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TECHNOLOGY TRANSFER AND THE CONTEXTUAL FILTER IN THE FINNISH SETTING. TRANSFER CHANNELS AND MECHANISMS IN AN HISTORICAL PERSPECTIVE*

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ABSTRACT: The first chapter of the study examines some key concepts of technological change and outline a theoretical model on the transfer of foreign technology to an industrialising country. The model of technology transfer presented is composed of five components. The first two components are the main parties of the transfer process, the suppliers and recipients of technology. The third component is the channel apparatus through which machinery and technological know-how are moved from one region to another. The fourth component is the societal and cultural filter that has a pivotal role in defining the framework and general rules of the transfer process. The fifth component consists of external factors. The function of a certain transfer model can be radically changed by some major outside influences, such as war, economic crisis or ecological calamity. The success of a transfer mechanism depends on the way in which these components interact with each other.

The second chapter analyses how industrialising Finland utilised various channels for the inter-country transfer of technology. Eight channels under study are natural diffusion, foreign experts, journeys abroad by nationals, the importation of machinery, direct foreign investment, foreign patents and licences, joint-ventures and turnkey plants.

The final chapter evaluates the function of the Finnish model of technology transfer, the national peculiarities of the Finnish contextual filter, and the contributions of the eight channels. As an outcome of the analysis, the study claims that in transferring technology into their country, the Finns used no shortcuts but chose instead fairly slow, roundabout and uncertain channels. That choice probably delayed industrialisation in the 19th century, but supported and boosted it during most of this century. The Finnish model did not exploit the available collection of transfer channels as efficiently as those of some more successful countries. One feature, however, is noteworthy: during the turbulent periods of the 20th century, transfer models that based on extensive dependence on the foreign suppliers of technology faced difficult times. Compared to those models, the Finnish model worked best during turmoil while suffering from certain drawbacks during periods of peace. As a result, it is likely that the Finnish model of technology transfer has stabilised economic development during this stormy century.

KEY WORDS: Technology transfer, technology policy, economic history, Finland.

CONTENTS

PREFACE

Interest in economic issues on technological change and the transfer of technology led me several years ago to research the history of technology, which was then a fairly new approach in studying the past of Finland. While penetrating the subject more closely, I noticed that in technological change, there is not only question on technical or economic phenomena but also socio-cultural constellations are of a pivotal significance. At the time, I began to ponder how socio-cultural factors influence on technological change. Later, I dealt with the subject in several writings. In a way, this paper is a synthesis of my earlier findings in studying the transfer of foreign technology into Finland during the period of industrialisation.

On various stages of the research, I have had a pleasure to receive feedback from distinct colleagues as well as watchful students who attended my courses on this topic at the Tampere University of Technology. While developing my model of technology transfer, the encouragement by Leslie Hannah, Thomas P. Hughes, Charles P. Kindleberger, Alan Milward and Robert C. Post acted as a spur. I am also very grateful to Marion A. Brown, Jane Morley, John Rogers, Synnöve Vuori and Pekka Ylä-Anttila for their constructive comments on the previous versions of this paper, which I worked out for the book *Mastering Technology Diffusion - The Finnish Experience*. I acknowledge the financial support by the Research Institute of the Finnish Economy, the NOS-S research project 'Industrialisation in the Nordic Countries' and the Finnish Ministry of Trade and Industry.

September, 1992 *Timo Myllyntaus*

1. A THEORETICAL APPROACH TO TECHNOLOGY TRANSFER

1.1 Points of Departure

Technological change is widely recognised as a factor that has restyled human life in history. Its role is even more important for the present time. The Brandt Commission on International Development Issues in 1980 identified difficulties in technology acquisition as central to the problems of the developing world (*North-South* 1980; *Transfer of International Technology* 1991, 2). The transfer of foreign technology promotes technological change in a latecomer economy. A major problem for developing countries presently is how to achieve efficient technology transfer. There is no single formula or universal recipe for organising successful and smooth technology transfer between countries.

So far only case studies of earlier transfers have been offered as lessons for latecomers, because we lack comprehensive theories on technology transfer. This paper is an intermediate step in the development of such a comprehensive theory. The goal is first to outline a general model comprising the basic elements of the transfer mechanism, and second, to illustrate the function of the model with an historical case study.

Technology can be defined as knowledge to innovate, design, produce and use tools, machines and other commodities as well as expertise to organise and manage production and marketing. Alternatively, it can simply be claimed that technology comprises man's methods of meeting his wants and needs by using physical means. In the case of technology, it is a question of know-how that is related to both physical means and goal-oriented activity (Lindqvist 1987, 11-33).

The transfer of technology generally denotes the flow of technological expertise and technical equipment from one geographical area to other. Furthermore, the purpose in the transfer is to initiate a process of technological transformation of the recipient society.

In technology transfer, there are two parties: the suppliers of technology, who possess technical expertise, and the recipients of technology, who would like to share in that expertise. These are the main actors in the transfer process. Most theoretical considerations of technology transfer - not only Anglo-American but also Finnish ones - approach the issue from the viewpoint of the suppliers (Saralehto 1986). In contrast, I aim to examine the technology transfer from the viewpoint of a recipient economy, and in an historical perspective as well. The difference in these viewpoints is not marginal; sometimes key issues seem almost unrelated if evaluated from contrasting standpoints.

The spread of a technology within a country or an economic region is what I call diffusion. In contrast, technology transfer means the spread of technology from one culture, country, or economic region to another. The difference between these concepts is related not only to geographical entities but also to characteristics of the phenomena. In the transfer process, the role of a recipient is generally more active and goal-orientated than in the diffusion process. In the case of technology transfer, the recipient cannot avoid evaluating evident consequences for the economy and society. When a diffusion process is set in motion, the technology in question is usually already present in society, while in the case of transfer, society has often first to decide whether it accepts or rejects a new optional technology.

