

Keskusteluaiheita Discussion papers

Jussi Raumolin

THE TRANSFER AND CREATION OF
TECHNOLOGY IN THE WORLD ECONOMY
WITH SPECIAL REFERENCE TO THE
MINING AND FOREST SECTORS

No 313

23.02.1990

Paper presented at the seminar "World Industrial Restructuring and North-South Cooperation" organized by the IMEMO and the University of Helsinki Institute of Development Studies in Moscow, January 25-27, 1989. Will be printed in the publication based on the papers of the seminar edited by K. Kiljunen & V.B. Avakov, The University of Helsinki Institute of Development Studies Publications Series B in 1990.

ISSN 0781-6847

This series consists of papers with limited circulation, intended to stimulate discussion. The papers must not be referred or quoted without the authors' permission.



RAUMOLIN, Jussi, THE TRANSFER AND CREATION OF TECHNOLOGY IN THE WORLD ECONOMY WITH SPECIAL REFERENCE TO THE MINING AND FOREST SECTORS. Helsinki : ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1990. 34 p. (Keskusteluaiheita, Discussion Papers, ISSN 0781-6847; no. 313).

ABSTRACT: Studies on the transfer and creation of technology in the mining and forest sectors are not, in general, as advanced as in many other resource-based and industrial sectors. Some basic theoretical concepts about the transfer and creation of technology in these sectors are dealt with in the study. It is argued that such traditional conceptual divisions of the world as the First, the Second and the Third World are losing their significance in view of new developments; it is appropriate to deal with the industrialization of Finland by using NIC concepts, for instance.

Historical examples from Finland, Canada, Japan and Africa are presented to illustrate problems of technology transfer and creation.

It is asserted that the world is dangerously dividing between the countries which are able to adopt foreign technology, develop domestic technology and initiate future-oriented technological transformation and those which are not able to do so.

Finally, attention is paid to new problems caused by the introduction of new technologies, such as information technology and materials technology, and the growing pollution and destruction of the environment. New international cooperative efforts are necessary in order to mobilize resources to meet these challenges.

KEY WORDS: Transfer and creation of technology, mining and forest sectors, world economy

THE TRANSFER AND CREATION OF TECHNOLOGY IN THE WORLD ECONOMY WITH SPECIAL REFERENCE TO THE MINING AND FOREST SECTORS

1. Introduction

The notion of the transfer of technology is quite problematic since diffusion of technology has been continuous, especially after the industrialization started on the globe. It has taken place within the industrialized countries, been transferred from these countries to the developing countries and, during the last few decades, shifted between the developing countries as well.

Because of my recent research interests, I shall focus on the transfer of technology in two resource-based sectors, the mining sector and the forest sector. These resource-based sectors are, of course, important in many developing countries whereas they still play a significant role in a few of the industrialized countries, such as Finland, Sweden, Canada.

Normally, the notion of the forest sector has been defined to consist of forestry and the forest products industries considered together, whereas the mining sector means the mining industry and the basic metallurgical industry considered together. I would like to add the engineering industries supplying those industries with machinery and equipment in these definitions.

As far as the transfer of technology in forestry is concerned, I have distinguished between the professional forestry model and the substantive forestry model. The case where foresters have succeeded in establishing the sustained-yield practice in a country has often been presented as a model for others to follow. The foresters, however, have traditionally concentrated only on technical issues while neglecting the larger socio-economic setting

of forestry. This model concentrating on technical issues can be called the professional forestry model.

On the other hand, the forestry model where the specific natural and socio-economic conditions in a given country are taken into account can be called the substantive forestry model. The professional model has been dominant in the transfer of technology in forestry while it seldom leads to good results.

Turning to the transfer of industrial technology, it is possible to distinguish between the engineering model and the integrated model. The former model has been represented by Western experts focusing on technical issues whereas the latter one pays attention to local natural conditions, society and culture. The engineering model has been dominant in the transfer of industrial technology but it produces good results only in specific responsive conditions which rarely exist outside the Western world. In table 1., some general characteristics of the transfer of technology are presented.

The industrial restructuring has been a continuous process from the perspective of global industrialization. In this context, it is perhaps worth mentioning that Thorstein Veblen analysed the reasons for the rise of new industrial powers, such as Germany and Japan, already at the beginning of this century. He especially emphasized certain advantages that latecomers in industrialization enjoyed.

As regards to the contemporary discussion on long-term economic cycles in the capitalist industrialization, it has been argued that this is characterized by a periodic rise of new industries, and a fall of old industries. Technological innovation plays a crucial role in this perspective.

Table 1.

The Transfer and Creation of Technology

Means of Acquisition of Foreign Technology

- 1) Receiving foreign direct investment;
- 2) Importing foreign machinery and equipment;
- 3) Acquiring turn key plants;
- 4) Importing of foreign knowhow:
labour force, experts, consulting services;
- 5) Acquiring foreign patents and licences;
- 6) Acquiring technical aid from international organizations;
- 7) Establishing joint-ventures with foreign companies;
- 8) "Industrial espionage": utilization of foreign publications, education in foreign schools and universities; practice and work abroad;

Means of Creation of Domestic Technological Capability

- 1) Imitating foreign technology;
- 2) Learning by doing;
- 3) Adapting foreign technology to domestic circumstances;
- 4) Improving foreign technology;
- 5) Making original inventions and innovations;

Key for Success

- 1) Good education of workers;
- 2) Good education of engineers;
- 3) Development of domestic design capability;
- 4) Development of domestic R&D capability

Passive



Active

Source: Jussi Raumolin: The Role of Education in the Development of the Mining Sector in Finland. The Research Institute of the Finnish Economy (ETLA) Discussion Papers No 219. 1986 p. 3.

Turning to the recent transformations of the world economy, the late 1970s were characterized by both liberal borrowing possibilities in the international funding markets and project exports on a large scale from the West to the developing countries. This resulted in great problems of the transfer of technology and the debt serving among developing countries in the new conditions of the 1980s.

In the following, I shall mainly deal with some cases of the transfer of technology and creation on a country basis. The countries in question are Japan, Zaire, Finland, and Canada. In my opinion, such traditional conceptual divisions of the world, as the First, the Second and the Third World, are losing their significance in view of new developments. In fact, it is quite appropriate to deal with the industrialization of Finland by using NIC concepts, for instance.

This study heavily leans on my former studies in the field; let us hope that this new combination produces some new insights not available earlier (Cf. particularly Raumolin 1986a, 1986b, 1988c).

2. Transfer of Technology in the Mining Sector

2.1. Introduction

Historical studies on economic development distinguish between three different development zones in the world according to conventional classifications based on the international division of labour: the industrialized centre, the peripheries of the industrialized West and the peripheral developing countries.¹

Turning to the centre, the historical studies on the spread of the mining and metallurgical technology have concentrated

¹ This section mainly includes extracts from Raumolin 1988c.

heavily on the study of the iron and steel industry because of the major importance of this industry for the industrialization.

Instead marginal attention has been paid to the spread of technology in the non-ferrous metal industry. In the same manner as the existence of many lags has characterized the spread of the non-ferrous metallurgy there are several gaps in the research (Cf. Fremdling 1982, OECD: Gaps ... 1969).

As concerns the peripheries of the West, such as Canada, the Nordic countries and Japan, the state of research is quite uneven. One of the founders of the Canadian variant of the staple theory, Harold A. Innis, created a good basis for studies on the development of the mining industry in Canada already in the 1930s. In his view, the rapid rise of the mining industry in a marginal country like Canada took place by means of a massive importation of foreign technology.

