ETLA ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 609 900 Telefax 601753

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Ali Malassu

ADVANTAGE FINLAND -

SAWMILL INDUSTRY

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Kansallinen kilpailukyky ja teollinen tulevaisuus -projektissa tutkitaan, millaista teollista toimintaa voidaan harjoittaa Suomessa menestyksekkäimmin. Siinä tutkitaan menestyneitä vientiyrityksiämme ja pohditaan, miten niiden toimintaympäristöä tulisi kehittää, jotta ne pystyisivät saavuttamaan kilpailuetuja kansainvälisiin kilpailijoihin verrattuna.

Projektin päärahoittajina ovat Suomen itsenäisyyden juhlarahasto (SITRA), Elinkeinoelämän Tutkimuslaitos (ETLA), kauppa- ja teollisuusministeriö (KTM) sekä eri alojen tärkeimmät yritykset.

"The Competitive Advantage of Finland" research project evaluates the competitiveness of Finnish export industries and crucial elements behind their performance. The project focuses on what kind of industrial activities have we best possibilities to be successful in Finland.

The project is organised by Etlatieto Ltd and financed mainly by the Finnish national Fund for Research and Development (SITRA), The Research Institute of the Finnish Economy (ETLA), Ministry of Trade and Industry (KTM) as well as major companies in various fields.

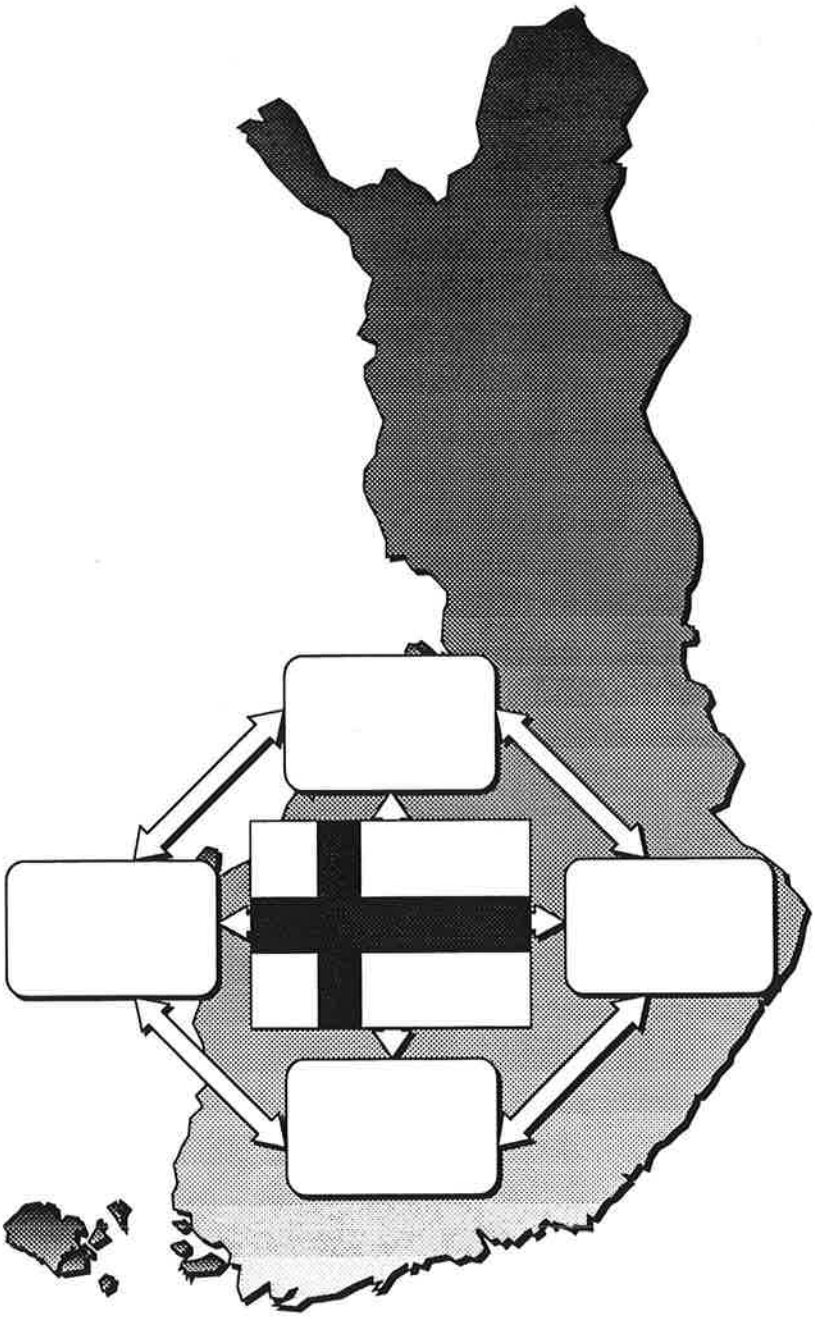
ETLATIETO
(ETLAn projektitutkimus- ja tietopalveluyksikkö)
Lönnrotinkatu 4 b 00120 Helsinki Finland
90 - 609 901 fax: 90 - 601 753

Ali Malassu

Kansallinen kilpailukyky ja teollinen tulevaisuus

The Competitive Advantage of Finland

ADVANTAGE FINLAND - SAWMILL INDUSTRY



MALASSU, Ali, **ADVANTAGE FINLAND - SAWMILL INDUSTRY**, Helsinki, ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1993, 82 p., (Keskusteluaiheita, Discussion Papers)

ABSTRACT

The objective of the study was to analyze the international competitive advantage of Finnish sawmill industry and its effects on the competitive advantage of the nation. The theories of Michael E. Porter play the major role in this research, the major focus was set on business level. The top level management of the leading Finnish sawmill companies provided valuable material which was not available elsewhere.

The competitive advantage determinants develop the Finnish sawmill industry towards high-quality and customer-based sawnwood production. Company strategies that aim to establish cutting methods in conformity with the needs of the industrial end users are ways to reach this end. Wood fibre flow development and integration benefits are essential to sawmill industry the position of which has eroded after 1950's because of lacking international strategic planning. Owing to the high share of domestic production inputs sawmill industry noticeably contributes to Finnish net currency earnings. This share could be risen by modest investments.

KEY WORDS

Sawmill industry, mechanical forest industry, forest industry, competitive advantage, competitive advantage of nation

TIIVISTELMÄ

Tutkimuksen tavoitteena oli arvioida Suomen sahateollisuuden kansainvälistä kilpailukykyä sekä sen vaikutusta koko valtakunnan kilpailukykyyn. Tavoitteena oli myös etsiä kilpailukykyyn vaikuttavia tekijöitä, joihin alan yritykset voivat toiminnallaan vaikuttaa. Teoreettisena aineistona olivat Michael E. Porterin teokset, joita täydettiin muiden teoreettikojen töillä. Suomen suurimpien sahateollisuusyritysten johtajien haastattelut tarjosivat tutkimuksen kannalta erittäin arvokasta materiaalia, jota ei olisi ollut saatavana muualta.

Suomen sahateollisuuden kansainvälistä kilpailuetua säätelevät muuttujat ohjaavat toimialaa kohti asiakassuuntautunutta korkealaatuista sahatavaraa. Yritykset pyrkivät tähän strategioilla, jotka tähtäävät raaka-aineen metsäkäsittelyn yhdenmukaistamiseen teollisen loppukäyttäjän tarpeita vastaavaksi. Sahateollisuuden kilpailukyky heikkeni 1950-luvulta aina 1980-luvulle asti, jolloin strategiseen suunnitteluun ryhdyttiin panostamaan kansainvälisen kilpailukyvyn kohentamiseksi. Sahateollisuuden merkitystä kansantaloudelle on mahdollista nostaa kohtalaisin investoinnein. Kotimaisten tuotanto-panosten käytöstä johtuen sahateollisuuden nettovaluuttatulot ovat suuret.

AVAINSANOJA

Sahateollisuus, mekaaninen metsäteollisuus, metsäteollisuus, kilpailuetu, kansakuntien kilpailuetu

YHTEENVETO

Tämä tutkimus on osa Advantage Finland-projektia, jossa tarkastellaan Suomen kansantalouden kannalta keskeisimpien teollisuudenalojen kilpailukykyä. Projektiin osallistuvat Elinkeinoelämän Tutkimuskeskus ETLA, Helsingin Kauppakorkeakoulu ja Teknillinen Korkeakoulu. Tutkimuksen tavoitteena on arvioida Suomen sahateollisuuden kansainvälistä kilpailukykyä sekä sen vaikutusta koko valtakunnan kilpailukykyyn. Tavoitteena on myös etsiä kilpailukykyyn vaikuttavia tekijöitä, joihin alan yritykset voivat toiminnallaan vaikutta.

Advantage Finland - projektin osaprojekteissa teoreettisena lähdeaineistona olivat Michael E. Porterin teokset, joita täydettiin muiden teoreettikojen töillä. Tämän tutkimuksen empiirinen osa toteutettiin haastattelemalla maan suurimpien sahateollisuusyritysten johtajia sekä muita keskeisiä alan vaikuttajia. Haastattelut tarjosivat tärkeää materiaalia, jota ei kirjallisessa muodossa ollut saatavilla.

Sahateollisuuden kilpailukyvyn determinantit ohjaavat sitä kohti korkealaatuisen, asiakaslähtöisen sahatavaran tuotantoa. Yritysten strategiat, jotka ohjaavat puun katkonnan kehittämistä, ovat tärkeä keino asiakaslähtöisyyden toteuttamiseksi. Puukuituvirran ohjaus sekä integraatioedut ovat olennainen osa sahateollisuutemme kilpailukykyä.

Timanttimallin determinanteista tärkeimmät ovat strategia, toimialan rakenne ja kilpailu sekä tuotantotekijädeterminantti. Näissä korostuvat fokusoituun differointiin tähtäävät strategiat, kilpailun intensiteetti, metsänomistajien ja sahatavaran ostajien neuvotteluvoima sekä maamme havumetsävarat, joita selittää Suomen maantieteellinen sijainti.

Kysyntätekijät ovat oleellisia, mutta niiden vuorovaikutusta tuotantotekijöiden sekä rinnakkaisten teollisuudenalojen kanssa tulisi voimistaa. Rinnakkaiset teollisuudenalat hyödyttävät koko metsäteollisuusklusteria, osa tästä hyödystää kohdistuu sahateollisuuteen. Valtion rooli sekä sattuman vaikutus eivät ole keskeisiä selittäviä muuttujia sahateollisuuden kilpailukyvyssä.

Euroopan integraation suorat vaikutukset sahateollisuuden kilpailukykyyn ovat vähäiset, olettaen että Suomesta tulee Euroopan Yhteisön jäsen. Pitkän aikavälin kilpailuympäristön muutoksia saattaa aiheutua kemiallisen metsäteollisuuden ja mm. kuljetusmääräysten muutosten kautta.

Sahateollisuuden tärkein rooli kansakunnan kilpailuedun synnyssä on sen käyttämien tuotantopanosten suuri kotimaisuusaste. Suomen nettovientituloista n. 10% tulee sahateollisuustuotteiden myynnistä. Sahateollisuus voi sijoittua lähelle raaka-ainetta paikkoihin, joissa muu teollinen tuotanto ei ole mahdollista sekä generoida riittävästi pääomaa maksaakseen tukkipuusta korkeaa hintaa. Tuottavuuden parantaminen vaatii investointeja uusiin katkontamenetelmiin ja puukuituvirran ohjaukseen.

Sahateollisuus muodostaa merkittävän osan Suomen teollisesta perustasta. Kilpailuetutimanttimalli tukee sen olemassaoloa myös tulevaisuudessa.

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1. INTRODUCTION

1.1. Sawmill Industry in International Comparison

As a primary wood-prosessing industry, the existence and size of sawmill industry in separate countries, or regions, is tightly connected to the forest resources. In addition, the utilized resource base distincts different types of industries and products. A broad division can be made between softwood (coniferous), hardwood (broadleaved), and tropical hardwood sawnwood. Softwood sawnwood producer countries are typically USA, Russia, Canada, Sweden, Finland, and Norway, which all are located in the boreal coniferous forest area in northern hemisphere. Also countries like Germany, Austria, and Chile are remarkable producers of coniferous sawnwood, mainly due to mountaneous regions of these countries. Hardwood sawnwood is produced e.g. in Central- and South-European countries, USA, and Russia. Major tropical hardwood sawnwood producer countries are e.g. Indonesia, Malaysia, and other South-Sea countries. The producers mentioned above are the most important ones in international trade.

Sawnwood is a bulky product, the long-distance trade of which is not very profitable. There may exist cost advantages in raw material or labor prices, but local demand, sawnwood quality, transportation costs, and/or resource scarcity cause barriers to exports to distant countries. As forest resources in western Europe per inhabitant are generally speaking modest, and local demand excess local supply, there is a need for imported sawnwood. Because of the production deficiencies and social changes the East-European countries cannot (yet) satisfy West-European demand, not to mention the North-African countries that barely have any forest resources. The Scandinavian countries stand out as the most important exporters. Significant export quantities take place also from Russia and eastern parts of Canada and USA.

In figure 1/1 the European import market shares of major exporters are presented. In 1990 the most important exporters in European market were (in brackets 1000 m^3) Sweden (5 600), CIS (5 100, mainly Russia), Canada (4 150), Austria (3 900), and Finland (3 500). The total imported quantity into European market totalled to app. 30 000 000 m^3 in 1990. Finland and Sweden have slightly lost their market shares in the 1980's. (Based on FAO 1992)

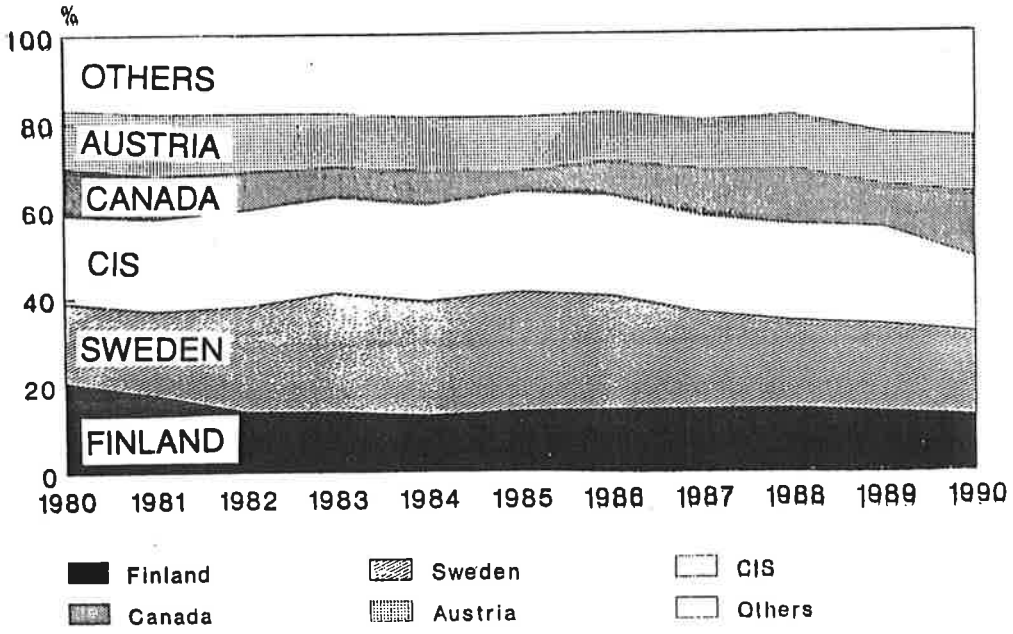

FIGURE 1/1 Market Shares of European Imports in 1980-1990

1.2. Country Reports

1.2.1. Austria

Austria is the fourth biggest coniferous sawnwood producer in Europe. In the 1980's the average annual production amounted to 6 000 000 - 6 500 000 m^3. A high proportion of produced sawnwood is exported, app. 4 000 000 m^3 annually in the 1980's, or to say, app. 65%. The main export countries are Italy and Germany. In 1990 these countries took 79% of Austrian coniferous sawnwood exports (Italy alone 66%). This is easily explained with the geographical location between Germany and the wealthy northern Italy. Another explaining factor is the structure of sawmill industry in Austria. Mills are mainly medium- and small-sized.

The trends show moderate increase in production and export quantities. The effects of storms in 1990 are visible in the year's figures. Export unit price has remained well below the unit price of Scandinavian producers, though it shows rising trend.

Opportunities for Austrian sawmill industry come from Eastern Europe. Especially countries like former Germany NL, Czech, and Hungary may provide growth potential for exports, despite of low purchasing power of the latter ones. Main problems are caused by machinery, which tends to be old, and by low refining rate.

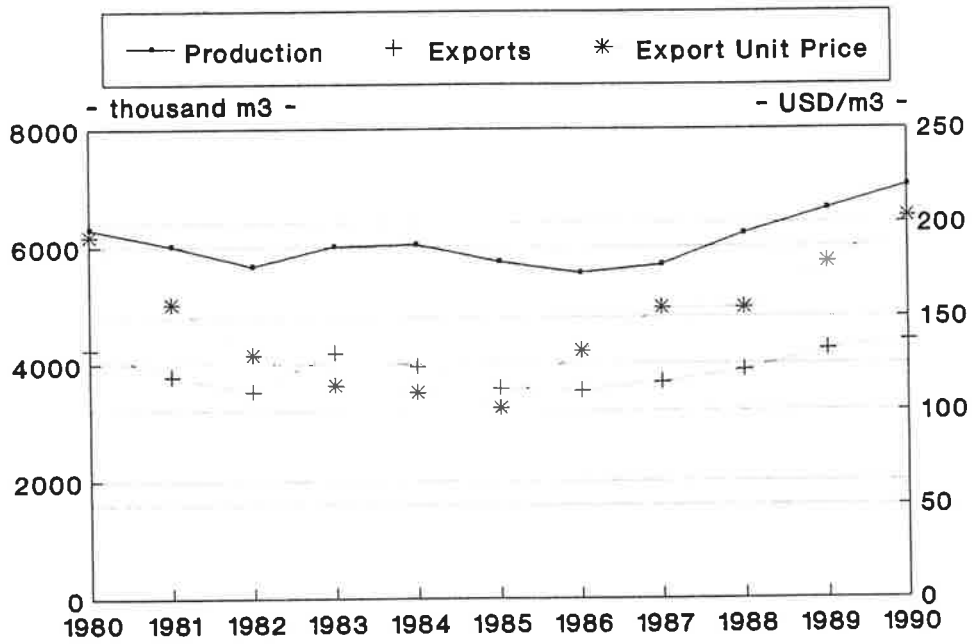

Figure 1/2 Austria: Coniferous Sawnwood Production, Export, and Export Unit Price[1]

[1] compiled from FAO 1992

1.2.2. Canada

Canada is the third largest coniferous sawnwood producer in the world. In the 1980's, the annually produced amount roughly corresponded the amount produced in West-European countries. Production fluctuated between 36 000 000 - 60 000 000 m^3 annually. Somewhat more than two thirds of it was exported, which made Canada the biggest coniferous sawnwood exporter in the world. The most important export countries were USA, Japan and UK (USA alone counted for 75% of exports in 1990). The European share of exports was only 11,4% in 1990. This means that from Canadian point of view Europe is marginal market area. The unit price of exported sawnwood was notably lower compared to Scandinavian exports.

The decrease of production was obvious in the late 1980's. This was mainly due to timber shortages and increased demands for nature preservation. Export quantities show similar decrease. It is likely that Canada can no longer increase its sawnwood production, at least in the short run. This together with recovery of the US-economy will lessen pressures in the European market, which gives opportunities to European producers.

The main opportunities of Canadian sawmill industry are in USA. Along with the economic upswing the sawnwood futures quotations in the raw material stock exchange of Chicago broke all former notations recently. Main threats are caused by nature conservation demands.

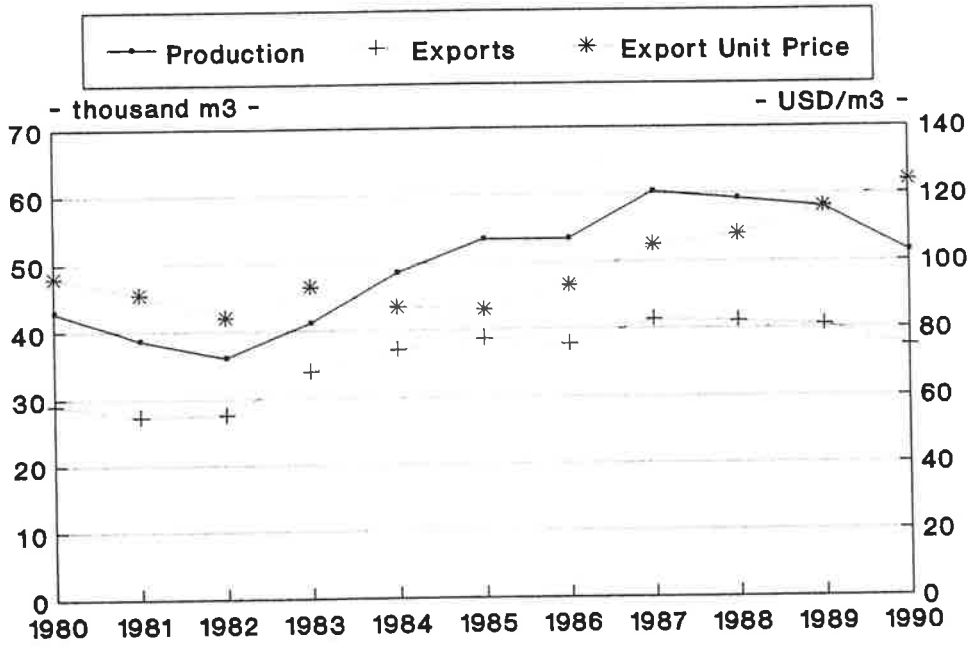

Figure 1/3 Canada: Coniferous Sawnwood Production, Export, and Export Unit Price[2]

[2] compiled from FAO 1992

1.2.3. Finland

Finland stands as the third biggest sawnwood producer in Europe. In 1980's the average production quantity was around 7 500 000 m^3, out of which 60-65% was exported. This made Finland the sixth largest coniferous sawnwood exporter in the world. (Austria surpassed Finland in 1990; it is likely that Finland will return to its normal rank: the fifth biggest.) The main export countries are UK, Germany, Netherlands, France, and Denmark. Exports are divided to numerous countires, none of which plays a dominant role. The unit price has been high compared to any other main producer countries (except Sweden, which is equal).

The decreasing trend in the 1980's is clearly visible both in production and in exports. The depreciations of FIM will probably turn the trend upwards, because production costs are competitive compared to any major producer at the moment. Opportunities are found in high quality, whereas threats come from changes in the markets where Finland is a minor player. It should be noted that the EC-membership cannot be considered as an opportunity or a threat (provided that Finland and Sweden act alike), because the EC-countries will have the need for imported sawnwood. Many other reasons back this statement, too.

As this study concentrates on Finnish sawmill industry, more detailed analysis follows.

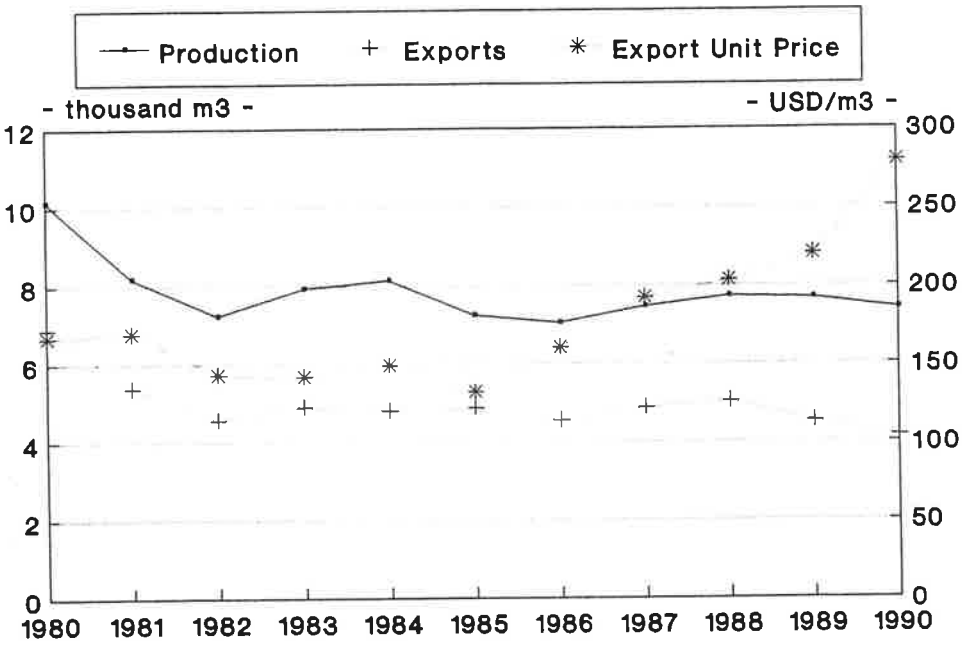

Figure 1/4 Finnland: Coniferous Sawnwood Production, Export, and Export Unit Price[3]

[3] compiled from FAO 1992

1.2.4. Germany

Towards the end of the 1980's, Germany increased its sawmill capacity and gained the place of the second biggest sawnwood producer in Europe. After the reunification of Germany FR and Germany NL the annual production will probably be the biggest in Europe. Germany's (FR) sawnwood production totalled to 10 400 000 m^3 in 1990, and it will increase by additional 2 000 000 m^3 (Germany NL). This will make Germany the sixth biggest coniferous sawnwood producer in the world, surpassed only by Russia, USA, Canada, Japan, and China. The exports of Germany FR have been around 10% of the production, which is likely to be the state of affairs also in the future. This, however, is enough to place Germany FR in the top 10 coniferous sawnwood exporters in the world (tenth). Netherlands and France are major export countries. Export unit price has been somewhat below of that of Scandinavian countries in the 1980's.

Production trend shows increase in the future, which may not necessarily be the case with export trend, because of the vast rebuilding that takes place in the former Germany NL. Opportunities came from close market areas and large home market. Investments to increase refining rate offer opportunities for better profitability (e.g. less wasted wood). The green movement and demands for environmental-friendly materials support sawmill industry. Threats come from forest health (which today seems to be a controversary issue: according to some researches forest health in Central Europe are improving) and from the small size of companies and sawmills. The strong DEM will also cause difficulties in export trade, though German millers are not heavily dependent on their international competitiveness.

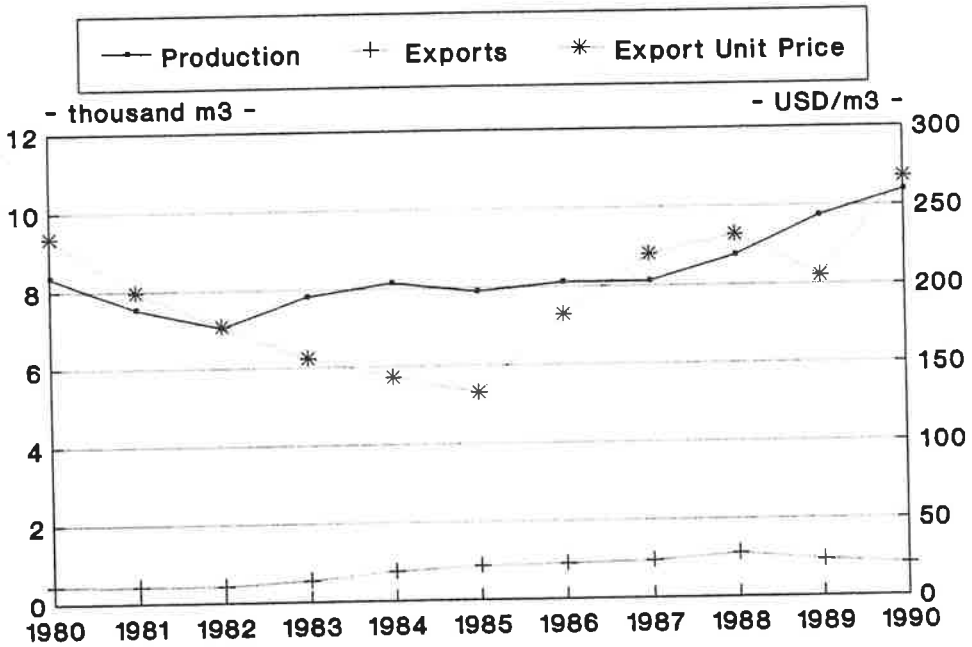

Figure 1/5 Germany: Coniferous Sawnwood Production, Export, and Export Unit Price[4]

[4] compiled from FAO 1992

1.2.5. Russia

With its enormous coniferous forest resources Russia (here: former Soviet Union) held the place of the biggest producer in the world untill 1990, when difficulties in economy caused a drop in coniferous sawnwood production. In the 1980's the average annual production quantity was app. 85 000 000 m^3. All time production world record of 90 300 000 m^3 was made in 1988. Because the nature of the economic system, exports are not significant compared to the production quantity, but the average annual export quantity of 7 500 000 m^3 was enough to make Russia the third biggest exporter in the 1980's. Exports amounted to only app. 8% of the production volume. The main export countries are UK, Germany NL, Hungary, and Germany FR. It is likely that Germany will be the most important export country in the future, though exports spread to many countries. The export unit price has remained strikingly low. Reasons for this are low finishing quality (wood itself is usually good), large sales deals, uncertain delivery, need for foreign currency earnings, etc. It should be noted that all statistical information must be interpreted with care, because it may be statistically inaccurate. This may be so especially with price information.

The trends are somewhat unclear because of the economic confusion in the country. The continued need for currency earnings will probably do the trade-off with domestic (re)construction needs. Export quantity is then likely to remain at current level.

Opportunities are few. Growth potential exists, but the means to achieve controlled development are at the moment scarce. Export markets will provide possibilities, when only trading practices are easened and sawnwood quality improved. Threats, then, are another issue. What is not an opportunity can be considered a threat right now at Russia. What comes to European markets, Russian sawnwood may cause severe fluctuations in price level. It is of course in everybody's interest that Russia will be able to participate international trade to its full scale in the future.