Technology transfer is not just a matter of transporting some piece of hardware from one place to another. On the contrary, it is a complex process of transformation that takes place in a specific economic, societal and cultural context. If certain conditions are not fulfilled, the same technology that has worked successfully somewhere else may completely fail in a new setting. In less developed countries, the pivotal problem in technology transfer is often their inability to supply sufficient material and societal infrastructure for new technology. The recipient economy should possess adequate prerequisites to adopt, use and maintain a new kind of technology, for example in an electrochemical factory. However, a material infrastructure, such as water and electricity supply, and transport and telecommunication facilities, is not enough. There must also be a sufficient nonmaterial infrastructure with components such as a stable functional political system and a pool of skilled labour.

1.2 Channels for Technology Transfer

Countries seeking to industrialise generally can create only a tiny fraction of the modern technology they need, so they are compelled to obtain foreign technology to modernise their economies. Those vehicles through which machinery and technological know-how are transferred from suppliers to recipients are called channels for transfer technology. Within specific limits, technology is a multidimensional phenomenon, and it can be transferred from one country to another in many forms and through various channels. Regarding economic and societal effects, it is significant in what form technology is transferred into a country and by whom. If it is obtained in such a way that the recipient country is able to control neither the transfer nor utilisation, then there is a risk that the recipient becomes dependent on the supplier of technology. Some types of technological know-how are also available easily without any obligation or at low cost from the world market. In that case, however, there is a danger that the recipient cannot exploit the acquisition of technology composed of separate, poorly compatible components, because the result may be an unworkable technological unit.

In the 18th and 19th centuries, the innovation of new technology was concentrated in a few major industrialised countries: Britain, France and, later, Germany and the United States. A great many other countries attempted to follow the example of these forerunners and to adopt their modern technology. In the 20th century, technology has become even more international. Innovative activities have dispersed among a larger group of countries than in the earlier periods. In recent decades, the greatest volume of technology transfer has taken place between advanced, industrialised countries.

The channels that transmit innovations from industrial centres to the peripheries of the world can be classified in many ways. I consider the following eight channels, depicted in Table 1, the most significant.

Table 1 presents channels that have been historically significant. Because the number of transfer channels has been increasing in the 20th century, it would be possible to classify dozens of different channels presently used if we preferred finer distinctions. The characteristics of channels can also be grouped in various ways. For example, according to the forms of transferred technology, the power structures of the transfer process, the roles of participants in the transfer process and the efficiency of channels.

Embodied vs. unembodied technology transfer. In the transfer of embodied technology, know-how is transported from a country to another in the form of tangible equipment. Technology can be transferred in a kind of a "guaranteed package," such as in machinery, or a whole plant as a turn-key delivery. In such a case, the recipient can expect to receive new technology that works.

The transferred hardware contains built-in technological expertise characteristic of the period during which it was manufactured. As a result, the capital stock of each industry consists of technically different vintages, the productivity of which is, as a rule, graded according to its age. Regardless of actual physical wear and tear on machinery, embodied technology always becomes obsolete when its new counterparts come onto the market. This type of technology is generally difficult to update in any economy. A country that imports its capital goods usually lacks resources to update and improve its machinery as it grows obsolete.

It is impossible to embody all technological knowledge in machinery. Part of the technical personnel's know-how is related to the organisation and management of the production process. This kind of expertise can be transferred only in an unembodied form. It is included in human capital that can be transferred through human performance, communication and education. Unembodied technological know-how is a result of management and vocational schooling, job training and learning by doing. Updating this kind of know-how becomes a continuous process resulting in a more meaningful adoption of technology.

Table 1. Channels for the inter-country transfer of technology.

Role of the recipient		Channels of transfer	Type of transfer
Passive	1	Receiving direct foreign investments	Controlled
	2	Importing foreign machinery and equipment	Controlled
	3	Acquiring turn-key plants	Controlled
	4	Acquiring foreign licenses and patents	Controlled
	5	Setting up joint-ventures with foreign entrepreneurs or companies	Controlled
II V	6	Recruiting skilled workers, artisans, engineers, teachers and consultants from abroad or permitting mass immigration consisting of a large spectrum of people ranging from unskilled labour to various craftsmen and professionals.	General
	7	Encouraging and supporting nationals' journeys abroad for studying at foreign schools and universities, or training in factories, visiting international congresses and trade fairs, making contacts with foreign experts, etc.	General
Active	8	Utilising "natural diffusion" or the low-cost diffusion of easily accessible techno-logy: the spread of know-how through trade and scientific publications, analysing foreign products, etc.	General

Embodied and unembodied technology complement each other, and they tend to appear together. In practice, machinery and expertise are often transferred simultaneously. Therefore, a successful transfer of technology requires a parallel use of several channels. Which type of technology transfer a country utilizes most seems to depend on its prerequisites and goals, as well as its relations with foreign countries. The mastery of various aspects of a specific technique helps to avoid dependence on a few oligopolistic suppliers.

General vs. controlled channels. From the viewpoint of a recipient economy, technology transfer may or may not include some sort of engagement or subordination. Technology transferred through general, unlimited channels is fairly easily available and inexpensive. It is not, as a rule, bought from the original innovators but through middlemen, or obtained from commonly accessible sources. In this case, the recipient makes the decisions on technology transfer; he chooses from whom he buys and what. In the extreme case of the general transfer, the supplier gradually becomes an outsider, because he does not finally know where his technology spreads (Saralehto 1986, 91-109).

In the controlled transfer of technology, there is always a supplier and a recipient who both make decisions. In this case, the object of transfer is clearly defined and its price is fairly high. This type of technology cannot generally be purchased freely on the world market because it includes at least some secret or otherwise protected components of technological expertise. In the controlled transfer of technology, the supplier has the upper hand; ultimately it is he who decides when and where his technology is transferred.