Recent Canadian studies such as Robert Armstrong's study on the development of the asbestos industry in Quebec and Alexander Dow's study of the development of the non-ferrous metal industry in general have resulted in a more balanced view of the interaction between the foreign and the domestic factors (Cf. Innis 1936, 1941, Armstrong 1985, Dow 1985).

It is surprising that in the Nordic countries, where studies on economic history are so advanced, almost nothing has been written about the role of the mining sector and the transfer of technology from the perspective of development studies. It may be so that a highly sophisticated treatment of economic history and an open study of development do not fit together well. In any case Sweden has strong traditions in the mining industry and in the research and development concerning metallurgical processes: it has long been close to the European industrial centre. Furthermore, active

research and development of electro-metallurgical processes has taken place in Norway during this century.

As far as the Japanese case is concerned, the historical development path is quite well known thanks to the project "Historical Background of Technology Transfer Transformation and Development of Japan" undertaken under the auspices of the United Nations University during the late 1970s. I shall take a closer look at the Japanese case a little later (Cf. Hayashi 1979).

Following the example of the industrialized West, special attention has been paid to the transfer of technology in the iron and steel industry in the peripheral developing countries. For instance UNIDO and the scholars associated with Le Centre de Recherche sur l'Industrialisation et le Développement de l'Université de Grenoble (I.R.E.P.) have dealt with these issues (Cf. Roberts & Perrin 1975, Judet 1980).

In contrast the transfer of technology in the non-ferrous mining and metal industries is largely unknown. Concerning Latin America, such organizations as the Andean Group and the International Development Research Centre in Ottawa have promoted studies on the technology transfer in the copper industry, for example. The British scholar John T. Thoburn has dealt with these problems in the case of the tin industry in Malaysia (Cf. Mytelka 1978, Warhulst 1985, Thoburn 1973).

In Africa, Robert E. Baldwin touched upon these problems in his classic study on the copper industry in Rhodesia (Baldwin 1963). Recently, the Belgian scholar Jean-Claude Willame has published an impressive study on the problem associated with the transfer of Western industrial technology to Zaire (Willame 1986).

Generally speaking, there is no synthetical study on the transfer of technology in the mining sector in the developing countries. This question is only marginally dealt with in most of the general, regional or sectoral studies of mining-based development in the developing countries (Cf. Metzger 1980, O'Faircheallaigh 1984, Yachir 1987).

2.2. Case Studies

In the following, I shall take a closer look at two cases: the results of the Japanese project "Historical Background of Technology Transfer, Transformation and Development of Japan" with special reference to the mining sector and the studies of Belgian scholars on the transfer of industrial technology to Zaire.

The Japanese study clearly points out that there were strong national traditions in the copper industry and in the iron production in Japan. When industrialization started, these traditions were both an advantage and an obstacle. For instance, the traditional organization of labour was a great obstacle (Cf. Hoshino 1982, Iida 1979, Murakushi 1979, Yoshiki 1979).

The role of the Japanese state has been very active in the development of the mining and metal industries since the beginning of the industrialization of the country. Military interests were heavily involved, the state sent students abroad to have well educated experts at its disposal in the future, domestic education was promoted as well and several industrial expositions were organized to spread the information on Western technology. Japanese scholars were, however, looking for appropriate solutions to the national conditions instead of slavishly imitating the technology developed in the West.

The role of cultural factors, such as nationalism and national self-respect, played an important role in the transfer of technology. Japan followed a kind of intelligent followers' strategy by selectively opening itself to Western influences while integrating foreign acquisitions with national development aims.

In addition, it is interesting to note that some leading contemporary Japanese electronics industry companies stem from the copper industry. Those original mining industry companies integrated their production forward by starting the production of copper wire, then shifting to the electrical engineering industry and finally, to the electronics industry. Hence an approach which radically distinguishes between traditional and high-tech industries may be artificial. In Finland, for instance, the leading electronics industry company Nokia similarly stems from the copper wire industry. In addition, this company is still active in the paper industry and the rubber industry, among other things.

The Japanese case well illustrates the good results achieved by the adoption of an appropriate national technological strategy. It may even be so that an effort to develop a general theory of technological strategy is not worthwhile. A good and appropriate technological strategy is different in different countries depending on the specific conditions in question.

Turning to the case of Zaire, it was realized in the 1930s that the Congo River possessed a considerable hydro-electrical potential. Since then, many grandiose plans for the canalization of this potential for the purposes of the industrialization of the country have been presented. After the Belgian Congo gained independence at the beginning of the 1960s, the new state became interested in hydro-electrical projects. Western consulting engineering firms were eager to offer their services to the new government.

The plans presented during the late 1960s demonstrated how the erection of large hydropower stations would lead to the building of many related industries, such as the steel, aluminium, ferro-magnese, nickel and chemical industries.

The building of hydropower installations started in the early 1970s supported by Western expertize and supplier industries. Efforts were undertaken to attract new industries to Zaire as well. All those efforts however, resulted in the ruin of the country's economy. In the middle of the 1980s, the rate of utilization of the installed hydropower capacity was only about 25 per cent. Most the associated industrial projects hardly worked at all. The foreign debt represented about 90 per cent of the GNP, and it surpassed 200 per cent of the annual export income of Zaire.

According to Jean-Claude Willame, such conventional explanations as the errors made in the nationalization of the copper industry in 1973, the drastic decline in the copper price in the world market, the rise in prices of the imported oil, the incompetence of planners, corruption, the rise of the exchange rate of dollar and the global inflation are not sufficient reasons for this catastrophe.

The role of external agents in the large-scale transfer of technology should be taken into account. All kinds of Westerns agencies, such as consulting engineers, industrial suppliers, development cooperation agencies, private banks and public loan guarantee agencies were involved. Consulting engineers, in particular, bear a special responsibility as they offered a kind of scientific caution to the projects in question. The geopolitical interests of the West had an influence of their own on these operations.

Technology transfer realized in the context of joint ventures can often be seen as a form of industrial exploitation

resulting in the creation of "éléphants blancs" or "cathédrales de désert" as they are called in the francophone litterature. The Belgian authors, for their part, speak about technological safaris in Africa.

2.3. Further Notes

The Japanese example has been followed by the dynamic NIC-countries in South-East Asia. These countries have been able to utilize the transfer of Western technology including turn-key plants or direct foreign investment to the aims of national industrialization, and to initiate a consequent technological transformation.

Finland, which was a kind of a NIC-country during the interwar period 1918-1939, adopted a kind of the intelligent followers' strategy, and used the advantages of being a latecomer in the erection of an efficient mining and basic metallurgical industry.

Finnish mining and metal industries have been able to absorb Norwegian, Swedish, German, British, American and, later on, Soviet technology and to develop original Finnish solutions as well. During the last few decades, the Finnish mining and metallurgical technology has been exported to actual NIC-countries, such as South Korea, India, Mexico and Brazil, among other countries.

On the other hand, Africa is filled with "cathédrales de désert", such as steel mills, oil refineries and concrete factories. In addition to Zaire, such failures in the transfer of technology are visible in Nigeria, Camerun, Mauritania, Togo, Gabon and Congo-Brazzaville, for instance. The aims of rapid industrialization by local leaders, the project export promotion by Western interests, and the insufficient cultural, economic, social and physical infrastructures all together have led to poor results.