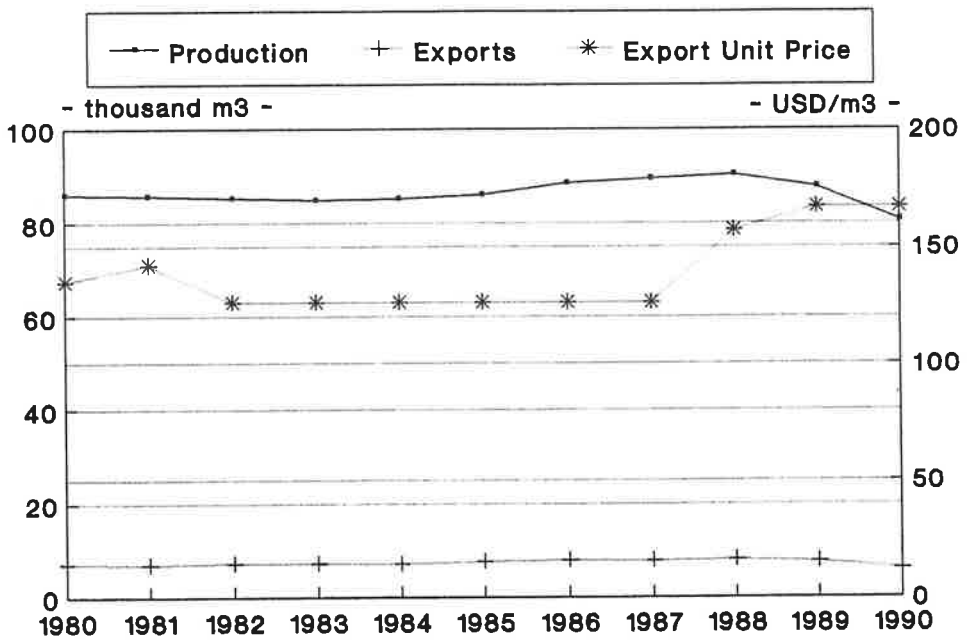

Figure 1/6 Russia: Coniferous Sawnwood Production, Export, and Export Unit Price[5]

[5] compiled from FAO 1992

1.2.6. Sweden

The coniferous sawnwood production in Sweden has slightly increased towards the end of the 1980's. In 1990, an amount of 11 594 000 m^3 was produced, which made Sweden the sixth largest producer in the world. Exports amounted to 6 234 000 m^3 (54%), which is well below the average export quantity. Normally, Sweden exports app. 65% of produced sawnwood. However, Sweden was the third biggest coniferous sawnwood exporter in 1990 (due to difficulties in Russia, export of which dropped in 1990). The major export export countries are UK, Germany FR, Denmark, and Netherland, none of which dominates. Much of the sawnwood trade in Europe is made in Swedish Crown (SEK). Export unit price is the highest among the major exporters, only Finland can show corresponding figures.

Trends show steady development. Production increases slowly and exports show steady development. The depreciation of the SEK will undoubtedly support the international competitiveness of Swedish sawmill industry, at least in the short run.

The Finnish and Swedish sawmill industries face much the same environmental conditions. Though the reasons for the better performance of the Swedish sawmill industry cannot be unambiguously explained, the major differences between them can be examined. One of the most important difference is that most of the Swedish sawmill companies are medium-sized or small. Also the major part of sawnwood is produced in average-size sawmills. Swedish sawmills use mainly circular sawing technique, which suits very well for medium-sized mills. Much of the machinery is purchased from domestic suppliers, such as ARI Ab and Söderhams Verkstäder Ab. What comes to the environmental factors, the two depreciations of SEK at the beginning of 1980's enhanced international competitiveness (in the short run). Perhaps also trading channels are more firmly established because of closer location to the main market areas (compared to Finland). The opportunites and threats that the Swedish sawmill industry faces are much alike those that the Finnish sawmill industry has.

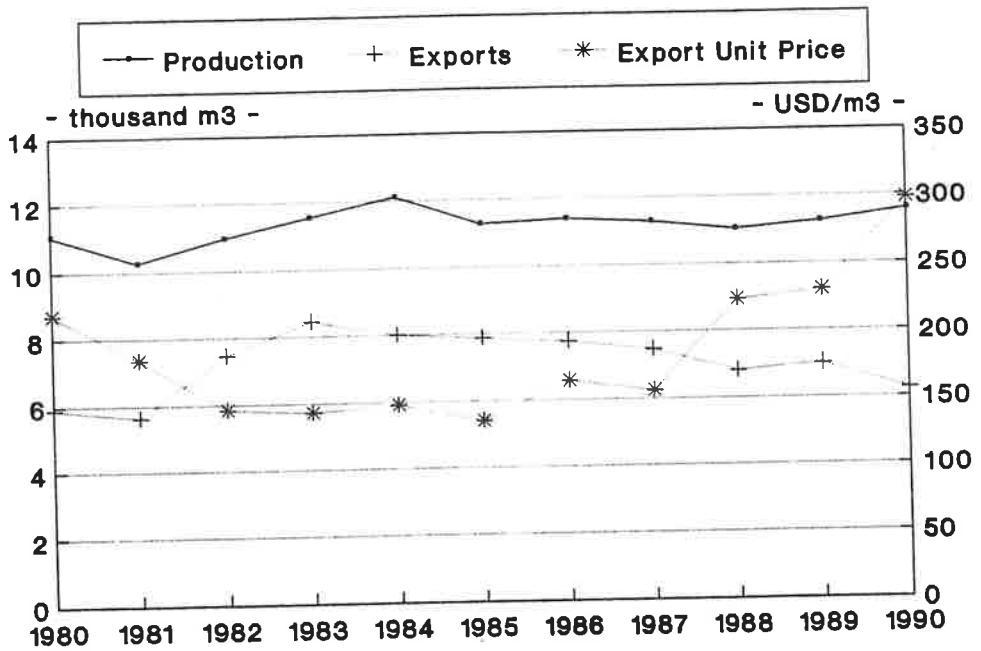

Figure 1/7 Sweden: Coniferous Sawnwood Production, Export, and Export Unit Price[6]

[6] compiled from FAO 1992

1.2.7. USA

In 1990, USA was the biggest coniferous sawnwood producer in the world. Production quantity increased rapidly since the downturn in 1981-1982. In 1990, the amount of 86 380 000 m^3 was produced, an increase of almost 28 000 000 m^3 from the year 1982. The 1981-1982 downturn was severe, because in 1979 the production volume totalled to 78 415 000 m^3. In 1990, only 6 970 000 m^3 of coniferous sawnwood was exported, which was only 8% of production. The export share remained below 10% in the 1980's. This was enough to make USA the second biggest exporter in the world. Japan, Canada, and Australia dominate exports with a share of 60%. European share was 13% in 1990, which meant only 1 250 000 m^3. The export unit price is remarkably higher than that of Canada, but well below the Scandinavian level.

Production trend shows remarkable increase in the 1980's, mostly due to low-production beginning of the decade. The export share has remained steady, but the amount has risen in line with the production increase. Unit price shows world market fluctuations.

Opportunities for sawmill industry are in domestic markets. The economic upswing increase the demand for sawnwood, and plantations and forest management may become more important as environmental concern grows. Threats are mainly in nature preservation and in green movement. The protection of some bird species has already caused local deficiencies in wood supply.

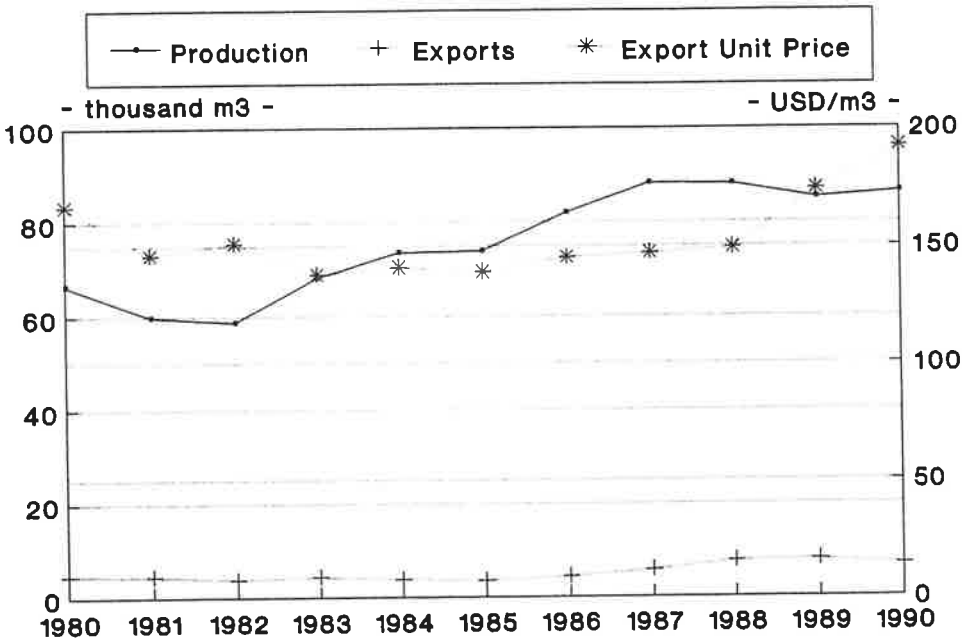

Figure 1/8 USA: Coniferous Sawnwood Production, Export, and Export Unit Price[7]

[7] compiled from FAO 1992

1.3. The Diamond Model

The diamond model deals with competitive advantage of an industry. An industry is a group of competitors producing products or services that compete directly with each other.[8] The nature of competition and the sources of competitive advantage differ widely among industries and even among industry segments.[9] The determinants of the model examine why a certain nation is more or less desirable *home base* for an industry. The home base is where strategy is set, core product and process development takes place, and the essential and proprietary skills reside.[10]

The forces affecting the industry structure can create competitive advantage in the long run. Firms gain and sustain competitive advantage in international competition through improvement, innovation, upgrading, and moving early to exploit a new market need. *Innovation* is broadly defined to include both improvements in technology and better methods or ways to doing things.[11] *Markets* are by definition a complex, multidimensional arenas of competition composed of a myriad of niches and categories. Change is continuous along each of the key market dimension of function, technology, customer segmentation, and degree of integration. Barriers to competitive movement along these dimensions are constantly shifting, creating both threats and opportunities for protected market positions.[12]

Nations succeed in industries that have the most dynamic and challenging environment, which stimulates and prods firms to upgrade. Competitive advantage based on only one or two determinants is possible in natural resource-dependent industries or industries involving little sophisticated technology or skills. Nation succeed not in isolated industries, but in *clusters*[13] of industries connected through vertical and horizontal relationships.[14]

Determinants of national competitive advantage work as a mutually reinforcing system. The effect of one determinant is contingent to the state of others. Government and change are viewed as additional variables, which can influence the national system in important ways.[15]

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[8] Porter 1990: 33

[9] Porter 1990: 69

[10] Porter 1990: 69

[11] Porter 1990: 45, 70

[12] Day 1984: 100

[13] see section 2.1.6.

[14] Porter 1990: 72-73

[15] Porter 1990: 71-73

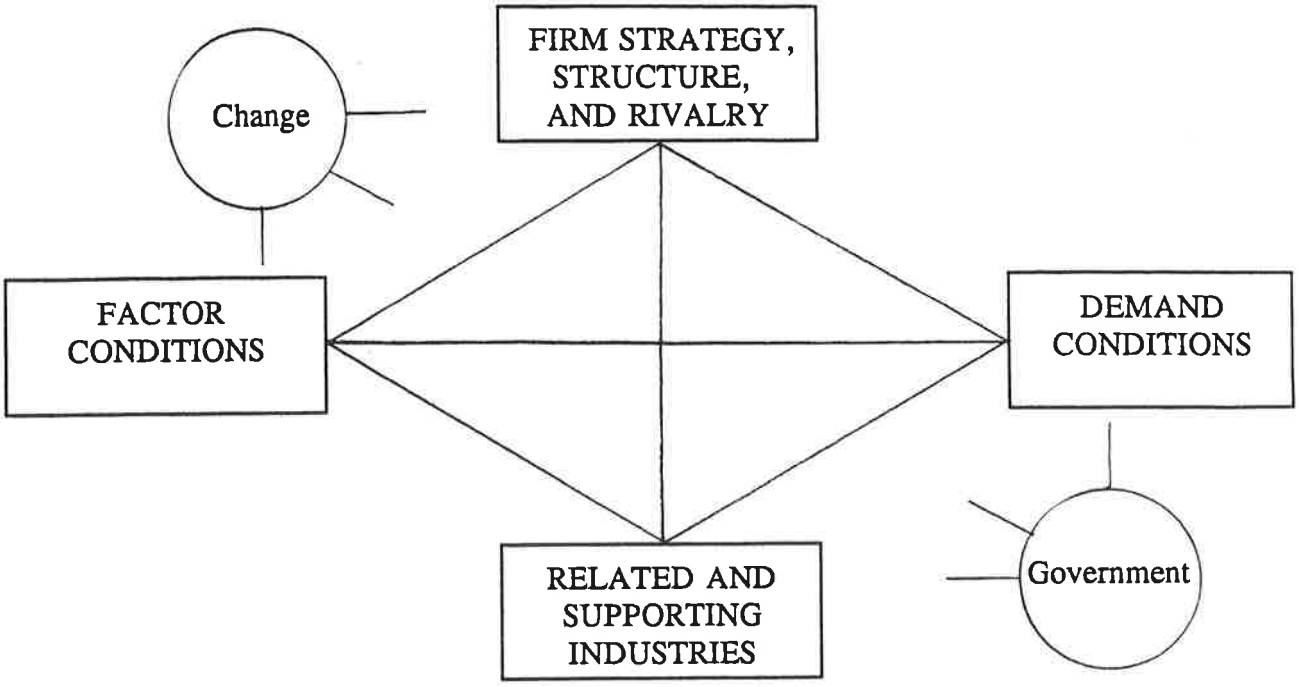

FIGURE 1/9 Determinants of National Advantage as a Complete System[16]

Factors of production are the inputs necessary to compete in an industry, e.g. labour, arable land, natural resources, capital, and infrastructure. The stock of factors at any particular time is less important than the rate at which they are created, upgraded, and made more specialized to certain industries. The abundance of factors may undermine instead of enhance competitive advantage, which depends on how efficiently and effectively factors are deployed. Other determinants in the diamond model will be necessary to explain where factor advantage translates into international success, because they shape the way factors are deployed.[17]

The quality of home *demand* is more important than the quantity of it in determining competitive advantage. Nations gain competitive advantage in industries or industry segments where the home demand gives local firms clearer or earlier picture of buyer needs than foreign rivals can have.[18]

Related and supporting industries consists of industries that either are suppliers to the particular industry or those with which the industry can coordinate or share activities. These industries must be internationally competitive in order to strengthen competitive advantage of the industry.[19]

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[16] Porter 1990: 127

[17] Porter 1990: 73-76

[18] Porter 1990: 86-92

[19] Porter 1990: 100-107

Strategies of firms in an industry, the *structure* of it and *rivalry* between firms in it all shape the competitive advantage. These variables differ from nation to nation causing different patterns of effects to the long-term development of competitive advantage.[20]

The role of government in national competitive advantage is influencing the four determinants either positively or negatively. *Change events* play a role in development of an industry. They are occurrences that have little to do with circumstances in a nation and are often largely outside the power of firms to influence. New innovations, technological discontinuity, discontinuities in production inputs, strong market changes, political decisions, and wars are examples of change events. They are important because they create discontinuities that allow shifts in competitive position. Change events have asymmetric impacts on different nations.[21]

1.4. Industry Structure

The state of competition depends on five basic competitive forces. The collective strength of these forces determines the long-term industry profitability.[22]

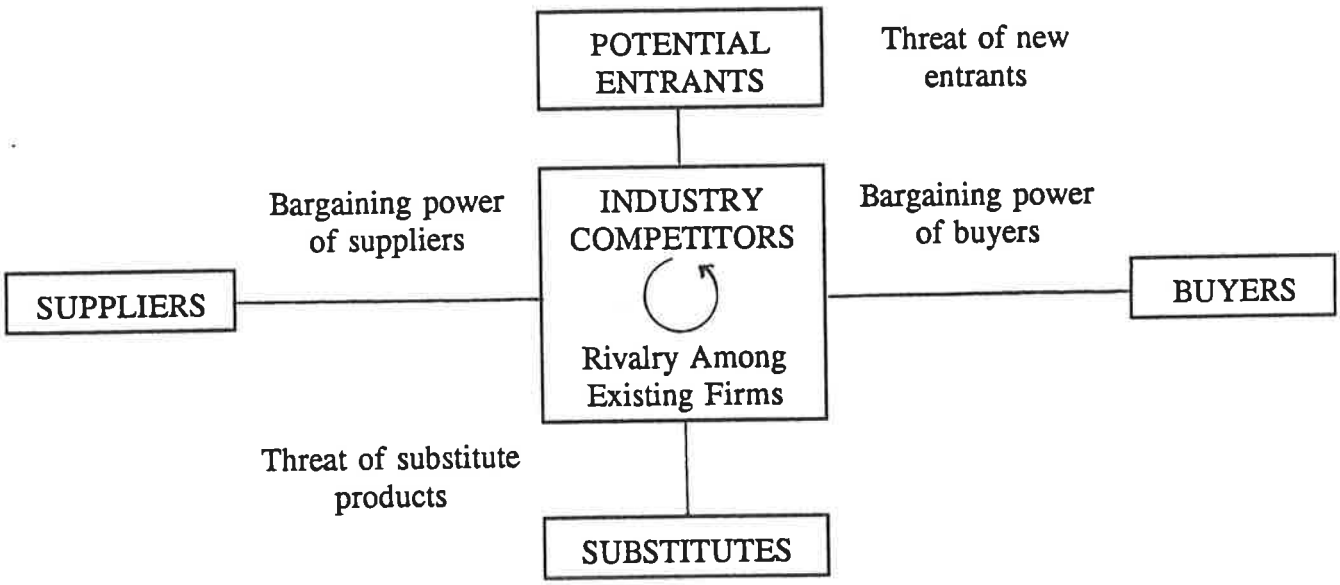

FIGURE 1/10 Forces Driving Industry Competition[23]

New *entrants* to an industry bring new capacity, the desire to gain market share, and often have substantial resources. The threat of entry into an industry depends on the barriers to entry that

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[20] Porter 1990: 110-113

[21] Porter 1990: 124-125

[22] Porter 1980: 3-4

[23] Porter 1980: 4

are present, and the reactions from existing companies towards the entrant.[24] A barrier of entry exist when established firms have some advantages over potential entrants.[25]

All firms in an industry are competing with industries producing *substitute products*. Goods are *substitutes* when an increase in the price of one good will increase the quantity purchased of the other (holding the price of the good under consideration constant).[26] Substitutes limit the potential returns of an industry by placing a ceiling on the prices firms in the industry can profitably charge. Substitute products that deserve the most attention are those that are subject to trends improving their price-performance trade-off with the industry's products or those that are produced by industries earning high profits.[27]

Buyers compete with the industry e.g. by forcing down prices and bargaining for higher quality or more services. A buyer group is powerful when it is concentrated or purchases large volumes relative to seller sales.[28]

Suppliers can exert bargaining power over firms in an industry by threatening to raise price or reduce the quality of purchased goods and services. Suppliers possess bargaining power e.g. when their product is an important input to the buyer's business.[29]

In most industries actions of one firm lead to counteractions of another firms. It refers to imperfect competition and especially to competition forms like oligopoly or, at some cases monopolistic competition.[30] For example equally balanced competitors, slow industry growth, lack of differentiation or switching costs, and high exit barriers are reasons for intense *rivalry*. High exit barriers may be a cause of specialized assets like production equipment, strategic interrelationships, and emotional barriers.[31]

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[24] Porter 1980: 7

[25] Maurice and Smithson 1981: 412

[26] Maurice and Smithson 1981: 18-19

[27] Porter 1980: 23-24

[28] Porter 1980: 24-25

[29] Porter 1980: 27-28

[30] see e.g. Maurice and Smithson 1981: 444-485

[31] Porter 1980: 17-21

2. SAWMILL INDUSTRY

2.1. Sawmill Industry among Forest Industries

Forest industry as a whole consists of mechanical and chemical forest industries. Sawnwood, plywood, particle board, and fibreboard industries are primary mechanical forest industries. Secondary mechanical forest industries consist of prefabricated woodhouse, loghouse, window, door, joinery, panel, flooring, moulding, packaging and other industries that process wood downstream.[32] Many of them fall into category joinery industries. Mechanical forest industries refer to the primary mechanical forest industries, which is the case after this paragraph unless otherwise stated. Sawnwood is the second largest export product category among the forest industries.

Pulp and paper industries are chemical forest industries. Pulp industry is divided further to mechanical, semi-chemical, and chemical pulp industries; the latter one further to dissolving sulphite, sulphite, and sulphate pulp branches. Paper industry, in its turn, consists of newsprint, printing and writing paper, kraft paper, paperboard, and converted paper products industries.[33]

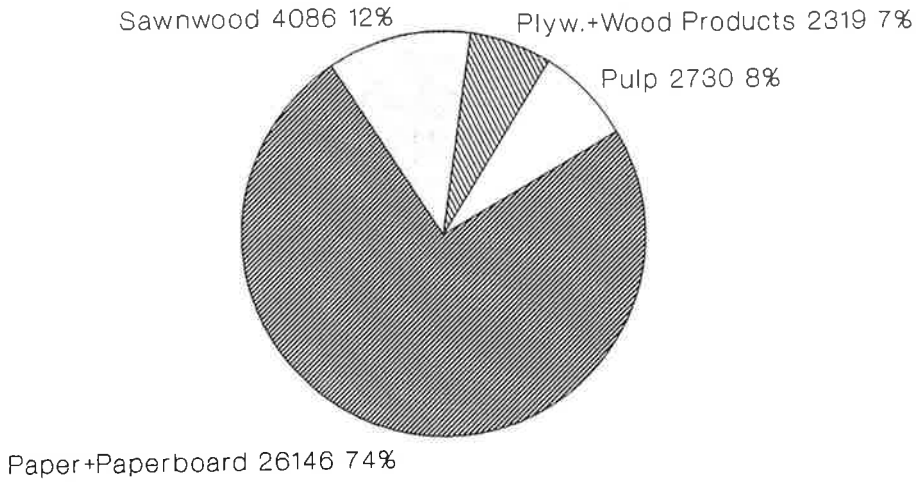

FIGURE 2/1 Value of Forest Industry Exports by Product Groups in 1991, Million FIM[34]

European countries took 84% of all forest industry exports in 1991. Within Europe, the EC and especially EC-countries like Germany, United Kingdom, and France are remarkable buyers of Finnish forest products. The proportions of forest products exports to these countries were

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[32] Pöyhönen, Ilkka: interview

[33] Metsätilastollinen vuosikirja 1992: 230-231

[34] The Finnish Forest Industries; Facts and Figures 1992: 16

19,5%, 17,3%, and 9,3% in 1991.[35] Finnish forest companies had 62 foreign subsidiaries in 16 countries in 1991.[36]

Export shares of different branches or product groups in mechanical forest industries are presented in table 2/1. Sawnwood's share of mechanical forest industries' exports is around 70% and the share of all forest industries' exports more than 10%. The contribution of sawmill industry to the value of Finnish exports is below 5%, but its share of net export earnings is around 10%.[37] This is due to the high proportion of domestic inputs in production. Sawmill industry also guides capital to remote and distant places where no other industrial production can possess sustainable competitive advantage.

TABLE 2/1 Mechanical Forest Industry Product Groups' export shares in 1991[38]

Product group	Exports million FIM	Mechanical forest industry exports 5 816 million FIM	Forest industry exports 35 358 million FIM	Nation's exports 92 863 million FIM
Sawnwood	4086	70,3%	11,6%	4,40%
Plywood, veneer	1508,1	25,9%	4,3%	1,62%
Particle board	137,7	2,4%	0,4%	0,15%
Fibreboard (Wallboard)	84,2	1,4%	0,2%	0,09%
Total	5816	100%	16,5%	6,15%

[35] Metsäteollisuuden vuosikirja 1992: Tilastotietoja; The Finnish Forest Industries; Facts and Figures 1992: 11

[36] The Finnish Forest Industries; Facts and Figures 1992: 8-9

[37] Paperi ja Puu 6/1992: 471

[38] Metsätilastollinen vuosikirja 1990-1991: 245 (modified)

2.2. Historical Development Of Sawmill Industry

TABLE 2/2 Summary of Historical Development

1433 First exports of roundwood, destination Tallinn

1533 First written evidence of water-powered sawmill
1550's Regular exports of sawnwood

1664 Timber use restricted by law

1708 Thin blade sawing technique
1734 Law of timber use (1664) easened
1743 Peace treaty of Uusikaupunki, Vyborg's province lost to Russia
1772 Sweden-Finland allowed sawnwood exports to Russia
1798 Russia abandoned sawnwood exports

1830 Gearing was introduced
1845-1856 The Saimaa Canal was constructed
1860 First steam-powered sawmill established, Kestilä sawmill in Oulu. Iron and Steel construction materials of sawmill machinery. Domestic machinery producers emerged.
1864 Establishment of National Board of Forestry
1870 First large log float (river Kymi)
1889 Sawmill integrated to pulp mill by Aktiebolag Walkiakoski in Valkeakoski
1895 Establishment of Finnish Sawmill Owners' Association

1914-1919 World War I
1915 Legal restrictions on forest land deals
1925 Tighter legal restrictions on forest land deals
1927-1933 European recession
1939-1945 World War II
1947 Peace treaty of Paris: sawmills and forest area lost to Soviet Union
1960's band saws, chippers, computerized edging, drying killns, lenght packaging, etc.
1970's process thinking, computerization, automatization, production logistics, etc.

2.2.1. Foundations

The Royal Fleet of Sweden-Finland acquired tar and timber from Finland in 14th and 15th century and thus laid the foundations of Finnish wood refining industry. In 1433, the first exports of round timber took place, destination was Tallinn. The very first remaining written evidence concerning sawmill industry in Finland dates back to the year 1533.[39]

In 16th century, sawnwood production stayed low and sawmill ownership was possible only for the crown, monasteries and some wealthy men. Regular exports of sawnwood to the Baltic states, Denmark, Netherlands, and Sweden started around the year 1550. Government acted as a promoter of sawmill industry.[40]

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[39] Ahvenainen 1984: 11, 20

[40] Ahvenainen 1984: 21-22

2.2.2. Sawmill Industry in the 17th Century

The sawmill industry of the crown was to be a supportive industry for mining- and metal industries. Forest resources were considered scarce, and usage of wood was restricted by an act in 1664.[41] Despite of the act, sawmills became more common, and they produced sawnwood mainly to supply local needs.

In the western coast of Finland, sawmills were integrated to shipbuilding docks. Technology changes were slow, and Finnish sawmill machinery producers emerged. Partly as a consequence, plants spread from Vyborg Bay along the coastline up to Kokkola. In 1680's exports of sawnwood became increasingly common.[42]

2.2.3. Changes in the 18th Century

After the peace treaty of Uusikaupunki in 1743, Vyborg's province belonged to Russia. This cut traditional trading routes and divided one from sawmill industry's point of view remarkable region into two separate areas, between which virtually no trade was possible. For example, important export harbours of Vyborg and Hamina were under control of Russia thereby cutting river routes from the province of Savo and the province of North-Karjala to the Gulf of Finland.[43]

The Old Finland (Vyborgs county) became an important area of sawnwood production. Sawmill industry was under tight control but received a favourable position among industries. Although exports were restricted, sawmill industry flourished. New thin blade-sawing technique has arrived from Zaandam in Netherlands via Baltic states into Vyborg as early as 1708, so many effective sawmills existed. Sawmill industry spread to the Lake Saimaa, as the parish of Savitaipale also belonged to Russia. Some sawmill owners (such as Hackman) moved their trading businesses to the province of Savo, which turned out to be wise when Russia abandoned sawnwood exports in 1798. Sawmill industry collapsed; in 1797 existed 60 sawmills, but only 10 remained in 1813. Nevertheless, the latter half of 18th century was the golden era of water-powered sawmills.[44]

Sawmill industry expanded also in Swedish part of Finland. The obligation to use domestic tonnage in export shipments remained, but more liberal attitude towards sawmill industry was taken. Sawnwood exports to Russia were allowed in the year 1772 and thereafter, which made possible the rapid expansion of sawmill industry in the province of Savo. Twelve thin-blade sawmills were established in the provinces of Savo and North-Karjala during the period 1772-1780. New sawmills were established also along the coastline. In 1757, Lamppi sawmill was established in western Finland. This sawmill was later bought by Antti Ahlström, and it was the beginning of (and the first sawmill in) the oldest still existing industrial forest company in

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[41] Ahvenainen 1984: 23

[42] Ahvenainen 1984: 27-43, 429

[43] Ahveninen 1984: 53

[44] Ahvenainen 1984: 53-134

Finland, A. Ahlström Oy. Technology was imported mainly from Netherlands and northern Germany.[45]

Exports of sawnwood increased. The main export countries of both eastern and western parts of Finland were Netherlands, United Kingdom, France, Spain, Portugal, Belgium, and Italy. Russia and Sweden were of course important buyers of Finnish sawnwood. The most important export harbours were Vyborg, Hamina, and Helsinki. The United Kingdom became the most important buyer of Finnish sawnwood in this century.[46]

2.2.4. Sawmill Industry from the Time of Autonomy to the World War I

After 1809, the whole area of Finland was under the command of Russia. Despite of that, Finnish sawmill industry continued its rapid development. This era of sawmill industry was characterized by many remarkable entrepreneurs like Antti Ahlström, Johan Friedrich Hackman, C.F. Rosenlew, Paul Wahl, and N.L. Arppe, just to mention a few of them. Structural arrangements in the field of sawmill industry started, too.