Active vs. passive recipients. The channels of technology transfer can also be classified according to which party is the most active in organising and managing the transfer. In the cases of controlled transfer, especially in direct foreign investments, the supplier is responsible and the most active party. In contrast, the general transfer of technology greatly depends on the activity of a recipient country. It preserves the dominance of the recipient country in the transaction, and its autonomous efforts to gain technological self-sufficiency, although the hazards of dependence are involved in the case of controlled technology transfer. Despite some advantage of controlled transfer and the direct involvement of foreign companies, less developed countries fear the consequences of technology imports on their aspirations for self-reliant growth and self-determination over resources (Jussawalla 1983, 134).

Efficient vs. inefficient channels. It is often claimed that the efficiency of the channels mentioned in Table 1 decreases from number 1 to number 6; in other words, know-how successfully transferred through the top channels will boost the economy of the recipient country in a shorter period of time than know-how brought in through the bottom channels (*Komiteanmietintö 1980:55*; Mansfield 1982, 29).

Although many experts and influential institutions, such as the OECD, support this hypothesis, it has met criticism. There are examples of less developed countries that have relied in their technology transfer on channels other than direct foreign

investments and have managed to boost their industrialisation. Such success sharply contradicts the common belief in the critical role of transnational companies.

Rarely has any type of technology been transferred through just one channel. Even in the early phases of industrialisation, the persons involved in the international spread of technology had to evaluate various alternative vehicles for transferring technological expertise, and they generally chose a mix of channels depending on the characteristics and needs of the individual project.

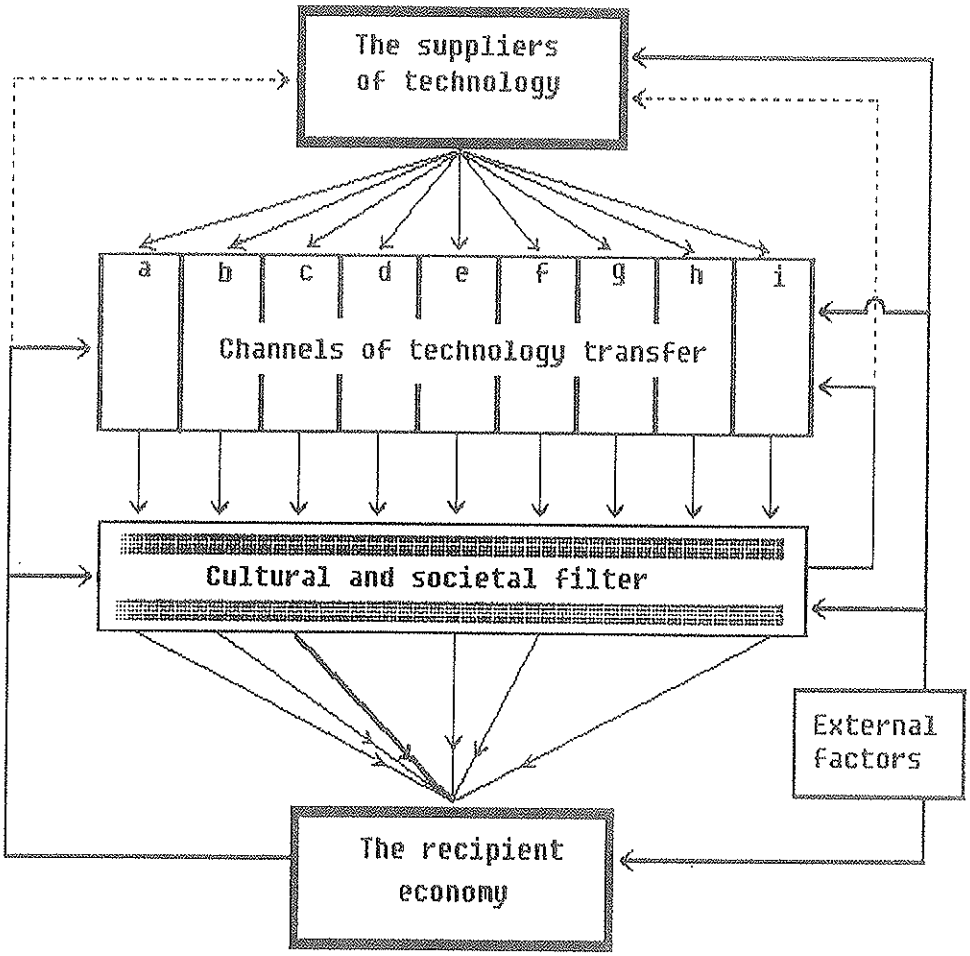
Compared to the circumstances of the 19th century, nowadays it is, of course, possible to provide much more comprehensive packages for the delivery of technology that comprise everything from the licensing package of a trademark product, turnkey deliveries with tailor-made equipment, and detailed engineering and design of production lines to equity joint ventures, expatriate technical managers, management consulting, training programmes for native workers, in-plant services, etc. Transfer channels generally complement each other, while if necessary, some channels could be supplemented by others. Although the channel apparatus is, as a rule, a fairly flexible "tool-kit," there are other factors defining what channels are economically and societally acceptable.

1.3 Societal and Cultural Filter

The channels of Table 1 have been utilised all over the world. If, however, an international comparison is made to determine to what extent various countries have used these channels, some clear differences in emphasis can be observed. Discrepancies can also be found in how the governments have favoured or discouraged the use of certain transfer channels. Many societal features of the recipient country - not only the government - have profound effects on the transfer of technology. As a result, it can be claimed that when a new technology is being transferred into a country, it should, in a way, be filtered through a "sieve" composed of various economic, political and cultural layers. This contextual filter affects the choice of technology as well as the channel through which it is transferred. The choice may essentially influence the pattern of adoption and its success. I have condensed my theory on the mechanism of technology transfer from the recipient's viewpoint in Figure 1.

At least in theory, the assortment of potential channels for technology transfer is roughly the same for all countries, but the contextual filter is always unique and nationally defined. This filter is very polymorphous. It can selectively close one channel completely, obstruct the functions of another, give the third a free-hand, and overload the fourth. It does not generally remain stable over time, but keeps shifting as a result of changes in government, foreign trade relations, or the economic situation.