The world is dangerously dividing between the countries which are able to adopt foreign technology, develop domestic technology and initiate future-oriented technological transformations and those which are not able to do so.

3. Transfer of Technology in the Forest Sector

3.1. Introduction

As in the case of the mining sector, studies about the role of the transfer of technology have been few in the case of the forest sector. In the following a short survey of theories of forest-based development and the transfer of technology in connection is given.²

The discussion of the development of forest exploitation has been based on the idea of development stages. During the last century, German theorists of forestry presented the idea according to which the development of forest exploitation passed through various stages from destructive exploitation to sustained yield forestry. A shortage provoked by destructive exploitation had been the mother of forestry in Central Europe. By pioneering the establishment of a regulated forestry system, Germany pointed the way for others to follow (von Berg 1871).

During this century, these basic ideas have not changed much but different variations on the theme have been presented. For example, the idea about development by stages has been projected outside Europe and new stages have been added, such as the multiple use stage of forestry and the stage of intensified sustained-yield management (Cf. Heske 1931a; Mantel 1962).

2 This section mainly includes extracts from Raumolin 1986b.

Some authors have tried to integrate technological transformations in the stages view by applying the morphological idea of technological complexes. Typical of the eotechnic, paleotechnic and neotechnic phases is a certain type of energy use, enterprise structure, spatial pattern, and forest exploitation. In stressing the scientific advances in connection with the shift from the destructive paleotechnic phase to the modern neotechnic phase, this kind of analysis seems, however, to forget such problems as pollution, ecological problems associated with intensive forestry practices, and the impact of mechanization of lumbering operations on rural structures (Cf. Dinsdale 1965).

Some foresters dealt with the impact of forest-based development on rural communities in the West during the interwar years. In North America, the forest exploitation connected with the moving frontier was called the roving lumbering industry. Its impact was destructive: deserted farms, deforestation of lands, local shortage of timber, land speculation and interruption of community development. In contrast, an integrated and stable combined farm-forestry system was studied in the Nordic countries based on small woodland ownership and sustained-yield management (Cf. Dana 1918; Saari 1928).

After the last World War, the linkage approach has been applied to the analysis of the development impact of the forest sector. Some authors have pointed out many potential positive impacts of forest-based development including the ones on regional and rural development. On the other hand, critical analysis has pointed out that many potential linkages leak out of peripheral regions specialized in forestry and forest products industries. During the last few decades, the rise of centre-periphery, neo-Marxist and dependency theories, among other things, among the scholars in the resource-based peripheries has confirmed the results

of critical analysis (Cf. Cohn Jr 1954; Westoby 1962; Kromm 1968, 1972).

In the context of the rapid mechanization of lumbering operations, some models of mechanization were presented in the 1960s. For example, models of diffusion of technology were used. The specific models of logging mechanization, such as the law of discontinuous evolution, were developed as well. These models were quite deterministic excluding alternative development paths. On the other hand, the socio-economic and cultural setting of mechanization was poorly taken into consideration (Cf. Silversides 1965, 1966; Samset 1966, 1972).

Turning to the transfer of technology, these issues have traditionally been dealt with mainly in the context of the "exportation" of the German sustained-yield idea, the assistance for the establishment of the Western type of forest administration, forest research institutes and forestry education in "new", "backward" and "developing" countries. This was one of central themes of "Weltforstwirtschaftlehre" developed in Germany in the 1930s. Finally, one was confronted with the problem of the cultural role of the forester in a different cultural setting (Cf. Heske 1931b, 1948; Ebner 1953; Westoby 1965; Schlie 1976).

Among the few studies, the importance of the study of the German expert Adalbert Ebner published in 1953 should be stressed. After having gained a large international experience in forestry, he dealt with the difficulties of introducing modern forestry in new countries (Ebner 1953).

Ebner stated that forestry development in frontier conditions was faced with many problems. Large gaps as regards basic knowledge on forest ecosystems or the transition from natural to managed forest existed. The forestry development was

characterized by extensive erosion problems as well as unregulated industrial exploitation. Large tracts of forests were destroyed by fire.

Typical of forest administration was the dominance of a bureaucratic central office in the capital which had limited control over regional and local affairs. Its activities focused on short-term issues which resulted in a neglect of long-term planning necessary for rational forestry. In addition, the work of the administration was hampered by lack of a stable professional staff independent from political pressure.

As no forestry traditions in the European sense existed, pioneer native foresters aimed at becoming forest engineers according to the example set by successful technical professions established earlier. They took special interest in conspicuous technical issues. Students in the forestry schools were more interested in lectures on logging technology than in fundamentals of forest biology and ecology.

The way of thinking à la mode in international organizations claimed that technical assistance would solve the problems of underdevelopment. No technical solutions existed, however, because these problems were socio-economic and cultural to a high degree. Ultimately the power structure in a country imposed the ways and means of the exploitation of forests. Forestry and conservationist interests were weak in underdeveloped countries.

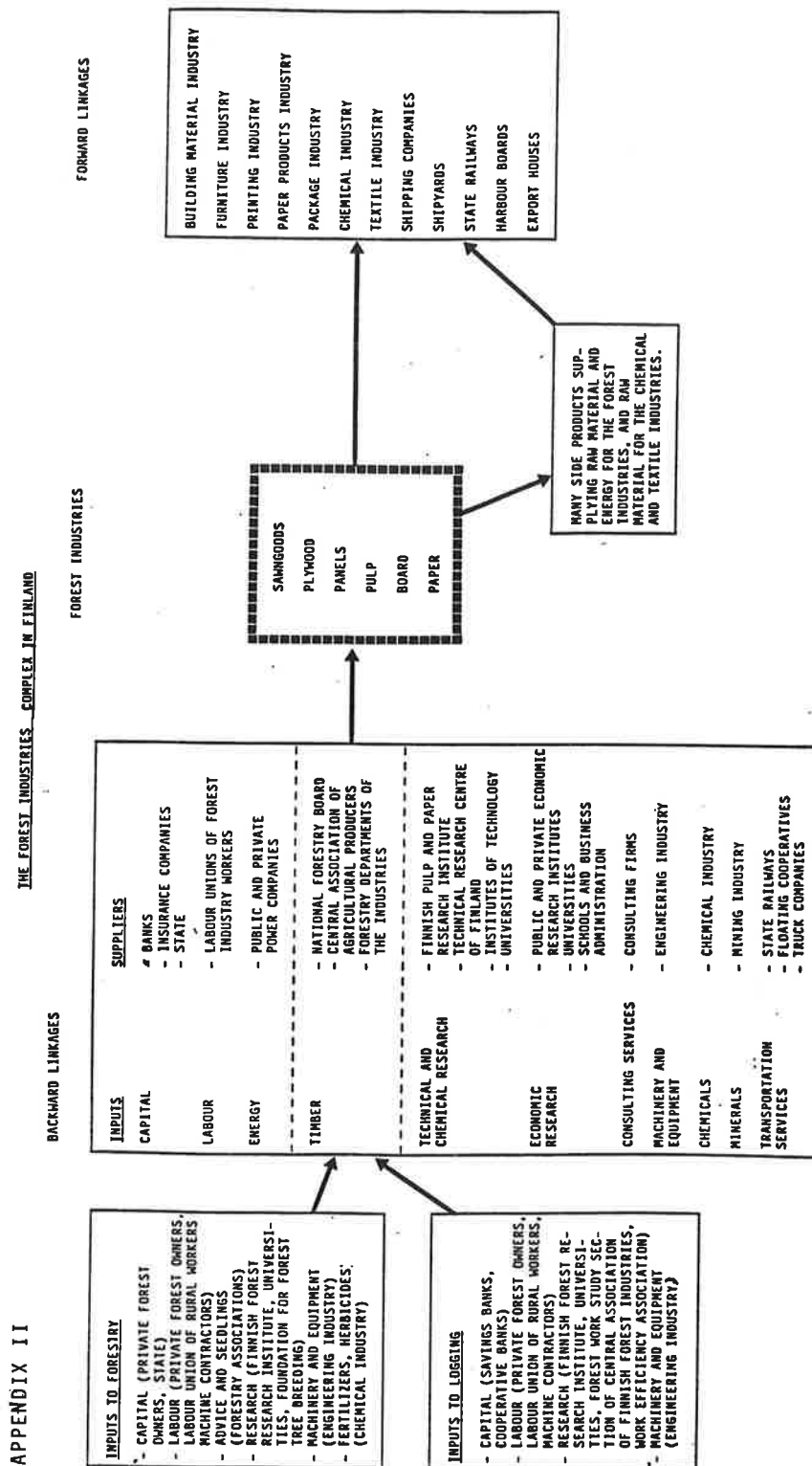
Ebner's analysis seems to be quite pertinent concerning the actual developing countries. From a historical point of view, it seems also to be relevant concerning the so-called new countries, such as Canada.