The Saimaa Canal was constructed in years 1845-1856, which allowed sea transports to Europe and shipments to Russia from lake areas in eastern Finland. Though export volumes fluctuated due to changes in custom practices and laws, the Saimaa Canal provided a substantial amount of competitive advantage to the sawmills at the lake area. Increased export to Europe due to overexploitation of Central-European forest resources and thus the need for imported sawnwood was one reason why water-powered sawmills prospered in the lake area, the others were the availability of raw material and hydroelectric power. The technology was easily obtainable and capital requirements were modest during the first decades of the century.[47]

Sawmills were established also along to the northern part of Finland's coastline. New export harbours such as Oulu and Pori emerged. From 1830 to 1860, a technical innovation that allowed larger sawing volumes was *gearing*. Due to the increase in sawnwood production volumes, the size of sawnwood stocks and capital requirements increased. As a consequence, the ownership became more centralized and powerful entrepreneurs emerged, as noted before. The life of water-powered sawmills sustained a long period though steam-powered sawmills became more common towards the end of the century.[48]

The time from 1850 to 1880 was a period of transition in Finnish forest industries. The first steam-powered sawmill was the Kestilä sawmill in Oulu established in 1860. New technology came from Sweden and Norway. The extensive demand in the export markets matched precisely the technological discontinuity of sawmill industry in Finland. Steam-powered sawmills were established and technical problems in large-scale sawmill logistics were solved. Iron and steel were new construction materials of steam-powered sawmills, as in water-powered sawmills wood was commonly used in construction of sawmill industry equipment. Sawmills were no longer dependent on hydroelectric power, and their location was to be optimized. At the same time, a

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[45] Ahvenainen 1984: 76-133

[46] Ahvenainen 1984: 136-138

[47] Ahvenainen 1984: 164-197

[48] Ahveninen 1984: 432

remarkable innovation took place in wood logistics. The very first big log float became reality in the river Kymi at the autumn 1870, which was the beginning of the long history of log floating in Finland.[49]

Sawmill establishment was liberated by an act in 1857, production quotas and licence procedures in 1861.[50] Foreign capital was tempted to Finland to finance the establishment of new sawmills. A norwegian Hans Gutzeit established a sawmill to the city of Kotka at 1871, followed only a couple of years later by Sunila Sågverks Aktiebolag that build a sawmill in Sunila, near Kotka, at 1874. The mouth of the river Kymi is located in Kotka.[51]

The transition in sawmill industry was a sum of innovations in technology and logistics, government action, and booming and selective international demand that together caused a substantial shift of competitive advantage to Finnish sawmill industry. This period saw also the establishment of the National Board of Forestry in 1864, which can be considered as a government action to ensure the availability and quality of wood by forest management.[52]

The rapid development of steam-powered sawmills in the late 19th century provided basis for internationally competitive machinery industry. For example, in the turn of the century Karhulan Konepaja Osakeyhtiö exported its chain saw machinery e.g. to Russia. Models like Ursus, Otso, 600, and 700 were of the newest technology. Karhula is located near Kotka, which was an important centre of steam-powered sawmill industry.[53] Karhulan Konepaja today belongs to A. Ahlström Oy.[54]

Pulp and paper industries started to develop strongly after 1860's. Without international success and concentration of sawmill industry other forest industries would not have developed so early and fastly. Synergies between sawnwood production and pulp production were noticed and a sawmill was integrated with a sulphate pulp plant in Valkeakoski in 1889, which demanded sophisticated technology at that time. Concentration of sawmills lead also to the establishment of Finnish Sawmill Owners' Association in 1895. Ownership changes were common in the late 19th and early 20th century.[55]

2.2.5. Sawmill Industry between the World War I and II

The World War I caused a collapse in production and exports and reshaped the industry structure. Foreign capital left Finland. After the war, foreign demand rose for almost a decade.

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[49] Ahvenainen 1984: 204-271

[50] Zettenberg 1984: 13

[51] Ahvenainen 1984: 221-224

[52] Ahvenainen 1984: 218-271

[53] Riikonen 1985: 1-22

[54] A. Ahlström Oy Annual Report 1991: 43

[55] Ahvenainen 1984: 265-283

The amount of small- and medium-sized sawmills increased fast in the 1920's, and electricity became more general in machinery.[56]

Export and domestic demand collapsed due to the European recession in 1927-1933. One fourth of sawmills were closed down. Exports concentrated to large sawmills. The rapid development of technology in pulp and paper manufacturing guided capital investments to them while sawmill industry received less attention. Those sawmill industry companies that have diversified into pulp and paper industries benefitted from this development, because fluctuations of demand for forest products levelled off and the capital structure strengthened. The biggest sawmill was Kymi Oy's Karihaara Sawmill with annual production capacity of 230 000 m^3.[57] At the years before the World War II, Finland was the biggest exporter of coniferous sawnwood in Europe[58]

2.2.6. Sawmill Industry after the World War II

In the peace treaty of Paris in 1947, Finland lost 14% of its forest area and about 30 large or medium-sized sawmills to the Soviet Union. The loss of sawmill industry capacity meant a downward shift of sawnwood production, as indicated in figure 2/4. Pulp and paper industries have played the leading role in Finnish forest industries from 1950's. Sawmill industry has received only small amounts of capital due to e.g. slow technology development in the first half of the 20th century, increased use of substitute materials, and low market demand i.e. oversupply of sawnwood. Numerous sawmills were closed down in the 1960's.[59]

Frame saw was the basic saw equipment in the 1960's, but is had new competitors, *band saws* and saws that made square timber. Also *computerized edging* was introduced. It means that log is measured optically, the position of it is chosen optimally to match the sawing procedure, and saw blades are adjusted automatically to maximize the sawnwood available from each log. *Drying plants* or *drying kilns* became more common in bigger sawmills. The normal moisture of exported sawnwood is 18-20% of its weight, and for special purposes lower, e.g. the moisture of joinery sawnwood is 8-10%. Along with the raise of refining grade, *length packaging* was introduced. This means that sawnwood is sorted and packaged by its length, ready for transport. Bulk sawnwood exports decreased in the 1960's.[60]

Technology development in sawmill industry equipment accelerated again in the 1970's accompanied with new ways of thinking. Technology proceeded in the fields of automation, integrated processes, remote-controlled sawing, material handling, production logistics etc. Innovations were achieved by the shift to process thinking, which means continuous production i.e. that no single log stops during the production process. In income logistics log handling was

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[56] Ahveninen 1984: 310-347

[57] Hjerppe 1986: 83

[58] Ahveninen 1984: 367-389

[59] Ahvenainen 1984: 414-435

[60] Juvonen 1986: 110, 122-129

improved[61] and in outcome logistics many length packages were handled and transported at the same time, which saved time and increased potential material stream in this process phase.[62]

Until the middle of 1970's, sawmills were mainly labour-intensive. Due to investments in equipment and machines their capital-intensivity has risen ever since. In terms of value, the investments in the 1970's were almost four times as large as investments in the 1960's.[63] As a consequence, the number of sawmills has decreased, as competitiveness is more difficult to sustain when capital requirements are higher. This again has driven the industry towards greater concentration and bigger units.

Salo examines the development of productivity of capital and labour over the period 1959-1984. She states that labour was substituted by capital, as the labour productivity was in 1984 almost 3,5 times as high as it was in 1959 while capital productivity decreased gradually over the period. Sawmill industry became more capital-intensive industry in the 1970's.[64] Jyrkkönen claims that while labour was substituted by capital in 1974-1984, the share of debt capital in liabilities and the share of capital costs from turnover rose remarkably.[65]

The calculations Q/K, Q/L, and K/L are based on sawnwood production volume (Q), gross capital stock in sawmill industry (K), and total annual working hours in sawmill industry (L). Because sawnwood as a product has not changed dramatically within the calculation period, it can be used in estimations. Capital values are unpublished material from ETLA files.[66]

Sawmill industry has become more capital-intensive especially in the 1970's and thereafter. Labor productivity has increased and capital productivity has decreased. Technological change i.e. innovations have caused substitution of labor by capital. This development is about to continue.

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[61] Kunnas 1981: 31

[62] Juvonen 1986: 110

[63] Kunnas 1981: 26

[64] Salo 1988: 55-62

[65] Jyrkkönen 1985: 10

[66] for closer examination of methodology, see Maurice and Smithson 1981: 239-261

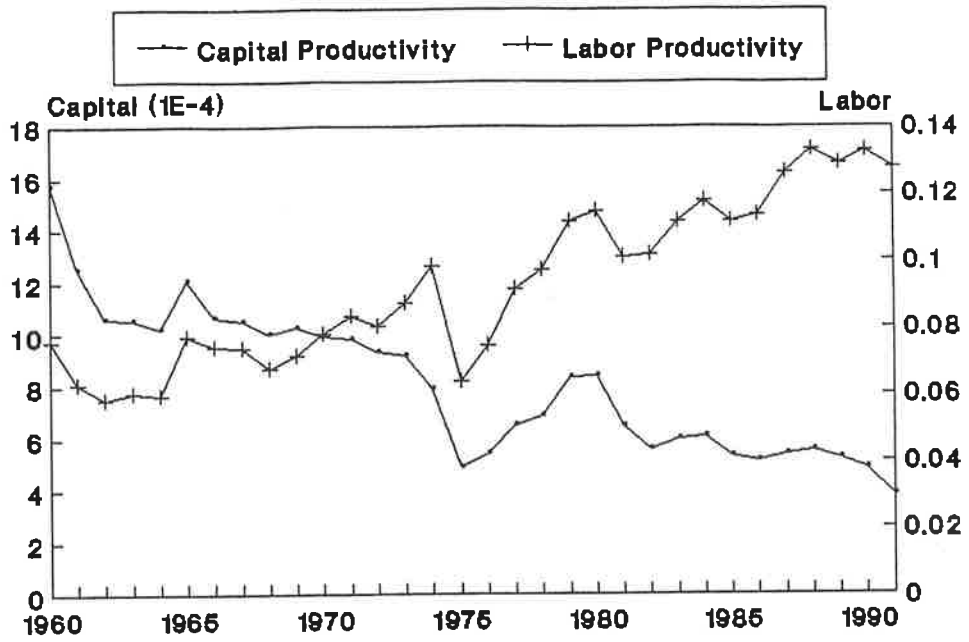

FIGURE 2/2 Partial Productivity Development of Capital and Labor 1960-1991[67]

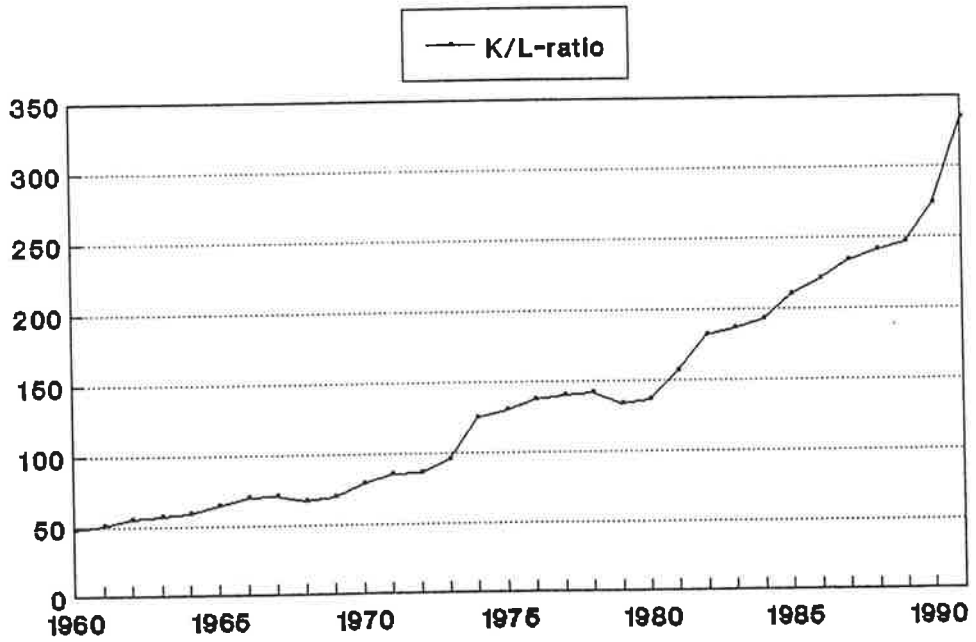

FIGURE 2/3 K/L-Ratio Development in Sawmill Industry 1960-1991

[67] compiled from Metsätilastollinen Vuosikirja 1968-1991, Industrial Statistics of Finland 1960-1963, and ETLA files. Capital appreciated by unreleased material from ETLA files, gross value, 1980 prices.

The annual sawnwood production quantity of Finnish sawmill industry gives a good insight to the development of the industry. All major international crisis reflect to the demand for sawnwood.

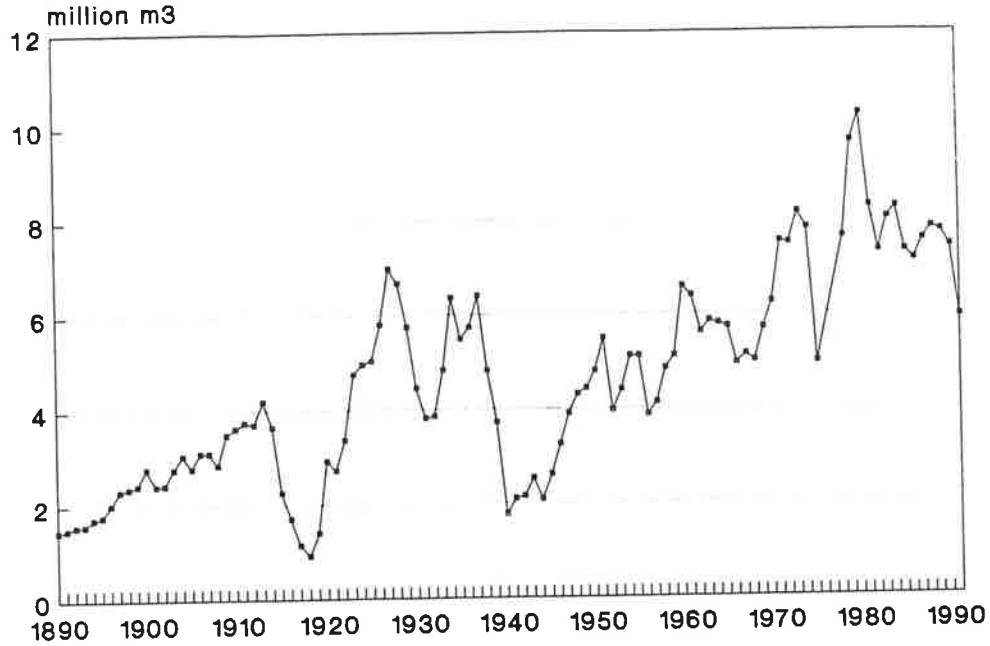

FIGURE 2/4 Annual Sawnwood Production Quantity of Finnish Sawmill Industry 1890-1991[68]

2.3. The Outlook of Sawmill Industry in the 1980's and 1990's

2.3.1. Production and Production Facilities

The trend of sawnwood production in 1980's has been decreasing in terms of quantity. All time production record was achieved in 1980, when the total quantity of sawnwood produced was 10 230 000 m^3. After that, production remained between 7 000 000- 8 000 000 m^3 annually, though slightly diminishing over time, until 1991, when only 5 900 000 m^3 was produced.[69]

One reason for the decrease is the change in demand and supply of coniferous sawnwood in European markets at the beginning of 1980's. Slowing housing construction decreased the demand for building-quality sawnwood, and at the same time Central European supply of sawnwood expanded due to increases in production capacity. Short-term competitive advantage of Finnish sawnwood was lessened by two devaluations of the Swedish Crown in 1981 and 1982. Because of these devaluations, the Swedish sawmills gained approximately 20% decrease in

[68] Vattula 1983: 152-154, Metsätilastollinen Vuosikirja 1975-1991

[69] compiled from Metsätilastollinen Vuosikirja 1980-1991

production costs compared to Finnish sawmills, which was transferred to prices of Swedish sawnwood.[70]

In years 1984, 1987, and 1988 the high timber price matched occasional shortage of saw logs and sawnwood production was somewhat restricted.[71] It should be noted, however, that long-time trend of sawnwood production is increasing. In Appendix 1, a trend is calculated from the year 1960.

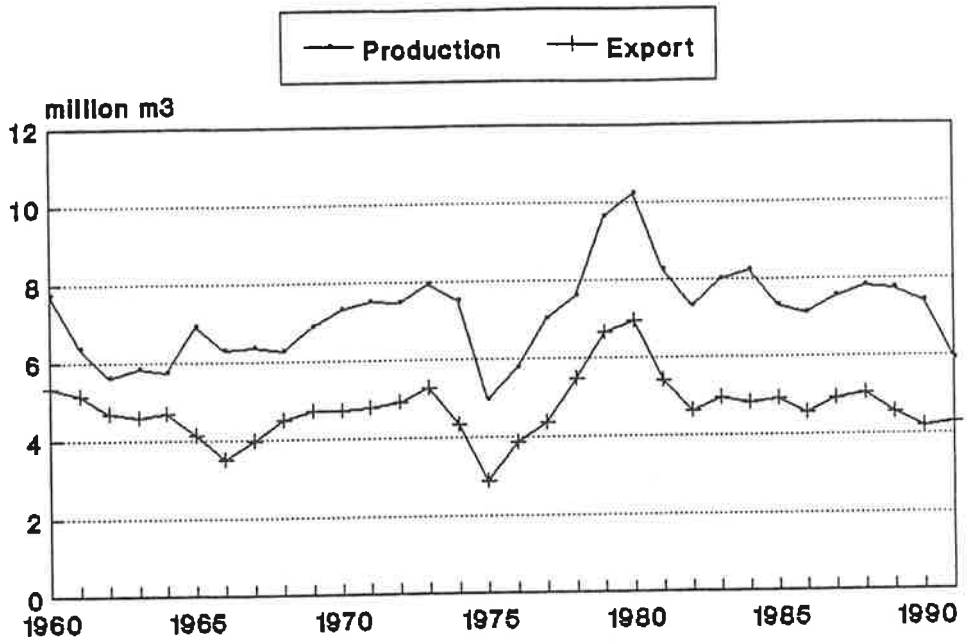

FIGURE 2/5 Sawnwood Production and Exports 1960-1991[72]

In 1980, there existed some 8 900 sawmills, but only 4 330 sawmills produced sawnwood in 1991. These figures include small sawmills and circular sawmills sawing for their own use only. In the Industrial Statistics of Finland, however, only 234 sawmills were included in 1990. About 120 sawmills exported sawnwood in 1991.[73] While the number of mills has decreased, the average size of them has risen. In sawmill industry the *economies of scale* are not straightforward, because timber costs rise due to lower utilization rate in timber use and longer transport distance as the mill gets bigger. The size of sawmill is therefore restricted.[74]

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[70] Väisänen ja Puputti 1987: 4; Sahiluoma 1988: 25

[71] Metsätilastollinen Vuosikirja 1990-1991: 149

[72] compiled from Metsätilastollinen Vuosikirja 1968-1991 and Industrial Statistics of Finland 1960-1963. Quantities in years 1960-1963 are converted from standards into cubic meters. 1 std = 4,672 m^3. It was used as a measure of timber quantity until the middle of 1960's.

[73] Industrial Statistics of Finland 1990: 124; Metsätilastollinen Vuosikirja 1990-1991: 231

[74] Kunnas 1981: 74

In 1992, the biggest sawnwood capacities in Finland were: United Sawmills Ltd 1 010 000 m^3, Enso-Gutzeit Oy 955 000 m^3, Kymmene Oy 900 000 m^3, Metsä-Serla Oy 620 000 m^3, and Botnia Wood Oy 330 000 m^3.[75] It should be noted that after Enso-Gutzeit Oy bought the Tampella Forest in the spring 1993, it became to the biggest coniferous sawnwood producer in Europe.

Because of overcapacity in sawnwood production, the capacity utilization rates of sawmills have also remained lower than in forest industries as a whole. Cyclical demand of sawnwood causes changes to capacity utilization rate of sawmills. Since 1980, the capacity utilization rate has been over 80% in 1980 and in 1987-1990.[76] Sawnwood production process plan is provided in appendix 4.

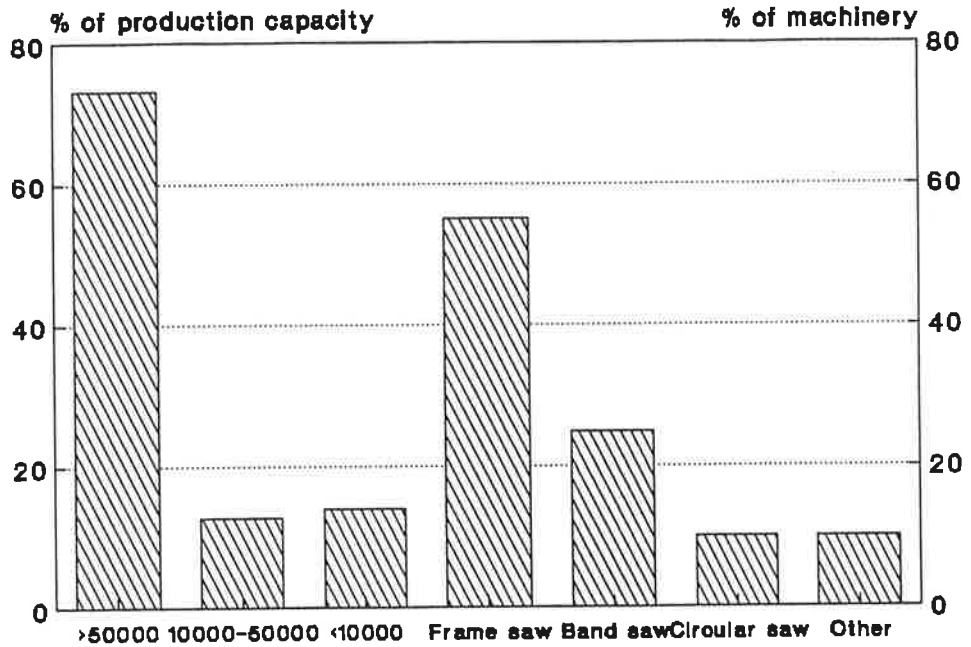

Figure 2/6 Distribution of Sawmills in 1988: Production Capacity m^3 and Machinery Type[77]

Large- and medium-sized sawmills with annual production capacity more than 50 000 m^3 produced 73,1% of all coniferous sawnwood production quantity in Finland in 1988. Sawmills with production capacity 10 000m^3 to 50 000 m^3 counted for 12,8% and those under 10 000 m^3 counted for 14,1%. The share of the biggest sawmills is high in European comparison. In 1988, the corresponding share was only 44,5% in Sweden and 35,5% in Austria, both of which are notable exporters of coniferous sawnwood in Europe.[78]

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[75] Annual Reports 1992; interviews

[76] Metsätilastollinen Vuosikirja 1990-1991: 228

[77] Jaakko Pöyry files; Pöyhönen 1991: 112

[78] Jaakko Pöyry files

The dominating sawmill machinery type in all countries mentioned above is *frame saw*, which counted for 55% of coniferous sawnwood production quantity in Finland in 1988. Band saws counted for 25%, circular saws for 10%, and other machinery for 10% of the corresponding production volume in 1988. The average age of frame saws was 15,7 years, band saws 8,1 years, circular saws 7,7 years, chipper canters 6,9 years, and hewing saws 3,7 years in 1991. The development of machinery is towards band saw machinery, as old frame saw lines are either closed down or modernized. Hewing saw popularity is increasing in small saw log production. To comparison, in Sweden circular saw machinery is becoming more general, because it suits for medium-sized sawmills, which counted for the major part (47,3%) of coniferous sawnwood production in Sweden in 1988.[79]

2.3.2. Cost Structure

The major portion of costs fall to net raw material costs, which are around 65%. The share of wages plus social security expenditures is ca. 15%, capital costs ca. 10%, and energy (electricity, fuels, heat) around 4% the rest being miscellaneous items such as maintenance, rents, packing materials, merchandise goods etc. It should be noted that in sawmills the share of capital costs varies greatly because of e.g. different working capital needs.[80]

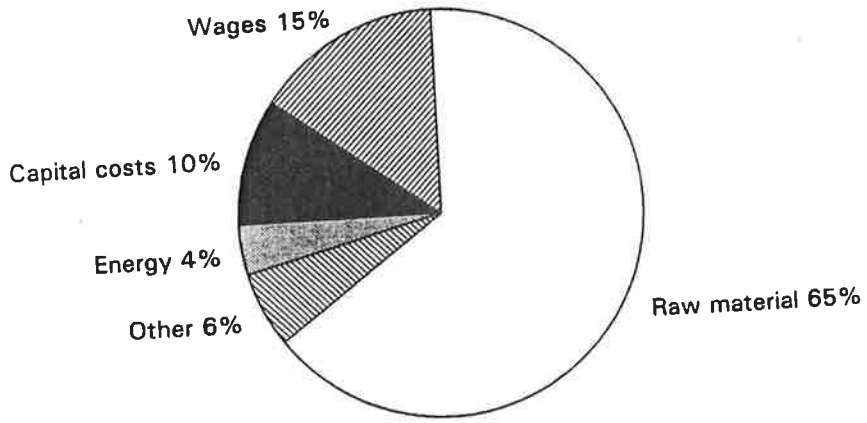

FIGURE 2/7 Breakdown of Sawmill Production Costs in 1990[81]

The biggest single cost factor in raw material costs breakdown is the stumpage price of timber, the share of which was 60-65% from raw material cost in 1990 (from mill price). The share remained at this level in the 1980's. While timber stumpage prices have decreased in 1991 and 1992, the share has somewhat diminished, and when the cost of felling, transportation in forest and long-distance transportation costs have remained at the same level, the mill price of timber in 1992 has decreased 17% compared to 1990.[82]

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[79] Pöyhönen 1991: 112; Jaakko Pöyry files

[80] compiled from Industrial Statistics of Finland 1990; Kunnas 1981: 34,67

[81] Industrial Statistics of Finland 1990: 124-125

[82] compiled from Metsätilastollinen Vuosikirja 1990-1991: 171-179; Tekniikka & Talous 19.11.1992: 13

2.3.3. Profitability and Investments

Profitability[83] of sawmills has remained under the profitability of other forest industries. The operating profit of sawmill industry averaged to ca. 5% between 1975-1991.[84] Cyclical variation of profitability caused by changes in demand[85] is visible in figure 2/8, where the average operating profit of Finnish Sawmill Owners' Association sawmills is presented. Also low capacity utilization rate (overcapacity), high capital costs, and weak adjustment to changing market demand lower the profitability of sawmills.[86] The effect of timber quality and the prices of by-products to the profitability is obvious and the profitability of small-, medium-, large-sized, or integrated sawmills can differ considerably.[87]

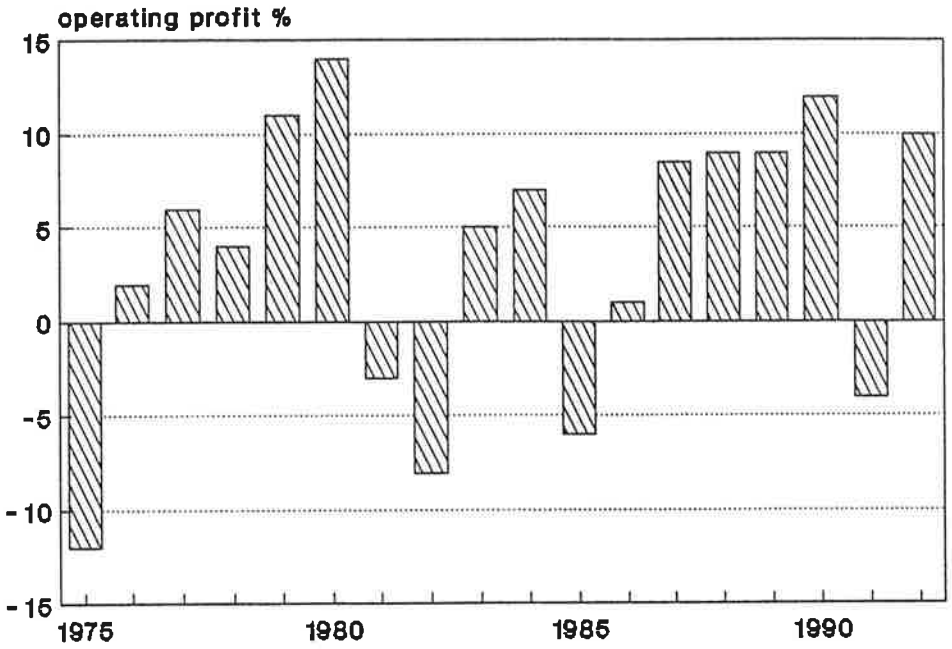

FIGURE 2/8 Average Operating Profit of Finntimber Sawmills in 1975-1992[88]

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[83] Profitability = operating margin / net sales

[84] Metsätilastollinen Vuosikirja 1990-1991: 229

[85] Domestic construction activity affects the profitability of sawmill industry. Although domestic demand has remained in 2,6-3,0 million m^3 annually, the periods of high profitability match booming domestic construction activity. (compiled from Metsätilastollinen Vuosikirja 1975-1991, interview: Ossi Kokkonen, Metsä-Serla Oy)

[86] Heino 1988: 92-93

[87] Väisänen ja Puputti 1987: 9; Sahiluoma 1988: 30; Pelkonen 1986: 189; Salunen 1985: 1-7

[88] Jaakko Pöyry files

The most profitable sawmills have strictly limited business targets, whether in customer-based or in standardized sawnwood production. Pine sawnwood is slightly more profitable than spruce sawnwood.[89] The average operating profit of sawmill industry should be 12-15% in order to maintain and develop machinery.[90]

Investment rate has in the last decades remained low in sawmill industry. Investments were high at the two periods of 1980-1981 and at the end of 1980's. This is clearly visible in figure 2/9. Investments to machinery and equipment account ca. 70% of all sawmill industry investments.[91]

Investments in production can raise long-term profitability because of the high raw material cost. (Such improvements can be achieved in measurement accuracy, saw blade setter adjustment, computerized optimization of sawing, sawn surface, edging, the amount and quality of sawing waste, or sawing gap. All these are more or less a function of sawing equipment.[92]) The effective use of raw material in production affects profitability more than e.g. labour productivity, because timber cost is five times as high as labour cost.[93] Investments to increase profitability are guided to production improvement instead of building new capacity.[94]

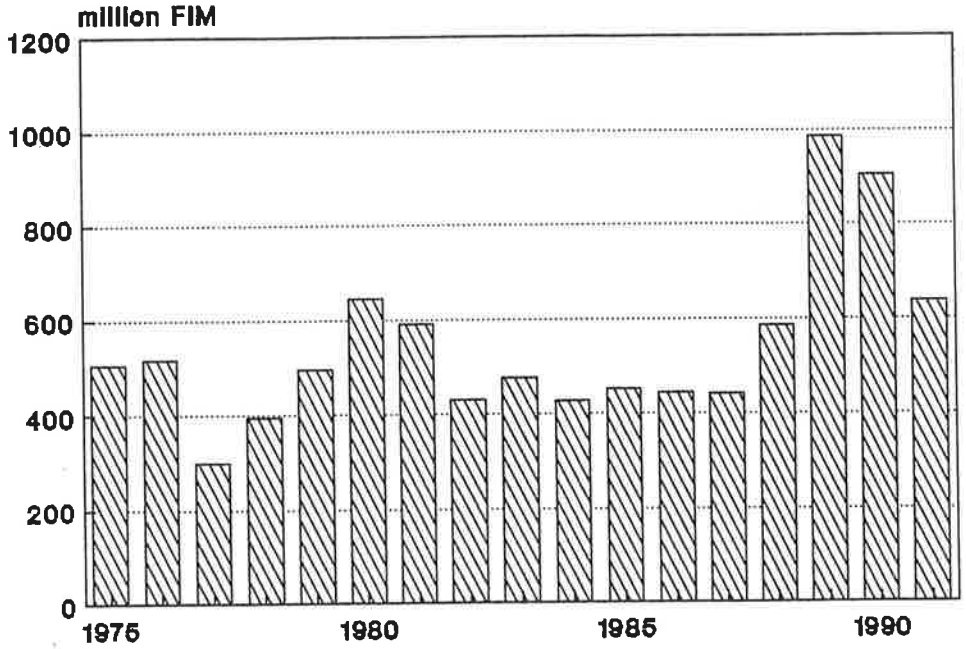

FIGURE 2/9 Investments in Machinery and Equipment 1975-1990, in 1985 Value[95]

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[89] Pöyhönen 1991: 94-96

[90] Paperi ja Puu 7/1991: 592; interview: Petri Wager, Enso-Gutzeit Oy; Ossi Kokkonen, Metsä-Serla Oy

[91] ETLA files

[92] Usenius 1985: 1-13

[93] Kunnas 1981: 78

[94] Vanhala 1988: 19

[95] ETLA files

High profitability encourages investments especially when it is caused by strong domestic demand, as was the case e.g. in 1989-1990. Rapid decrease of operating profit is caused by demand fluctuations and continued investments, as was the case in 1981 and 1991. Market demand affects profitability, which then affects investment level. High profitability causes increasing investment in sawmill industry, which indicates that pressures to modernize machinery are present.

