of rent will be examined (Gregory, 1972; 76 - 77, 354 - 355).

Suppose that the forest industry in a country is composed only of saw-mills, each of them having ordinary average total cost and marginal cost curves (Fig. 1a). The equilibrium price covers all costs of lumber production including stumpage payment, S_1. The aggregated marginal cost curves yield the industry's supply curve SS, which intersects the demand curve DD for lumber at a price of P_1 (Fig. 1b). If the lumber demand increases, the shift of demand curve to a new position D_1D_1 will result in a higher price for lumber, P_2 and increased output thereof. With higher prices, all the firms make additional profits $Q_2(P_2-C)$, but not for very long. If the timber supply is perfectly controlled by the forest owner he can make an additional charge of exactly P_2-C, which raises the average total cost curve to a new position of ATC_2, where the lumber producer will be just as well off as before the demand curve of lumber shifted. In this classical case of "Ricardian Increasing Rent" the forest owner can take the entire additional profit of the lumber firm as rent for the scarce timber he owns.

Is there any correspondence between this rent model of stumpage and real life in the forest sector? Of course, the degree of correspondence depends much on the structure of timber markets. The basic assumption of the model is simple and easily agreeable: the forest owners are willing to benefit from the price increases of forest products. To what extent they have been able to do that is a matter of comprehensive empirical research. The data presented in Fig. 2 are not a result of that kind of research; rather it illustrates a way of approaching the question.



a) A firm b) An industry

Fig. 1. Stumpage as a rent (Gregory 1972)

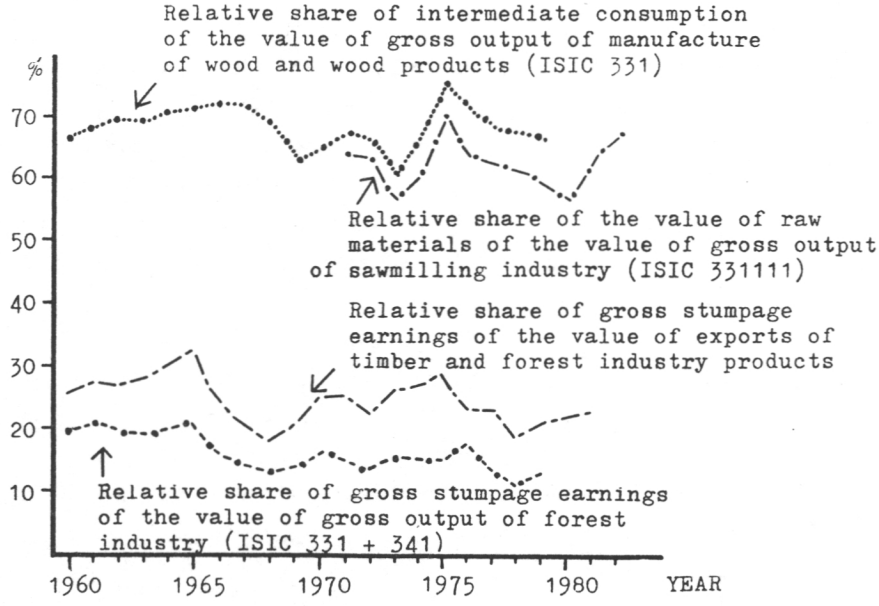


Fig. 2. Tentative figures illustrating the role of stumpage as a factor income

3. DIFFERENTIAL AND ABSOLUTE RENT

One of the most constant feature of stumpage prices is their wide geographical variation. The difference in stumpage prices have been focused on in comparative studies by countries (e.g. Pöyry, 1979) and in a country by regions (in Finland e.g. Palo 1977). There is not much problem with the reasons for these differences, if the market structure and similar factors are put aside, the remaining basic reason for stumpage price differences is the cost of availability. What are these differences from the point of view of rent theory?

As a factor of production land is nonhomogenous: different parcels of land differ in fertility and in accessibility. The Ricardian rent was agricultural rent and it was based on the specific feature of price formation of agricultural products: the price of agricultural products is determined not by average conditions of production but by the conditions of production on the poorest land. The producers cultivating the best and inferior soils get the difference between the market price and their individual costs of production. The difference is called differential rent. The differential rent is not merely due to variation in soil fertility. In stumpage prices, as stated above, the cost of availability, the cost-distance factor or the location plays a major role. The stumpage price differences between the marginal timber harvested in the most distant location (in cost-miles) and the timber closer to mills express precisely the differential rent. J. H. von Thünen's locational rent (Heikinheimo & Lehikoinen, 1981) is nothing but differential rent.

In Finland recently there has been a heated debate on our stumpage price level, which, it is argued, is one of the highest in the world. As much as it is when compared to other countries, due to the differential rent, there must not be anything to worry about. If, on the other hand, the high stumpage price level is greatly influenced by the other form of rent, i.e. absolute rent, the situation gets more complicated.

Absolute rent was not considered by Ricardo; his rent was merely differential rent. As Blaug (1977; 85) has said, it was price-determined, not price-determining. Smith (1776; 160) saw the possibility of absolute rent but it was Marx (e.g. 1894; 760) who comprehensively analysed absolute rent. The source for the possible existense of absolute rent is the lower organic composition of capital in agriculture (which results in more surplus-value) compared to capital of the same size in the manufacturing industry. The reason for its existense is the monopoly of private property in land, and, as a consequence, absolute rent can become a determining element of the general market prices of agricultural products (Marx 1894; 760 - 765). It may be pointed that the concept of absolute rent is not generally accepted, e.g. Blaug (1977; 291) regards Marx's theory of absolute rent as having no validity expect in terms of his theory of surplus value and the resulting necessity of transforming value into prices. However, it may be possible that at least some controversies on absolute rent are due to the different opinions on the source or reasons of it. The possibility of absolute rent, as such, is less disputable, at least in the sense that in addition to a price-determined rent (differential rent) there may a part of total rent which can be considered as being price-determining. Briefly, for example, Gregory's (1972; 337) concept of forest owner's preservation price for timber, can be understood to support the possibility of absolute rent.

It is the task of empirical research to confirm the existense and the extent of absolute rent in the stumpage prices. If it exists, the total rent in stumpage prices is the sum of it and differential rent. From a point of view of a country's position in an international context, one may suppose that the differential rent is more generated by external factors and absolute rent more dependent on domestic factors, but both of them are influenced by the economic circumstances as a whole.

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A RECURSIVE MODEL OF THE FINNISH ROUNDWOOD MARKETS

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Abstract

The paper presents an econometric model of the Finnish roundwood markets. Three sectors of roundwood consumption are analyzed: forest industries, exports of roundwood and transport and communication. The supply of roundwood consists of four sources: State forests, forest industry companies' forests, private forests and imports.