During the last few years, scholars have paid special attention to the relation of forestry to rural communities and

special agro-forestry studies have been started as well. Finally, questions about appropriate technology in forestry have been posed. Problems of forestry extension work in the developing countries have become socio-anthropological problems to a high degree (Cf. FAO 1978, 1982; Cernea 1981; Larman et al. 1981).

The actual state of socio-economic studies of forestry is a little perplexing because the clarification of such basis issues as the classification of enterprise forms, forest exploitation and forestry forms, and technological forms of exploitation is far from being satisfactory. During the last few years, new holistic approaches, such as forest sector studies via dynamic systems analysis or using industry complex analysis have been introduced. On the other hand, certain studies in the field of forest sector and forestry sociology have analysed power constellations and social conflicts associated in the exploitation of forest resource (Cf. Lönnstedt & Randers 1979, Raumolin 1981, 1984a, 1984b, Marchak 1983; Lee 1984 and table 2.).

Traditionally, studies in the field of cultural geography of forests in dealing with myths, values, and multiple uses of forest introduced a kind of anthropological dimension in the study of forest exploitation. The proper anthropological studies of forest and forest exploitation except for swidden cultivation, are not, however, well developed (Cf. Raumolin 1987, 1988a).



SOURCE: J. RAUMOLIN: DEVELOPMENT PROBLEMS IN THE SCANDINAVIAN PERIPHERY. UNPUBL. MSc. VANTAA, MAY 1980 P. 111 (SLIGHTLY MODIFIED).

NOTE: THERE IS A STRONG HORIZONTAL AND VERTICAL INTEGRATION AROUND THE MAIN PULP AND PAPER COMPANIES AS WELL AS COMMON EXPORT CARTELS.

In Jussi Raumolin: The Impact of Technological Change on Rural and Regional Forestry in Finland. Final report to the WIDER study programme "Development and Technical Transformation in Traditional Society. Alternative Approaches" Helsinki 1986 Appendix II.

3.2. A Comparison of Forest-Based Development in Finland and Canada

Next, a synopsis of my comparative studies about the development impact of the forest sector in Finland and Canada is given. In this synopsis, some ideas about the diffusion and transfer of technology are included.³

Even though Finland is a relatively small country in northern Europe and Canada a vast continental country in North America, there are good reasons to compare these two countries with each other. There are evident geographical similarities. The main parts of Finland and Eastern Canada are situated on the Precambrian formation which has been moulded by the retreat of glacial sheets. Typical of both regions is an ample network of lakes and rivers. During the winter, the ground is covered by snow and the waterways are frozen.

Historically both Finland and Canada were dependent on metropolitan powers. Traditionally, both Finland's and Canada's role in the international division of labour was to provide various staple products, such as fur, fish, timber, sailing ships, tar, and potash, for metropolitan markets. During the last century, the industrialization of Great Britain had a decisive influence on the rise of the modern sawmill industry in Eastern Canada and Finland.

So geography and history serve as a good starting point for comparative studies in economic development in Finland and Canada. A good theoretical starting point for such studies is the staple theory. Because geographical and historical similarities are the most pronounced between Finland and Eastern Canada, the development of the forest sector in these two regions will be compared with each other.

3 This section mainly includes extracts from Raumolin 1986a.

Table 3.

Main Differences in the Development of the Forest Sector in Finland and Eastern Canada, 1990-1980

<u>Finland</u>	<u>Eastern Canada:</u>
Intensive and Integrated Development Path	Extensive and Incoherent Development Path
- Forest resource chief asset	- Forests, mines and hydro-electricity
- Three main tree species	- Diverse tree species
- Private small woodland ownership dominant	- Public forest ownership-dominant
- Well-developed botanical research: original forest classification system	- Biogeographical research limited: expanded after World War II
- Sustained-yield forestry	- Extractive exploitation
- Western European export market dominant	- U.S. export market dominant
- In addition to sawmill and pulp and paper products, spool and plywood products important export articles	- Sawmill and pulp and paper products dominate exports
- Finnish control of industries	- Direct foreign investment in the pulp and paper industry
- Direct public intervention in the production via state-owned companies	- Economic liberalism dominant attitude with regard enterprise
- Close integration between forest industries	- Separate forest industries
- Strong export cartels	- Individual marketing organizations dominant
- "Negotiating" labour union movement	- "Striking" labour union movement
- Strained war conditions	- Expansionist war conditions
- Close integration between forest industries and engineering industry	- Separated forest industries and engineering industry
- Domestic control of the production of machinery and supplies	- Foreign branch plants dominate the production of machinery and other supplies
- Export of machinery and supplies	- Import and home market production of machinery and supplies dominant

In Jussi Raumolin: The Impact of Forest Sector on Economic Development in Finland and Eastern Canada in J. Raumolin (ed.), Natural Resources Exploitation and Problems of Staples-based Industrialization in Finland and Canada. Fennia 163:2, 1985 p. 428 (slightly modified).

The exports of forest products have played a very important role in the industrialization of Finland and Eastern Canada.

In the case of Finland, this role has been even more primordial. These exports are still the most important export items in both regions. In general, the development impact has been, however, quite different in each case. The differentiation of the development paths is mainly due to institutional differences. The principal elements of these differences are summed up in the table 3.

Except for many differences of an institutional nature, there have been many similarities in the development experience as well. The location of the industries close to the raw material sources, hydroelectric sources, and the main transportation network have exerted a profound impact on regional development both in Finland and Eastern Canada. The rise of the pulp and paper industry has had a decentralizing influence on industrial location and town structures in both regions.

The exploitation of forest resources has had a profound impact on the development of rural settlement as well. As the cultivation conditions are not very favourable, typical of the rural settlement in the forested parts of Finland and Eastern Canada has been a mixed farming system more or less specialized in dairy farming. The work outside the farm, principally forest work were important for the viability of the farms. The extensive rural colonization programmes in Finland and Eastern Canada during the first half of this century would not have been possible without the support of the expansion of forest product industries and forest work.