2.3.4. By-Products and Integrated Sawmills

Out of a sawn timber log only 45-46% of wood volume is processed to sawnwood, the rest being by-products. Sawmill chips account for 30-31%, sawdust for 11-13%, and bark for 10-12% of sawn wood volume. Sulphate pulp mills can use sawmill chips and sawdust, if they fulfil certain strick classification.[96] Chips and sawdust can be used also in board industries, and sawdust can be burned in heating-centres.[97] By-products contribute to 12-17% of sawmills total earnings. The share of chips is ca. 80% and sawdust ca. 15 % of this value.[98] However, in Finland by-products are not considered as a separate sales product, which is the case in international markets. The sales value is subtracted from timber purchase value.

Many sawmills of large forest corporations are integrated e.g. to pulp mills. Such integration means vertical or multiproduct integration, in which one production unit uses other unit's products, by-products, or services as its raw material. Synergies often exist in raw material purchasing, energy production, transports, administration etc. Integration means the optimal guidance of purchased wood fibre in the fibre flow inside the company. It does not necessarily mean physical proximity.[99]

Integration allows, at least in theory, the optimal use and allocation of corporate resources. It is often claimed that costs are not divided equally in an integrate and transfer pricing is not based on market prices, or at least that mills do not operate as an independent business units and that they cannot affect the price of raw material purchased or by-products sold. Sawmill's profitability in an integrate depends to internal transfer pricing to a great extent.[100] On the other hand, sawmills have an important function in using large timber, which justifies their position.[101]

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[96] For example, the requirements of chips for sulphate pulp are the following: length 13-25 mm, thickness 3-5 mm, max. amount of bark 1% and sawdust 2%, sifted, no other materials such as plastic, sand, coal etc. (Juvonen 1988: 185-187)

[97] Kunnas 1981: 5-7

[98] Juvonen 1986: 178-189

[99] Salunen 1985: 1

[100] Vanhala 1988: 29

[101] Salunen 1985: 1-7

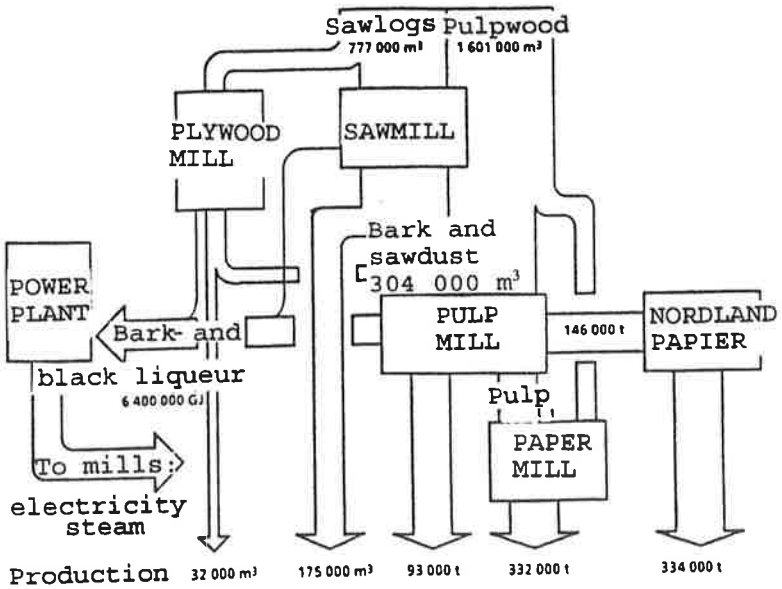

Figure 2/10 Kymmene Oy Kaukas Mill Integrate (1985)[102]

2.3.5. Sawnwood Markets

The main industrial end-users of sawnwood are construction, joinery, furniture, planing, and packaging industries. Demand for sawnwood is cyclical due to changes in user industries, mainly in construction industry. Finnish sawnwood production correlates with the changes of construction activity in both domestic and especially export markets.[103] Cyclicality of the demand is partly levelled off if sawnwood is exported to countries that are independent from each other's economic activity. The share of domestic use was 36% and the share of exports 64% from sawnwood produced in Finland in 1991. Sawmill industry is strongly export-oriented.[104]

Softwoods (conifers: pine and spruce) dominate Finnish sawnwood exports. Their share of volume was 95% and value 93% of all sawnwood exports in 1991. Total exports of sawn softwood decreased in the 1980's, both by volume and value.[105]

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[102] Standertskjöld 1988: 236

[103] Vanhala 1988: 22; Kunnas 1981: 85

[104] The Finnish Forest Industries, Facts and Figures 1992: 7, 16

[105] Metsätilastollinen Vuosikirja 1990-1991: 245-252

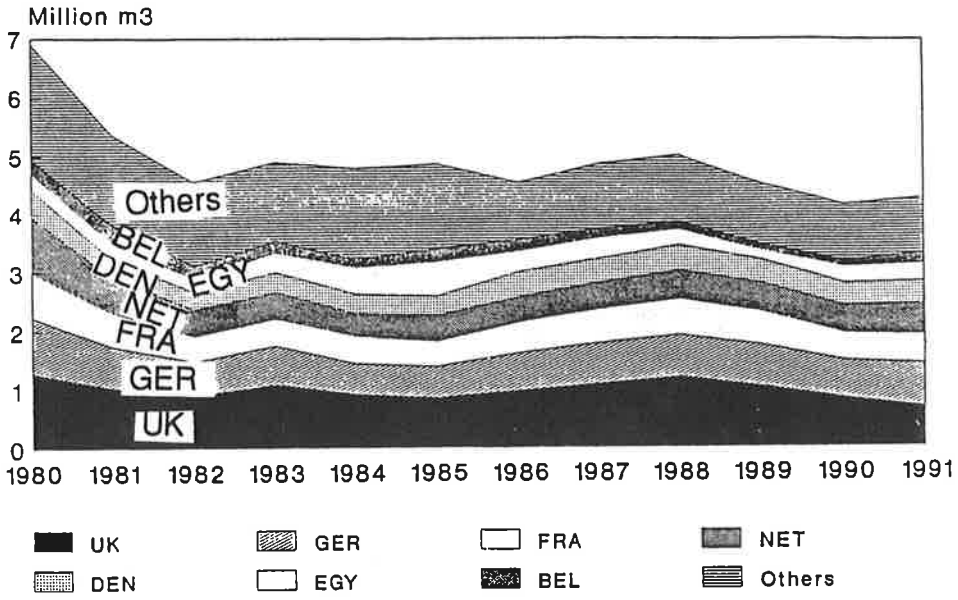

FIGURE 2/11 Exports of Coniferous Sawnwood 1980-1991[106]

In 1991, the EC countries share of Finnish sawnwood exports volume is 78%, but the share of exports value is 81%, which means that higher quality and/or higher price sawnwood is exported to these countries. Within the EC the most important buyers in this respect are United Kingdom, Germany, Denmark, and Belgium, though the export volume to United Kingdom has decreased in 1980's. The export value share is greater than the export volume share in these countries. This is at least partly connected to the higher price of pine sawnwood.[107] In figure 2/12 the export volumes and values based on regions and countries are presented.

[106] compiled from Metsätilastollinen Vuosikirja 1980-1991

[107] The Finnish Forest Industries, Facts and Figures 1992: 14; Metsätilastollinen Vuosikirja 1990-1991: 247

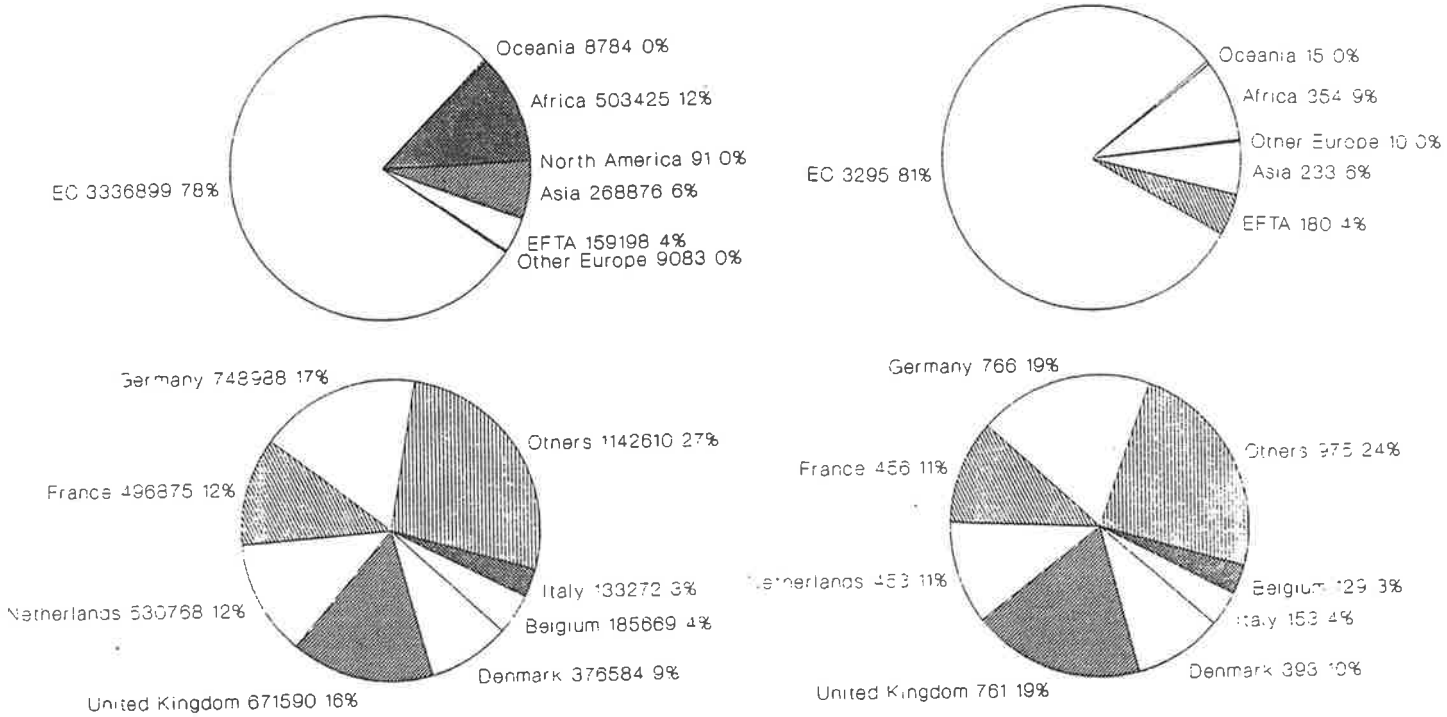

FIGURE 2/12 Sawnwood Export Volume and Value by Region and Country in 1991, m^3 and million FIM[108]

Exported sawnwood is classified into quality categories, which are u/s, V, VI, and sf. Quality is determined according to certain properties of every single piece of sawnwood, e.g. number and size of branches and edges of the board are examined. U/S is the highest quality class (and divided further into subclasses I-IV), whereas VI is the lowest export grade. Mark sf means sawnwood that is sold by sawnwood falling i.e. it is not sorted in sawmill.[109] The higher the quality, usually, the higher the export price.

The quality breakdown of pine sawnwood exports in the period 1980-1991 reveals that no remarkable changes have taken place. More than one fourth of exported pine sawnwood was classified into u/s, and the share of V was ca. 50%, and VI ca. 15-20%. The share of sf has been low, though slightly increased towards the end of the period. The biggest buyers of pine sawnwood are United Kingdom and Denmark.[110]

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[108] The Finnish Forest Industries, Facts and Figures 1992: 14, Metsätilastollinen Vuosikirja 1990-1991: 247

[109] Sahatavaraopas

[110] Jaakko Pöyry files

With spruce, the quality breakdown in the period 1980-1991 looks a bit different. The share of u/s was about one fourth but the share of V was somewhat less that one fourth. VI accounted for no more that ca. 10%, and the share of sf was dominating by ca. 40% of all spruce sawnwood exports in 1991. Change has taken place from higher qualities to sawfalling, because higher cost of better qualities has driven the end users to do sorting by themselves. The biggest buyers of spruce sawnwood are Germany, France, and Netherlands.[111]

2.3.6. Related and Supporting Industries

The Finnish sawmill industry has only spawned a few competitive related or supporting industries. One reason for this is the position of industry in the production chain. Sawmill industry is primary processing of timber, which does not demand a wide variety of specialized suppliers.

Forest management has developed from the needs of forest industries. Increased timber stands have been one aim of forest management, because timber logs count for one third of the total wood volume, but two thirds of the total stumpage price income, and thus forest management is closely related to sawmill industry. Finnish forest management is known worldwide and it represents the very top knowledge on its field in the whole world. Know-how exports take place e.g. through bilateral and multilateral development aid to countries such as Nepal, Sudan, Tanzania, and many others.[112] Finnish forest management is internationally competitive and all forest industries benefit from it.

Multiprocess machines, harvesters, and forwarders have developed from the needs of forest management, or originally from the needs of forest industries. The world leader of forest machines production is the company FMG Timberjack, which belongs the Repola Group. The forest machines world market share of FMG Timberjack is 25% and net sales in 1991 around 400 million USD. FMG operates in 70 countries and only 15% of its personnel is based in Finland. Major products are single and two-grip harvesters, forwarders, feller bunchers, and grapple and cable skidders.[113] The other major producer of forest machines is Valmet Forest Machines with turnover of 474 million FIM in 1991, out of which only 21% came from domestic markets.[114] Also e.g. Fiskars Oy, Metsäsavotta Oy, and Norcar Oy manufacture and export forest machines. The forest machinery industry is thus internationally competitive.

Sawmill industry machinery is specialized. The leading Finnish company that manufacturers and exports sawmill equipment is A. Ahlström Sahakoneet Oy[115] with the turnover of 125 million FIM and 170 employees in 1992.[116] The other major Finnish producers of sawmill machinery that also export their products are presented in table 4/3. The sawmill machinery industry can

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[111] Jaakko Pöyry files

[112] see e.g. Whose Trees? 1991

[113] Repola Oy, Vuosikertomus 1991: 42; FMG Timberjack, brochures

[114] Valmet Oy, Vuosikertomus 1991: 40-41

[115] A. Ahlström Osakeyhtiö 1963: pages not numbered; A. Ahlström Oy Annual Report 1991

[116] interview: Heikki Mäntylä, A. Ahlström Sahakoneet Oy

be considered as internationally competitive, though not to that extent which is the case with forest machines.

TABLE 2/3 Major Finnish Manufacturers of Sawmill Machinery[117]

COMPANY	FIELD OF SPECIALIZATION
A. Ahlström Sahakoneet Oy	whole production process except drying
Järme Oy	sawnwood handling equipment, length packaging
Tähkä Oy	log sorting and feed systems
Valmet Oy	sawnwood drying units
Veistorakenne Rautio Oy	sawmill machinery and chipper canters
Woodma Oy	sawnwood handling equipment, sorting equipment

Internationally speaking, Swedish sawmill machinery manufacturers tend to be more firmly established in European markets than the Finnish ones, i.e. the competitive advantage they hold is greater. The major manufacturers are Söderhams Verkstäder Ab and ARI Ab, both of which sell complete solutions. Another two important producers are Rvanholmen Ab and Shej Ab, the field of specialization of which is mainly in sawing technique, blades, and different kinds of conveyor systems.[118] Italia and Germany do also have machinery industry worth mentioning. In North America, the Canadian and US-manufacturers are highly specialized, but the difference in raw material (notably its size: the diameter of trunk is much wider in North America than it is in e.g. Scandinavia, e.g. the trees are simply bigger) has guided the machinery development to a direction that is not readily suitable for Scandinavian (and European) purposes. This fact limits machinery trade between these two continents.

Because sawmills were established along the waterways far from towns, they have had an impact on the development of Finnish infrastructure such as highways and railways.[119] Thus transportation has developed also from the needs of sawmill industry, and it can be considered as a related industry. For transportation of timber, a specialized trucks are needed. They are also exported from Finland.

Sawmill industry has had its effects also to the emergening of pulp and paper industries e.g. in means of creating capital to large investments needed in establishment of pulp and paper mills. This is backed by Porters theory that the scale of *cluster* guides resources to it and encourages investments.[120]

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[117] interview: Henrik Simberg, Jaakko Pöyry Consulting Oy

[118] interview: Jan Wintzell, Jaakko Pöyry Consulting Oy

[119] Lilja 1991: 6

[120] Porter 1990: 148-152

3. The Role of Sawmill Industry in Pursuit of Finnish Competitive Advantage

The proportional shares of raw material stock, production, and exports outline the competitive advantage that Finland possesses. Though Finland's share of world's coniferous sawnwood production is just around 2%, the share of world's coniferous sawnwood exports is 6%.[121] The share of OECD coniferous sawnwood exports is even higher, 10,6% in 1990.[122] Clearly, Finnish sawmill industry is internationally competitive.

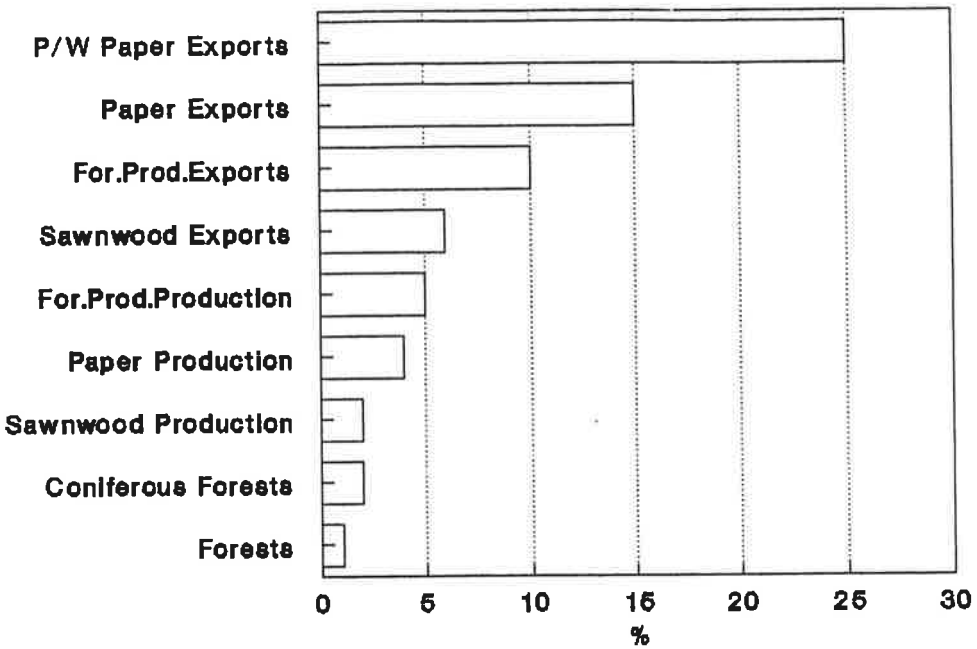

FIGURE 3/1 Finland's Share of World's Raw Material, Production, and Exports in 1990: Forest-Related Products[123]

Finland's share of world's coniferous sawnwood exports has declined in the past decades. While the share of world's export volume was almost 15% in 1960, it was around 6% in 1990. Evidently, the competitive advantage of Finnish sawmill industry is eroding. However, the decrease of export value has *not* been as large as the decrease of export volume share. This indicates that the *refining rate* of exports has improved in this period. The value share has in this period usually been larger than the volume share.[124]

Seppälä studies the shares of mechanical forest industry products and paper products in the total value of Finnish exports. Starting from 1860, the statistical material shows clearly the decline in tar exports at the late 19th century, as well as the decline in timber and mechanical forest industry products exports starting from 1960's. On the other hand, the emergence of paper industry is clearly visible, although the recent development shows that also paper products' share

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[121] Metsäteollisuus, Ympäristö, Luonto 1991: 28

[122] ETLA files

[123] Metsäteollisuus, Ympäristö, Luonto 1991: 28; Metsätilastollinen Vuosikirja 1990-1991: 262

[124] compiled from FAO Yearbook of Forest Products 1960-1990

of Finnish exports is declining. Still, mechanical forest industries' products and paper products stand out as the most remarkable export sectors among forest industries.[125]

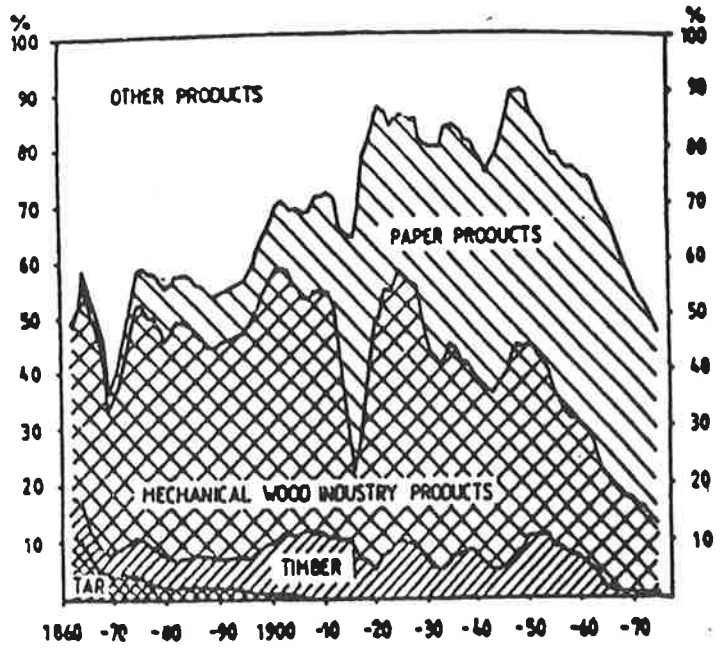

FIGURE 3/2 Value of Exports of Forest Industry Products as Per Cent of Total Finnish Exports 1860-1977[126]

3.1. Factor Conditions

3.1.1. Basic and Generalized Factors

Among *factors of production* the most important one for sawmill industry is raw material, timber. Climate forms the base in which forest deposits grow. By effective forest management, or *silviculture*, the rate of growth can be increased. In spite of forest management, the rate of growth cannot exceed limits given by the nature.

The forest type in which Finland belongs is *boreal coniferous forest.* These forests occupy two great zones, one stretching from the Atlantic coast of Scandinavia to the Pacific coast of Siberia and the other across North America from Alaska to Newfoundland. In these zones, the climate is characterized by short growing seasons and long, cold winters. The forests are dominated by conifers. The boreal coniferous forest is the most extensive surviving forest type outside the tropics and it has a great impact on the production of wood processed goods.[127] The geographical location of Finland is one explaining factor to the existing competitive advantage in coniferous sawnwood production.

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[125] Seppälä, H. 1980: 10

[126] Seppälä, H. 1980: 10

[127] Matther 1990: 18

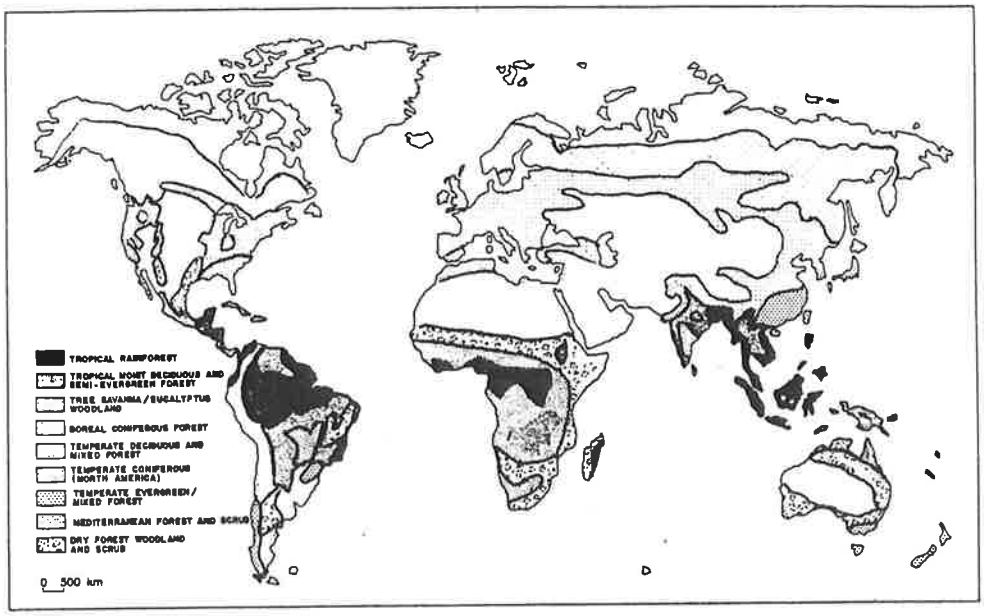

FIGURE 3/3 Forest Distribution[128]

Although there are similarities of form and structure between the Eurasian and North American parts of the boreal coniferous forest, there are important differences in species composition both between and within these areas. These differences do create competitive advantage. The European sector is much poorer in species than its counterparts in North America and eastern Asia. Scots pine and Norway spruce dominate the European section. Siberian species gradually increase eastward. In terms of species diversity, the North American section more closely resembles the east Asian part of the boreal forest than the European area. Likewise in Eurasia, there is west-east graduation. In eastern Canada the white and black spruces are commonly found on areas of better and poorer drainage respectively and give way to species such as jack pine on poorer soils. The eastern dominants give way to lodgepole pine and western species of spruce and fir. Although one distinctive feature of the boreal forest is the frequent occurrence of almost pure, single species stands, the small amount of species gives competitive advantage to forest industries in Scandinavian countries e.g. in means of better forest management, harvesting, transports, and production. Also the resource base of one certain species is large enough for production in international scale.[129]

In addition to the scarcity of species in European boreal coniferous forests, the annual growth (measured as m^3/ha/yr) of them is due to the climate faster than in Siberian and North-American boreal coniferous forests. Growing periods are longer because of the effect of the Gulf Stream to the European climate. The growth rate decreases northwards as usual in northern hemisphere. According to the classification presented by Matther, the growth in northern part of our nation provides a weaker base for sustaining competitive advantage, though by plantations and effective forest management growth can be substantially increased. The classification clearly shows that

[128] Matther 1990: 13

[129] Matther 1990: 18-19

the creation of forest resource-based competitive advantage is more difficult and less sustainable in northern latitudes than in southern ones in boreal coniferous forest.[130]

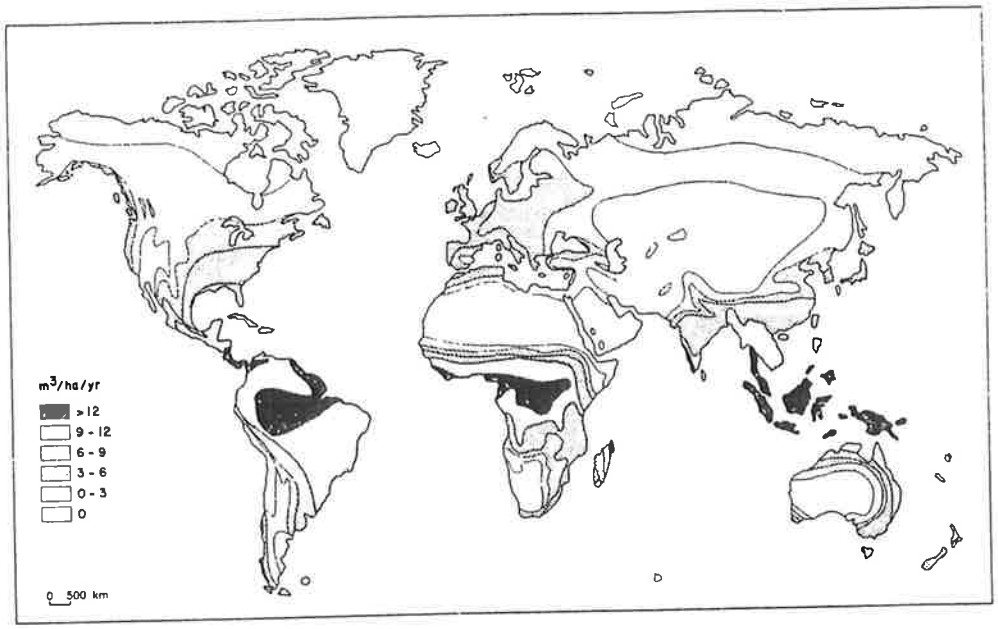

FIGURE 3/4 Potential Productivity[131]

The location of Finland in boreal coniferous forest area is according to Porter a *basic factor*. Porter claims that such factors are either unimportant to national competitive advantage or the advantage they provide is unsustainable.[132] Coniferous forest resources give competitive advantage, which has sustained because of coniferous wood scarcity in Europe, where only Finland, Norway, and Sweden are located in this area. In addition, conifers grow in the area of the Alps, e.g. in Austria, which is a notable exporter of sawn softwood in European markets, and in Germany, which is the second largest producer of coniferous sawnwood in Europe, though almost all of it is sold in the domestic market. Russia holds a remarkable coniferous forest resources, but lately it has had difficulties in sawnwood production.[133] The total volume of Finnish forests amounted to 1 880 million m^3 in the beginning of 1990, out of which pine accounted for 45%, spruce for 37%, and non-coniferous trees for 18%.[134]

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[130] Matther 1990: 26-27

[131] Matther 1990: 27

[132] Porter 1990: 77

[133] compiled from FAO Yearbook of Forest Products 1990

[134] Siitonen 1990: 1

3.1.2 Advanced and Specialized Factors

In 1926, in the Helsinki University of Technology (HUT) a professorship of sawmill industry was established. The popularity of this specific education has decreased, and today only 6-7% of students in Forest Products Department of HUT choose mechanical forest industry as their major subject. This share was close to 20% until 1980's.[135] This has clearly contributed to the decrease in *specialized* or *advanced factors*, in this case the pool of highly educated engineers. The competitive advantage available from this source is clearly eroding. According to Porter, Finland as a nation would be better off in the long run if this line of education was located in the region where many sawmills existed.