The demand for roundwood is assumed to be perfectly inelastic in respect to the current stumpage price. The parameters of the recursive model are estimated using annual time-series data for the period 1964-80. The export demand of forest industry products is the primary source of fluctuations in the volumes and prices of roundwood. The increase in the demand for roundwood has caused a structural change in the foreign trade of roundwood. The fluctuations of the sales of roundwood from State and company forests have been contracyclical. The demand of roundwood from private forests is presented as excess demand and the stumpage price of roundwood from private forests as a function of the volume demanded and regressive price expectations.

1. STRUCTURE OF THE ROUNDWOOD MARKET

In this paper factors affecting the volumes and prices of commercial roundwood are analyzed. In the cutting statistics,

commercial roundwood is defined as roundwood for export and for use by industry and in transport and communications. Three sources of domestic commercial roundwood are analyzed: State forests, the forests of forest industry companies and private forests. The imports of roundwood and wood residues are also analyzed. The market shares, by use categories and sources of supply, during 1976-80 were as follows:

Use categories		Market share %
Industry, of which		97,0
- domestic	87,0	
- imports of roundwood and wood residues	10,0	
Export		2,7
Transport and communications		0,3
	Total	100,00
Sources of roundwood		
National Board of Forestry		10,1
Company forests		8,6
Imports of roundwood and wood residues		10,5
Private forests		70,8
	Total	100,00

1.1. Demand for roundwood

According to the principle of derived demand, the demand for roundwood is positively correlated to the prices of forest industry products and the prices of other inputs and negatively correlated to the price of roundwood (Marshall 1927). In the short run, the production function of the forest industry is supposed to have fixed input coefficients. The factor shares can only be changed through investments or disinvestments in the capacity of forest industry. Recent studies have shown that the material productivity in the pulp industry has remained the same from the 1950s to 1970s. The material productivity in the sawmilling industry has deteriorated during the same period perhaps due to decrease in the quality of sawlogs.

In the following analysis of the roundwood markets, round-

wood demand is assumed to be perfectly inelastic in respect to stumpage prices (e.g. Leuschner 1973, Glück 1972 and Seppälä 1974). Because 60-80 percent of the main products of Finnish forest industry are exported, the export demand of forest industry products is considered as the primary source of fluctuations in the demand for roundwood.

The exports of forest industry products are determined outside this model. Therefore, the model od roundwood markets describes how the fluctuations in the exports of forest industry products are transferred to the volumes and prices of roundwood from different sources of roundwood. Private forest owners have organized roundwood exports in order to increase the demand for roundwood and to raise stumpage prices. In transport and communications, 55% of the roundwood was used as firewood in steam locomotives during the period 1955-59. Sleepers and telephone and electricity poles were the largest end-uses of heavy timber.

1.2. Supply of roundwood

Production costs, prices of roundwood, volume and diameter growth, and rent are decisive factors in determining the optimum of roundwood production in the long run. The total annual drain in Finland, however, has been less than 10% of the volume of mature timber and less than 5% of the total volume of timber. Therefore, the above mentioned factors are not considered decisive in the short run supply of roundwood (Wohlin 1970). Each of the four sources of roundwood supply have different factors affecting the annual selling or cutting decisions. These factors are described simultaneously with the estimated demand and supply equations.

2. THE ESTIMATED ROUNDWOOD MARKET MODEL

The demand for roundwood, as well as other supplies than that from private forests, are assumed perfectly inelastic with respect to current stumpage prices. Therefore, and because of the causal ordering of the equations, the model is

Table 1 A recursive model of the roundwood markets [1]

	RB^2	D-W
Exports of forest industry products		
EXP = 0,005 + 1,077 INV (0,2) (1,9)	0,14	1,96
Production of forest industry products		
PROD = 0,010 + 0,759 EXP (1,1) (10,3)	0,87	1,30
Total consumption of roundwood in forest industry		
CIT = -0,014 + 1,024 PROD (1,0) (7,3)	0,76	1,80
Imports of roundwood and wood residues		
CII = 0,048 + 0,413 PPR_{-1} (1,0) (1,6)	0,09	1,52
Consumption of domestic roundwood in forest industry		
CID = CIT - CII		
Exports of roundwood		
CEX = 0,053 - 1,568 $PROD_{-2}$ - 0,128 PPR_{-2} (0,7) (1,8) (0,3)	0,07	1,35
Consumption of roundwood in transport and communications		
CTR = - 0,043 TIME [2] (9,1)	0,84	1,65
Total consumption of domestic commercial roundwood		
CTOT = CID + CEX + CTR		
Fellings of commercial roundwood		
CUT = 0,002 + 0,925 CTOT (0,2) (6,9)	0,75	3,25
Purchases of commercial roundwood		
XD = 0,006 + 1,034 CUT + 0,033 WISS (0,1) (2,8) (0,2)	0,34	2,67
Fellings of roundwood from State forests		
XSST = 0,013 + 1,443 ALLOW - 1,190 QL (0,7) (3,0) (1,3)	0,43	2,38
Fellings of roundwood from company forests		
XSCO = 0,007 - 0,502 WISS (0,1) (3,5)	0,45	2,65
Purchases of roundwood from private forests		
XDPR = XD - (XSST + XSCO)		
Sales of roundwood from private forests (XSPR = XDPR)		
XSPR = - 0,007 + 0,703 PPR - 1,113 PPR_{-1} - 0,808 IDA + 0,090 REC (0,1) (2,1) (4,3) (1,2) (0,8)	0,70	3,12
Stumpage prices in private forests (deflated)		
PPR = -0,017 + 0,556 XDPR + 0,703 PPR_{-1} (0,5) (4,1) (3,0)	0,49	2,1

Estimation method: OLS Data: years 1964-80, annual data

[1] Logaritmic differences of variables [2] Log.lin. trend (percentage growth per annum)

Exogenous variables:

INV	Gross fixed capital formation in Western Europe
TIME	Time trend
ALLOW	Allowable cut for State forests
QL	Total employment
WISS	The forest industry's stock of roundwood: uncut roundwood in stumpage sales and undelivered roundwood in delivery sales
IDA	Income from debt-free agriculture per hectare on book-keeping farms
REC	Dummy: A stumpage price agreement for pulpwood
RB^2	Coefficient of determination, adjusted for degrees of freedom
D-W	Durbin Watson statistics
	Values of t-statistics in parenthesis below the estimated regression coefficients

considered recursive, though the annual data and the chronological ordering of the phenomena in the markets of roundwood and forest industry products may imply simultaneity.

The demand for roundwood from private forests is modelled as excess demand, or as a residual, which is the difference between total demand and supply of roundwood from other sources than private forests (cf. Adams 1983). Estimates of the consumption and fellings/sales equations are listed in table 1. The coefficients were estimated using annual time-series data during 1964-80 and the method of ordinary least squares. To avoid multicollinearity caused by a common linear trend, the variables were transformed into logarithmic differences.

2.1. The demand side of the model

The fluctuations of exports are traditionally explained with variables of economic activity in the markets and relative prices of competive products and producers. Investments are used as a measure of economic activity (See figure 1). The fluctuations of production depend heavily on exports. The dependence between the consumption of roundwood and production of primary forest industry products is a technical one. In the short run, the expected size of technical (input) coefficient is one. At this stage of the modelling work reported here, the behaviour of the stocks between the different phases of product and roundwood markets is not explained.