In spite of the clear geographical distinction of the main export markets, the forest product industries in Finland and Eastern Canada have met each other in other export

markets as well. The newsprint from Newfoundland has been a heavy competitor to the Finnish newsprint in the British market since the Great European War 1914-1918. On the other hand, the Finnish industry exported pulp to the American market during the interwar years. For their part, the Canadian sawmill exports returned to the British market supported by the British preferences again in the 1930s, and great amounts of Canadian pulp have arrived in the Western European market since the last World War.

As regards interconnections between the forest sector in Finland and Eastern Canada, the labour force provided by Finnish immigrants has been important in some parts in northern Ontario. Efforts were made to apply the Finnish forest and peatland classification ideas in Eastern Canada, especially in the 1930s and 1940s. The transfer of the Finnish technology to the forest product industries in Eastern Canada started in the 1960s. The Canadian contributions to the development of the Finnish forest sector have been limited. The transfer of some consulting services to the industries and the transfer of ideas and technology as regards the mechanization of woodland operations are worth mentioning.

During the 1960s and 1970s, a certain convergence between the development paths in Finland and Eastern Canada took place, such as rural depopulation due to mechanization of woodland operations and the erosion of competitiveness of the industries in the international markets.

The rise of "francophone" economic nationalism in Quebec was similar to the rise of Finnish-language economic nationalism in Finland in the 1920s. The effort toward domestic control of the forest product industries and toward integration of production in Eastern Canada made the Eastern Canadian development path move closer to the Finnish one than before.

Great differences between the development paths persist, however, continuously. Extractive exploitation is still practised in Eastern Canada irrespective of reformist speech and radical reform proposals. In fact, the productivity of forest per hectare is 3-4 times higher in Finland than there. On the other hand, prices of important production factors are continuously cheap in Eastern Canada as compared with Finland. For example, stumpage prices and electricity costs are 2 times higher in Finland. On the contrary, the production structure is more efficient, integrated and upgraded in this country.

Concerning the company size the largest Eastern Canadian pulp and paper companies lag far behind the largest American and Japanese companies. The company size is, however, much larger in Canada than in Finland, generally speaking. The recent restructuring of the Finnish pulp and paper industry has resulted in the formation of two additional companies with international stature along with Enso-Gutzeit, Kymmene and United Paper Mills (Cf. Raumolin 1988b).

Among the Western industrialized countries, Finland and Canada are not famous for the size of the national R&D effort. Among the industrial sectors in these countries, the R&D effort of the pulp and paper industry is low as compared with chemical and engineering industry, for example. The Finnish industry is pursuing, however, relatively more R&D than the Canadian one. Whereas the R&D expenditure per value added in production is around 1.00 per cent in Finland, the equivalent percentage in Canada is around 0.80. The R&D expenditure in the supplier industries is relatively higher in Finland as well (Cf. Hayter 1982, Hanel 1985, OECD 1985).

If R&D effort is considered a key to success in the future, the Finnish industry seems to have better chances. Because of domestic control of the industries, the close integration

between the forest industries and the supplier industries, and the well-established traditions of collective research and action, the diffusion of new technologies seems, in general, to be easier in Finland than in Eastern Canada.

The internationalization of the Finnish industries has extended to Canada as well. The transfer of the Finnish technology is passing via exports of machinery and equipment, export of licenses, and direct investment. The transfer of technology the other way round is actually minimal.

The forestry experts in Eastern Canada like to present the Scandinavian forestry as a model to strive for. As the Canadian experts in general are interested in technical questions, the specific historical, social and political context of the Finnish model is abstracted away from the discussion. The technocratic model of intensive forestry established in Finland in the 1960s is close to their preferences. It is a kind of irony of history that this kind of forestry seems to be only a passing phase in Finland (Cf. Raumolin 1986b).

During the last few years, some directors of the Finnish forest product industries, exasperated by the problems of wood market, have proposed that the Canadian model of forest exploitation should be adopted in Finland. The industry should, for example, have free access to public forests. These proposals tend to forget the decisive difference between extractive exploitation and sustained-yield forestry. As the internationalization of the Finnish industries progresses, in the direction of both the West and the East, the forestry discussion will surely become even more lively in the country.

3.3. Further Notes

Many developing countries have adopted the aim of creating domestic pulp and paper industries. The FAO and Western consulting engineering companies, including Finnish and Canadian ones, have given their support to these aims. However, the result has often been the erection of "cathédrales de désert" in small African countries and some smaller Latin American and Asian countries (Cf. Gomez 1978, Sila-On 1978, Douglas 1983, Willame 1986).

The large-size of the mills due to economies of scale needed in the modern pulp and paper industry, insufficient domestic demand for paper, gaps in infrastructures and problems related to wood supplies all together have contributed to these failures of the transfer of technology.

On the other hand, considerable progress had been made in larger Latin American countries, such as Brazil, Chile, Argentina and Mexico in the modern pulp and paper industry. Direct foreign investment, capable domestic entrepreneurship, existence of a sufficient domestic market and modern infrastructures as well as the extensive plantations of rapidly-growing trees have all contributed to this success. Brazil and Chile are even becoming significant exporters of forest products, by and by.

Recent technological developments in the Western pulp and paper industry, such as the adoption of millwide automation systems and the extension of the use of fast and large paper machines into new paper grades, such as printing and writing papers, have increased the size of chemical pulp and paper mills. These tendencies work against the opportunities of successfully transferring Western pulp and paper technology to most of the developing countries (Cf. Raumolin 1988a).

On the other hand, the development of new pulping methods, such as chemithermomechanical (CTMP) pulping technology has made the erection of small-scale pulp mills economically feasible. These developments may contribute to the spread of the modern pulp industry to the developing countries.

Because of depressed prices for sugar in the world market, initiatives have been taken in many sugar-growing countries to find out new uses for sugar-based by-products. The possibilities of using bagasse as a raw material for producing pulp and paper are receiving new attention in Cuba.

The Cuba-9 Experimental Center aims at developing new applications facilitating high-yield bagasse pulping of small-scale mills. It has recently developed a new chemi-mechanical pulping technology for this purpose. In general, new breakthroughs in pulping technology will be forthcoming, supported by recent advances in biotechnology (Cf. Luis Garcia 1989).