Large forest companies cooperate with related and supporting industries and also with each other. The *network* in which the biggest companies belong to is quite effective and can build competitive advantage. The pool of resources can be employed effectively as information exchange and interaction between firms are often crucial preconditions for *innovation*. Because investments to sawmill equipment are usually modest, in case of major technological improvement the *innovation diffusion* would take place among the largest sawmill companies.[136] Other sawmill owners would probably be in weaker position, if they were not able to reap enough information from their network and familiarize themselves with the invention.

The share of investments in R&D of the total value of production amounted to 0,14% in 1987. This figure is very low, it is also the lowest among all mechanical forest industries. The corresponding average value of all industries was 2,2% in 1987. It should be noted that in process industries much of the R&D is carried out by supplying industries. In the whole woodworking industry the R&D expenditures were divided as follows: products 58%, production process 25,3%, usage and marketing 7,9%, raw material 6,0%, and standards and testing 2,5%. The share of marketing is notably low.[137] The most important areas of R&D in sawmill industry are presented in table 5/1 (descending order of importance) and the most important institutions that made R&D concerning mechanical forest industries in appendix 3.

Other determinants that have affected to the development of factor conditions are mainly *domestic rivalry*, *related and supporting industries*, and *government*. Domestic rivalry had lead to the establishment of research institutions and education lines, which are mostly located by the government. Factor conditions are also affected by the *bargaining power of suppliers*.[138]

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[135] Puun mekaanisen teknologian oppituoli 60 vuotta 1987: 9-14

[136] interview: Petri Wager, Enso Gutzeit Oy

[137] Tarvainen 1989: 3-11, 37

[138] interview: Petri Wager, Enso-Gutzeit Oy

FIGURE 3/1 The Most Important Areas of R&D in Sawmill Industry[139]

Raw material	quality classification, optimized cutting, automatic sorting, interdependence of log quality and sawnwood quality
Drying	drying machinery, general information guide
Machinery	measurement, guiding and feed systems, saw blade technology
Sorting	automatic sorting of sawnwood
Products	precut and preformed sawnwood, customer-based sawnwood production
Markets	quality demands and standards for sawnwood and refined sawnwood in export markets

3.2. Demand Conditions

Today, the home market demand usually does not give earlier picture of demand development in export countries in sawmill industry. Finnish buyers are not *sophisticated or demanding*, but usually buy sawnwood to construction purposes. There exist only few *segments*, the demand of which can be considered sophisticated. For example, joinery industries and furniture industry demand sawnwood which moisture is 8-12% and which needs special drying. Drying kilns have became very common in sawmills, but in the first place because of export deliveries. The moisture of exported sawnwood is at least around 20% (construction quality), because it then better withstands the effects of weather.

Joinery industries and furniture industry do also demand preformed sawnwood. The price of preformed sawnwood is higher, so this option is worth studying for sawmill owners. It would require investments in specific equipment and aimed strategy. However, the size of this segment is in the domestic market not large enough to develop the whole sawmill industry.

Log house construction is a segment, demand of which is both *sophisticated and demanding*, and also *anticipatory* and precede foreign demand. Log houses are today a fast growing export product. They are exported to Central Europe, Japan, and Scandinavia. The manufacturing of preformed logs in sawmills has already taken a considerable share of sawnwood production, especially in northern Finland. Low quality timber the sawfalling from which consist lower class sawnwood is suitable for log houses. This (and preforming) gives more value to the trunk than if it were sawn. Log house manufacturers also have established foreign sales subsidiaries to numerous countries, because foreign demand is expanding due to e.g. ecological movement. In

[139] Tarvainen 1989: 76-77

1991, the value of loghouse exports totalled to 120 million FIM.[140] Log house manufacturers association has also been established.[141]

Finnish sawmill industry is dependent on export demand. Investments are made to improve the international competitiveness of sawmill industry. In export markets, single segments such as joinery industries or furniture industry are large enough to give a base for tailored sawnwood products. Their demand shapes sawmill industry's structure as some companies decide to specialize to the needs of these sectors.

The export data provided in 2.3.5. shows that the core of the competitive advantage of Finnish sawmill industry lies in pine sawnwood. The major buyer countries of pine sawnwood account higher share of export value compared to the share of export volume. Therefore special attention must be paid to tailored products of pine sawnwood.

Export demand of spruce sawnwood has lately been less sophisticated, as noted before in 2.3.5. Many foreign buyers want to buy cheaper quality and do the sorting, cutting, and other refining by themselves. This weakens our competitive advantage, because lower quality spruce sawnwood is also available from Austria, Germany, France, Canada, and Russia. The attempts to compete against non-Scandinavian producers in low quality grades of spruce is difficult. The only competitive advantage source that Finnish and other Scandinavian producers posses in this field is the use of chips in chemical forest industries, which underlines the role of integrated sawmills.

Buyers are *independent* and *numerous* both in domestic and in export markets. This should have expanded the pool of market information available to sawmill owners. However, the delivery chain of sawnwood is usually complex. It can include agent in the export country, wholesaler, and retailer in the export country. It is often claimed that the market information does not flow freely in the distribution chain, because the interests of each party differ.[142] This factor does not create competitive advantage, unless wholly controlled by sawmill industry companies themselves. Today, buyers demand smaller quantities and just-on-time deliveries, which calls for improvement in sawnwood deliveries.[143]

Small and open domestic market has caused pressures to export sawnwood, as domestic market has not been sizeable enough and potential profits have been available in the export markets, which has contributed to the development of sawmill industry structure. Sawmills can be divided into two categories: the small ones that sell only to domestic market and the ones that do also export.

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[140] Log houses are classified under the heading Prefabricated wooden residential buildings (9406 0021) in the Official statistics of Finland. This class also includes conventional prefabricated wooden houses. (Official Statistics of Finland, Foreign Trade 1990: part 1, 460)

[141] interview: Juha Kohonen, Honkarakenne Oy; Veli Perälä, Finwood Oy

[142] Metsäteollisuus 3/1986: 37

[143] Lehtomaa 1991: 67-68

Demand conditions is not a central element in the development of competitive advantage of sawmill industry. Nevertheless, market information gathering is more important in the future than it is today, as the possibilities that selective demand offers are realized.[144]

Related and supporting industries have had their effects on the demand conditions. Fast and reliable transportation bolsters foreign demand and brings competitive advantage e.g. against Russia, deliveries of which may indeed be uncertain. The quality of Finnish sawnwood that affects demand is due to the high quality sawmill equipment such as sawmill machinery and drying kilns.

Domestic rivalry and many exporting sawmills have given the buyer the option to change sawnwood supplier, which has also quaranteed high and steady quality of export deliveries. In this sense, rivalry has increased the demand for high-quality products. This is also seen in figure 5 in Appendix 2, where Finnish share of world's coniferous sawnwood export value is higher than volume. In the long run, domestic rivalry has forced sawmills to improve their quality, which has reinforced the competitive advantage.

3.3. Related and Supporting Industries

The benefits from effective *forest management* have only partially fallen to sawmills, but forest management forms the base from which growth of all forest industries can take place. The competitive advantage it creates is sustainable, because it is based on *advanced* or *specialized factors*.

The reason behind high investments in forest machines R&D is the high price of timber in Finland. *Harvesting machines* and *transportation* create competitive advantage.[145] The investments in R&D by the producers in this field has benefitted the whole Finnish forest industry. The proportion of harvesting and forwarding costs is ca. 25% of raw material price. The cost of long-distance transportation is around 15%. In 4.3.2. we stated that the proportion of raw material is around 65% of all production costs. Thus the share of harvesting and forwarding is 16% and the share of long-distance transportation is 10% of all production costs, roughly estimated. The cost decrease of these functions does create competitive advantage to sawmill industry.[146] The use of harvesting machines is increasing.[147]

Domestic manufacturers of sawmill machinery increase the competitive advantage of Finnish sawmill industry through interaction, R&D cooperation, and joined resources of the parties.Pulp and paper industries use by-products from sawmills, and often operate in an integrate. The negative side of this relation is that pulp and paper industries receive the major portion of investments.

As a conclusion, *related and supporting industries* are not a central element of the competitive advantage of Finnish sawmills, because much of the benefit does not fall into sawmill industry.

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[144] Metsäteollisuus 3/1986: 37

[145] Metsätilastollinen Vuosikirja 1990-1991: 172

[146] Tekniikka ja Talous 19.11.1992: 13

[147] Metsätilastollinen Vuosikirja 1990-1991: 169-179

Factor conditions is the most important determinant that has affected related and supporting industries. The number of *domestic rivals* has encouraged related and supporting industries to invest in R&D, though sawmill industry has been as a part of forest cluster in this case. Silvicultural and forest improvement work increased heavily in the 1960's, when seeded and planted areas, seedling stand improvement, and forest fertilization areas expanded rapidly.[148] This improvement in forest management accounted to the development of the total forest cluster. *Government* had an effect on this development through the National Board of Forestry.

3.4. Firm Strategy, Structure, and Rivalry

Company goals concerning their sawmill industry differ. Company size and the importance of sawmill industry to it affect company goals, which then affect investment decisions. One important goal of the biggest forest companies is the maintaining of fibre balance, in which sawmills play an important role because they use large scale timber and pine timber. The *ownership* of Finnish forest firms is usually scattered and the firms have powerful management. Though the goals of managers may differ, it is the management that make strategic decisions. The goals of management and companies have driven our forest industries towards chemical forest industry.

Sawmill industry is because of its history *national prestigious*, which may affect firm decisions. If sawmills are kept running artificially, the overall competitive advantage is decreased because the wealth mills then have to operate in distorted environment.

3.4.1. Industry Structure

Threat of new entrants

The existing sawmills may have an economies of scale advantage that restricts entries. Low capital costs or other cost disadvantages may also form an entry barrier. The existing large mills benefit an integrate position or timber delivery cost advantage. Capital requirements may also be a barrier to entry. If the existing firms were allowed to influence the delivery chain, it would be difficult for an entrant to sell its products. In some cases, *basic factors* such as mill location or control over raw material supply in a certain region or *advanced* and *specialized factors* such as trained personnel may restrict the establishment of new sawmill. These factors are also referred to as *cost disadvantages independent to scale.*[149]

Entries are not a conceivable threat to Finnish sawmill industry in domestic markets, because they are due to the low profitability of the industry restricted by *government* actions. The Working Committee of the Ministry for Trade and Industry stated in 1983 that no investment should be made to increase sawing capacity until the average utilization rate would be over 80%. The Bank of Finland also gave a special announcement in 1983 that foreign loans are not to be used in sawmill investments. The barriers caused by official sector are high.[150]

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[148] Metsätilastollinen Vuosikirja 1990-1991: 83-89

[149] Porter 1980: 11; interview: Petri Wager, Enso-Gutzeit Oy

[150] Sahateollisuustyöryhmän muistio 1983: 27

Product differentiation and switching costs are not a specific barrier to entry, because sawnwood is not a highly refined product. Also sawmill machinery in itself does not demand huge sums of capital compared to e.g. paper mill investment, though investors or banks may consider the expectable return on investment too low in relation to risk and neglect the investment plan. The availability of raw material should usually not prevent entries, as forest ownership is scattered in Finland.

The threat of entrants does not affect the strategies of forest companies to a great extent. New and efficient capacity is not build, which causes the eroding of long-term international competitive advantage and lowers the ability to pay from raw material in the long run. Also the formation rate of specialized resources will decrease if sawmill industry will be considered as industry that cannot be renewed.

Threat of substitute products

Substitute products are a threat to sawmill industry. The increasing use of boards, stone, concrete, brick, steel, glass, plastic, and aluminium in construction, furniture, and joinery industries possess a serious threat not to mention the changes in e.g. construction methods. Sawnwood cannot gain market share by improving its price performance, because price decreases cannot be transferred to raw material price due to the *supplier bargaining power*. Furthermore, as substitutes come from distant industries, they are not in relation to the price development of sawnwood, at least in the short run.

The threat of substitutes affects companies' strategies by forcing them to concentrate on e.g. higher refining, preforming, and cut-to-length sawnwood deliveries. This calls for investment in machinery, which moves industry structure to capital-intensive direction and improves the competitive advantage of Finnish sawmill industry. Higher refining and customer-based deliveries and services are necessary for sawmill industry in Scandinavia, as Central European producers are also improving their refining rate by e.g. investing in drying units. The amount of production that is dried is exceptionally high in Scandinavian countries.[151]

In construction sector the use of steel and glas is increasing. Concrete and brick a also about to take sawnwood market share. However, construction materials use differ in every country. In Scandinavia one-family (detached) houses, row (terraced) houses, and agricultural buildings are ofted made of wood, which is not the case in e.g. many countries in Central Europe. In Scandinavia, there is a tradition of wood houses. Of course official buildings, blocks of flats, etc. are made of another materials. As the matrerial flows in building sites are increasingly effective, the amount of sawnwood used in construction has decreased. The green values and environmental thinking will decrease the popularity of steel and especially aluminium in construction. This is further fortified by e.g. German legislation, which sets new counting methods for the definition of environment-friendly building by investigating the energy, which has been spent in manufacturing the construction materials. Aluminium and steel are highly energy intensive compared to sawnwood and brick. Another case is the definition of the so-called K-value, which measures the insulation capacity of e.g. a building. Also here the use of energy is now one defining measure.

[151] Jaakko Pöyry files

In joinery and furniture industries wood will probably maintain its position, and in segments like flooring, decorating (panels), and moulding the use of wood is perhaps about to increase. Of course furniture industry uses much plastic and steel, which competes directly with wood, but for some purposes wood (in some of its forms) is by far the most wanted material. In this sector, the cooperation with designers would yield beneficial results. What comes to a medium- or small sized sawmill company, cooperation with a major furniture manufacturer might create good performance. A Swedish furniture company IKEA purchases much sawnwood and other prefabricated wood products from Finnish manufacturers. Subcontraction provides many opportunities in this field of business.

Bargaining power of buyers

The buyers possess *bargaining power* because sawnwood is, to some end users, an undifferentiated product. This means that buyers face low switching costs, as the seller of sawnwood may be selected quite freely. In many cases, sawnwood is used as a material to produce something and the quality of it is not in itself important, as may be the case with construction industry. Buyers often have full information about supply and demand of sawnwood and are specialized in sawnwood trade. These facts do apply both in domestic and international markets.[152]

Buyers do *not* possess a threat of upstream integration and their behaviour can be affected. Obviously, by raising the switching costs of buyer a sawmill can benefit from higher margins. This could be done by improving control over the delivery chain by cooperating with both the middlemen and the industrial end user. A sort of production process can be build, in which the role of the sawmill industry company is to provide exactly what the end user needs. If the preformed and pre-cut sawnwood can be precisely matched to end-users production, the switching costs rise remarkably. Customer-based production design or *differentiation* already affects strategies of sawmill companies in Finland.[153]

The bargaining power of buyers forces Finnish sawmills to cut costs and improve performance in order to be able to sell at the world market price in the long run, which affects the industry structure and company strategies. Performance can be improved by increasing productivity or by customer-oriented strategies. In the long run, high bargaining power of buyers forces firms to take care of their competitiveness, which increases the competitive advantage of nation.

Bargaining power of suppliers

The only supplier group that possess considerable power to sawmill industry are the suppliers of raw material. Raw material cannot be substituted in the production or stored for long periods. Due to the high long distance transportation costs only small part of the Finnish sawmills can benefit raw material imported from Russia. There has also been difficulties and price disagreements in timber imports.[154]

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[152] Porter 1980: 24-26

[153] interview: Petri Wager, Enso-Gutzeit Oy

[154] interview: Kari Anttilainen, United Sawmills Ltd

Forest ownership is fragmented, as private persons own 64%, companies 28%, and state and municipalities 8% of Finland's forests. Private ownership is smaller in the main competitor countries.[155] The reason behind this fragmentation is *government* action. In the late 19th century, forest companies bought forest from farmers. In 1915 a law was introduced, which prevented direct forest land trade. Due to the use of middlemen in forest companies' land deals, a new and stricter law was issued in 1925.[156]

Forest owners possess bargaining power because they are concentrated. An organization named Central Union of Agricultural Producers (Maataloustuottajain Keskusliitto MTK) represents farmers and forest owners and uses a conceivable negotiating power. Supplier group has also integrated forward and established a company named Metsäliitto-Yhtymä in 1934.[157] Due to the supplier power the stumpage price of timber has been higher in Finland than it is in the most important competitor countries. One reason for this were price agreements, in which the price of pulpwood was the primary negotiating target of forest industries. The price development of coniferous saw log is presented in figure 3/5.

FIGURE 3/5 Development of Coniferous Saw Log Stumpage Price 1960-1990[158]

The high timber price is a *selective factor disadvantage*, because it has contributed to investments in R&D and machinery improvement. High raw material cost forces sawmill companies to improve cost and raw material efficiency and profitability by investments in machinery, which have in affected the strategies of machinery producers to invest more in R&D. High timber price has also had its effects to the development of forest management and forest machines industry. Raw material cost disadvantage contributes effectively to the development of competitive advantage. International comparison is difficult e.g. because forest ownership and

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[155] The Finnish Forest Industries; Facts and Figures 1992: 5

[156] Lilja et al. 1991: 11-12

[157] Zettenberg 1984: 42-43

[158] Metsätilastollinen Vuosikirja 1990-1991: 143, 148

sawmill industry structure are different, raw material share of production costs is not alike, and strong integration benefits may not exist in all the competitor countries, not to mention the value of forest land and the expected yield to it.

Sawmill companies must take the bargaining power of suppliers in strategy formulation. The price and reliable availability of raw material are important variables of sawmill productivity. Industry structure is also affected by them in means of sawmill location.

In recent years, the growth of forest volume has clearly exceeded the volume of fellings in Finland. Reasons for this are e.g. effective forest management and increased timber imports. This situation will remain at least 10-20 years, which will lower the supplier power. This causes pressures to timber price cuts.[159]

Timber and pulpwood imports have provided forest companies on option to decrease the supplier power. Imports of roundwood have increased from 7,4% to 12,7% from 1980 to 1991 of the total volume of commercial roundwood fellings in Finland plus imports of roundwood.[160] Central Union of Agricultural Producers has lost its negotiating power. The price decrease improves sawmill industry's performance and hence also improves the short-term competitive advantage of sawmill industry. If higher profitability caused increasing investments, the long-term competitive advantage of sawmill industry would probably improve.

Rivalry

Rivalry in sawmill industry is tough both in domestic and export markets. Competitors are numerous and equally balanced, which causes instability and fluctuations of supply because some firms may believe that they can make moves without being noticed. Slow sawmill industry growth increases competition.[161]

High exit barriers are perhaps the most important single reason for heavy rivalry in sawmill industry, because the excess capacity does not leave the industry but prefers to operate at a loss. The reasons for high exit barriers in sawmill industry are highly specialized assets i.e. sawmill machinery, strategic interrelationships i.e. forest company integrates or relationship is raw material deliveries, fixed costs of exit, and emotional barriers. One reason behind the low profitability of sawmill industry is clearly high exit barriers.[162]

Central European sawmill industry investments are today made to increase sawmill capacity and refining rate. Scandinavian sawmill companies must emphasis their strengths both by investment and marketing strategies. Industry structure is affected both by rivalry itself and the strategies that rivalry makes companies to choose. Rivalry improves the long-term competitive advantage, because it forces companies to seek the source of their competitive advantage and concentrate on it.

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[159] Metsä 2000 - Tarkistustoimikunnan mietintö 1992: 51-66

[160] Metsätilastollinen Vuosikirja 1990-1991: 131

[161] Porter 1980: 18-19

[162] Porter 1980: 20-21; Puumies 2/1991: 13

The long-distance transportation of sawnwood increases costs sharply. A Canadian producer of sawnwood must be able to decrease other costs in order to sell sawnwood at market price in Europe and make exporting profitable. Due to the lower cost of timber Canada holds a substantial share of European import markets of coniferous sawnwood.[163]

As a conclusion, *industry structure* is a crucial element shaping company strategies and the competitive advantage of Finnish sawmill industry. Industry structure affects the division of work between nations.

3.4.2. Positioning

Finnish sawmill industry produces high-quality coniferous sawnwood to international markets. Finnish sawnwood is, from wood quality's point of view, *differentiated* or *focused differentiated*. This may not hold at business level, because company strategies vary considerably. Finnish sawmills have good possibilities for *focused differentiation* strategy, because of the high raw material quality and modern machinery compared to many competitor countries.

The major part of Finnish sawnwood is produced in large sawmills, which means that sawmill companies seek for cost advantages from large-scale production. The products of large sawmills are usually sold to broad segments. *Cost leadership* strategy in Finnish sawmill industry does not defend a firm against powerful buyers and suppliers, or the threat of substitutes in international markets.[164] In domestic markets, cost leadership strategy is obvious. United Sawmills Oy seem to run cost leadership strategy in domestic market, but in export markets it also sells to selected targets at low cost, which means *cost focus* strategy.[165]

3.4.3. Industry Evolution

Many characteristics that Porter connects to a mature industry match Finnish sawmill industry. Examples of this are that sawnwood dimensions are standardized, products do not change rapidly, sawmills emphasize production costs, the demand for sawnwood is cyclical, etc.[166]

It seems that many sawmill owners do not realize this long-term trend and no attempts are taken to improve current situation, which then causes eroding of competitive advantage. Life cycle could be prolonged, if new *innovations* were searched effectively. Here innovation may as well mean the way in which things are done. It could be sourced from raw material, production, markets, new thinking etc.

Sawmill industry development was after 1950's less important than the development of chemical forest industry. In the middle of 1980's the eroding competitive advantage was generally noticed and after that measures such as strategic development of sawmill industry have been taken.[167]

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[163] compiled from FAO Yearbook of Forest Products 1990

[164] Porter 1980: 35-36

[165] interview: Kari Anttilainen, United Sawmills Ltd

[166] Porter 1980: 159-161

[167] see eg. Metsäteollisuus 7/1985: 6-8; Metsäteollisuus 3/1986: 36-37; Sahiluoma 1988: 25-32

Much of the competitive advantage once existed was lost and strategic development of the whole industry started from totally different point. Sawmill industry still contributes to a substantial share of Finnish net currency earnings, and the value could be increased in short period of time with modest investments. Actions to improve competitive advantage of sawmill industry must be taken in this decade.

3.4.4. Investment Strategies

Investment decisions affect much industry evolution, as was the case of sawmill industry after 1950's. In that time and afterwards, the investment strategy that considered sawmill industry was *protect current position*, *selectively manage for earnings*, or even *harvest* or *divest*. These investment strategies are by no means enough to sustain and develop the competitive advantage.

The investment strategies that firms pursue are *invest to build gradually*, *build selectively*, or at least *protect current position*. Investments should match the sources of competitive advantage, which means higher refining rate by e.g. investments in drying kilns, precutting machinery, planing, distribution, or market development. This would more clearly mean differentiated, customer-based products, which would clearly improve both the short- and long-term competitive advantage of Finnish sawmill industry.

Twiss claims that a mature industry should emphasize R&D investments to process development.[168] In case of sawmill industry R&D investment should also be guided to the market improvements such as the EDIFACT-system, which is handled more below.

Investment strategies shape the industry structure and affect the competitive advantage. *Factor conditions* are affected, if e.g. the demand/supply balance of needed inputs is changed, *demand conditions* if investments improve customer-orientation, *bargaining power of buyers* if customer-orientation raises switching costs, and *rivalry* if many firms at the same time pursue customer-orientation strategies through investments. Thus if investments are targeted successfully, they may enhance the competitive advantage considerably.

3.4.5. Innovation

The major reason for innovations in Finnish sawmill industry has been the high price of raw material i.e. *selective factor disadvantage*. Innovations may take place in raw material use, production process, product, market, or service. In Finnish sawmill industry innovations are usually aimed to improve the production process and the utilization rate of timber as well as the product quality.[169] In this sense, *sophisticated demand* have had its effects especially in the past, increased drying and further processing are examples of that.

Innovation Sources in Related and Supporting Industries and Factor Conditions

Related and supporting industries from which innovations may come are sawmill machinery and forest management. Raw material cutting could provide substantial possibilities for improvement of the competitive advantage of Finnish sawmill industry. With modern forest machines each tree

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[168] Twiss 1980: 61-62

[169] see e.g. Tarvainen 1989

could be sorted and cut to match the requirements set by the end product. The volume of waste timber would be reduced.[170]

The highest quality pine sawnwood comes from butt log (or to be more precise, from the outer layers of butt log) which has virtually no branches and from the crown log that has big but healthy branches. The sawfalling from middle part of the trunk, which has dead, black branches, consists only of lower sawnwood quality classes the prices of which are also lower. Pine sawnwood with no or only a few small healthy branches belongs to the class u/s and with big but healthy branches it is classified to the class V.[171] Forest management methods (e.g. pruning) and cutting that exactly matches different parts of the trunk would provide competitive advantage.

Timber is bought as stands and the volume usually decides its price, and only to some extent the quality. If the quality of logs could be estimated at the millsite (in purchasing deals) and the value weights for each part of the trunk were given, quality cutting would became general. The weights of different parts of the trunk could be e.g. butt 120, crown 100, and middle part 70. Thus the market value of sawnwood from each part would match the timber value of it. Value-based timber pricing experiments are made in Finland.[172]

Customer-based cutting would maximize the quality and volume of sawnwood available from a trunk and minimize the volume of by-products. Performance would improve, as the pricing of sawfalling i.e. sawnwood from the trunk and the price of the trunk itself would be market-based. Also the value of by-products per m^3 is much lower than the value of sawnwood per m^3. To produce 1 m^3 of sawnwood 2,2m^3 of timber is needed today.[173] By-products count for 1,2m^3 of the timber volume (more precisely chips 0,7m^3, sawdust 0,3m^3, and bark 0,2 m^3).[174]

The establishment of sawmill *network* has required deep time dimension. This network forms a *pool of resources* that benefits the whole industry and improves the competitive advantage. Investments to network development should be continuous in order to improve current level of knowledge. The pool of resources eroded after 1950's when chemical forest industries received attention. However, the life-time of *know-how* in slow-growth industry is long and much of it was not lost. The increasing role of forest management in Finnish economy after 1960's has partly supported the existence of the pool of resources suitable for sawmill industry's purposes.

As the knowledge base or *basic research* of sawmill industry is solid the role of *applied research* that specialized institutions represent is crucial in development of the long-term competitive advantage.[175]

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[170] interview: Ossi Kokkonen, Metsä-Serla Oy

[171] Sahatavaraopas

[172] interview: Ossi Kokkonen, Metsä-Serla Oy; Ismo Leppäniemi, Oy Botnia Wood Ab

[173] Bark is included to timber volume in Finland.

[174] Teollisuuden Metsäviesti 3/1991: 11

[175] Rogers 1983: 135-149

Investments in network development or the development of the pool of advanced and specialized factors such as highly educated people increase the competitive advantage. Sawmill industry should pay attention to improve its image in order to temp talented people to specialize in it.

The *diffusion of innovation* takes place through sawmill industry network. As information of innovations is available through e.g. personal contacts or joint R&D, the innovation diffusion process is more rapid. There exists no major obstacles for innovation diffusion in Finnish sawmill industry.[176]

Innovation Sources in Demand Conditions

Innovation may occur as new buyer needs are identified. Innovations may take place e.g. in product, product use, delivery chain, or in the way that business is done. Demand for precut sawnwood is a market innovation in product and product use that also affects the production units. An example of this are furnitures which the buyer itself must complete from the part delivery. Sawmill companies respond to *sophisticated demand* for preformed sawnwood by improving refining rate, which improves the competitive advantage.