The exports of roundwood comprised 15% of the total consumption of commercial roundwood during the period 1955-59. It decreased rapidly during the first half of the 1960s simultaneously with the increase of the capacity of primary forest industry. The exports of roundwood increased the total demand for roundwood, raised the level and diminished the regional differences of roundwood prices. Before the private forest owners constructed their present forest industry, it was in their interest to organize exports of roundwood. The consumption of roundwood by forest industries and stumpage prices, explain the development of roundwood exports satisfactorily.

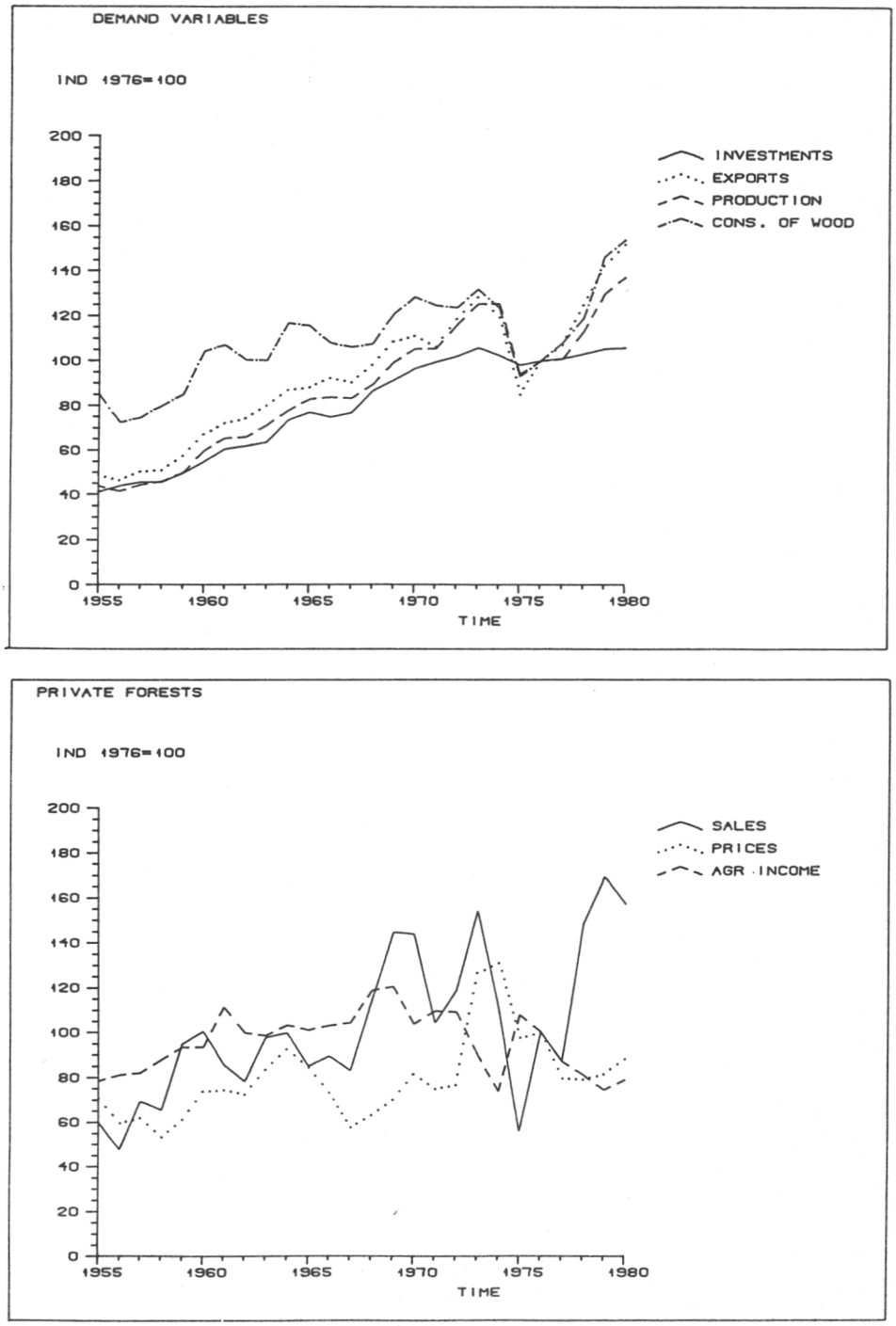

Figure 1. Development of some factors affecting the price and volume of roundwood from private forests (investments = gross fixed capital formation in Western Europe).

In transport and communications other materials have been gradually substituted for wood e.g. diesel and electric locomotives replaced steam engines. No causal explanation of this substitution is attempted. During the period 1964-80, the consumption of roundwood in transport and communications has decreased 4,3% per annum.

The total consumption of roundwood is a sum of domestic and imported roundwood consumed by the forest industries, in transport and communications and exports of roundwood. The fellings of commercial roundwood fluctuate simultaneously with the consumption of domestic roundwood. Total purchases of roundwood fluctuate directly with the fellings of commercial roundwood.

2.2. The supply side of the roundwood market model

The volume of annual fellings of State forests is mainly determined by the allowable cut. Compared with other volume series in the roundwood markets, the fellings of State forests have the smallest variation around the trend. The contra-cyclical annual fluctuations are coincident with the expectations of forest labour, who desire stable employment.

The forest industry companies have used their forests as a buffer stock: the fellings of company forests are negatively correlated to the volume of the stocks of standing timber (= undelivered orders of roundwood). An increase in the fellings of company forests has been the first sign of a recovery in the roundwood markets after a recession.

Imported wood and wood residues come mainly from the Soviet Union. Imports are based partly on long-term contracts, and partly on annual negotiations of commodity exchange. The largest shifts in the volume of roundwood imports have taken place after extreme booms in the roundwood markets when the total drain has exceeded the allowable cut (or growth), and when stumpage prices have been exceptionally high. The stepwise development of imports is better explained with equations

where the variables are measured in logarithms than in logaritmic differences.

In the earlier studies into the roundwood supply from private forests, the price of roundwood has been the most important, and often the only, explanatory variable. Graphical analysis of the respective time-series suggests that the sales of roundwood from private forests are elastic with respect to current stumpage prices. In addition to current stumpage prices, the forest owners' price expectations affect the short term selling decisions of private forest owners (e.g. Duerr 1960, Saether 1964). The simplest possible specification of price expectations is used in this study: the expected price change is equal to the change of stumpage prices during the previous year (Korpinen 1980). Current and past price changes alone explain 70% of the variation of the sales of roundwood from private forests during the period 1964-80.