Figure 1. The Mechanism of Technology Transfer.



The societal and cultural filter of technology transfer is an ambiguous combination of various elements ranging from unconscious popular attitudes to strict laws. The societal and cultural filter comprises the autonomous mechanism that regulates the transfer and application of technology. The introduction of an innovation is successful only if the social environment of the recipient country is supportive of it. Therefore, technology transfer is not only a technical operation but also a societal manoeuvre. The crucial factor is whether there are effective and socially accepted methods of carrying out the intercultural process. The technology itself and its transfer channels should be coordinated with the existing societal and cultural environment.

Innovation diffusion or modernisation do not follow the classical model if people concerned disagree upon the line of development. In the many countries, the peasantry has nibbled unpopular government schemes and programmes to death. In resisting the type of technology transfer imposed on the common people, "the weapons of the weak" are various negative or affirmative, conscious or unconscious efforts such as apparent co-operation or non-co-operation, neglecting the maintenance of the equipment, stealing spare parts and tools, "going slow", etc. (Scott 1985, 7; Swantz 1989, 144-45).

The transfer of modern technology may severely clash with the traditional culture of a late industrialising country. For example, islamic countries tend to have an extraordinarily strong socio-cultural filter. A common viewpoint there is that technology should be subordinated to culture, especially Western technology, which should be just a servant, not a boss. Nevertheless, Islamic nations consider technology the best Western civilisation has to offer and worth adopting. The Grand Mufti of Lebanon, Dr. Mohammad Al El Gawzer, recently stated his idea about the Islamic way to filter Western technology from other Western influences: "We should take from Western culture only that which helps us in industry and scientific progress, while preserving our own Islamic character" (*Egyptian Mail*, April 27, 1991, 2).

The function of a certain transfer model can be radically changed by some major exogenous influences such as war, economic crisis, or ecological calamity. External factors may have a considerable impact on the economies of the supplier or the recipient or both; they may also affect the modification of some channels or the entire transfer mechanism. The contextual filter is very sensitive to alterations in external circumstances; it may react even if an external shock had practically no impact on the recipient economy or the channel apparatus. A crisis in the opposite hemisphere may change societal values, behaviourial patterns, or government policy, and thus remodel the filter.

The success of a transfer mechanism depends on the way components interact with each other. In the normal situation, the contextual filter dominates the whole mechanism. Technology transfer is more or less a smooth process if the filter's demands are in balance with the qualities of the channels and the requirements of the economy. The filter might be a significant stimulator of technology transfer in one country, while it is a barrier in another country. The socio-cultural filter plays the key role in the technological modernisation of less developed countries.

2. THE FINNISH MODEL

Figure 1 illustrates the theoretical mechanism of technology transfer. The mechanism can be regarded as a universal model that can be used as a tool in studying technology transfer to any industrialising country. Each economy utilises available opportunities in its own way; so, although the basic model is universal, its applications may vary. Countries differ from each other in what kind of a contextual filter they possess and in the profile of their channel set. We find that individual countries have created a great variety of different applications from the basic mechanism of technology transfer. Therefore, we can call these variants "national models".

Like many other countries, a national model evolved in Finland during industrialisation. The Finnish model of technology transfer is interesting because it possesses some untypical features compared to many other European countries. The Finnish case illuminates technology transfer from a special perspective. An anomolous case of an issue under study may help to identify some essential features in international technology transfer. For this reason, the Finnish case is a contribution to our knowledge of technology transfer.

For centuries, certain peculiarities have characterised the transfer of technology into Finland. It is worthwhile to pay attention to the actual channels and mechanisms of the historical transfer process and study how the Finnish model of technology transfer has been shaped. The following sections highlight the development of eight transfer channels. Because of my historical approach, channels are not dealt with in the order of their present importance but in a rough chronological order according to their introduction in Finland.

Considering the present Third World, 19th-century Finland is an interesting case. Being a peripheral country with a long history of foreign subordination, a harsh climate, few natural resources and a low standard of living, the country's development prospects did not seem promising 150 years ago. It seemed that in the setting of pre-industrial Finland, economic, political and cultural factors did not favour the transfer of foreign technology. The country shaped its own variety of the transfer model. The characteristics and evolution of the Finnish model will be examined in the latter part of the paper.

2.1 Natural Diffusion

The spread of technical skills and expertise from one geographical area to another is not new. Technology has always been spread through the locations when people have moved or have communicated with each other. Technology belongs to every-

day life; as an inseparable part of life, it has never existed outside the rest of human activities.