Control over the delivery chain is even more important in the future than it is today e.g. because importers of sawnwood integrate to downstream industries. Control could be achieved by cooperation and by increasing switching costs of the agent or importer and the end user. Vertical integration of sawmill to importer is hardly possible, because few agents are not enough to deliver the whole production and the remaining independent agents may refuse to buy sawnwood from the integrated sawmill company. Swedish sawmill owners tried downstream integration in the 1980's with weak results.[177] Own sales subsidiaries or joint sales organizations are innovations that come from sawmill industry.

The ongoing market innovation is Electronic Data Interchange For Administration, Commerce, and Transport, also known as EDIFACT or more shortly EDI. EDIFACT is widely used in many industries and it is spreading to forest industries. The purpose of EDIFACT is to improve trading routines by electronic data interchange between the buyer and the seller. The sawmills using EDI gain competitive advantage due to the fast and reliable delivery information, higher switching costs, and more time for service functions. This system falls under European standard ISO 9735. In Scandinavia, the EDI system is being developed by *network* of sawmill companies, consisting also Swedish sawmill firms.[178]

Effects to the industry structure and firm strategy

Industry structure is shaped by innovations. The innovation diffusion in Finnish sawmill industry is a function of the available benefit from the innovation in relation to the invested amount. If the innovation improves profitability it will spread fast. Innovations that improve the *differentiated* position of Finnish sawmill industry will guide strategies to more customer-oriented direction in sense that the end users of high-quality sawnwood also often need customer-based solutions or dimensions. Innovations guide Finnish sawmill industry towards the core of

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[176] interview: Petri Wager, Enso-Gutzeit Oy; Kari Anttilainen, United Sawmills Ltd

[177] interview: Kari Anttilainen, United Sawmills Ltd

[178] Paperi ja Puu 6/1992: 467-468

competitive advantage, which is high quality pine sawnwood made by raw material that is scarce in Central Europe.

Foreign innovations do not weaken the position of Finnish sawmill industry, because the biggest domestic machinery suppliers operate internationally and sawmill machinery is available from foreign suppliers. For example, A. Ahlström Sahakoneet Oy manufacturers equipment also under the license from the Canadian company CAE Machinery Ltd.[179] Foreign innovations will diffuse rapidly to Finnish sawmill industry through *related or supporting industries*.

3.5. The Role of Government and Change Events

Government affects competitive advantage positively and negatively. Also foreign governments may affect the variables of the diamond model of Finnish sawmill industry by e.g. setting standards. The harmonization of standards concerning sawnwood and timber structures proceeds within the EC and EFTA countries due to the European integration process. Standards CEN TC 175 Sawn Timber and Saw Logs and CEN TC 124 Timber Structures are the most important for Finnish sawmill industry. As an evidence of competitive advantage, the Scandinavian norms of both visual and mechanical strength sorting methods and classification will be included to CEN TC 124. Measurement tolerances will also be defined in the sawnwood and planned sawnwood moisture of 20%.[180] The competitive advantage of Scandinavian sawmill industries will strengthen due to these standards.

Government is involved in R&D function through many institutions. Specialized research is done e.g. in The Laboratory of Mechanical Wood Technology in Helsinki University of Technology, which works in close cooperation with Forest Products Laboratory of Technical Research Centre of Finland (VTT). The University of Helsinki carries a strong reputation in Forest Department R&D work. State is a shareholder of Suomen Puututkimus Oy.[181]

Government deals with the Technology Program for Mechanical Forest Industries, which is a research run by Technology Research Centre (TEKES) and Central Association of Finnish Forest Industries. The project with budget of 115 million FIM will be carried out in 1992-1996. Main goals for the program are to create new alternatives to traditional ways of doing things, to apply the know-how from other industries, to develop the contact network between producers and machinery suppliers, to create new products and production methods, and to develop the R&D culture of the industries. One aim is to raise the share of sawnwood in net currency income of the country from the present 10% level up to 14%. This program will clearly improve the competitive advantage of sawmill industry as well as other mechanical forest industries.[182]

The negative role of government comes up in the form of laws, tax policy, exchange rate policy, and investment restrictions. All of these cause heavy impacts to the environment in which sawmill industry operates.

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[179] A. Ahlström Sahakoneet Oy, brochures

[180] Metsäteollisuus tiedottaa 5/92: 6

[181] Tarvainen 1989: 40-55; 71-72

[182] Paperi ja Puu 6/1992: 469-471; Puumies 9/1991: 2-4

Government restricted forest companies' purchases of private forests by laws that were imposed in 1915 and 1925.[183] Investment restrictions concerning sawmill industry were given in 1983 by the Ministry of Trade and Industry.[184] Forest taxation changes in 1993, the new taxation is based on the sales income from actual wood sales value instead of the annual net increment of forest volume.[185] This has given a strong incentive to forest owners to sell wood in 1992. Sales may decrease in 1993 due to the new tax.

Exchange rate policy is one essential determinant of short-term competitive advantage. One of the main reasons for difficulties and low performance of Finnish sawmill industry in the 1980's lie in exchange rate policy. When Swedish Crown was devaluated by 10% in 1981 followed by a devaluation of 16% in 1982, Swedish sawmills gained short-term competitive advantage. Finnish sawmill industry became a marginal supplier in its traditional market areas in Central Europe.[186] The devaluation of Swedish Crown was especially hard because much of the sawnwood trade is in this currency.[187]

The development of exchange rates in the long run shows the shifting of competitive advantage. The figure 3/6 shows the steady rise of DEM, which has created competitive advantage. The decrease of SEK and the fall GBP are visible. The development of SEK and FRF follows almost the same pattern. The competitive advantage of Finnish sawmill industry in Great Britain has decreased. Sophisticated exchange rate analysis demand e.g. cross-rate or purchasing power parity analysis, which are by no means the subject of this study. The presented figures emphasize the role of government in the development of long-term competitive advantage caused by exchange rate fluctuations.[188] The devaluation of FIM in November 1991 and the ongoing floating of it have already strengthened the position of sawmill industry, but because of the bargaining power of buyers price cuts have taken place.

The European integration process does not have significant direct effects to Finnish sawmill industry, because all Finnish forest industries already operate in European markets. In addition to the harmonized standards, the European sawmill industry as a whole will benefit if sawnwood imports from non-EC countries like Canada and Russia are restricted.

At the moment it seems that government actions are improving the competitive advantage of sawmill industry. Devaluation in itself does *not* improve the factors that create competitive advantage, because it lowers concentration to the core factors that do create sustainable competitive advantage and it also feeds ineffectiveness. The current technology program improves competitive advantage remarkably, e.g. because it develops specialized and advanced resources and the network between sawmill owners and related and supporting industries.

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[183] Lilja et al. 1991: 11-12

[184] Sahteollisuustyöryhmän muistio 1983

[185] Jaakko Pöyry files

[186] Sahiluoma 1988: 25

[187] interview: Kari Anttilainen, United Sawmills Ltd

[188] ETLA files

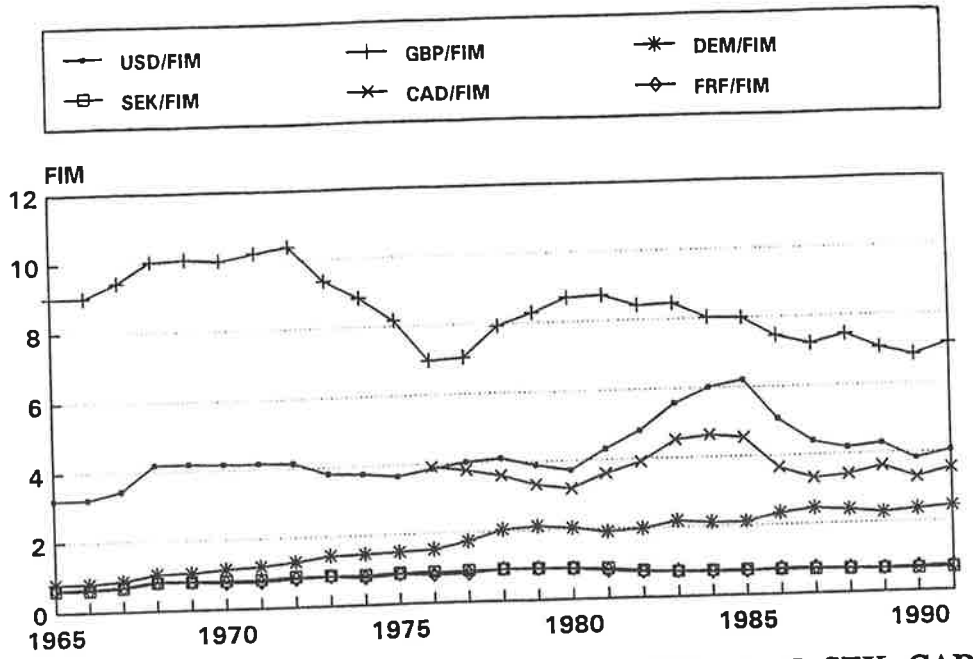

Figure 3/6 Annual Average Exchange Rate of USD, GBP, DEM, SEK, CAD, and FRF to FIM 1965-1991[189]

Change events that have affected Finnish sawmill industry several times have been both domestic and international. Change has come from sources like technological discontinuity, wars, oil crisis etc. Fluctuations in the demand for sawnwood caused by international changes immediate affects the Finnish sawmill industry. The change forces during the last one hundred years are clearly visible in the figure 2/4 in page 42.

The effects of change events have been mostly negative to our sawmill industry, e.g. the loss of sawmill capacity after II World War. Change events have also affected other determinants of the competitive advantage. Forest area was lost in II World War, which had its effects on *factor conditions* and also affected *industry structure* and *rivalry*. *Demand conditions* are affected by every major international conflict, but the direction may be positive or negative. The environmental movement will benefit sawmill industry. *Related and supporting industries* have not suffered from change events as hard sawmill industry itself.

[189] ETLA files

4. Case Companies

Although all of the case companies are large sawmill companies, have large chemical forest industry, and operate internationally their ownership structure is very different. The main owner of Enso-Gutzeit Oy is the state of Finland. Metsä-Serla Oy is owned by Metsäliitto-Yhtymä, which in its turn is owned by private forest owners. United Sawmill Oy belongs to United Paper Mills Oy, which is a business unit of Repola Oy, the biggest privately owned corporation in Finland (ownership is concentrated to the banking sector). These companies have clearly different historical development.[190]

4.1. Enso-Gutzeit Oy

The section 4.1. is based on the interview with Petri Wager, the general manager of Enso-Gutzeit sawmill division. The other sources are mentioned in the text.

4.1.1. Description of the Company History

In 1872, the Norway Sawmill was established in Kotka by a Norwegian W. Gutzeit. Company name was W. Gutzeit & Co., but was changed to limited partnership company in 1875. Steam-powered sawmills spread that time in Finland and this sawmill was among the first ones. Large river floats started at the river Kymi. Company named Tornator Oy was established in 1887 and Enso Puuhiomo Oy in 1889. These two became later one parts to W. Gutzeit & Co.[191] Company was changed to limited company in 1897.[192]

In the following decades, the company acquired sawmills, forest areas, and rapids. A sulphate pulp mill started its production in Kotka in 1907. This pulp mill was integrated to the existing Norway Sawmill. The most notably purchases were Ab Utra Wood Co in 1902, Pankakoski sawmill in 1909, and Enso Puuhiomo Oy in 1911. The latter included large water power capacity in the form of unharnessed rapids.[193]

In 1919, the ownership structure of the company changed as the government became the major shareholder. After the World War I the sawmill industry of Finland was in crisis, and Gutzeit returned to Norway. Company name was changed to Enso-Gutzeit Oy. The former part Enso refers to the area of Enso which in Russian is Svetogorsk and which was lost in the reparations to Russia in 1940 and officially in 1944, and the latter part Gutzeit to the founder of the company.[194]

In the decades before the World War II, Enso-Gutzeit Oy expanded rapidly to pulp industries. The company acquired also sawmills and other mechanical forest industry firms. The majority

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[190] Enso-Gutzeit, Annual Report 1991; Metsä-Serla, Annual Report 1991; United Paper Mills Ltd, Annual Report 1991

[191] Hoving 1961: 53, 85, 140, 285

[192] Hoving 1961: 120

[193] Hoving 1961: 131-132, 140

[194] Hoving 1961: 81, 529

of shares in Tornator Oy was acquired in 1931-1932. Tornator Oy was a sizeable forest company at that time. Also companies such as The Insulite Co. of Finland, Utra Wood Co., and Aunuksen Puuhioke Oy were purchased at this period.[195]

After the World War II, Enso-Gutzeit Oy has continued its diversifying and strengthened its position in board, packaging and pulp industries, as well as in sawmill industry and other mechanical forest industries. The most important areas today are chemical forest industries.

From 1950's the most important persons in the company have been Aku Nesman, who developed sawmill industry in 1950's, Pentti Halle in 1960's, and Pentti Larvio and Jaakko Paronen. Pentti Salmi was the managing director and the chairman of the Board of Directors until he retired recently. The operating strategies in Canada and in Soviet Union are formed by him. Director Jouko Taukojärvi has formed the present structure of company's sawmill industry.

The firm owned the following sawmills in 1991 (the annual production capacity in brackets): Honkalahti sawmill (320 000 m^3), Kitee sawmill (250 000 m^3), Varkaus sawmill (210 000 m^3), Kotka sawmill (115 000 m^3), and Nurmes sawmill (60 000m^3).[196] The total production capacity was 955 000 m^3 in 1991. Sawmill industry contributed 7,8% to company turnover in 1991. In addition, the company holds 40% of shares of Tavastimber Oy. Concentration to chemical forest industries after the World War II has proved itself successful and the firm today is one of the oldest forest companies in Finland.

4.1.2. Company Strategy

The core of strategy for sawmill industry is to base products to customer needs. The main end users in export markets are furniture industry, joinery industries (especially decorative), and construction industry. The product range of each sawmill is narrow, and products from each mill are combined to form the assortment. Foreign producers can also be used as suppliers.

Delivery is carried out through one domestic and two foreign distribution chains that are fully owned, three chains in which the company is a shareholder, and through agents and importers. Control over distribution is improved through cooperation and customer-based products. One essential part of overall strategy is the concentration of sawmills in eastern part of Finland, where company's forests are located. Most of the sawmills are integrated.

Investment strategies are aimed to support the overall strategies. Investments were guided to improvement of production in 1980-1986 and thereafter to improve the characters in products that affect sales, such as drying, smooth surface, cutting etc. Cost efficiency was improved remarkably from 1986 to 1992. Today investments are also guided to market development. The investment strategy is thus *build selectively*, i.e. strategically important improvements are made in addition to the maintenance investments.

The aimed level of investments in R&D is 0,5% of the annual turnover of sawmill sector, which is clearly above the average value of the industry. R&D is concentrated on product and technology development and market research and it is done mostly in cooperation with other firms or institutions. An example of R&D is the EDIFACT system that will be taken in use

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[195] Hoving 1961: 449-452

[196] The Finnish Timber and Paper Directory 1990-1991: 58-60

during the 1993. Company also has R&D director for sawnwood. In addition, each sawmill has its own quality manager. The company is a shareholder of Suomen Puututkimus Oy.

4.1.3. Company-Specific Factors

Factor Conditions

Forest ownership has always been a central element of company strategy. Resources are guided to develop wood deliveries and cutting to the direction of value chain thinking, which means the end product is taken into account when cutting takes place. Product development is based on customer needs and the company possess strength especially in pine sawnwood, which counts for 55% of produced sawnwood. Pine also accounts for 55% and spruce for 45% of company's forests. The company develops ISO 9002 quality standard.

Demand Conditions

The main export market areas are the United Kingdom, Denmark, North-Italy, and Sweden especially for pine sawnwood and France for spruce sawnwood. The company operates mainly in segments in which the demand is *sophisticated*. Also the EC-standards, laws, and directives and the green movement affect company's products. The company owns a joint sales company with United Sawmills Oy, which sales sawnwood to non-European markets.

Related and Supporting Industries

The firm works in close cooperation with major suppliers of sawmill machinery. Enso-Gutzeit Oy had its own engineering industry until 1987 when it was sold to A. Ahlström Oy.[197]

Role of Government

The majority of the firm is owned by the state. This causes obligations to maintain good social reputation and contacts. The ownership structure has sometimes caused restrictions in capital availability, because stock issues to raise capital funding from the markets have not always been possible due the state ownership. The optional capital source is then loan capital, which is more expensive and weakens the company's financial position in the balance sheet. On the other hand, the interest rates of taken private loans have been lower compared to competitors, because state ownership lowers investors' risk.

4.1.4. Analysis

The company strategy *strengthens* the competitive advantage of Finnish sawmill industry. Enso-Gutzeit Oy follows *focused differentiation* strategy in its sawmill industry.

Factor Conditions

The company develops *factor conditions* by developing customer-based cutting methods and raw material usage rate in production. International sourcing for lower quality sawnwood gives an opportunity to concentrate to the core know-how of pine sawnwood. The availability of high

[197] Enso-Gutzeit Oy, Vuosikertomus 1987

quality timber may cause restrictions to the strategy, as was the case in 1987 and 1988.[198] The investments to specialized factor improvements are above the average in sawmill industry's field, but the amount may still be too low to develop the pool of these resources.

Demand Conditions

Demand conditions are affected by niche strategy on sophisticated buyer segments. Switching costs are higher when demand is sophisticated and products are customer-based. The strategy will increase segmentation of demand, which increases the competitive advantage in areas of core know-how. Negative side is that company also increases its own switching costs and binds itself to certain segments. It accepts the risk of changing customer needs and negative economical fluctuations that affect the demand for the end products.

Related and Supporting Industries

The concentration to demanding products calls for high quality equipment, which gives an incentive to *related and supporting industries* to improve their performance. Machinery development is done in cooperation with the supplier industries.

Industry Structure and Rivalry

Industry structure changes when the company integrates to downstream delivery chain by increasing switching costs of the buyers. Also international sourcing from Canada has its effects to which products are produced in which country. *Rivalry* is affected when the competitor companies have to reformulate their strategies in order to match the market changes.

As a conclusion, the strategy that Enso-Gutzeit Oy pursues in its sawmill industry is based on modern thinking in which the position of sawmill industry on its life cycle is recognized and new growth is sought from specialization into market needs. The current position is the result of the long work started at the early 1980's. This strategy is ahead of the competitor's strategies in sense that it may prolong the life cycle of sawmill industry. It improves the competitive advantage of Finnish sawmill industry.

4.2. Metsä-Serla Oy

The section 4.2. is based on the interview with Ossi Kokkonen, the managing director of Metsä-Serla sawmill and pulp industries. He is also a member in the Management Board of Directors of the company. The other sources are mentioned in the text.

4.2.1. Description of the Company History

The roots of Metsä-Serla Oy trace back to 1899, when Pellervo-Seura was established. Metsänomistajain Metsäkeskus was established in 1920. Metsäliitto Oy was established in 1934

[198] Enso Gutzeit Oy, Vuosikertomus 1987 and 1988

to continue roundwood exports of Central Union of Agricultural Producers.[199] In 1947, Metsäliitto Oy and Metsänomistajain Metsäkeskus were combined to Osuuskunta Metsäliitto.[200]

Osuuskunta Metsäliitto has established or bought e.g. the following sawmills after 1947 (year in brackets): K.E. Blomberg Ab (included e.g. Tiirikainen and Pyhe sawmills) and Vääksy sawmills (1949), Lehtiniemi and Valkeakoski sawmills (1950), Ylä-Savo sawmill (1960), Teollisuusosuuskunta Metsä-Saimaa was established to build sawmill capacity (1961, sawmill started 1963), Paimio sawmill (1971), joint company Oy Metsä-Skogby Ab sawmill (1975), Isojoki sawmill (1976), joint company Metsä-Koski Oy (1977), and Ukkola sawmill (1978).[201] In addition, Kyrö, Pohja, Riihivuori, and Vilppula were bought by the company.

No later than 1953 the company started to diversify to chemical forest industries when Metsäliiton Selluloosa Oy was set up and Äänekoski pulp mill was bought. The majority of Savon Sellu Oy was acquired in 1965 and Oy Metsä-Botnia Ab was established in 1973. At the same time, the sales company Finnforests Ltd was established in United Kingdom. The Metsäliitto Group and domestic delivery chain were re-organized in 1974. Finnforest GmbH was founded in Germany in 1976. Oy Metsä-Botnia Ab's pulp mill started in Kaskinen in 1977. Metsäliitto has became a large-scale industrial company.[202]

The reason behind the expansion of Osuuskunta Metsäliitto lies in its ownership structure. Because private forest owners own the company, the main purpose of it is to promote wood sales. This caused the need to build own capacity when the revenue generated from wood exports and sales to other domestic forest companies provided lower income prospects than own industrial refining. This was recognized in the late 1960's.[203]

In 1980's and thereafter the company has continued its integration to higher refining industries and established a strong position in paper industry. The weak profitability and restructuring of sawmill industry to suit the needs of integrated functions caused divestments in that sector, the latest of which is Riihivuori sawmill in 1991. Metsä-Serla Oy was established in 1986 to continue the work of Metsäliiton Teollisuus Oy. From the beginning of this year, Metsä-Serla Oy is re-organized to eight divisions. Sawmill and pulp industry form one division the turnover of which contributes 18% to the company turnover, sawmill industry alone 6,3%. The share of sawmill industry was 13,6% ten years before. The position of sawmill industry is stronger in the new organization. The most important persons that have affected company's sawmill industry development in the postwar period are directors Veikko Vainio and Mikko Vouti.

Today the company owns four sawmills: Kyrö, Metsä-Saimaa, Ukkola, and Vilppula sawmills. The location of sawmills dictates the sawn tree species. Metsä-Saimaa and Ukkola sawmills located in eastern Finland produce in practice only pine sawnwood whereas Vilppula sawmill, which is located in western Finland, produce mainly spruce sawnwood. In Kyrö sawmill, the

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[199] Zettenberg 1984: 17-43

[200] Zettenberg 1984: 88-91; Metsäliitto Annual Report 1982: 48

[201] Zettenberg 1984: 117-271; Metsäliitto Annual Report 1982: 48

[202] Zettenberg 1984: 124-331

[203] Zettenberg 1984: 158-162

production is equally divided to spruce and pine sawnwood. The annual production capacity of these sawmills is 620 000 m^3. The company is also a major shareholder in Oy Botnia Wood Ab, the sawmill capacity of which is 330 000 m^3.[204]

4.2.2. Company Strategy

Company strategy is to match sawnwood production to the market demand. Control over the whole production chain from stumpage to the needs of the end-user is essential. Market demand gives base to customer orientation, delivery organization, and increased direct sales to the industrial end users. Development of cutting methods and raw material resource guidance are methods to achieve this goal. Metsä-Serla Oy already practices value-based cutting described above. Synergies from integrates are important, as sawmill and pulp industries form one business division.

Re-organization of company structure is behind this approach. The production was earlier concentrating on bulky sawnwood. The most notably changes are restructuring of markets, change in cutting methods, emphasis on measurement accuracy, and value-based raw material pricing.

Investment strategies support customer-orientation. Sawnwood quality is improved by investments in e.g. drying units, packaging, and storage. After this quality building phase investments can be more wholly guided to market development. The investment strategy is *build selectively* or *protect current position*.

The company uses existing technology. Own R&D function has actively participated to the development of cutting methods and raw material resource guidance. All the sawmills are installing ISO 9000 quality standard. The company is a shareholder of Suomen Puututkimus Oy.

4.2.3. Company-Specific Factors

Factor Conditions

The ownership structure of the company is a source of competitive advantage, because it enables reliable on time raw material deliveries. The amount of raw material in production chain can be lowered as large buffer stocks are not necessary, which releases capital. Cutting methods development makes raw material advantage even more stronger. Pine sawnwood accounts for 52% and spruce sawnwood 48% of company's production. Company considers its personnel as highly skilled and motivated.

Demand Conditions

Domestic market accounts for 20-25% of company's sawnwood sales. The main export markets are Denmark, United Kingdom, North Italy, and North Africa for pine sawnwood and Germany, France, and Netherlands for spruce sawnwood. The company considers its delivery chain and own sales units as a source of competitive advantage.

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[204] The Finnish Timber and Paper Directory 1990-1991: 84-86

4.2.4. Analysis

The company strategy *strengthens* the competitive advantage of Finnish sawmill industry. Metsä-Serla Oy follows *focused differentiation* strategy in its sawmill industry. However, because the strategy has changed recently, there still exist clear signs of *cost focus* strategy.

Factor Conditions

The company develops *factor conditions* by developing cutting methods to suit the market needs. Spruce know-how is a special strength of the company. Machinery investments aim to raise the labour productivity.

Demand Conditions

Metsä-Serla Oy tries to concentrate sales to sophisticated buyer segments, which increases buyer switching costs and decreases buyer bargaining power. Such segments are joinery and furniture industries for pine sawnwood and planing industry for spruce sawnwood. DIY products affect sawnwood deliveries to retailers. The division retailers-industrial end users is strenghtening, which will call for smaller parties and JOT deliveries. Distribution is organized on segment basis.

Related and Supporting Industries

Sophisticated buyers demand high quality sawnwood, which causes pressures to machinery producers to improve their performance. According to Metsä-Serla Oy, frame saw equipment cannot produce high quality sawnwood in the future, because the sawn surface is not smooth enough for the purposes of the end users. This is especially so with spruce sawnwood and planing industry.

Industry Structure and Rivalry

The effects to these elements lie in the market orientation. Other sawmill companies are forced to reformulate their strategies in order to either challenge customer-based quality or to tailor a niche for themselves. Rivalry is shifting to high quality sawnwood as both domestic and international changes force some companies to source their competitive advantage from high quality raw material.

As a conclusion, the strategy that Metsä-Serla Oy pursues in its sawmill industry is based on market improvement and development of cutting methods. The competitive advantage creating connection is the matching of these two. It must be noted, however, that the company still has much to do before it can wholly benefit this strategy. In that sense, the sawmill industry of Metsä-Serla Oy is in the phase of transition in the ways which things are done. This strategy supports the development of long-term competitive advantage of Finnish sawmill industry.

4.3. United Sawmills Ltd

The section 4.3. is based on the interview with Kari Anttilainen, the managing director of United Sawmills Ltd. The other sources are mentioned in the text.

4.3.1. Description of the Company History

The history of United Sawmills Ltd in its present form dates back to 1991, when the Repola Group was formed in a major merger. The companies that merged were Rauma-Repola Oy and United Paper Mills Ltd. Half of Rauma-Repola Oy consisted of forest industries and the other half of metal industries. It had a sizeable sawmill industry. In 1987, it had acquired a large mechanical forest and metal industry company W. Rosenlew Oy. United Paper Mills Ltd was a large forest company at that time. It acquired Kajaani Oy that had large sawmill capacity in 1989, before the merger with Rauma-Repola Oy. Today United Paper Mills Ltd is the subsidiary of the Repola Group. It deals with both mechanical and chemical forest industries of the group. The whole sawmill capacity is organized under United Sawmills Ltd, which is a business unit of United Paper Mills Ltd. The most important part of the present sawmill industry is the part that belonged to Rauma-Repola Oy.

Rauma-Repola Oy was formed in a large merger in 1952. The participants of this merger were Repola-Viipuri Oy, Rauma-Raahe Oy, and Lahti Oy. The roots of Repola-Viipuri Oy were in Penttilän Saha established in 1871 by Gustaf Cederberg in Joensuu. Vuojoki GNDS Ab established in 1911 and Råpsö Angsågs Aktiebolag established in 1872 by J.E. Francke laid the foundations of Rauma-Raahe Oy. The roots of Lahti Oy date back to 1869, when Lahtis Ångsåg Aktiebolag was established in Lahti.[205] The reasons behind the merger in 1952 were indebtedness, similar functions in forest industries, forest areas that supplemented each other, cooperation in R&D in machinery, and the same shareholder, a large commercial bank.[206] Rauma-Repola Oy has been the largest producer of sawngoods in the whole Europe in many years. Later on, the company moved its functions more to metal industry and chemical forest industries.[207] The formation of Rauma-Repola Oy is provided in figure 4/1.

The most notable persons that have affected sawmill industry development in Rauma-Repola Oy are Mining Counsellor Paavo Honkajuuri and Commercial Counsellor Eino J. Aro, who have successfully integrated sawmill industry to chemical forest industries, and Director Eero J. Lehmusoksa, who has developed the current sawnwood distribution strategy. In United Paper Mills Oy the most important persons to sawmill industry have been Executive Vice President Häggblom and Senior Vice President Eero Kanto.

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[205] Vahe 1991: 14-63

[206] Vahe 1991: 61

[207] Vahe 1991: 82-106; Ahvenainen 1984: 423

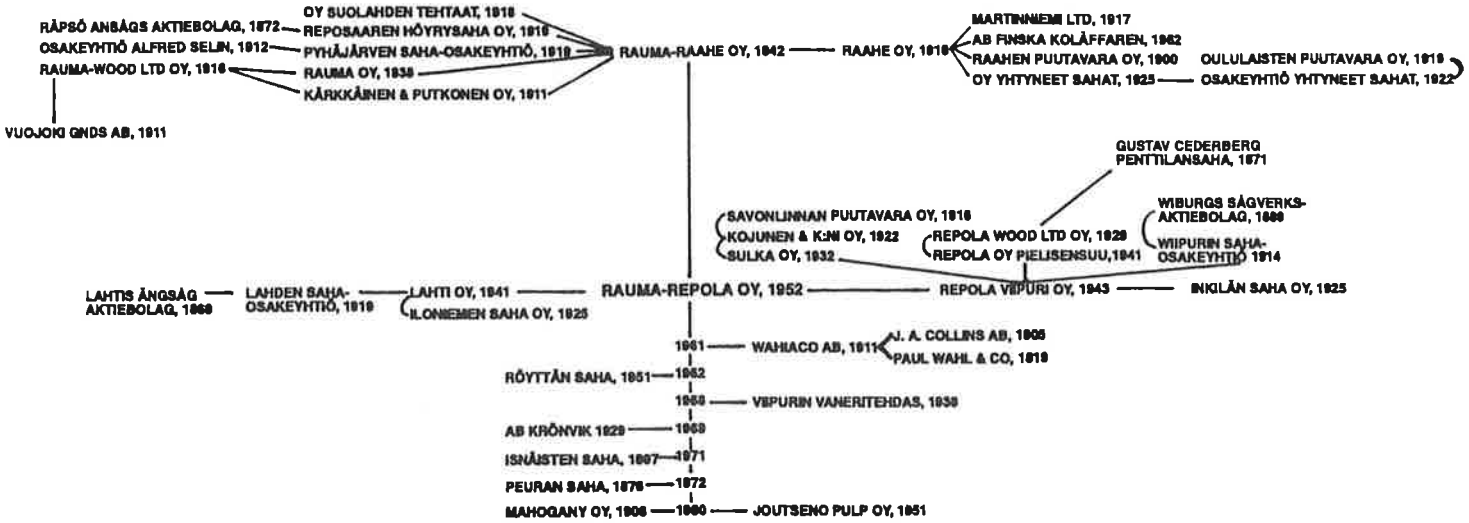

FIGURE 4/1 Formation of Rauma-Repola Oy[208]

The firm owns the following sawmills in 1992 (annual production capacity in brackets): Seikku sawmill (285 000 m^3), Kajaani sawmills (200 000 m^3), Korkeakoski sawmill (180 000 m^3), Rauma sawmill (140 000 m^3, not running in 1992), Parkano sawmill (75 000 m^3), Kettula sawmill (75 000 m^3), and Leivonmäki sawmill (55 000 m^3).[209] The total production capacity is 1 010 000 m^3. Ets Ferdinand Braun sawmill company (180 000 m^3) in France is owned by United Paper Mills Ltd.