The stumpage price agreements between the central organizations of the buyers and sellers of roundwood include a calculation of roundwood requirements and an agreement of sales promotion. Indications of a positive dependence between the sales of roundwood and stumpage price agreement were found but the estimated coefficients were not statistically significant. Changes in the exogenous income of private forest owners are assumed to affect the supply of roundwood (Saether 1964, Glück 1972, Knapp 1981). However, the dependence between the volume of roundwood sales and variables measuring annual harvest or agricultural income was not statistically significant in all sub-periods of 1955-80.

The assumptions concerning perfectly inelastic demand and recursiveness of the model suggest that the volume of roundwood from private forests is exogenously determined in the short run. Consequently, the stumpage price is a dependent variable instead of the volume of sales. The volume of roundwood purchased from private forests and regressive price

expectations explain 50% of the variation in stumpage prices of private forests.

3. DISCUSSION OF THE RESULTS

The recursive model of the Finnish roundwood markets is based on strong assumptions concerning the structure and functioning of roundwood markets. However, the model has its counterpart in the actual roundwood market: the roundwood requirements of the forest industry are calculated in the following way during the negotiations concerning stumpage price agreements:

(1) export and production forecasts are made for the coming cutting year
(2) production forecasts are transformed into roundwood equivalents
(3) the amount of roundwood coming from other sources is subtracted from, and the intended change in the stocks of roundwood is added to the total requirements
(4) the requirements of roundwood from private forests is achieved as a residual
(5) the actual development of stumpage prices often deviates from the agreements - often due to excess "heating" of the markets.

The assumption of perfect inelasticity of the demand for roundwood will be the first assumption to be relaxed in the future. The markets may also be disaggregated by roundwood assortments, because the fluctuations in the markets of lumber and sawlogs have been different to those in the markets of pulp, paper, paperboard and pulpwood. Also, some geographical disaggregation will be considered. Because of the annual nature of the data, most of the equations are static. Monthly or quarterly data would make possible a more realistic and dynamic description and analysis of the business cycles.

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S A W T I M B E R M A R K E T S I N F I N L A N D

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The paper presents results of an ongoing econometric study on the short term demand for and supply of sawtimber from private nonindustrial forests.

The demand for sawtimber is determined by the production and raw material stock holding decisions of the sawmilling firms. An estimable equation is initially derived for the beginning of the production period raw material stock of the representative firm. The firm is assumed to be maximizing profits (with a fixed coefficient production function) while facing stochastic lumber demand in the export markets where prices are rigid, but the firm is assumed to have great flexibility in quantity adjustment.

The firm is buying raw material in competitive roundwood markets from utility maximizing nonindustrial forest owners. The estimable supply equation of sawtimber is derived when the consumption of goods and services and the standing timber stock of the forest owner's woodlot are the arguments of the utility function.

Preliminary estimated results are discussed.

1. INTRODUCTION

For a competitive firm in price flexible markets, the motive for holding stocks is often argued to be speculative. The firm can sell at the current price any amount it chooses.

The reason for holding stocks therefore is to be able to sell the production at the most profitable point in time. Speculation with raw material prices is equally possible. In competitive input markets the firm aims at buying the raw material at the most profitable point in time. (cf. Blinder 1980)

Situation is different if prices, for some reason, are rigid. In this case the present price is not necessarily the equilibrium price. The firm may not be able to sell its entire production at the ruling price. Arrow (1959) has shown that disequilibrium in the markets makes firms behave like monopolists even in objectively competitive markets. When information is not totally carried by the prices alone the firms trace their demand curves by trial and error.

If the firm does not know exactly how much will be demanded at each price, it is likely to produce an amount that permits a remaining stock at the end of the period (Mills 1962;82). The firm can obtain zero stocks only by producing so little that on average some profitable sales are missed. If no profitable sales are missed the stocks are likely to be unprofitably large. This is the buffer stock motive, where the problem is how much risk is worth taking by carrying different amounts of stocks. The optimal stock is determined by carrying costs, endproduct prices, production costs, probability distribution of demand and the length of the firms planning horizon.

Extensive carry forward of stocks is an important feature of short run sawtimber markets. Sawmilling industry firms buy raw material stocks (above the technically required minimum) to meet the stochastic endproduct demand at the markets with rigid prices. Carry forward of lumber stocks is abstracted away because of the relatively easy capacity usage rate adjustment and extensive production to order in export markets. Raw material stocks are also used to anticipate price changes in price flexible sawtimber markets. There

the supply is, in the short run, supply from the existing stock of standing timber. To summarise, representative firm uses raw material stocks to buffer stochastic end product demand and to anticipate raw material price changes. In the present paper, the derivation of a short run sawtimber market model is outlined. Detailed description of the model and the derivation of the supply and demand functions is presented in Kuuluvainen (forthcoming).

2. SAWTIMBER DEMAND

General treatment of the stock model presented below is complicated matter (cf. Arrow et. al. 1958). Following Mills (1962), therefore, special funtional forms will be used. For the purposes of the intended empirically orientated investigation this is considered justified.

The representative firm has a directly proportional production function and one scarce input, raw material. The firm is facing an additively stochastic lumber demand function

$$(1) \quad z_j = \bar{z}(\bar{p}_j, d_j) + v = \bar{z}_j + v \; ; \; \bar{z}_{\bar{p}_j} < 0.$$

The deterministic part of the demand depends on the price ($\bar{p}_j$) and other known demand determinants (d_j). The firm has to make the ex ante production decision (the decision how much raw material to buy) before observing the value of v. The firm predicts z_j knowing the probability distribution of v, at any given price $\bar{p}_j$. The cumulative distribution function of v, known by the firm, can be calculated from

$$(2) \quad F(a) = \int_{-\infty}^{a} f(v)\,dv$$

To guarantee non-negativity of the observed demand, it is assumed that $E(v)=0$ and that $f(v)$ is defined over a closed

interval $-\bar{z}_j \leq v \leq \infty$ (Atkinson 1981;314). The total revenue from sales during period j is the minimum of price multiplied by quantity demanded and produced (cf. Mills 1962;88, Atkinson 1981;314)

$$(3) \quad tr_{sales} = \begin{cases} \bar{p}_j z_j & \forall\ z_j \leq \alpha k_j = y_j \\ p_j \alpha k_j = y_j & \forall\ z_j > \alpha k_j = y_j \end{cases}$$

In (3) α is the conversion coefficient of directly proportional production function and k_j is the stock of raw material at the beginning of the production period.

Arrow (1957) has shown that it is possible to solve a multistage programming problem only by considering the first period. In this case the effects of the present period on the future are given as a function of present events and states of nature. Again following Mills (1962;115), it is assumed that the intertemporal aspects can be summarized in a function which gives the value of the end of period j raw material stock or the cost of stock shortage

$$(4) \quad \rho(y_j - z_j) \gtrless 0 \ \forall\ y_j \gtrless z_j$$

According the equation (4) the firm gives a positive value to remaining stock, whereas shortage means costs (e.g. emergency procurement of raw material).