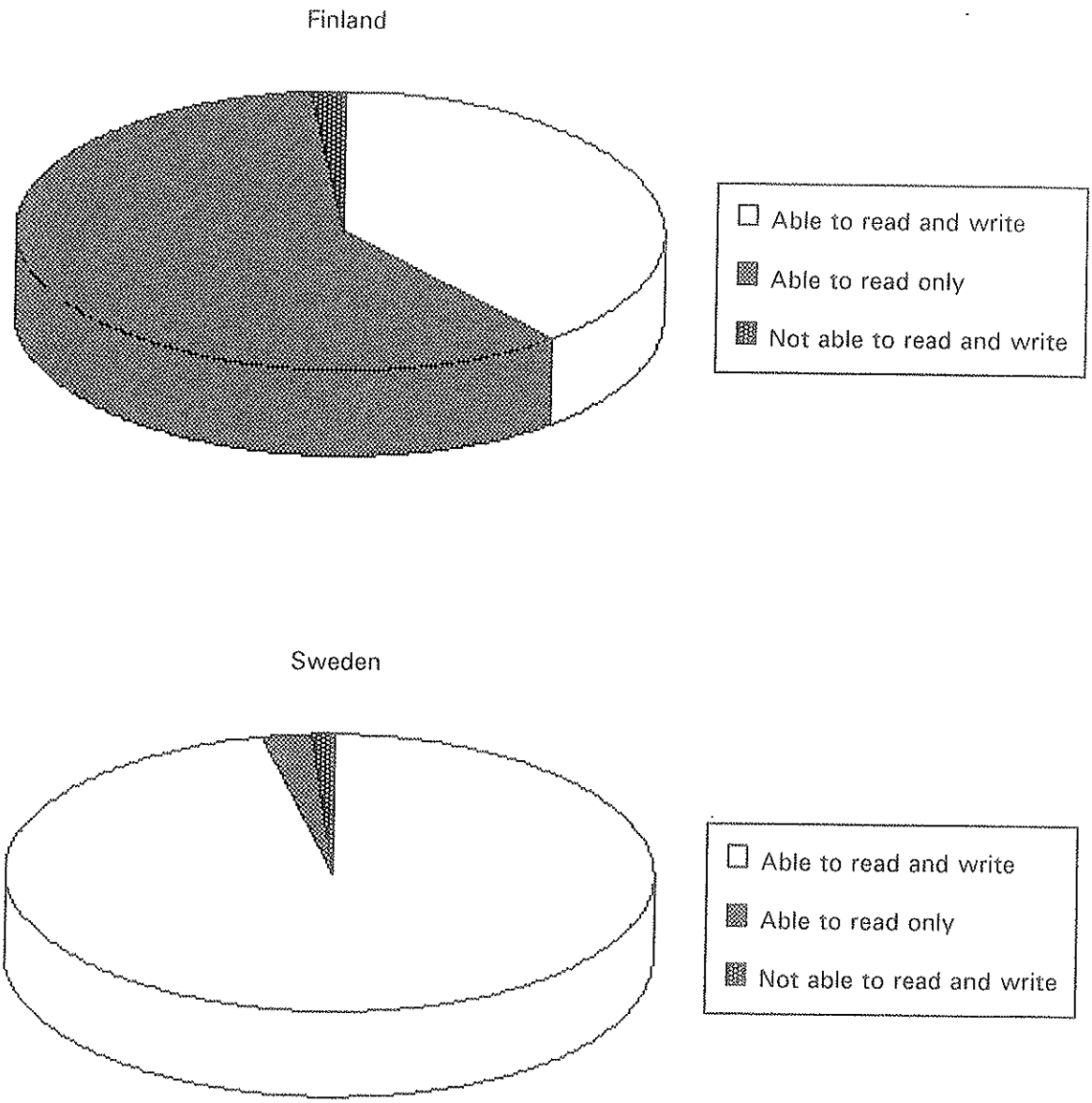
Technology is, and has always been, international. It has often been transferred from one community to another without the intervention of government officials, well-established organisations or multinational corporations. Various new technical skills, methods and products have been spread through natural diffusion, in other words, through the normal communication between communities. From prehistorical times, technological know-how has been spread through personal contacts, trade, and population movements. In general, both cultural and technological innovations are adopted from the neighbouring nations. This is a natural result of the fact that the communication is as a rule more lively, the closer the two regions are geographically.

Although technology has greatly advanced, societies have industrialised, big companies have their own R&D programmes and governments pursue their technology policy, natural diffusion is still important in technology transfer. During the last two hundred years, great amounts of technological know-how have been transferred through personal contacts, mass media, professional literature, scientific congresses and exhibitions. To a recipient, this kind of technology transfer is relatively cheap, often even totally free. Knowledge adopted through the mass media or corresponding channels, in general, works as an informative impulse, an incentive to obtain more details on technological features and manufacturing requirements of an innovation. For instance in 1877, the Finnish junior engineer of the Telegraph Board, Daniel Johannes Wadén, read with enthusiasm articles about the telephone invented by the Scottish American Alexander Graham Bell from the Swiss *Journal Telegraphique*. As a result, he began to gather more knowledge and acquired components from various sources. Only a year after the publication of Bell's invention, Wadén opened the first telephone line in Finland. The line connected his flat and nearby workshop in the center of Helsinki (*Helsingfors Dagblad*, December 27, 1877; Schantz 1932, 35-46).

At first glance, natural diffusion seems a very uncomplicated way to transfer technology, but in practice, it is not a channel without problems. Developing countries cannot have straightaway success if they start to imitate even the simplest western innovations. Technical expertise must be supplemented with economic resources, commercial experience and marketing abilities if one aims to succeed by imitation.

In Finland, one of the factors that limited the chances for deriving benefits via natural diffusion was the language problem. Most adult Finns could read: the proportion of that group rose from about 70 per cent to 98.5 per cent during the second half of the nineteenth century. The situation was not, however, particularly favourable for technology transfer and modernisation in general. First, most Finns could read only Finnish, and very little technical literature was published in that language. Second, most 19th-century Finns were semiliterate; still at the turn of the century, the majority of adults - over 60 per cent - were not able to write (Myllyntaus 1990c, 154-59, 168). At that time, Finland was clearly behind Sweden where only about 2.5 per cent of adults were semiliterate, while just one per cent was illiterate (Fig 2).

Figure 2. Literacy in Finland and Sweden, 1900.



Sources: Egil Johansson, "The History of Literacy in Sweden," *Literacy and Social Development in the West: A Reader*, Ed. Harvey J. Graff (New York, 1981), pp. 165-181; Timo Myllyntaus, "Education in the Making of Modern Finland", *Education and Economic Development since the Industrial Revolution*, Ed. Gabriel Tortella (Valencia, 1990), pp. 153-172.

From the viewpoint of technology transfer, it was important that 15 - 20 per cent of the adult population could read Swedish in the late nineteenth century, because basic technical literature was reasonably readily available in Swedish. Nevertheless, the most modern know-how was, as a rule, not published in any Scandinavian language. Often, detailed information about the significant innovations in science and technology was available only in French, German or English, and only a small percentage of the Finns could read those languages. As a result, that small fraction of the population, most of whom were native speakers of Swedish, became a transmitting group, which informed their countrymen about new foreign technological achievements abroad through translations into Swedish or into Finnish.