Mergers, which are mostly due to bank ownership, do play an important role in the history of Repola Group. The company re-organizes its functions in order to be profitable. Sawmill industry is in the phase of structural transition. This must be kept in mind when examining strategies of sawmill sector.

4.3.2. Company Strategy

The role of sawmill industry in United Paper Mills Ltd is to use all high quality pine saw logs from fellings of stands made to chemical forest industries of the company. Half of the produced sawnwood consists of spruce sawnwood, because company's chemical forest industry mills need sawmill chips in production and because sawmills must fill sawing capacity. Sawmill industry will concentrate to three areas, which are Jämsänkoski-Valkeakoski, Kajaani, and Rauma-Pori. These areas as well as raw material supply of sawmills is guided by location and raw material needs of company's chemical forest industries.

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[208] Vahe 1991: 14

[209] The Finnish Timber and Paper Directory 1990-1991: 104-108

Investment strategies emphasize the optimal location of sawmills. This means that good performing sawmills that are located in the areas mentioned above receive the major share of investments. Investments to machinery aim to improve labour productivity, i.e. labour is substituted by capital. The investment strategy is *protect current position* or *selectively manage for earnings*. This matches the stage of maturity, but does not support the development of long-term competitive advantage of the industry. The level of investments is normally 5% of the turnover of United Sawmills Ltd.

Investments in R&D amounted to 0,2% of sawmill turnover in 1991. Weight is given to R&D in drying and raw material handling, which are according to Twiss typical areas of investments in a mature industry.[210] The technical director of the company is responsible for R&D function. The firm is a shareholder of Suomen Puututkimus Oy.

4.3.3. Company-Specific Factors

Factor Conditions

Spruce accounts for 57% and pine for 43% of company's sawngoods production. High quality pine sawnwood is considered as a competitive edge to foreign competitors, but know-how of spruce is also important to the firm. Because the company produces mostly standardized sawnwood with large volume, the development of saw log price is essential to profitability. Resources are guided to the improvement of cutting methods, which is already one key area of company know-how. Quality- and customer-based cutting methods of both spruce and pine are developed. Emphasis is given to the improvement of personnel, as specialized workers are not easily available.

Demand Conditions

The main customer groups of the firm are construction, furniture, and joinery industries. In domestic markets, which count for 25% of sawnwood sales, the company owns distribution channel Puukeskus Oy and other downstream industry firms in fields of e.g. window, door, and house manufacturing. European markets cover 65% of sawnwood sales. The most important export countries are United Kingdom, Germany, and France. The export share of North Africa and Middle East is 10%.

Demand conditions are changing as distribution channels concentrate and the importers integrate to downstream industries. Also direct sales to end user companies increase. The company owns a joint sales company with Enso-Gutzeit Oy. This company sales sawnwood to non-European markets.

Related and Supporting Industries

FMG Timberjack Ltd, which belongs to Rauma Oy, plays an important role in R&D with related and supporting industries. This gives the option to develop harvesting from the needs of both mechanical and chemical forest industries.

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[210] Twiss 1980: 62

The Role of Government

Government action has affected the major mergers in which first Rauma-Repola Oy and then Repola Oy have been formed. The law for commercial banks changed in 1951, after which a bank was allowed to own more than 20% of the shares of an industrial company for a long period. This made it possible for the commercial bank behind these firms to re-organize the ownership structure. The indebted firms were merged to Rauma-Repola Oy, and the existing debts were changed to shares part of which were then sold to cover the debts.[211]

4.3.4. Analysis

The strategy of United Sawmills Ltd supports the competitive advantage, but it does develop it only modestly. The company practices *cost focus* strategy.

Factor Conditions

Company strategy develops harvesting and cutting methods of both spruce and pine, because emphasis is given to quality-based harvesting. The firm considers its forest department as a source of competitive advantage. Factor conditions will also develop when company concentrates to three major purchase areas. The company recognizes the importance of highly educated employees, which supports the existing *advanced and specialized factors*.

Demand Conditions

The demand of construction industry, which is the biggest buyer industry of company's sawnwood, seldom is sophisticated and does not develop demand conditions. Customer groups like furniture and joinery industries demand selectively. In the field of furniture industry the firm does cooperation that upgrades market demand and strengthens the long-term competitive advantage of sawmill industry. In domestic markets the integration to downstream joinery industries represents the improvement in domestic demand conditions.

Direct sales to end user industries are increasing as the importers integrate to downstream industries. The distribution of company's sawnwood will partly concentrate to particular importers, which will increase the competitive advantage if these importers are integrated to downstream industries and switching costs are increased.

Related and Supporting Industries

The major contribution of United Sawmill Ltd to the competitive advantage development lies perhaps in related and supporting industries. The firm FMG Timberjack, which also belongs to the Repola Group and is the world market leader in forest machines, does R&D cooperation with mechanical and chemical forest industries of the group. The effects of sawmill industry to forest machines R&D is considerable e.g. in fields of measurement, timber grabbles, and forwarding. The know-how is then available to the whole forest sector in the Finnish economy.

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[211] Vahe 1991: 61-63

Industry Structure and Rivalry

The restructuring of sawmill industry of the company has changed industry structure conceivably. During the 1980's and early 1990's one million m^3 of annual sawnwood production capacity of the company has been closed because of weak profitability or company strategy that locates sawmills to the areas mentioned above. United Sawmills Ltd has sold or closed the following sawmills since 1984 (the year in brackets.): Peura sawmill (closed 1984), Krunvik sawmill (closed 1984), Röyttä sawmill (closed 1985), Lahti sawmill (closed 1985), Martinniemi sawmill (closed 1986), Pikisaari sawmill (sold 1986), Penttilä sawmill (sold 1986), Riihivuori sawmill (sold 1986), Askolin sawmill (sold 1988), Nikkarila sawmill (closed 1990), Olkkola sawmill (closed 1991), and Rauma sawmill (not running 1992).

The capacity that has left the industry has improved the competitive advantage, at least of United Sawmills Ltd. Although the production equipment are specialized and the *exit barriers* high, these exits took place and only the best performing sawmills still exist. On the other hand, this development represents a considerable *shift of competitive advantage* to other producer countries, because the production and export volume did not rose in the late 1980's (see figure 2/5 in page 44). Some domestic sawmills benefitted the decrease of production capacity and were better able to sell both in domestic and foreign markets.

As a conclusion, United Sawmills Ltd has successfully gone through a major structural change. The results of taken efforts are today visible and the company shows signs of healthy upgrading and it is improving its performance. As the phase of structural transition is behind the company strategy is more easily formed to the direction of sustainable competitive advantage development.

5. CONCLUSION

5.1. Determinants of the Competitive Advantage of Finnish Sawmill Industry as a System

The most important determinant of Finnish sawmill industry diamond is *strategy, structure, and rivalry*, because it has strong connections to factor and demand conditions and to related and supporting industries. Very close to the importance of this determinant stands *factor conditions*, which interacts also with related and supporting industries and the government. These two determinants form the core of the national diamond. The eroding of *advanced* and *specialized factors* of sawmill industry weakens the interaction effectiveness in the long run.

Foreign *demand conditions* improve the competitive advantage through interaction with other determinants, but domestic demand is usually not *sophisticated*. If the important link between factor and demand conditions could be established, it would create sustainable competitive advantage. Demand conditions have weak connection with related and supporting industries, which is connected to the missing interchange with factor conditions. Demand conditions transfer the messages from government and change events to company strategy, structure, and rivalry. Efforts to benefit from demand conditions should be emphasized.

Related and supporting industries interchanges directly only with factor conditions and strategy, structure, and rivalry. Government actions towards related and supporting industries do usually not affect the long-term competitive advantage of Finnish sawmill industry.

The role of government is not improving the sawmill diamond. It could play more important role, if actions like technology programs were more common. *Change events* affect national diamond too strongly through demand conditions. Measures should be taken to decrease this power.

The national competitive advantage diamond lacks some very important connections, the establishment of which would be essential. Although the national diamond is not complete, it guides Finnish sawmill industry to the direction of high-quality sawnwood and higher refining rate. Efforts to improve this development create sustainable competitive advantage.

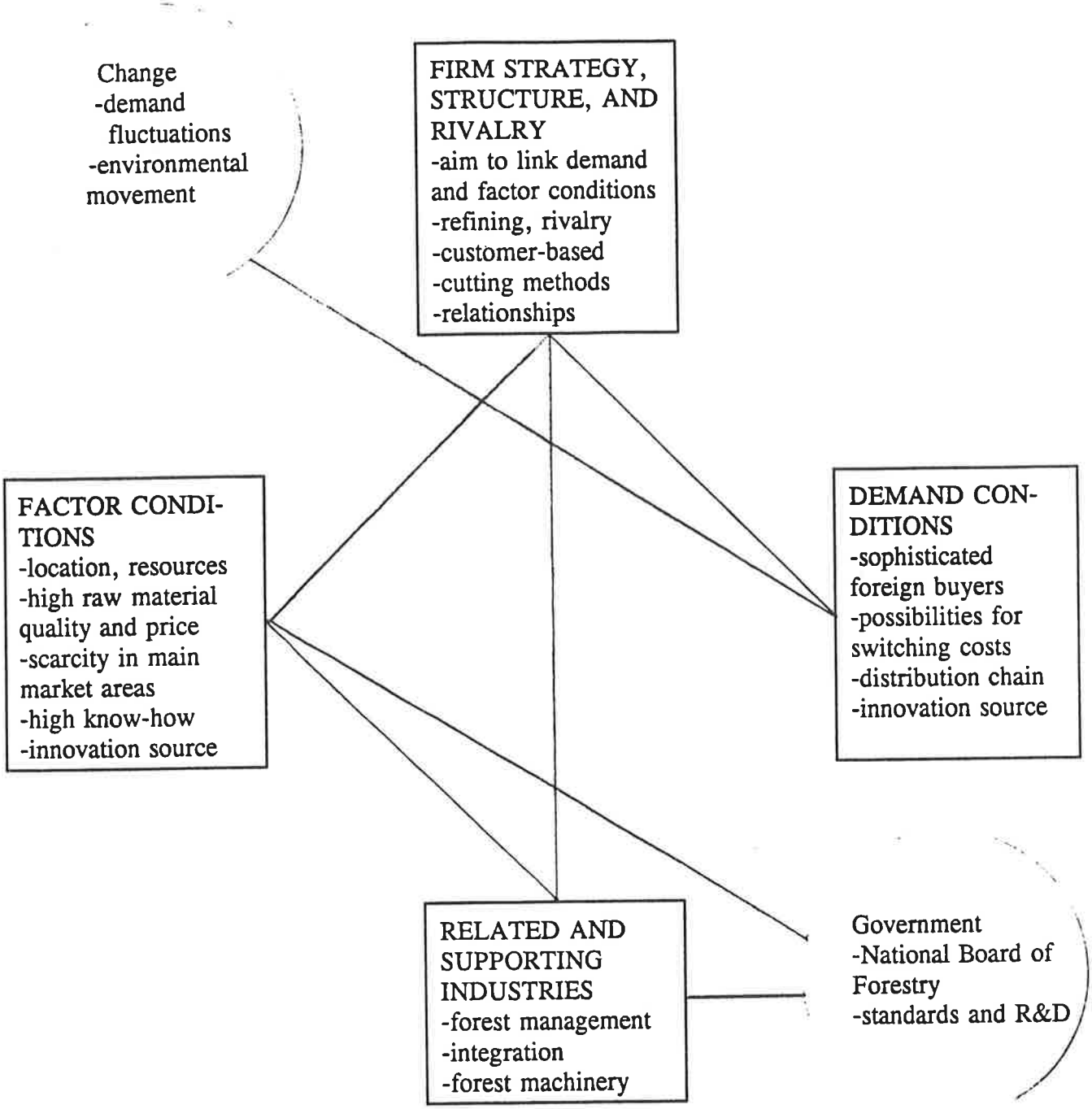

FIGURE 5/1 Factors Improving the Competitive Advantage of Sawmill Industry and the Most Important Interactions

Company Strategy and Development of Competitive Advantage

Companies try to pursue strategies that maximize their performance under certain restrictions caused by the operating environment. In case of Finnish sawmill industry, the most important environmental determinants are the *factor conditions*, both large, high quality raw material stock and at the same time *selective factor disadvantage* in raw material price. High raw material quality causes the fact that Finnish softwood sawnwood is of high quality in international

markets. *Demand conditions* emphasize investments in higher refining, such as drying or planing, which guides Finnish sawmill industry towards focused differentiation strategies.

The core of competitive advantage can be found by examining the strategies of the firms.[212] Companies can pursue strategies that affect the determinants of the diamond model. For example, strategies that improve factor and demand conditions can contribute to the development of sustainable competitive advantage.

Effects of Determinants and Trends on Sawmill Industry

The growth of sawnwood production quantity in Finnish sawmills is despite of the decreasing trend in 1980's in line with the world's coniferous sawnwood production growth rate. This is supported by the long-term production trend. However, a downward shift of the production trend may have taken place in 1980's, when the decrease of production capacity was due to e.g. cyclical demand and exchange rate development.

According to Porter, high raw material price improves the long-term competitive advantage, because it forces companies to develop and innovate. Saw log price is likely to stay at high level, which suggests that the profitability will also remain low, because high raw material cost cannot be transferred to sawnwood prices.

Sawmill industry is a mature industry in which no large and rapid growth can be expected. By effective management of the industry the whole nation could benefit from modest investments to it, because there at the moment exists both production overcapacity and saw log growth surplus. Investment strategy should be build gradually or protect current position, and the target should be in marketing, refining rate improvements, and cutting and fibre flow improvements.

Starting from 1970's the capital intensity of sawmill industry has increased along with the rise of labour productivity. This trend continues, which leads to higher ownership concentration and integrations to chemical forest industries. This represents healthy development and supports the development of competitive advantage.

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[212] Porter 1990: 37-40

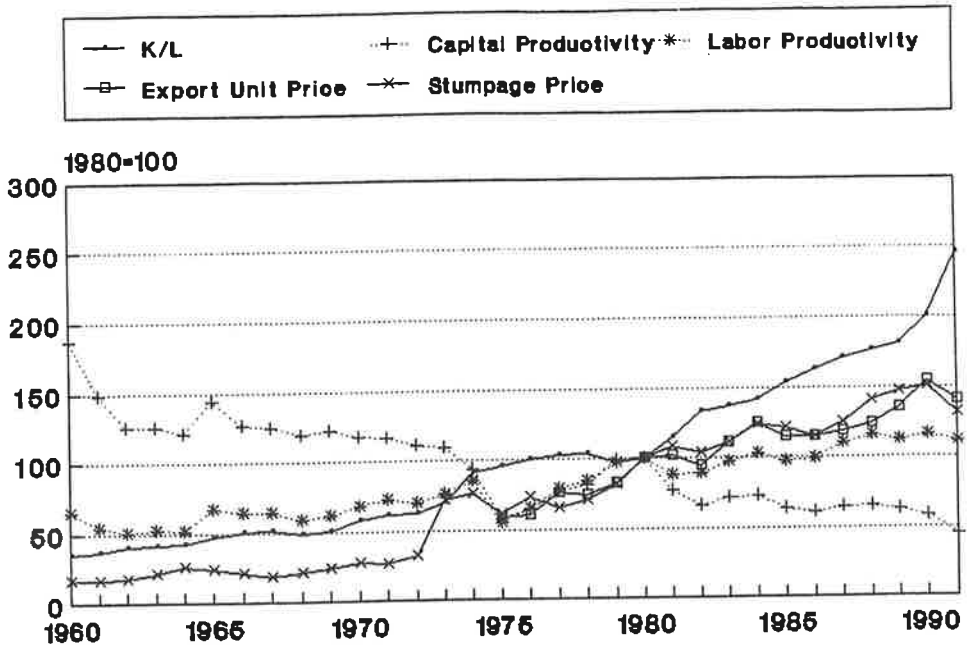

FIGURE 5/2 Development of K/L, Capital and Labor Productivity, Export Unit Price, and Coniferous Saw Log Stumpage Price Indexies 1960-1991, 1980=100[213]

After 1975, the export unit price index has been increasing, as indicated in figure 5/2. Stumpage price index matches the export unit price index with high correlation. In case of high demand for saw logs, the price increases have been larger than the price increases of export unit price. This development indicates that due to high bargaining power the suppliers have taken the most of the benefit from export price increases. Sawmill companies have tried to increase profitability by investments to machinery, as K/L-ratio development shows. Labor productivity development somewhat follows the export unit price and stumpage price development. Capital productivity has decreased within this period.

Integration to pulp and paper industries supports the development of sawmill industry, due to fibre flow synergies. It is unlikely that sawnwood production capacity will continue to decrease rapidly, provided that pulp and paper production remains at current level in Finland.

The role of government is important in the exchange rate development, because the sawnwood price is given by the markets. After the devaluation of FIM in 1991 and the ongoing floating of it sawmill industry has gained short-term price competitiveness, which according to Porter does not improve competitive advantage. In the short run it will create better financial performance.

Government investments to forest management do not benefit the nation as much as possible, because the annual growth of (especially) saw logs exceeds the annual cuttings. The growth rate of forests will decrease when the optimal average age of them is exceeded, which is one outcome of growth surplus. Thus the government should have incentive to improve the operating environment of sawmill industry. Growth surplus can cause oversupply of saw logs and thus price decreases. Both of these factors affect sawmill industry positively.

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[213] compiled and modified from Metsätilastollinen Vuosikirja 1968-1991, Industrial Statistics of Finland 1960-1963, and ETLA files. Includes unreleased material.

Negative development is caused by entries in international markets, development of sawmill industry in competitor countries, growing bulk sawnwood production, increasing use of substitutes (environmental movement resists some substitutes like aluminium), bargaining power of suppliers and buyers (e.g. change in construction materials and methods), eroding of advanced and specialized factors, and low R&D expenditure.

5.2. Sawmill Industry and the Competitive Advantage of Nation

The most important contribution of sawmill industry to the competitive advantage of Finland as a nation is that it uses domestic inputs and creates considerable net currency earnings, which amount to ca. 10% of net currency earnings of Finland. This affects e.g. current and payments account and also the creditworthiness of Finland in international capital markets (i.e. it makes it easier and/or less costly to the nation to obtain finance to other (industrial) purposes).

No other industry than sawmill industry can use a vast amount of large-scale timber and generate enough capital to pay a high price from it. Chemical forest industries would not be able to pay the price this high, and thus the nation as a whole would be worse off if sawmill industry not existed. This may partly explain the existence of sawmill industry despite of low profitability.

Sawmill industry can be located near raw material to distant places, where no other industrial production would be possible. It guides capital and creates working places to regions otherwise deserted. This is important, because our national resources are then more effectively benefitted and our population more equally dispersed.

The role of sawmill industry in creating the well-being to Finland is underestimated. Efforts should be taken to receive the full benefit available from this industry sector, which then could be used to develop high technology or other sectors that at the moment cannot be self-supportive.

As a conclusion, sawmill industry forms a notable part of the industrial base of Finland. The diamond model supports its existence also in the future.

5.2.1. Suggestions For the Players

What comes to *factor conditions*, the key influence lies in forest owners. The current forest growth clearly exceeds annual cuttings, by an amount of app. 20 million cubic metres (1992). This should indicate oversupply of sawlogs and falling prices. However, today the situation is likely to differ. Especially farmers are anxious to decrease cuttings and wait for the time of high prices. At the same time large companies increase their cuttings from own forests and also increase import, whether profitable. Because the market mechanisms do not work properly (and pulp industry faces undersupply of birch), wood is imported and the nation as a whole is worse off. However, *any duties for imported wood shoud not be presented*, because it would only distort competition and the nation as a whole would *loose a source for price competitiveness*. Duties as this are *hidden subsidies* to the forest owners. These subsidies are covered by tax payers. In addition, the difference between sawlog and pulp log price should be much lower. The solution to both of these problems would be innovation in cutting methods, as described earlier.

It should be kept in mind that the exploitable (coniferous) forest coverage is quite modest in many countries in Central Europe (e.g. Great Britain, Netherlands etc.). This means that our

natural resource abundance will support the competitive advantage for sawmill industry, even in the long run. It is questionable, whether forest plantations in Europe will ever be sufficient to cover the demand. Also the nations may have to sacrifice huge resources to reap this end. Therefore, it is likely that sawnwood (and pulp and some fine papers) will be imported from Scandinavian countries also in the future.

The image of sawmill industry should not be of secondary importance. By raising their image among the becoming professionals (such as students at the field) the long term factor development would be secured.

In *demand conditions* the only reasonable approach is customer based marketing joined with heavy product development (drying, dimensions, customer lenghts, etc.). Demand can be guided with good arguments or delivery chain reorganization. This is difficult to organize, and the available benefits may be unsure. Still, many of the today most profitable sawmill companies pursue this strategy.

Sawmill companies should establish more firm contacts to *related and supporting industries*, such as to transportation or pulp industry. Minimize transportation costs by cooperation or buy transportation from outside of the company. Do long-term contracts to sell by-products to pulp mills. These two can be matched, when local sawmills use the same transporter and sell to the same pulp mill. What comes to forest management, short-term changes are hardly possible. Try to influence e.g. all local forest owners to maintain good forestry to secure raw material availability in the areas of strategic importance. Public guidance and experts may be available.

Company *strategy* is the most impotant single factor in this field of business. Although rapid changes are difficult, strategy should be guided to the direction that the most closely fits the company's way to operate. There is no ultimate general strategy. Good, reliable contacts, customers, and agents are the base to which a company can build. Customer service and customer-based production may be the means to secure company success. *Industry structure* and *rivalry* are components out of the reach of one single firm. There is place for new sawmills in the market, if and only if the end price of produced sawnwood does not (much) exceed the market price. As an example, the Swedish sawmills produce annually app. 11-12 million cubic meters of sawnwood, almost two times as much as in Finland. In addition, the economic growth of USA and difficulties in Russia will decrease the amount of imported sawnwood from these countries and from Canada in the coming years.

Investments should be guided to match the chosen strategy. There is no use to invest in marketing, if the production, delivery, and quality cannot match it. On the contrary, if the customers do not appreciate any higher refining, there no use to invest in it unless customer taste can be changed or new customers found by effective marketing. Generally speaking, before any major changes much investment must be made to support the coming change. In the phase of low profitability and high real interest rates there can hardly be any effective investment strategy but *build selectively*, if one seeks for growth. *Maintain current position* is then minimum strategy that supports the long term development of the firm.

Government can influence sawmill industry by various ways. By negotiating a custom duty and high technical specifications (e.g. drying) for the sawnwood that the EC imports much of the trade from East-Europe (here incl. Russia) will slacken. Also Canadian producers must then invesment to drying. This kind of trade restriction, though it negatively distorts trade and competition and though the EC as a whole would be worse off, would be beneficial, because it

would force countries outside the EC to carry the cost to fit their production to the EC standards, if they were about to continue their exports. This would probably rise production costs and thus also the unit price of produced sawnwood. Also import embargoes for non-dryed sawnwood or import quotas in general would do the trick (and cause competition distortion).

Government may also influence the transportation system first by building roads, but more important, improve the transport subsidies from distant places (which again distorts competition, but can be viewed as area policy). Truck sizes are also one subject to negotiation with the EC. It is then another question, whether truck, train, or water transportation should be in the most favoured position; truth is that to many distant places it is not profitable to build a railroad. However, it should be remembered that truck transportation is the most expensive long distance transportation form for sawnwood (provided that other possibilities exist).

Change events as such are out of the influence of a single firm, but if the recognizes them early it can benefit the trend. Such megatrends are e.g. changes in Russia, war in Balkan (followed by reconstruction), EC-membership and all kinds of standards, increasing data communication in sawnwood trade, computerization and automatizatio, etc. It would be suitable for the Central Association of Finnish Forest Industries to investigate these trends and see that the interests of Finnish forest companies are taken into account.

5.3. Connections Between Theory and Empirical Findings

Company strategies turned out to be one dominating determinant of the diamond, and the understanding of the interaction between competitive advantage determinants is essential in formulation of them. If strategies can reveal and emphasize vital interconnections, the industry can gain sustainable competitive advantage. In sawmill industry, strategies develop towards customer-orientation and market development, to which they are guided by the national diamond. The national diamond puts emphasis to company strategies, as the national diamond is not complete.

Factor conditions is another main determinant of the diamond, which matches the theory, because sawmill industry is raw-material intensive. Two important interactions underline the meaning of factor conditions. Firms pursue strategies that aim to optimize raw material use (cutting, sawmill location, fibre flow, integrate benefits etc.) and to take the end user needs into account already in cutting. These interactions are suggested also by the model, because the national diamond guides companies towards high-quality sawnwood segments.

Selective demand will emphasize high-quality sawnwood and effective distribution chain. Here exists one important interaction with company strategy. Unestablished interaction exists between raw material resources and demand conditions.

The theory also states that the national diamond of raw-material intensive industry seldom is complete, which is also one result of the research. The reasons for it are small role of related and supporting industries and the government, and the missing interchange between determinants. As one result of the study, sustainable competitive advantage could be drawn by establishing more stronger connections between factor and demand conditions.

5.4. Explanations

Consistent Findings

The explanation to consistent results mentioned above lie mainly in high-quality raw material, which is scarce in Central Europe, in company strategies that pursue integrate and fibre flow synergies and customer orientation, and in selective demand that requires market and delivery development.

Conflicting Findings

Exit barriers were surprisingly low among large sawmill companies, although theories suggested that they would be high due to e.g. specialized equipment. The reasons for low exit barriers lie in fibre flow synergies and in low profitability, e.g. in business level decisions.

Price of saw logs was another somewhat conflicting result, because high timber price as a selective factor disadvantage does not improve the short-term competitive advantage. In the long run, companies must concentrate to the core of their competitive advantage, which improves industry structure and long-term competitive advantage. The reason behind this conflicting result is that the price of sawnwood is given by the market, but the price of saw logs by suppliers. The price of saw logs does not decrease easily, but it may match sawnwood price increase quite fast.

Innovations should take place in production and process development in a mature industry. This is partly the case with sawmill industry, though much innovation happens in raw material handling and in markets. The national diamond and the prolonged life cycle explain raw material and market innovations, because company strategies aim to establish interconnection between raw material and end use. In case of product improvement emphasis must be given to market development.

The role of exchange rate development in long-term competitive advantage turned out to be problematic. Finnish sawmill industry has since the early 1980's suffered from overvaluation of FIM, which has caused decreasing annual production quantities. Negative long-term exchange rate development improves the industry structure, as the least profitable mills are closed down. However, the reduction in production capacity may also mean a loss of market share and indicate a shift of competitive advantage. In the short run, weakest sawmills distort industry environment by operating at a loss.

5.5. Reliability and Generalization

The research results are mainly in line with the existing knowledge of the industry. Reliability can be considered good. As this research deals only with large sawmill companies, some interconnections of the national diamond may remain untack, especially if they are company-specific, which may lower reliability.

The research method suits other industries and services. In the case of the entire nation, the interconnections are very complex and special care must be taken in analysis.

6. SUMMARY

6.1. Background

This study is a partial project of research Advantage Finland, in which the most essential industries are examined in order to investigate the competitive advantage of the whole nation. In this work, the competitive advantage determinants of sawmill industry are searched.

The participants of the project are The Research Institute of the Finnish Economy (ETLA), Helsinki School of Economics, and Helsinki University of Technology. The final research is carried out by ETLA and it should be finished by 1994.

6.2. Theories

The theoretical frame of reference for analyzing the competitive advantage of the whole nation is based on Michael E. Porter's work The competitive advantage of nation, which is used in the major project and also in the partial projects. The other publications of Porter are also applied to, as well as the literature in fields of business strategy, industry structure, networks, and innovation.

The theoretical frame of reference causes restrictions in the width of the presentation of other theories and theoreticians. This is why they are used mainly to support and supplement the theories of Porter. In addition, because of the major project the emphasis of all partial projects lies at the business level.

6.3. Research Methods

Statistical information is the one major source of information in this research, personal interviews are the other. Statistics and long time series and the interrelationships between them are important, because they reveal the direction of development of the competitive advantage.

Personal interviews turned out to be extremely valuable, because they gave insight to the present strategies and problem field of the sawmill industry. The interviewed persons are responsible for the whole sawmill industry of the company in which they work. Without the empirical interview part the connections between theories and business level would not have been properly established. The attitude of the interviewed persons was very positive towards this research.