The expected total revenue is price multiplied by mean demand from which is subtracted the value of the mean unsatisfied demand ($\gtrless 0$), and to which is added the value of the end of the production period raw material stock

$$(5) \quad E(tr)_{sales} = \bar{p}_j \bar{z} - \bar{p}_j h(\bar{p}_j, y_j) + \int_{-\infty}^{\infty} \rho \left[(1/\alpha)(y_j - \bar{z}_j - v) \right] f(v)\,dv,$$

$$\text{Function} \quad h(\bar{p}_j, y_j) = \int_{y_j - \bar{z}_j}^{\infty} (v - y_j + \bar{z}_j) f(v)\,dv$$

is the mean of unsatisfied demand.

The firm buys the raw material for period j (>t) production

during previous period t. It knows the initial stock k_t and the consumption of raw material during the period t ($\bar{u}_t$). Only raw material input is considered, therefore production costs of the representative firm are given by

$$(6) \quad tc_{prod} = q_t x_t + (n/2)(k_j - k_t)^2$$

where q_t is stumpage price in competitive roundwood markets, x_t is the amount of saw timber purchased, k_t is the initial stock and k_j is the beginning of the production period stock. It is assumed that changes in raw material procurement and production are costly. These costs are presented as a quadratic function of the change in the level of the raw material stock (the slope of the function is given by nonnegative constant n).

Following Mills (op cit;96) the frequency function f(v) is approximated by a constant, so that F(.) is a linear function of its argument

$$(7) \quad f(v) = \begin{cases} 0 \ \forall \ \mu < -\lambda \\ 1/2\lambda \ \forall \ -\lambda < \mu < \lambda \\ 0 \ \forall \ \mu > \lambda \end{cases} \Rightarrow F(a) = (a+\lambda)/2$$

Function ρ is presented as sum of two functions giving the value of stock and penalty of shortage

$$(8) \quad \rho = \begin{cases} (q_j - r_j)(y_j - z_j)/\alpha & \forall \ y_j \geq z_j \\ (\bar{c} - (q_t - q_j))(y_j - z_j)/\alpha & \forall \ y_j < z_j \end{cases}$$

In equation (8) q_j is the production period stumpage price, r_j is the unit storage cost and $\bar{c}$ the constant penalty of shortage, all independent of the size of the stock.

The first order condition for expected profits to be maximized is the equality of expected marginal revenue to marginal costs

$$(9) \quad \bar{p}_j\left[1-(y_j-\bar{z}_j+\lambda)/2\lambda\right]+\frac{1}{\alpha}\left\{(q_j-r_j)\left[(y_j-\bar{z}_j+\lambda)/2\lambda\right]\right.$$
$$\left.+(\bar{c}-q_t+q_j)\left[1-(y_j-\bar{z}_j+\lambda)/2\lambda\right]\right\} = \frac{1}{\alpha}\left[q_t+n(y_j/\alpha-y_t^*/\alpha)\right].$$

Equation (9) is derived using the stock identity $k_j - k_t = x_t - \bar{u}_t$ and proportional production function $y_j = \alpha k_j$ to replace x_t, k_j and k_t in total cost function ($y_t^* = \alpha k_t$ and $y_j = \alpha k_j$, y_t^* is present period ex ante planned production).

The first order condition gives the following equation for the beginning of the production period stock (again the proportional production function is used)

$$(10)\quad k_j = \frac{\lambda(\alpha\bar{p}_j + 2q_j - 3q_t + c)}{B} + \frac{\alpha\bar{p}_j + r_j + \bar{c} - q_t}{B} z_j + \frac{2\lambda n}{B} k_t, \text{ where } B = \alpha(\alpha\bar{p}_j + r_j + \bar{c} - q_t) + 2\lambda n.$$

Multiplying both sides with B (from second order condition B>0) and differentiating, the following implicit equation for the beginning of the production period stock is obtained

$$(11)\quad k_j = k(z_j^e, \bar{p}_j^e, q_t, q_j^e, r_j^e, k_t)$$

$$+ \quad + \quad - \quad + \quad - \quad +$$

Signs of the partial derivatives of k_j with respect to the exogenous variables are given under the variables. Parameters which are assumed constant over time are left aside. Because all variables marked with superscript e (for expectations) are unobservable, some proxy-variables and approximations are further required in empirical analysis.

3. SAWTIMBER SUPPLY FROM PRIVATE NONINDUSTRIAL FORESTS

The representative private nonindustrial forest owner is assumed to be maximizing his utility over some arbitrary planning period (t = 1,... T). The utility function has two arguments, the consumption of goods and servicies (c_t) and the stock of standing timber (s_t). This utility function is closely related to the one used by Binkley (1981) (see also Löfgren and Johansson (1982;70)),

$$(12)\quad u = \sum_{t=1}^{T} (1+i)^{1-t} u(s_t, c_t)$$

and has the normal properties: $u_c, u_s > 0$; $u_{ss}, u_{cc} < 0$ and $u_{cs} \geq 0$.

The forest owner is constrained by the budget and the standing stock identities[1)]

(13) $p_t c_t = (m_t + q_t x_t)$ and

(14) $s_t = s_{t-1} + g(s_{t-1}) - x_t^*$

where m_t is exogenous income, q_t stumpage price x_t fellings (or sales) p_t price of goods and services, c_t goods and services consumed, s_t standing volume (including all vintages from zero to the oldest age class) and g a strictly concave growth function. The following equilibrium condition is obtained

(15) $u_1^t = u_2^t q_t - (1+i)^{-1}(1+g')u_2^{t+1} q_{t+1}$

When computing (15) budget identity is normalized deviding both sides by p_t and solved for c_t. The value of c_t has then been sustituted into (12). In (15) u_1 and u_2 are the partial derivatives of the utility function with respect to its first and second arguments respectively. The first derivative of growth with respect to the beginning of the period standing stock is denoted by g'. Condition (15) says that in equilibrium the utility gain from consumption of goods and services must be enough to ofset the utility loss caused by the decrease in consumption of nontimber outputs. The additional feature introduced by the utility maximization compared to the present value maximization of stumpage income is the dependence of the timber supply also on the model exogenous income component of the forest owner. If standing stock imputes no utility to forest owner and $u_2^t = u_2^{t+1} = 1$ (15) reduces to the equilibrium condition of the forest owner maximizing the present value of stumpage sales income.

1) I am grateful to Darius Adams for suggesting the inclusion of the stock identity as a constraint to the forest owners maximizing problem.

Unfortunately the solution of this maximization problem with dynamic standing stock identity gives no unambiguous signs to the effects of the exogenous variables on the timber supply. Therefore the dynamic feature is abstracted away and only a single period model is considered. This means that stock identity is left aside when solving the forest owner's maximization problem. In this case the equilibrium condition gets a particularly simple form, $u_1=u_2q_t$. The condition says that marginal imputed utility of standing stock must be equal to the marqinal utility of other consumption. Differentiating implicitely the following equation for the supply of timber during the period t is obtained (cf. Knapp 1981;30)

$$(16)\quad \underset{+/-}{x_t}=x(\underset{-}{q_t},\underset{+}{m_t},\underset{+}{s_{t-1}})$$

This can be equivalently presented as an equation for the end of period t stock s_t

$$(17)\quad \underset{+/-}{s_t}=s(\underset{-}{q_t},\underset{+}{m_t},\underset{+}{s_{t-1}})$$

The presence of the lagged endogenous variable is interpreted so that the optimal level of stock s_t^x, dependent on exogenous variables, can be approached only gradually.