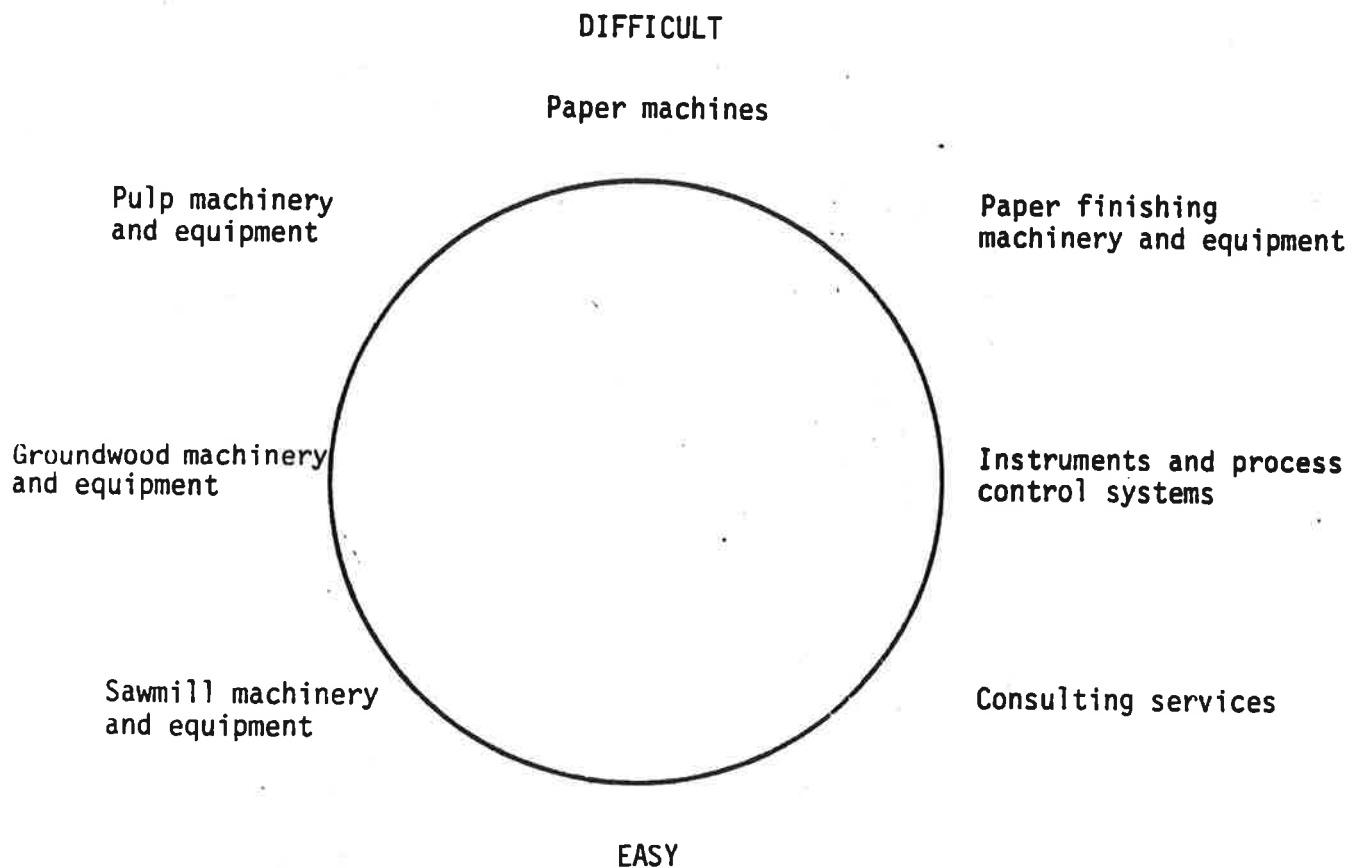
The engineering industry producing machinery and supplies to the chemical pulp and paper industry has traditionally been concentrated in the leading industrial countries.

Finland seems to be the only peripheral exporter of forest products which has been able to rise in the forefront of global production of machinery and equipment for the forest sector during this century (Cf. Raumolin 1984c, 1988b).

I have sketched a market entry circle to point out the paradox that the entry to the production of very traditional machinery and equipment, and to the most modern services and instruments may be much easier than moving directly to the heart of the system, i.e. the production of heavy paper machines (Cf. table 4.).

Table 4.

The Market Entry Circle in the Production of Supplies for the Forest Products Industries



Source: Jussi Raumolin: Forests, Technology Transfer and Creation, and Forest-Based Development in Finland, Canada Brazil. Plan for a Research Project. University of Helsinki Institute of Development Studies. October 15, 1986 p. 22.

4. Final Reflections

Finally, I shall briefly deal with certain consequences of the introduction of new technologies, such as information technology and materials technology, on the world economy of the mining and metal industries and the publishing industry.

Firstly, the substitution of new materials for traditional metals and the dematerialization trends in production processes in the West may provoke serious problems for the traditional exporters of metals, such as copper, among the developing countries in the long run (Cf. Raumolin 1986c).

Secondly, the introduction of new information technology seems to be difficult in many developing countries because the necessary infrastructures, such as a dense telephone network and a stable and continuous supply of electrical power are lacking.

Hence any possibilities of substituting new information technology for use of paper are quite restricted in the developing countries. The introduction of a new highly automatized printing technology in the West is also eliminating technological choices within the developing countries because the only suppliers of modern printing technology are concentrated in a couple of the leading industrial countries of the West (Cf. Winsbury 1981).

Because paper will play an important role in the promotion of literacy and education in the developing countries, new efforts, to develop alternative small-scale technologies in the printing paper production and printing technology are badly needed. In this field, cooperative efforts are necessary, and international organizations in particular will play a more important role in this field (Cf. Becker 1983).

Ultimately, the alarming devastation of the tropical forests as well as the havoc caused by airborne pollution in the Northern coniferous forests pose great new challenges for the traditional concepts of development and industrialization. The strengthening of international cooperative efforts is necessary in order to mobilize resources to meet these new challenges.

5. Bibliography

- Armstrong, R. 1985. The Quebec asbestos industry: technological change, 1878-1929 in: D. Cameron (ed.) *Explorations in Canadian Economic History. Essays in Honour of Irene Spry.* Ottawa, 198-210.
- Baldwin, R.E. 1966. *Economic Development and Export Growth. The Study of Northern Rhodesia 1920-1960.* Berkeley.
- Becker, J. 1983. *Papiertechnologie und dritte Welt. Ökonomieische Rahmenbedingungen und technische Alternative für die Produktion von Kulturpapier. Eine Studie für die Deutsche Gesellschaft für Technische Zusammenarbeit.* 2 bd. Frankfurt a.M.
- Berg, C.H.E. von. 1871. *Geschichte der deutschen Wälder bis zum Schlusse des Mittelalters.* Dresden.
- Cernea, M. 1981. *Land Tenure Systems and Social Implications of Forestry Development Programs.* World Bank Staff Working Paper no 452.
- Cohn, E.J. Jr. 1954. *Industry in the Pacific Northwest and Location Theory.* New York.
- Dana, S.T. 1918. *Forestry and Community Development.* U.S. Department of Agricultural Bulletin no 638.
- Dinsdale, E.M. 1965. Spatial patterns of technological change: the lumber industry of northern New York. Economic Geography 41, 252-74.
- Douglas J.J. 1983. *A Re-Appraisal of Forestry Development in Developing Countries.* The Hague.
- Dow, A. 1985. Prometeus in Canada. The expansion of metal mining, 1900-1950 in: D. Cameron (ed.) *Exploration in Canadian Economic History. Essay in Honour of Ireny Spry.* Ottawa, 211-28.
- Ebner, A. 1953. Menschliche Fragen als Begrenzung der Weltforstwirtschaft, Zeitschrift für Weltforstwirtschaft 16, 1-15.
- FAO: 1978. *Forestry for Local Community Development.* FAO Forestry Papers no 7.