Nineteenth-century Finns were aware that modern technology adopted from abroad also brought about negative social and cultural changes. Although Arghiri Emmanuel believes that "national cultural authenticity is only an alibi for backwardness," the Finns attempted to resist the negative consequences of foreign technology and to adapt it into their culture on their own terms (Emmanuel 1982, 104-5). The Finns wished to strengthen their economy with rapid industrialisation but without losing their national and cultural identity. For them, these goals were not conflicting.

In adopting foreign technology, one of the first tasks was to change its language to Finnish. Because for centuries Finnish had been a language only of the peasants, its vocabulary for culture as well as science, technology, and other fields of higher education was extremely limited. Therefore, engineers and their organisations had to invent Finnish equivalents for foreign technical terms. In the late nineteenth century, domestic professional and trade journals frequently contained glossaries that listed newly invented words in Finnish with their established counterparts in both German and Swedish.

Besides the cultural goal, the construction of a native technical terminology also aimed to promote the acceptance and adoption of new technology. Ubiquitous loanwords, such as 'telegraphy', 'telephone' or 'electricity', said nothing to a Finn with no knowledge of any Indo-European language. In contrast, their new counterparts in Finnish, deliberately derived from ordinary native words, at least hinting at the function of these techniques even to a simple backwoodsman. When the function of a new technology was easily understood, the innovation was accepted more smoothly.

Finnish has remained one of the purest languages in Europe; there are relatively few modern loanwords from other languages in it. For the Finns, adopting foreign technology did not mean accepting foreign terminology or switching completely to a non-native language. Although Swedish was the traditional *lingua franca* in technology and in the sphere of the educated classes in pre-1917 Finland, it was Finnish that gained ground in both the societal and cultural life in the late 19th and early 20th century. Nonetheless, the fairly widespread knowledge of Swedish enabled Finnish engineers to utilise all forms of natural diffusion for adopting expertise from and through Sweden. Germany and Switzerland also served as model countries in the academic fields. From the 1880s, the inflow of scientific and technical literature in German expanded markedly in Finland. World War II meant

a turning point in this respect, too. In the post-1945 period, the Anglo-American impact has been dominating in science and technology.

In summary, natural diffusion is the oldest channel for technology transfer. Through normal human communication, technology is transferred in all the places where people from various regions and communities interact. Natural diffusion can also be called learning from example. For a recipient, this kind of technology transfer is advantageous because it can often provide easily available know-how and it does not bind him formally to the supplier of technology. While technology has become more complicated, the relative importance of this channel has decreased during the present century.

Natural diffusion is closely related to economic and educational prerequisites of the recipient. It is also interwoven with psychological characteristics and the climate of opinion in society that I have tried to illustrate with the socio-cultural filter in the Table 1. Hence, money and talents are not the only decisive factors. Technology transfer also depends on the population's attitudes and values.

2.2 Foreign Experts

Besides communication between neighbouring communities, migration between distant regions has played a key role in technology transfer. Migrants brought their know-how and perhaps some technical equipment with them to the new areas they settled. Technical expertise brought by migrants was then transferred to local people, and gradually it spread around the region. For example, the Finns learned masonry, brick burning and brickwork from the Swedes who arrived in Finland to build castles in the late Middle Ages. Similarly, the Finns adopted skills to erect windmills from the carpenters who came from or through Sweden.

There are several types of population movements that have transferred technology from one country to another. First, mass migration can be a vehicle. In the 19th and early 20th century, the immigration of Europeans to America and Australia was mainly composed of unskilled labour, but it also included a broad spectrum of skilled labour. Immigrants often try to carry on their trade in their new home country and then try to apply their old skills in the new circumstances.

Second, migration can be movements of certain special occupational groups. The experts of a particular field tend to see certain regions appealing and move there or at least spend some time there. These people leave their home country - as a rule voluntarily without any political or economic pressure - and move to another country that attracts them with its higher living standards, better educational opportunities or more promising and lucrative working conditions. *"Brain drain"* is the current term for this type of selective population movements.

Third, certain countries actively recruit foreign experts and skilled workforce for limited periods. Nowadays, by advertising in the international press, rich oil-producing countries recruit qualified western specialists in technology, economics,

education and health care. Many international organisations, such as the UN and the Red Cross, hire competent experts to work in Third World countries. The aim is to transfer qualified skills and current know-how by means of a relatively small groups of specially selected competent people.

Foreign experts are generally recruited to countries that cannot, for some reason, attract spontaneous immigration. Such recruitment has, however, a long historical precedent. An outstanding example of this was Imperial Russia, which, from the time of Peter the Great, actively drafted craftsmen, entrepreneurs and educated personnel for service in education, science, administration and business. Over two centuries, a great number of Germans, Britons and Frenchmen moved to Russia for a limited period or permanently. Besides the government, various private Russian firms and organisations also carried out similar recruitment.

The Finnish authorities did not register foreigners living in the country before World War I. In the 19th century, foreigners were not enlisted in census records or parish registers. They were also excluded from periodic population censuses. The official statistics on foreigners in Finland start only in 1928, but these are incomplete and unreliable. There are also unofficial figures available, and they differ markedly from the official statistics, as Table 2 indicates:

Table 2. Estimated number of foreigners in Finland, 1810 - 1991

Year	The number of all foreigners, official statistics	Russian army	Refugees from Russia/USSR, unofficial estimates
1810	"	55,000	"
1820	"	12,000	"
1830	"	12,000	"
1840	"	12,000	"
1850	"	12,000	"
1856	"	45-50,000	"
1860	"	8,500	"
1863	"	16,000	"
1870	"	9,000	"
1880	"	9,000	"
1890	"	9,000	"
1900	"	10,000	"
1910	"	20,000	"
1913	"	30,000	"
1917	"	125,000	"
1919	"	-	11,000
1922	"	-	33,000
1928	29,700	-	"
1930	27,700	-	"
1935	24,100	-	"
1938	21,200	-	"
1944	31,800	-	63,000
1945	11,000	-	8,000
1951	11,100	-	"
1960	7,500	-	"
1970	7,200	-	"
1975	11,300	-	"
1980	12,100	-	"
1985	16,800	-	"
1988	17,700	-	"
1989	21,200	-	"
1990	23,100	-	"
1991	31,900	-	"

" No data available - Concept not applicable

Sources: *Statistical Yearbook of Finland 1930 - 1990*; Matti Närhi, "Venäläiset joukot Suomessa autonomian aikana", *Venäläiset Suomessa 1809 - 1917*, Historiallinen arkisto 83 (Helsinki, 1984), pp. 161-180; *Aamulehti* 30.11.1988; *Helsingin Sanomat* 16.10.1988, 29.4.1989, 20.2.1992.