The effect of the stumpage price on supply can be divided into positive substitution effect and negative income effect

$$(18)\quad dx_t/dq_t = \underset{+}{\frac{\partial x_t}{\partial q_t}\Big|_{u=\text{const.}}} \underset{-}{+x_t\frac{\partial x_t}{\partial m_t}}$$

This division is analogous to the one in consumer theory. It is assumed that the substitution effect dominates, at least in the short run.

4. SAWTIMBER MARKET MODEL

Assuming that aggregation is possible, the relations derived for the representative firm and the private nonindustrial forest owner are used as such in empirical estimations (cf. Maccini 1976). Using capital letters for aggregated model the partial adjustment equation for beginning of the period t+1 (=j) stock is written as follows,

$$(19)\quad K_{t+1} = \Phi_0+\Phi_1 Z^e_{t,t+1}+\Phi_2 P^e_{t,t+1}+\Phi_3 Q_t+\Phi_4 RQ_t+(1-\delta)K_t+\delta E_{1t}+E_{2t}.$$

An equation for demand, using the stock identity, (where K_t and $\bar{U}_t$ are predetermined) is

$$(20)\quad X^d_t = \bar{U}_t+K_{t+1}-K_t = \Pi_0+\Pi_1 Z^e_{t,t+1}+\Pi_2 P^e_{t,t+1}+\Pi_3 Q_t+\Pi_4 RQ_t-\delta K_t+\bar{U}_t$$
$$+\delta E_{1t}+E_{2t}.$$

As a proxy for unobserved expected demand ($Z^e_{t,t+1}$) the realized export sales with two period lag is used (cf. Irvine 1981a; 371, 1981b; 635). The expected price of production ($P^e_{t,t+1}$) is described using unit value shippings with two period lead. Because of technical delays, this actually gives an approximate of the present period sales price known by the firm. Variable RQ is the difference of interest rate and stumpage price inflation during period t (a proxy of expected stumpage price change) and is describing the user cost of capital (cf. Irvine 1981a;358).

An estimable equation for timber supply is derived by using the formula of Houthakker and Taylor where current value of the explained variable depends on an unobserved stock (Houthakker and Taylor 1970). It is assumed that the equation (16) is linear. Growth function g is approximated by constant percentage (G) of the average stock of the

period t. Equation (16) when, rewritten in linear form is as follows

$$(21)\quad X_t^s = \Gamma_0+\Gamma_1(\frac{S_t+S_{t+1}}{2})+\Gamma_2 Q_t+\Gamma_3 M_t$$

Then using the following standing stock identity

$$(22)\quad \Delta S_t = S_t-S_{t-1} = G(\frac{S_t+S_{t+1}}{2})-X_t$$

the Houthakker Taylor estimable equation becomes

$$(23)\quad X_t^s = B_0+B_1X_{t-1}^s+B_2\Delta Q_t+B_3Q_{t-1}+B_4\Delta M_t+B_5M_{t-1}+E_{4t}.$$

The derivation of (23) is analogous to that of the demand equations derived by Houthakker and Taylor (op cit), except for the stock identity in (22). In (23) B_i:s (i=1,..7) are functions of the parameters of the structural equations (21) and (22). It is possible to solve the structural parameters using the estimated values of B_i:s (Houthakker and Taylor 1971). The endogenity of the stumpage prices is taken into account in estimations by assuming that supply and demand are equal in each period.

5. DISCUSSION

Because empirical work on the model is still continuing only some comments on results obtained so far are in order (detailed results of the estimations will be published in Kuuluvainen (forthcoming) and are obtainable from the author upon request). The model is estimated using structurally ordered instrumental variables method (Wonnacott and Wonnacott 1979;295) with semiannual data where seasonal adjustment with two term mowing sums is used. The method is similar to two stage least squares except that some exogenous variables of the complete system have been left aside from the instrument list (in the present case, the supply from other forest owner groups, cf. Tervo 1981).

The model may be estimated either using stock equation (19) or demand equation (20) on the demand side (and corresponding equilibrium condition). The supply equation is the same in both cases. Statistically both the stock equation (19) and the demand equation (20) behave rather well. Stock adjustment seems to be slower than expected (δ =.26) so that about 25 percent of the descrepancy between actual and desired stock is corrected semiannually. The elasticity of sawtimber demand with respect to stumpage price is negative, and in absolute value smaller than unity, with respect to (expected) endproduct price positive and greater than unity. Also, the service cost of capital has a statistically significant effect on stock at the 10 percent risk level, but the absolute value of negative elasticity is close to zero.

In the supply equation, only stumpage price change and lagged endogenous variable obtain clearly significant coefficients. A serious problem is also that overidentifying restrictions between B_i:s are not satisfied. Nonlinear estimations with these restrictions did not succeed. If the forest owner is present value maximizer of stumpage income in perfect markets the exogenous income does not affect the supply. In this case the supply is also affected by the interest rate and expected stumpage price. Actually, for the present value maximizer of the stumpage income (in case of natural forests) only the expected stumpage price changes matter, not the absolute present stumpage price. The reason that M_t and I_t (which was also experimented in estimations with the implication of present value maximizing forest owner) do not obtain statistically statistically significant and theoretically meaningfull parameter estimates may be either wrong specification or poor proxy variables. Following Houthakker and Taylor (op cit), the variables with t values less than one are left aside from the supply equation of the final model. The estimated equation is therefore

(24) $X_t^S = B_0 + B_1 X_{t-1} + B_2 \Delta Q_t + B_3 Q_{t-1} + E_{5t}$

Only the short run price elasticity of supply can be reported with any confidence and indicates elastic supply with respect to price in the short run. The coefficient of Q_{t-1} did not obtain a statistically significant parameter estimate, indicating that G=0. This is plausible because the estimated parameter does not reflect the physical growth, but the forest owner's subjective valuation of growth in the short run. The long run effects of stumpage price cannot be computed with confidence because of the nonsignificant parameter estimate of Q_{t-1}.

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AN ECONOMETRIC ANALYSIS OF TIMBER SUPPLY IN SWEDEN. A SUMMARY*

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ABSTRACT

In this paper we present an econometric analysis of the sawtimber market, and the market for pulpwood in Sweden. The analysis is based on time-series data covering the period 1953-1981.

The results of this exercise are satisfactory. All coefficients of the supply curves have the expected signs and most of them are statistically significant. The same is true for the demand curve in the saw timber market. This is the more surprising as the conventional wisdom in the field sometimes describes wood trade in Sweden as something quite irrational.