- FAO: 1982. Appropriate Technology in Forestry. FAO Forestry Papers no 31.
- Fremdling, R. 1982. The development of the iron industry in Western Europe 1820-1860. A comparative view of the adaptation of cokesmelting and puddling in Belgium, France and Germany in: L. Jörberg & N. Rosenberg (eds.) Technical Change, Employment and Investment. Department of Economic History. University of Lund, 111-21.
- Gomez, G. 1978. Case history of a South American paper mill. Unasylva 30, No 122.
- Hayter, R. 1982. Research and development in the Canadian forest products sector-another weak link? Canadian Geographer 26, 256-63.
- Hanel, P. 1985. La technologie et les exportations canadiennes du matériel pour la filière bois-papier. L'Institut de recherches politiques. Montréal.
- Hayashi, T. 1979. Technology transfer and adaptation. The Japanese experience: Introduction. Development Economies 17, 373-97.
- Heske, F. 1931a. Ziele und Wege der Weltforstwirtschaft. Tharandter Forstliches Jahrbuch 82, 1-35.
- 1931b. Probleme der Forstwirtschaft in unentwickelten Ländern als Lehr- und Forschungsgebiet. Tharandter Forstliches Jahrbuch 82, 737-820.
1948. Die Forstwissenschaften auf Grundlage weltweiter Erfahrung. Zeitschrift für Weltforstwirtschaft 12, 3-10.
- Hoshino, Y. 1982. Technological and managerial development of the Japanese mining: the case of the Ansio Copper Mine. Development Economies 20, 220-39.
- Iida, K. 1979. The iron and steel industry. Development Economies 17, 444-60.
- Innis, H.A. 1936. Settlement and the Mining Frontier in Canada. Toronto.

- Innis, H.A. 1941. The Canadian Mining Industry. Preface to E.S. Moore: American Influence in Canadian Mining. Toronto, v-xvii.
- Judet, P. 1980. Iron and steel industry and transfer of technology concerning the direct reduction process in: D. Ernst (ed.) The New International Division of Labour. Technology and Underdevelopment. Frankfurt a.M., 307-25.
- Kromm, D.E. 1968. Sequences of forest utilization in northern Michigan. Canadian Geographer 12, 144-57.
1972. Limitations on the role of forestry in regional economic development. Journal of Forestry 70, 630-33.
- Larman, J., K. Virtanen & N. Jurvelius. 1981. Choice of Technology in Forestry. A Philippine Case Study. ILO. Quezon City.
- Lee, R. 1984. Sustained-yield and social order in: H.K. Steen (ed.) History of Sustained-Yield Forestry. A Symposium in Portland, Oregon, Oct 18-19, 1983. Forest History Society. Santa Cruz, Cal., 90-100.
- Luis Garcia, O. 1989. Cuba-9 Project develops bagasse CMP. Pulp and Paper International, March 1989, 49-50.
- Lönnsted, L & J. Randers (eds.) 1979. Wood Resource Dynamics in the Scandinavian Forest Sector. Studia Forestalia Suecica 152.
- Mantel, K. 1962. Aufgaben und Bedeutung von Wald- und Forstwirtschaften in historisch- und geographisch-vergleichenden Betrachtung von Entwicklungsstufen. Schriftenreihe der Forstlichen Abteilung des Albert Ludwigs Universität, Freiburg. Berichte 1., 51-67.
- Marchak, P. 1983. Green Gold. The Forest Industry in British Columbia. Vancouver.
- Mezger, D. 1980. Copper in the World Economy. New York.
- Murakushi, N. 1979. Coal mining. Development Economies, 27-46-183.
- Mytelka, L. 1978. Technological dependence in the Andean Group. International Organization 32, 101-39.

- OECD: 1969. Gaps in Technology. Non-Ferrous Metals. Paris.
1985. Reviews of National Science Policies: Finland.
Paris.
- O'Faircheallaigh, C. 1984. Mining and Development. London.
- Raumolin, J. 1981. Suomen ja Kanadan metsäsektorin yhteiskuntataloudellista tarkastelua (Socio-economic approach in the study of the forest sector in Finland and Canada) Yearbook of the Finnish Society for Economic Research 1980/1981, 78-99.
- 1984a. Metsäsektorin vaikutus Suomen taloudelliseen ja yhteiskunnalliseen kehitykseen (The impact of the forest sector on economic and social development in Finland). University of Oulu. Publications of the Research Institute of Northern Finland C 51.
- 1984b. The formation of the sustained-yield forestry system in Finland in: H.K. Steen (ed.) History of Sustained-Yield Forestry. A Symposium in Portland, Oregon, Oct. 18-19, 1983. Forest History Society, Santa Cruz, Cal., 155-69.
- 1984c. The world economy of forest products and the comparative development impact of the forest sector. An exploratory inquiry. Yearbook of the Finnish Society for Economic Research 1983/1984, 188-211.
1985. The impact of forest sector on economic development in Finland and eastern Canada in: J. Raumolin (ed.) Natural Resources Exploitation and Problems of Staples-Based Industrialization in Finland and Canada. Fennia 163:2, 395-434.
- 1986a. Recent trends in the development of the forest sector in Finland and eastern Canada. Zeitschrift der Gesellschaft für Kanada-Studien 11, 89-114.
- 1986b. The Impact of Technological Change on Rural and Regional Forestry in Finland. Final report to the WIDER study programme "Development and Technical Transformation in Traditional Societies: Alternative Approaches". Mimeo 84 p. Helsinki Dec. 30, 1986.

- Raumolin J. 1986c. Kaivos- ja metallituotteiden maailmantalous (The world economy of mining and metal products). The Research Institute of the Finnish Economy (ETLA) Discussion Papers 211.
- 1986d. The Role of Education in the Development of the Mining Sector in Finland. The Research Institute of the Finnish Economy (ETLA) Discussion Papers 218.
- 1986e. Forests, Technology Transfer and Creation and Forest-Based Development in Finland, Canada and Brazil. Plan for a Research Project. The University of Helsinki Institute of Development Studies. Oct, 15, 1986 67 p plus 7 app.
1987. Introduction to the study of swidden cultivation in: J. Raumolin (ed.) Special Issue on Swidden Cultivation. Suomen Antropologi/Journal of the Finnish Anthropological Society 12:4, 185-98.
- 1988a. Trooppisten metsien integroituminen maailmantalouteen. Historiallinen ja kehitysteoreettinen näkökulma (The integration of the tropical forests into the world economy as seen from the point of view of history and development theories) in: A. Erkkilä & J. Kuuluvainen (eds.) Tropiikin metsät (Tropical forests). University of Joensuu. Silva Carelica 12, 305-22.
- 1988b. Restructuring and Internationalization of the Forest, Mining and Related Engineering Industries in Finland. The Research Institute of the Finnish Economy (ETLA) Discussion Papers 267. An abridged version will be published in J.C. Hansen & M. Hebbert (eds.) Unfamiliar Territory. The Reshaping of European Geography. London 1990.
- 1988c. Problems related to the transfer of technology in the mining sector with special reference to Finland in: J. Raumolin & L. Siitonen (eds.) Problems Related to Transfer of Technology and

Mineral-Based Industrialization with
Special Reference to Finland and Africa.
Publications of the University of Helsinki
Institute of Development Studies 16/1988
B, 33-65.