During the period (1809 - 1917) when Finland was a grand duchy affiliated in the Russian Empire, the largest group of foreigners consisted of Russian military personnel, the size of which fluctuated from 9,000 to 125,000 men (Närhi 1984, 173, 180). Russian civil servants constituted another, but much smaller, group. Unfortunately, no statistics are available on their numbers. The significance of Russian civilians, soldiers and officials for technology transfer to Finland has not been evaluated. It is very likely that they at least increased and diversified the demand for consumption goods, because following their own customs they demanded a different set of consumer goods than the Finns. In a way, Russians accelerated the modernisation of the administrative towns and the localities of garrisons. They introduced new habits and new products to the Finns.

Traditionally, the immigrants from Sweden have been the largest Western group of foreigners in Finland. The cession of the remaining eastern overseas provinces of Sweden to Russia in 1809 did not stop the flow of Swedes to the country. Among Swedish immigrants, there were skilled workers, educated experts or businessmen. Some arrived by their own initiative. A great many experts were, however, recruited to the grand duchy by Finns. Due to poor sources, there is no estimate of the number of Westerners in 19th-century Finland; probably their proportion of the total population never rose over one per cent.

The official statistics indicate that the number of foreigners - or to be more precise citizens of foreign countries - decreased from 30,000 in the late 1920s to almost 20,000 persons by the end of the 1930s. A similar fall in the number of foreigners took place after World War II - but for different reasons. The lowest point was reached in 1971; at that time there were only 5,500 registered foreigners in Finland. Although immigration increased thereafter, the number of foreigners surpassed the peak of the interwar period only very recently. At the end of January, 1992, 36,500 foreigners were registered in Finland. They account for 0.7 per cent of the total population, still the lowest figure in Western Europe (*Helsingin Sanomat*, February 20, 1992). Table 3 indicates the number of legal foreigners in the late 1980s.

Table 3. The number of officially registered foreigners in Western Europe

Country	Year	The number of foreigners	Percentage of the total population
Luxembourg	1981	96,000	26.3
Switzerland	1988	1,006,500	15.3
Belgium	1988	868,800	8.8
West-Germany	1988	4,716,900	7.7
France	1985	3,752,200	6.8
Sweden	1988	421,000	5.0
Britain	1987	2,526,200	4.5
Netherlands	1988	623,700	4.2
Austria	1988	297,800	3.9
Norway	1988	135,900	3.2
Denmark	1988	142,000	3.0
Ireland	1985	88,000	2.5
Iceland	1988	4,800	2.0
Greece	1987	193,000	1.9
Italy	1987	541,000	0.9
Spain	1987	335,000	0.9
Portugal	1987	90,000	0.9
Finland	1989	21,200	0.4

Source: Juhani Lönnroth, "YK tehostaa siirtolaisten oikeusturvaa", *Helsingin Sanomat* 3.2.1991.

In Finland there have also lived foreigners whom the authorities have not enlisted on their census records or any other statistical records. Part of them stayed in the country as visitors, part studied and part even worked legally or illegally. They had arrived in the country more or less individually.

In modern times, the first wave of mass immigration to Finland took place in 1917 - 1922. When revolutionary turmoil broke out in Russia, refugees started to flow over the eastern border of the grand duchy. The number of refugees was greatest in the spring of 1922 when it was by estimate 33,000 - 35,000. About half of those people were Russians and half East-Karelians, Ingrians and Estonians (*Helsingin Sanomat*, April 29, 1989). The above figure does not include those thousands of Finnish citizens who lived in Russia under the tsarist regime but who returned to Finland due to the revolution in the Empire. It is difficult to estimate the number of returned Finns; as an indication of the size of the Finnish population in Russia is that in 1910 in St. Petersburg alone there lived 17,100 Finns (Engman 1990, 104).

Most of refugees from the East were ordinary people whose occupational skills hardly differed from those of the Finnish country people. Most were women, children and elderly people; young and middle aged men were in no way the dominant group. Nevertheless, it is worth noting that part of Russian refugees and returning Finns were educated or otherwise qualified people. There were craftsmen, businessmen, officers, sailors, civil servants, engineers, scientists, etc. After a short stay in Finland, a considerable part of the educated Russian refugees moved to the West. A small part of the refugees stayed in Finland and some of them tried purposefully to assimilate into the Finnish population; a few even changed their surnames to Finnish ones.

Most of the returning Finns, in contrast, settled in the young republi permanently. It is quite evident that by occupation, on average they were mor qualified than the Finns. It seems likely that the Finnish economy benefitted fro Russian refugees and returning Finns because the wave of mass immigration of 1917 - 1922 brought thousands of skilled workers, educated clerical employees, competent experts and entrepreneurs into the country. At that time, Finland really needed these types of people.

The second wave of refugees rolled into Finland during the Continuation War. In 1943 - 1944, the Finnish and German army moved over 63,000 Ingrians to Finland. Although Ingrians were identified as evacuated Karelians, they were not Finnish citizens. After the truce of Moscow in September 1944, most Ingrians voluntarily returned to the Soviet Union or the Finnish authorities deported them there. Only about 8,000 Ingrians stayed, but half of them moved to Sweden in the late 1940s or in the 1950s. The importance of the Ingrians to the Finnish economy and to technology transfer was insignificant because they stayed for a short time; most of them were country people and a rather small percentage of them - much less than expected - were of working age (*Aamulehti,* November 30, 1988; Nevalainen 1990).