1. INTRODUCTION

We divide the analysis of roundwood supply into an analysis of two distinct but interrelated markets; the market for sawtimber and the market for pulpwood. The demand side of the timber market is explicitly specified by a demand function with the price of sawnwood, the price of timber, and the wage rate in the sawmill industry as arguments. The supply side of the market consists of a supply function, which in a minimum version of the model contains the price

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* This is a shortened version of Brännlund, Johansson & Löfgren (1983). The authors acknowledge a research grant from Nils and Dorthi Troedssons Fund for Forest Research.

of timber, the price of pulpwood, and cutting costs as arguments[1]. The idea behind the use of the price of pulpwood as a separate argument is that some of the smallwood could be used either as sawtimber or as pulpwood. The higher the price of pulpwood the more smallwood is transferred from the timber market to the pulpwood market. There is in addition an effect which stems from the fact that a higher price for pulpwood makes thinning more profitable than before (unprofitable thinnings become profitable), and this persuades some of the forest owners to carry out a thinning instead of a final felling, which in turn decreases the supply of sawtimber, and increases the supply of pulpwood.

The pulpwood market is treated in a somewhat different manner. There are theoretical and institutional reasons why the price of pulpwood should be treated as an exogeneous variable, i.e. not determined by the simultaneous interplay between supply and demand, in an analysis of pulpwood supply. As the industry is the strong party in the price negotiations between buyers and sellers the price could be viewed as determined solely from the demand side of the market. The price of pulpwood is then a reflection of the expected needs of wood in the pulp and paper industry, and the forest owners react to the given price by adjusting supply accordingly[2]. In a standard version of the model we estimate the supply of pulpwood as a function of the price of pulpwood, the cutting costs, and the price of sawtimber. The latter argument is used to cover the possibilities to use smallwood either as sawtimber or as pulpwood. Hence, an increased sawtimber price should decrease the supply of pulpwood.

2.2 The empirical model and the empirical results

A linear variation of the standard version of the model looks like this

$$(i) \quad C_t^D = \underset{}{0} + \underset{(+)}{\alpha_1} p_t^{sw} + \underset{(-)}{\alpha_2} p_t^{s} + \underset{(-)}{\alpha_3} w_t^{s}$$

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1 We could also report results where in addition the share of mature stands in the total stock of growing trees, the real interest rate, the real interest rate on bonds, and/or the real yield from equities are used as separate arguments in the supply function. However, these variables were - in most runs - not statistically significant, and the rate of return measures generated coefficients with wrong signs.

2 For a more detailed theoretical analysis, see Brännlund, Johansson & Löfgren (1983) and the references therein.

$$\text{(ii)} \quad C_t^s = \beta_0 + \underset{(+)}{\beta_1} p_t^s + \underset{(-)}{\beta_2} p_t^p + \underset{(-)}{\beta_3} Z_t$$

$$\text{(iii)} \quad C_t^D = C_t^s \qquad (1)$$

$$\text{(iv)} \quad c_t^s = \gamma_0 + \underset{(-)}{\gamma_1} p_t^s + \underset{(+)}{\gamma_2} p_t^p + \underset{(-)}{\gamma_3} Z_t$$

Where C^D = the demand for sawtimber, C^S = the supply of sawtimber, p^{SW} = a price index for the world market prices of sawn products, p^S = the price of sawtimber, p^P = the price of pulpwood, w^S = the wage rate in the sawmill industry, Z = the cutting cost and c^S = the supply of pulpwood.

All prices and costs are indexes measured in real terms, i.e. deflated by the consumer price index. The signs under the arguments denote the expected signs of the coefficients.

2.1 Data

The data we use are time series covering the period 1953-1981. The data are collected from the Yearbook of Forest Statistics, FAO Yearbook of Forest Products, and UN World Forest Product Statistics. The price data on sawtimber prices and pulpwood prices cover the whole country, and are the so-called list prices. This is a weakness, as only part of the roundwood trade is conducted at these prices. We have, however, correlated these price data with series of prices of standing timber for sale[1]. The correlation coefficients are 0.81 for pulpwood prices adn 0.89 for sawtimber prices, which is to some extent comforting for the validity of our data set.

We aggregate data mainly because it is not possible to single out data for each separate market area. We report, however, some preliminary estimates on data from price area one - the northern part of Sweden.

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1 This series is also incomplete as it covers only part of the stumpage purchases.

2.2 The results of the estimations

Linear and log-linear variations of the simultaneous model have been estimated by 2-SLS and 3-SLS. The residuals have been treated as being generated by an AR-1 process[1]. The supply equation for the pulpwood market - equation (1.iv) - has been estimated by ordinary least squares. This equation is given below in a linear and a log-linear version with the price of pulpwood, the price of sawtimber, and cutting costs as arguments. These arguments are also used in the supply function of sawtimber. The demand function for sawtimber have been estimated with varying combinations of independent variables. In one version we use the sawtimber price together with a price index of sawnwood (unit value), and unit labor cost. In a second version we delete unit labor cost, and in a third version the sawtimber price is used as an independent variable together with a variable which is generated by taking the difference between the unit value of sawnwood and unit labor cost. The latter argument can be viewed upon as an index of the ability to pay for sawtimber.

The most reasonable estimates of both the supply and demand curve are obtained when we use the ability to pay for wood and lagged production of sawnwood[2] together with the sawtimber price in the demand curve. These estimates are presented in table 1 below.

Table 1 The supply curve and the demand curve for sawtimber (loglinear version). The modified model.

	α_0	p^s	p^p	Z	$p^{sw}-w^s$	PR^{sw}	R^2	D-W
C^D	-4.957***	-0.989***			0.852**	0.848***	0.998	2.03
C^s	5.283***	0.609**	-0.681***	-0.848***			0.998	1.31

** = significant at the 5 % probability level
*** = " " " 1 % " "

1 The Cochrane-Orcutt iterative technique

2 One way to look upon this argument is to say that the demand for wood in period t depends not only on prices of the final product in the same period, but also on the expectations of future prices which were created a period ago. Another related way to view it is that adjustment lags make the demand for wood in a particular period a positive function of the demand for wood in the preceeding period.

The model is log-linear so the coefficients can be interpreted as elasticities. As can be seen from the table the model shows fairly good fit. All coefficients in the supply curve are statistically significant and have the expected signs. The estimates tell us that the supply elasticity of an increase in the sawtimber price is 0.609, i.e. a ceteris paribus increase in the sawtimber price by 10 per cent will increase the supply of sawtimber by approximately 6 per cent. The coefficient for the pulpwood price tells us that a 10 per cent increase in the puplpwood price will decrease the supply of sawtimber by approximately 7 per cent. Taken togehter these results mean that it is difficult to increase sawtimber supply by price stimuli during periods in which the business cycles of the pulp and paper industry and the sawmill industry run in "phase" with each other. Finally, an increase of cutting costs have the expected negative influence on sawtimber supply.