- Roberts, J. & J. Perrin 1975. Engineering consultancy in India: the public sector steel industry in: M. Radice (ed.) *International Firms and Modern Imperialism*. Harmondsworth, 215-29.
- Saari, E. 1928. Metsien merkitys maataloille (The role of forests on Finnish farms). Yhteiskuntataloudellinen aikakauskirja 24, 28-40.
- Samset, I. 1966. The implication of mechanization of forest employment on developing countries. Proceedings of the Sixth World Forestry Congress 3. Madrid, 2952-65.
1972. Forestry Operations in a Dynamic Production Forestry Illustrated by Examples from Norway. University of British Columbia. Faculty of Forestry. The H.R. Macmillan Forestry Lecture.
- Schlie, T.W. 1976. The transfer of agricultural and forestry technology between regional and national research institutions in: D.B. Thomas et al. *Importing Technology on Africa. Foreign Investment and the Supply of Technological Innovations*. New York, 102-33.
- Sila-On, A. 1978. The transfer of technology. Unasylva 30, no 122.
- Silversides, C.R. 1965. Developments of Logging Mechanization in Eastern Canada. University of British Columbia. Faculty of Forestry. The H.R. Macmillan Forestry Lecture.
1966. The rate of diffusion of new harvesting systems and machines in the pulpwood logging industry in eastern Canada. Pulp and Paper Canada 1967, no 10 WR, 510-38.

- Thoburn, J.T. 1973. Exports and the Malaysian engineering industry: a case study of backward linkages. Oxford Bulletin of Economics and Statistics 35, 91-117.
- Warhust, A. 1985. Biotechnology for mining: the potential of an emerging technology, the Andean Pact Copper Projects and some policy implications. Development and Change 16, 93-121.
- Westoby, J.C. 1962. The role of forest industries in the attack on underdevelopment. Unasylva 16, 168-201.
1965. World Forest Development. Markets, Men and Methods. University of British Columbia. Faculty of Forestry.
- The H.R. Macmillan Forestry Lecture.
- Willame, J.-C. 1986. Zaire. L'épopée d'Inga. Paris.
- Winsbury, R. 1981. New Technologies in Newspaper Production in Developing Countries and their Labour and Social Implications. ILO WEP 2-22/WP 85.
- Yachir, F. 1987. Enjeux miniers en Africa. Paris.
- Yoshiki, F. 1979. Metal mining and foreign employees. Development Economies, 17, 484-505.

ELINKEINOELÄMÄN TUTKIMUSLAITOS (ETLA)
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, SF-00120 HELSINKI

Puh./Tel. (90) 601 322
Int. 358-0-601 322

Telefax (90) 601 753
Int. 358-0-601 753

KESKUSTELUAIHEITA - DISCUSSION PAPERS ISSN 0781-6847

- No 284 JAMEL BOUCELHAM - TIMO TERÄSVIRTA, How to Use Preliminary Values in Forecasting the Monthly Index of Industrial Production? 08.03.1989. 14 pp.
- No 285 OLLE KRANTZ, Svensk ekonomisk förändring i ett långtids- perspektiv. 28.02.1989. 29 p.
- No 286 TOR ERIKSSON - ANTTI SUVANTO - PENTTI VARTIA, Wage Setting in Finland. 20.03.1989. 77 p.
- No 287 PEKKA ILMAKUNNAS, Tests of the Efficiency of Some Finnish Macro- economic Forecasts: An Analysis of Forecast Revisions. 30.03.1989. 19 p.
- No 288 PAAVO OKKO, Tuotantomuodon muutos ja sen merkitys yritys- ja aluerakenteelle. 08.05.1989. 14 s.
- No 289 ESKO TORSTI, The Forecasting System in ETLA. 10.05.1989. 36 p.
- No 290 ESKO TORSTI, MAT-ohjelmointitulkkin käyttö ja rakenne. 11.05.1989. 67 s.
- No 291 GUJA BACCHILEGA - ROBERTO GOLINELLI, Medium Term Prospects for the European Economies. 17.05.1989. 27 p.
- No 292 KARI ALHO, Deregulation of Financial Markets: A General Equilibrium Analysis of Finland. 31.05.1989. 43 p.
- No 293 PAAVO OKKO - EERO KASANEN, A Model of Banking Competition. 15.06.1989. 20 p.
- No 294 HILKKA TAIMIO, Naisten kotityö ja taloudellinen kasvu Suomessa vuosina 1860-1985. 28.06.1989. 38 s.
- No 295 PETTERI HIRVONEN, Kysyntä-tarjonta -kehikon mukainen siirtofunktiomalli bruttokansantuotteelle. 23.08.1989. 38 s.
- No 296 PAAVO OKKO, Suomen aluekehityksen ja aluepolitiikan nykyvaihe. 01.09.1989. 20 s.
- No 297 ANTTI RIPATTI - PENTTI VARTIA - PEKKA YLÄ-ANTTILA, Suomen talouden ja yritysraakenteen muutokset 1938-1988. 11.09.1989. 95 s.

- No 298 ROBERT HAGFORS, On Economic Welfare Equality as a Policy Goal and Social Transfers as Instruments. 11.09.1989. 20 p.
- No 299 SYNNOVE VUORI - PEKKA YLÄ-ANTTILA, Joustava tuotantostrategia puu- ja huonekaluteollisuudessa. 27.09.1989. 60 s.
- No 300 SEVERI KEINÄLÄ, Finnish High-Tech Industries and European Integration; Sectoral Study 1: The Telecommunications Equipment Industry. 12.10.1989. 85 p.
- No 301 VESA KANNIAINEN, The Arch Model and the Capm: A Note. 30.10.1989. 10 p.
- No 302 VESA KANNIAINEN, Research Issues in Corporate Taxation. 30.10.1989. 10 p.
- No 303 TOM BERGLUND, Perceived and Measured Risk; An Empirical Analysis. 30.10.1989. 29 p.
- No 304 SEVERI KEINÄLÄ, Finnish High-Tech Industries and European Integration; Sectoral Study 2: The Data Processing Equipment Industry. 01.11.1989. 44 p.
- No 305 MASSIMO TAZZARI, Numeeriset yleisen tasapainon ulkomaankaupan mallit, teoria ja sovellutuksia. 02.11.1989. 64 s.
- No 306 JUKKA LASSILA, Preliminary Data in Economic Databases. 10.11.1989.
- No 307 SEVERI KEINÄLÄ, Finnish High-Tech Industries and European Integration; Sectoral Study 3: The Pharmaceutical Industry. 15.11.1989.
- No 308 T.R.G. BINGHAM, Recent Changes in Financial Markets: The Implications for Systemic Liquidity. 12.12.1989. 39 p.
- No 309 PEKKA ILMAKUNNAS, A Note on Forecast Evaluation and Correction. 27.12.1989. 13 p.
- No 310 PEKKA ILMAKUNNAS, Linking Firm Data to Macroeconomic Data: Some Theoretical and Econometric Considerations. 27.12.1989. 38 p.
- No 311 THOMAS WIESER, What Price Integration? Price Differentials in Europe: The Case of Finland. 27.12.1989. 30 p.
- No 312 TIMO MYLLYNTAUS, Education in the Making of Modern Finland. 22.02.1990. 36 p.
- No 313 JUSSI RAUMOLIN, The Transfer and Creation of Technology in the World Economy with Special Reference to the Mining and Forest Sectors. 23.02.1990. 34 p.

Elinkeinoelämän Tutkimuslaitoksen julkaisemat "Keskusteluaiheet" ovat raportteja alustavista tutkimustuloksista ja väliraportteja tekeillä olevista tutkimuksista. Tässä sarjassa julkaistuja monisteita on rajoitetusti saatavissa ETLAn kirjastosta tai ao. tutkijalta. Papers in this series are reports on preliminary research results and on studies in progress; they can be obtained, on request, by the author's permission.

E:\sekal\DPjulk.chp/23.02.1990