6.4. Conclusions

The national competitive advantage diamond guides Finnish sawmill industry to the direction of high-quality sawnwood and higher refining rate. The most essential determinants of the diamond are *strategy, structure, and rivalry* and *factor conditions*. In the former, the most important determinants that improve the competitive advantage are rivalry, bargaining power of suppliers and buyers, company strategies that aim to focused differentiation (positioning), the threat of substitute products and in the latter the raw material resources and the location of Finland. Negative factors in the preceding are company goals, national prestige, threat of new entrants, threat of substitute products, and investment strategies of companies.

Demand conditions is an important determinant, but the competitive advantage provided by this determinant is not wholly benefitted, because the essential interchange with factor conditions and

related and supporting industries is missing. Foreign demand contributes to the improvement of competitive advantage when it is sophisticated.

Related and supporting industries benefit the whole forest cluster of Finland, and part of this benefit falls into sawmill industry. Forest management and forest machinery industry would make it possible to benefit much more from the interchange between the determinants of competitive advantage. This interchange should be increased.

The role of government and *change events* do not provide considerable competitive advantage. If the role of government were more active in creating the preconditions for effective interaction of the determinants, the nation would benefit it as a whole.

The main contribution of sawmill industry to the competitive advantage of Finland as a nation is that it creates currency inflows that positively affect the balance of payments, as export earnings belong to the visible trade on the current account. Sawmill industry covers ca. 10% of net currency earnings owing to high share of domestic raw material as a production input. Other forest industries would not be able to use the same amount of large-scale logs and generate as much income from it as sawmill industry.

Efforts should be taken to improve the position of sawmill industry. The capital generated by it could be used to finance the development of other industries not yet self-supportable.

6.5. Visions

The European integration process does not affect Finnish sawmill industry very much *directly*, because many of the properties are already included in everyday business operations. Nevertheless, some long-term changes may take place, mainly due to changes in related industries, e.g. if pulp production decreased in Finland, the selling of by-products would be difficult. Also if regulation affected truck transportation (maximum weight, transport subsidies etc.) the transportation cost would perhaps rise steep, ehich would reduce the forest area in which cuttings are profitable i.e. the latitude of zero stumpage price would move southwards.

The benefits from the EC membership outweight the negative impacts, especially if customs rates and formalities raise Canadian and Russian producers' costs and thus prevent imports in favor of Scandinavian producers.

Some factors concerning the future development of Finnish sawmill industry that came up during this research are presented in table 8/1. All of these match the findings of this study. The national diamond allows sustained competitive advantage also under these forces.

TABLE 6/1 Factors Affecting the Development of Finnish Sawmill Industry in the Future[214]

- customer-orientation will increase, partly because industrial end users and intermediaries will concentrate.
- the role of marketing and distribution channel is more important
- the need for international skills in maintaining strong market position will increase
- innovations are searched in raw material handling and in markets
- raw material handling and demand are integrated and integrate benefits are even more important
- stumpage prices may rise and/or fellings may decrease due to new taxation system
- resource network is more important
- frame saw surface quality will be insufficient for selective buyers
- spruce sawnwood production in Central Europe will increase and refining rate will be higher, but the need for imported high-quality sawnwood will increase due to increased consumption
- production and exports of sawnwood (and furniture exports especially to Finnish market) from Russia to European markets will increase
- East-Canadian producers adopt Scandinavian production methods and raise refining rate, e.g. drying. Lodgepole pine imports from North America will decrease due to economic growth in USA.
- Radiata pine sawnwood from Chile will enter European bulk sawnwood markets

An interesting option is the *integration* between sawmill and energy production, where the by-products of a sawmill (bark, sawdust, perhaps even chips) could be used in energy production as well as cutting waste or peat. This option is backed by the current and continuing oversupply of wood in Finland. (Growth exceeds cuttings by a rough 20 million m^3 annually, which (as trees get older) leads to decreased productivity of forests and decreased returns on investments in forestry. As a consequence, the nation as a whole is worse off. This is also discussed earlier in 3.4.1.) However, the current technology cannot offer competitive price for the by-products, and the collection of cutting waste is at the moment too expensive. This calls for technological innovation and re-organization of fibre flows to serve also energy purposes. It is by no means a vision that cannot be implemented, because even today forest industries create heat energy by burning wood waste, and there exists small, local power plants, which use sawmill by-products. Close to this is the energy plant in Kemijärvi. In addition, wood energy cannot supply the energy need of our nation, at least not in the short run. Tampella Power Oy and Ahlström Oy are investigating this technology, and recently Tampella Power announced a breakthrough. In

[214] compiled from interviews: Petri Wager, Enso-Gutzeit Oy; Ossi Kokkonen, Metsä-Serla Oy; Kari Anttilainen, United Sawmills Ltd; Ismo Leppäniemi, Botnia Wood Ab and from Tekniikka & Talous 3.12.1992: 5; Metsäteollisuus tiedottaa 9/1992: 3

this model, chips, sawdust, bark, and cutting waste could be gasifyed, guided into turbines, and create electricity. The by-products would be carbondioxide and wood ash. This environment-friendly alternative could produce electricity at current prices, but the raw material price is at the moment too high. As Tampella (perhaps joined with Ahlström and the state) are looking for a suitable site for pilot plant, wouldn't it be interesting to integrate it with a large sawmill in area, where also other preconditions are fulfilled?. Research on this field is valuable, because it may create the possibility to use our natural resource more effectively in the future. At the moment this alternative is not economically possible.

The firms that better understand the situation of the industry and the determinants that create competitive advantage to the whole nation, are equipped to formulate strategies to match the sources of it. The benefit would be higher, if firms were able to develop the competitive advantage of the whole nation, because the diamond then reinforces the positive development. Long-term strategic planning must be one part of Finnish sawmill industry.

APPENDIX 1 Sawnwood Production Trend Calculations[215]

The estimators of the least squares method are:
$b = [\text{sum } x_i y_i - (\text{sum } x_i \text{ sum } y_i)/n]/[\text{sum } x_i^2 - (\text{sum } x_i)^2/n]$
$a = y_{ave} - bx_{ave}$
Where:
x_i = year
y_i = production quantity in year x_i
x_{ave} = average value of x_i
y_{ave} = average value of y_i
n = number of observations
a,b = parameters of the least square method
The estimated regression straight is: $y = a + bx$

The estimated least squares regression straight for sawnwood production is:
$y = -15223049 + 8435{,}6x$

The increasing trend and the corresponding production quantities are presented below. Long-term development of production quantity follows the development of world's coniferous sawnwood production presented in appendix 2. However, because the presented trend is calculated in the period 1960-1991, it omits the possible change in development at the early 1980's. The trend in the period 1980-1991 is clearly decreasing, which may show a shift of competitive advantage or long-term demand fluctuation. One evidence of the former are depreciations of SEK in 1981 and 1982.

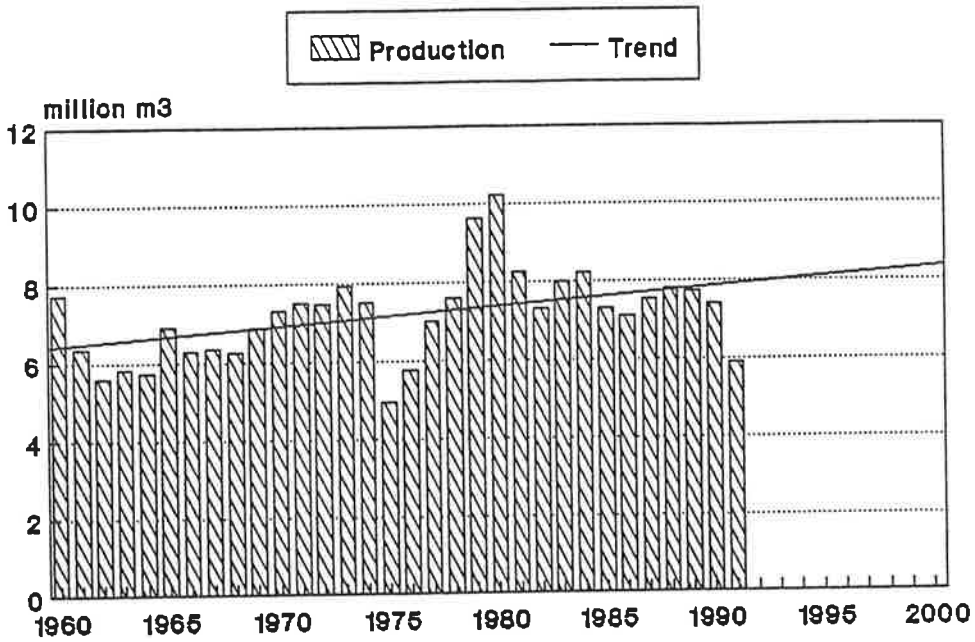

FIGURE 1 Sawnwood Production Trend 1960-1991

[215] Lehtonen and Niemi 1977: 2, 17

APPENDIX 2 The Shares Are Indeed Declining[216]

The share of sawnwood from the total export value of Finland has declined drastically during the last thirty years. In 1960, the share of sawnwood from exports was 20,2% but in 1991 only 4,4%. This is presented in figure 1.

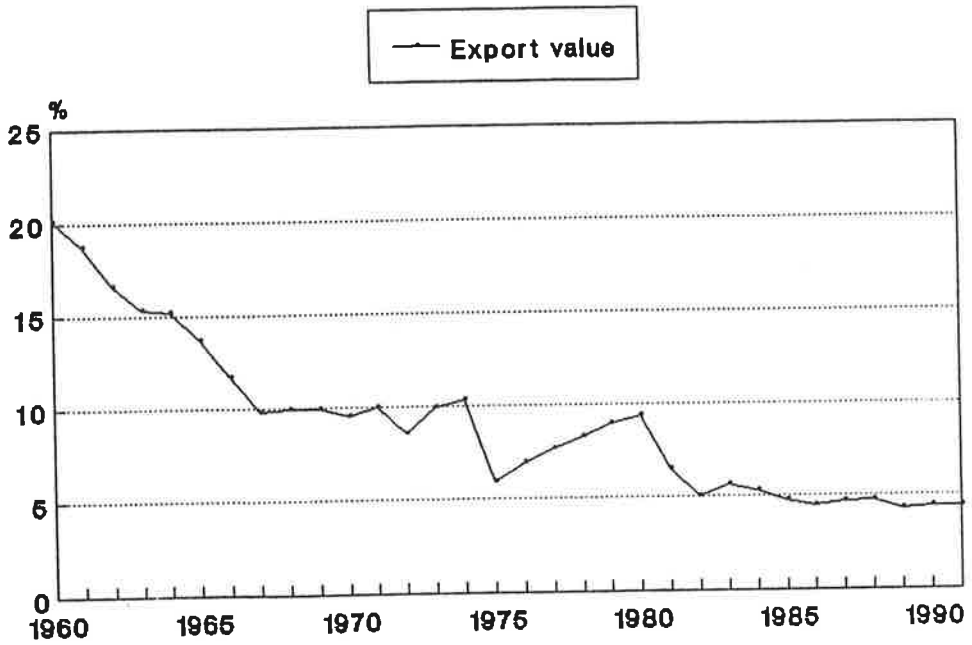

Figure 1 The Share of Sawnwood of the Export Value of Finland 1960-1991

The reason behind this decline is clear. The export value of Finland has risen rapidly. In 1960, the total export value was 3,2 billion FIM whereas in 1991 it was 92,7 billion FIM in current prices. This is visible in figure 2, where the export value of sawnwood is also presented, the growth of which is much slower than the overall growth of export value. In 1960, the value of sawnwood exports was 637,9 million FIM and in 1991 it was 4086 million FIM.

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[216] All figures presented in Appendix 2 are compiled from Metsätilastollinen Vuosikirja 1968 - 1990-1991; The Industrial Statistics Of Finland 1960-1963, 1990; FAO Yearbook of Forest Products 1990, 1989, 1983, 1970, 1961. All base values are in current prices.

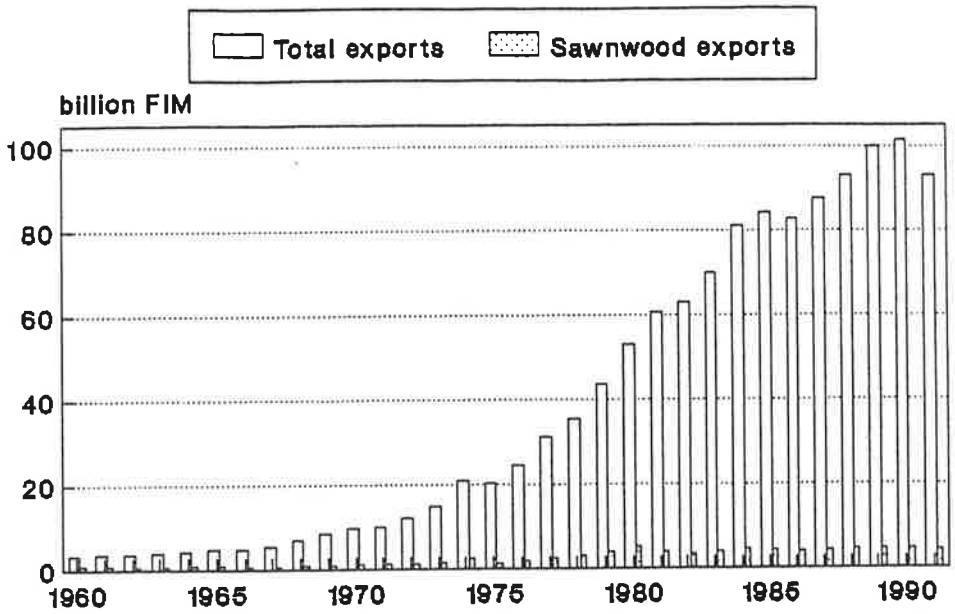

Figure 2 Value of Total Exports and Sawnwood Exports from Finland 1960-1991

The total value of sawnwood production in the world is not available, but if we examined production and export quantities of coniferous sawnwood, we would notice only slightly rising trend. This means that sawmill industry growth is slow, which indicates the industry maturity. Finnish sawmill industry production follows this trend.

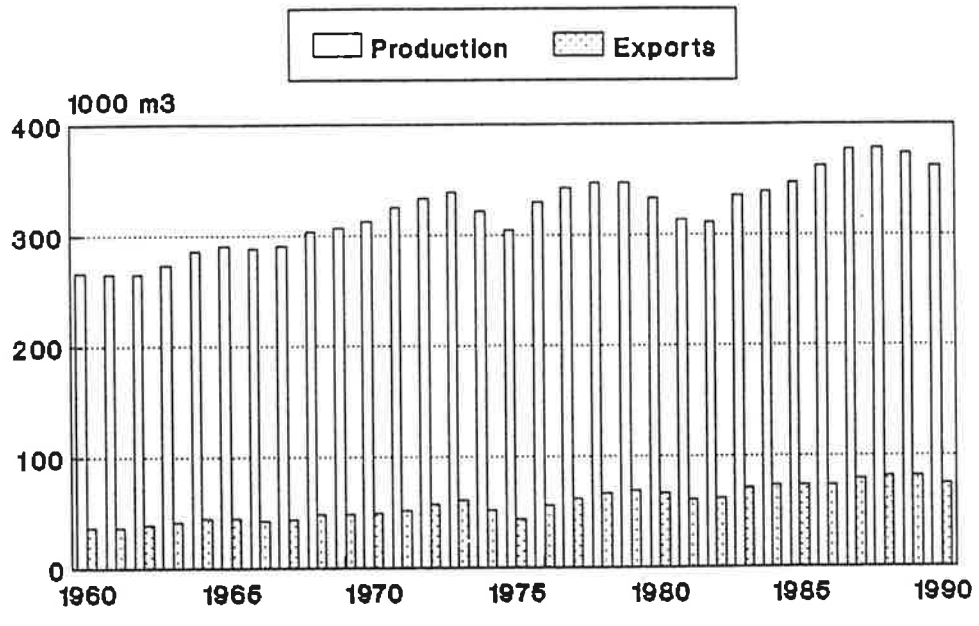

Figure 3 World's Production and Exports of Coniferous Sawnwood, by Volume 1960-1990

The share of Finnish sawmill industry's production from the production of the world has decreased only somewhat less than 1% during the last thirty years. The decline of sawnwood in the export value of Finland is not serious in itself, but this decline in world's production means the eroding of competitive advantage.

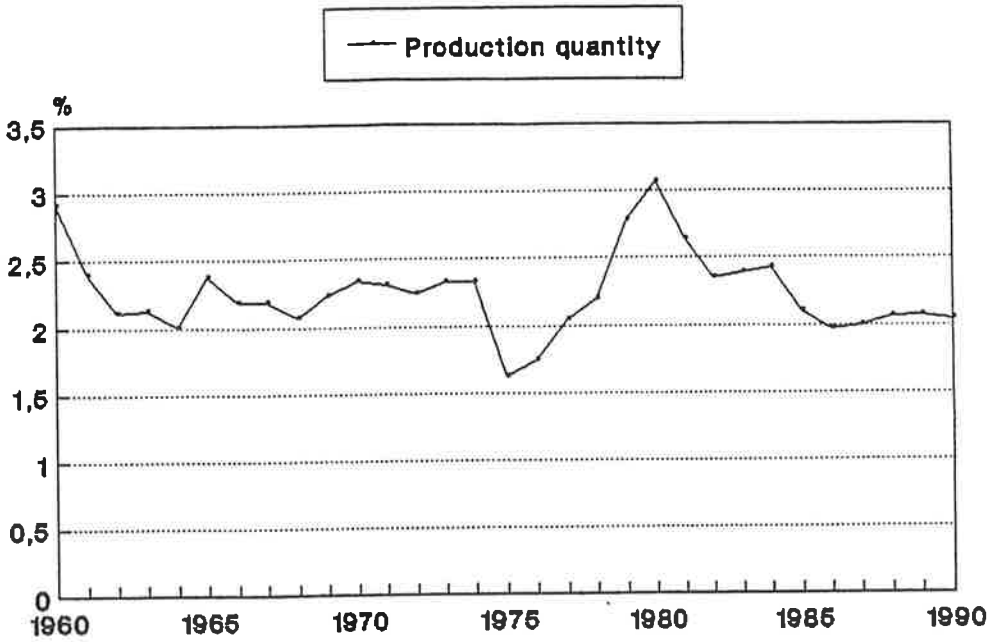

Figure 4 Finland's Share of World's Coniferous Sawnwood Production Quantity in 1960-1990

Even more clearly this decline is visible when export volume and value are compared. The reason for this is that when the share of world's production has fallen ca. 1%, the share of export volume and value must decrease more. The only positive development in figure 5 is that the share of world's export value has fallen *less* than the share of world's export volume. This means either that world market prices of high quality pine and spruce sawnwood have risen or that the refining rate of Finnish sawnwood exports has improved. The latter contributes to major part of the explanation. Though the competitive advantage has been eroding, the national diamond has guided Finnish sawmill industry to the direction of higher refining rate.

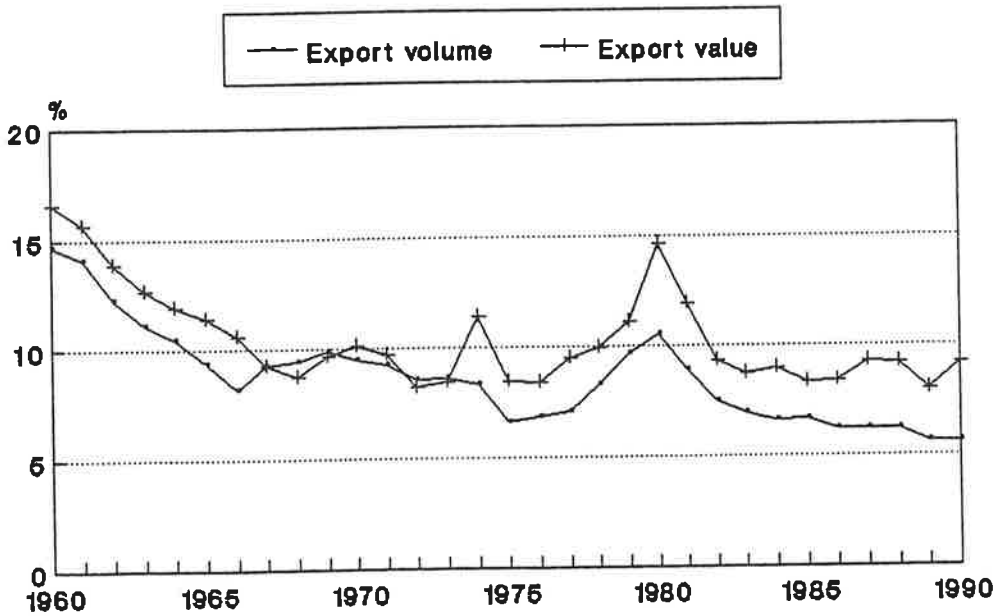

Figure 5 Finland's Share of World's Coniferous Sawnwood Export Volume and Value 1960-1990

APPENDIX 3 The Most Important Institutions that Carried Out R&D for Mechanical Forest Industries in 1987.[217]

Helsingin Yliopisto Metsäteknologian laitos
Helsingin Yliopisto Puumarkkinatieteen laitos
Lappeenrannan Aluetyöterveyslaitos
Metsäntutkimuslaitos
Metsäteho
TKK Puun mekaanisen tekniikan laboratorio
TKK Radiolaboratorio
TKK Talonrakennustekniikan laboratorio
TTKK Rakennustekniikan laboratorio
VTT LVI-tekniikan laboratorio
VTT Palotekniikan laboratorio
VTT Puulaboratorio
VTT Rakennetekniikan laboratorio
VTT Rakennuslaboratorio
VTT Sähkötekniikan laboratorio
VTT Työsuojelutekniikan laboratorio

The following instances also carried out R&D work:

Joensuun Metsä- ja Puutalousoppilaitos
Kullaan Metsä- ja Puutalousoppilaitos
Kotkan Metsä- ja Puutalousoppilaitos
Lahden Teknillinen Oppilaitos
Seinäjoen Teknillinen oppilaitos

Ekono Oy
Jaakko Pöyry Oy
Suomen Puututkimus Oy

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[217] Tarvainen 1989: 40-69

APPENDIX 4 Example of Sawnwood Production Process[218]

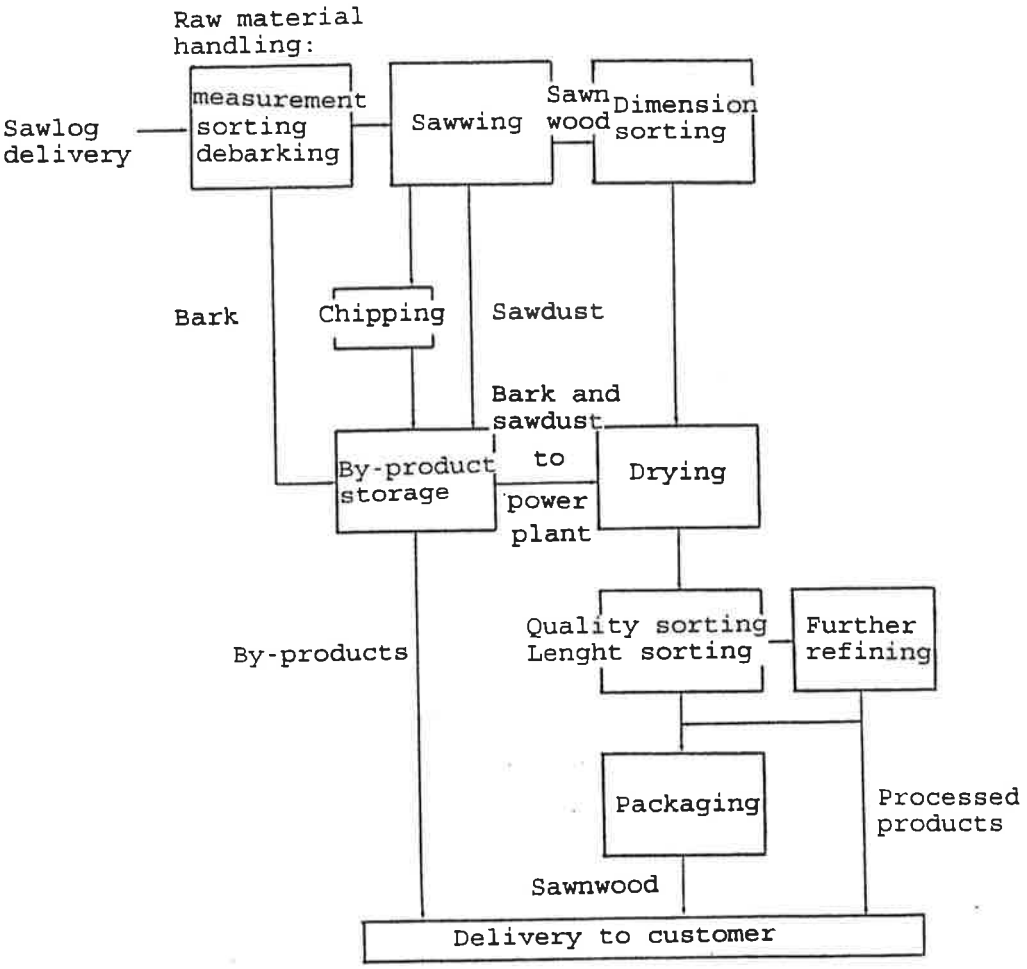

FIGURE 1 Sawnwood Production Process

[218] Kunnas 1981: 7

APPENDIX 5 Typical Sawing Methods in Scandinavia and North America

The major differences in sawing methods between Scandinavia and North America are illustrated in figure Appendix 5.1. The sizes of the trees growing in these regions set very dissimilar demands for both procedures and machinery.

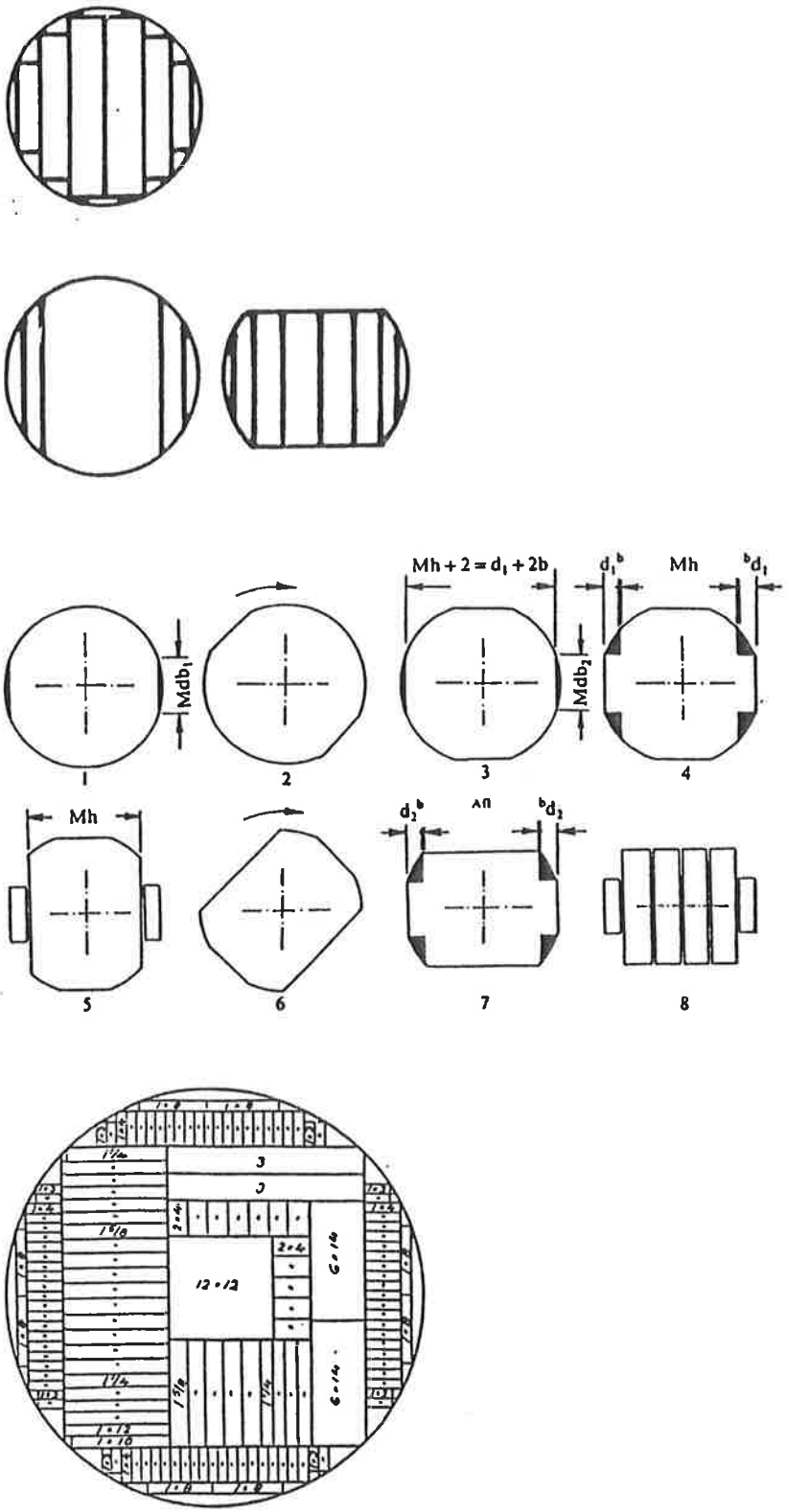

FIGURE 1 Sawing Methods in Scandinavia (1-3) and North America (4).

STATISTICAL REMARKS

These general definitions are provided by FAO Yearbook of Forest Products 1990, p. 114-121. They are generally accepted and widely used among forest industries all over the world.

PRODUCTION: The total production of primary products is reported, even though a portion may immediately be consumed in the production of another commodity (e.g. wood pulp, which may immediately be converted into paper as part of a continuous process). An exception is made in the case of veneer production, which excludes veneer sheets used for plywood production within the country.

IMPORTS: Products for domestic consumption or processing shipped into the country. "In-transit" shipments are excluded; in certain instances, imports for re-export may be included. Values are normally c.i.f.

EXPORTS: All quantities of domestic origin or manufacture shipped out of the country. As indicated above under "imports", re-exports may be included. "In-transit" shipments are excluded. Values are normally f.o.b.

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