In this variation of the model, the demand elasticities have a reasonable size, the coefficient for the ability to pay has the expected sign, and the lagged production variable (PR^{SW}) has both a reasonable sign and a reasonable size. All coefficients are strongly significant. The reduced form estimates of both the cut and the price of sawtimber are given in table 2 below.

Table 2 The reduced form estimates of the cut and the price of sawtimber

	α_0	p^p	Z	$p^{SW}-w^S$	PR^{SW}	R^2	D-W
$\bar{p}^s$	-3.712***	0.430***	0.279	0.554***	0.294**	0.88	2.32
$\bar{C}$	-1.19	-0.417***	-0.308	0.302**	0.553	0.85	1.71

** = significant at the 5 % probability level
*** = " " " 1 % " "

Figure 1 below shows the predictive power of the modified model. The predictions of sawtimber price, and cut for the period 1953-1980 have





Figure 2 Actual and predicted prices (2a) and quantities (2b)

been obtained by making use of the corresponding reduced form equations. No doubt, the model is able to describe the fluctuations in prices and quantities in a satisfactory manner. It is worth noting that the model picks up the steep decline of the cut from 1973-1975. However, the model underestimates the supply during the period 1976-1978. This is interesting, because at the end of this period there were some indications of rationing in the roundwood market, i.e. the amount of wood buyers were willing to buy at the ruling price was larger than the amount supplied. If we are to believe the model these tendencies should have been even more pronounced in 1979, as the model this year overestimates supply by 2 million m^3.

If we turn to the estimates of the supply function for pulpwood we do not, in order to save space, report the estimates of the "standard equation" formulated in (1.iv). It should, however, be mentioned that all coefficients had expected signs and sizes. Most coefficients were also statistically significant[1]. However, the R^2 value (0.40) indicates a considerable residual variance. Therefore, we respecified the equation trying to model the possibility that today's price as well as the expected future prices affect the supply of pulpwood, i.e.

$$c_t^s = \gamma_0 + \gamma_1 p_t^s + \gamma_2 p_t^p + \gamma_3 Z_t + \gamma_4 p^e \qquad (2)$$

where p^e is a variable taking care of the expected future price level. The expectations of future prices are assumed to be based on a distributed lag of present and previous prices

$$p^e = \sum_{i=0}^{\infty} \beta_{t-i} p_{t-i} \qquad (3)$$

Substitution of (3) into (2) yields after appropriate transformations the following possible specification of the supply equation[2].

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1 The only nonsignificant coefficient was the coefficient for the sawtimber price.

2 p^s and Z should also appropriately enter as lagged variables, but the respective coefficients are insignificant, and the variables have therefore been taken out.

$$c_t^s = \gamma_0 + \gamma_1 p_t^s + \gamma_2 p_t^p + \gamma_3 Z_t + \gamma_5 p_{t-1}^p + \gamma_6 c_{t-1}^s \qquad (2a)$$

The effect of an increase in today's price of pulpwood on the supply of pulpwood should diminish by the introduction of explicit expectations of future prices. This follows in a deterministic context from homogenity of degree zero in prices of the supply function, and the distributed lag character of the expectation mechanism ($\gamma_4 < 0$). In table 3 we report the results from the estimation of (2a).

Table 3 The supply function of pulpwood

	γ_0	p^p	p_{t-1}^p	p^s	Z	c_{t-1}^s	R^2	D-W
C^s	2.61***	0.744***	-0.722***	-0.283	-0.089	0.591***	0.84	1.98

** = significant at the 5 % probability level
*** = " " " 1 % " "

All coefficients have the expected signs. The R^2 value is decent and this is also true for the D-W-statistics. However, both the coefficient for cutting costs and the coefficient for the sawtimber price are not statistically significant. The direct supply elasticity is slightly lower than the supply elasticity in the standard model - 0.74 compared to 0.85 - which was to be expected in a model containing a variable which picks up price expectations. It is worth noting the small influence from the sawtimber price on pulpwood supply. A possible explanation is the following: The sawtimber price is likely to have two effects on pulpwood supply; one is due to the fact that an increased sawtimber price increases the relative profitability of final cuttings in relation to thinnings, and this has a negative effect on pulpwood supply. The second effect is a "joint production effect"; every increase in final cuttings will produce an increased volume of both sawtimber and pulpwood, and this effect counteracts the negative substitution effect. Going back to the estimates of the sawtimber supply curve we find that the pulpwood

price has a considerable negative influence on the supply of sawtimber. Interpreted in the above mentioned decomposition it should be clear that an increased pulpwood price has a negative substitution effect, but also a negative joint production effect as thinnings result in mainly pulpwood. This explains the obvious assymetry in the estimated crossprice effects.

3. CONCLUDING COMMENTS

The above presented estimates of timber supply show that Swedish forest owners seem to react on price stimuli, and also that timber supply can be modeled by using a simple text-book model of a perfect market. The latter is a bit surprising as, at least during the end of the investigated period, tendencies of rationing and price discrimination have been prevalent. However, a closer look at the results also reveals that the fit of the model deteriorates at the end of the period. Both sawtimber supply and the supply of pulpwood is overestimated by the model the years 1979-1980.

Another feature of the model worth mentioning is the inelasticity of sawtimber supply under simultaneous increases in both sawtimber prices and pulpwood prices. According to the model, a simultaneous increase in these prices, by say 10 percent, would slightly decrease sawtimber supply. One reason behind this phenomenon could be related to the above discussed substitution effect. An increase of the pulpwood price will mean that former unprofitable thinnings become profitable and this induces a transformation of felling capacity from final cuttings to thinnings. Another possible reason is the homogeneity of degree zero of the supply function. If a 10 per cent general increase of the price of wood induces the forest owner to believe that all future prices will increase by 10 per cent this leaves the optimal cutting program unaffected. A third reason could be risk aversion in connection with the uncertainty of future prices, which would make the slope of the supply curve ambiguous. A fourth reason, finally, could be the presence of constraints which

regulates the permissible cut. It can be shown that such regulatory constraints[1] make the supply function less elastic (see Brännlund, Johansson & Löfgren, (1983) and the references therein).

To discriminate between these possible explanations or to pick the most important is far from easy. Nevertheless, an affirmative answer would be interesting.

The model is estimated on data for the whole country. This is probably a clear advantage for the fit of the model, as irrational and/or specific reasons to cut tend to cancel out. It would, however, be interesting to estimate the model on data from some of the regionally separated price areas. Preliminary estimates on data from price area one[2], indicates that the precision of the estimates deteriorates a bit, while the general tendencies prevail.

Finally, applying "disequilibrium econometrics"[3] would probably tell us more about the severity of the rationing tendencies, which were prevailing at the end of the period. This, however, has also to be the subject of another paper.

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1 The idea behind these regulations is to create a sustained yield at the aggregate level by regulating the cut at the farm level. One type of constraints refers to the age of the stand and another refers to the age composition of the endowments.

2 The northern part of Sweden

3 See e.g. Bowden (1978)

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