Up to the early 1990s, Finland was not attractive to the masses of foreign immigrants. Neither has the country been a target for any selective immigration. In the late 19th century some thousand foreign craftsmen, technicians and other

qualified technological or scientific experts appear to have lived in Finland. The proportion of foreigners has never risen above three per cent of the industrial workforce, and generally, it has been under one per cent. In an international comparison that figure is quite small (Jeremy 1981, 256).

Despite their small number, foreign experts and skilled workforce, however, were of vital importance in transferring technology into Finland. Very few foreigners arrived in the country to seek work or to do independent business. Most of the foreign technical experts were recruited by Finnish businessmen or private firms. The Finnish government has never favoured immigration. The tsarist regime, in turn, even opposed the immigration of western Europeans into the grand duchy - especially in the early nineteenth century. The statutes of 1835 and 1848 restricted the recruitment of immigrant craftsmen and technical experts. The tsarist regime considered that accommodating larger groups of Western workers might prove to be politically risky in this sensitive area (Myllyntaus 1980, 358).

Because political authorities prevented the hiring of foreign labour in larger numbers, Finnish industrialists attempted to recruit competent individuals to their factories and that was accepted by the authorities. An often used procedure was the following: a Finnish factory ordered a machine from a foreign engineering workshop that sent along a good mechanic to install it. The mechanic was warmly welcomed and during the installation he was persuaded to accept a post of a foreman or a technical director of the plant. Quite many of those recruits stayed for long periods in Finland. Some of them settled in the country for the rest of their lives.

As individuals, foreigners from various countries were valuable transfer agents for the outlying grand duchy: Swedish technicians contributed substantially to the development of almost all the major industries; British immigrants pioneered the textile, engineering, and paper industries; Germans influenced the growth and technological change of the engineering, glass, wood-processing and printing industries. Russians promoted beverage and foodstuff production as well as water-powered sawmills, traditional ironworks and mines in eastern Finland; Norwegians improved the technology of timber floating, sawmilling and wood-pulping. Danes and the Swiss developed dairy production. Some Swiss entrepreneurs introduced new innovations related to chocolate manufacturing, water piping and heating technology. Foreigners acted in many key posts as entrepreneurs, technical directors, foremen or other experts in industry (Urbans 1957, 156-57, 174). At the turn of the 19th century, foreigners also constituted a fairly large share of teachers at the polytechnics. Work training and formal technical education under foreign experts formed a vital part of the Finnish model by eliminating the severe shortage of skilled native-born workers and engineers.

During the 20th century, foreigners have contributed to the Finnish economy especially as planning engineers, technical designers, consultants and owners of engineering offices. The role of expatriate consultants and planning engineers was vital in the transfer of foreign energy technology to Finland. Most of them were Swedes or Germans. In interwar Finland, they planned many of the hydroelectric power plants, thermal power plants, high-voltage transmission lines, power transformers and substations.

After World War II, the significance of foreign technical experts has been steadily decreasing due to the rise of Finnish higher education and the growing supply of competent Finnish engineers and scientists. Foreign experts still constitute a marked channel for technology transfer in some brand new fields where no qualified Finnish specialists are available.

2.3 Journeys Abroad by Nationals

Foreign firms that controlled modern technology in the nineteenth century saw Finland as an unattractive and insignificant market area on the periphery, isolated behind the barriers of ice, language, and bureaucracy. These factors intensified the trend that foreign technology did not begin to flow spontaneously into the grand duchy. Consequently, circumstances pressed the Finns to help themselves. The significance of various kinds of study tours abroad increased toward the end of the Russian period.

Journeys abroad for vocational training were an old tradition dating back several centuries. Such travelling began a long time before industrialisation during the period of the guild system. Journeymen travelled abroad, both in Scandinavia and on the Continent, to increase their experience in the service of various masters. During the Russian period, thousands of Finnish craftsmen headed to Russia, primarily to St. Petersburg. In the late 19th century, metal craftsmen and workers, jewelers, goldsmiths, silversmiths, shoemakers, tailors, carpenters, chimney sweeps, clock makers, bookbinders and bakers constituted the most important crafts Finnish workers brought to the capital of Russia (Engman 1983, 311; Engman 1990, 107).

The Finns were especially numerous in metal and machine factories, the most advanced sector of industry in St. Petersburg. Although they were not as competent as English or German specialists and overseers, they were often skilled workers and foremen. The Finns were over-represented in certain artistic crafts; for example, in the famous firm of Fabergé, a large proportion of the masters and goldsmiths were Finns. They were also engaged in dirty jobs, but chimney-sweeping constituted the only occupation in which Finns were in the majority (Engman 1990, 106).

In Imperial Russia, Finns also worked in occupations other than handicrafts and manufacturing. During the period 1809 - 1917, at least 3,300 Finns served as officers in the Russian army. Between 1852 and 1867, over 2,000 passports were issued for Finnish seamen on Russian ships sailing abroad, mainly in St. Petersburg and other Baltic ports. Finns were also well represented in river shipping in Russia (Engman 1990, 102-103). Thousands of educated or skilled Finns remigrated to their home country. A great many of them rose to very important positions in Finnish society.

Regularly, a large number of Finnish journeymen, trainees and casual workers returned from abroad to their home country. Thus before 1917, a surprisingly great

number of Finnish workers in certain crafts widened their vocational experience by working abroad. According to a study published in 1911, about ten per cent of the current Finnish engineering workers had worked abroad, mainly in Russia, and stayed there three years on average. Correspondingly, seven per cent of their Swedish counterparts had obtained vocational training abroad (Herranen 1986, 45-46).

In the interwar period, among craftsmen and workers the vocational training abroad substantially decreased. After World War II, thousands of Finns annually left for other countries. They aimed at a higher standard of living, not necessarily at learning a particular trade.

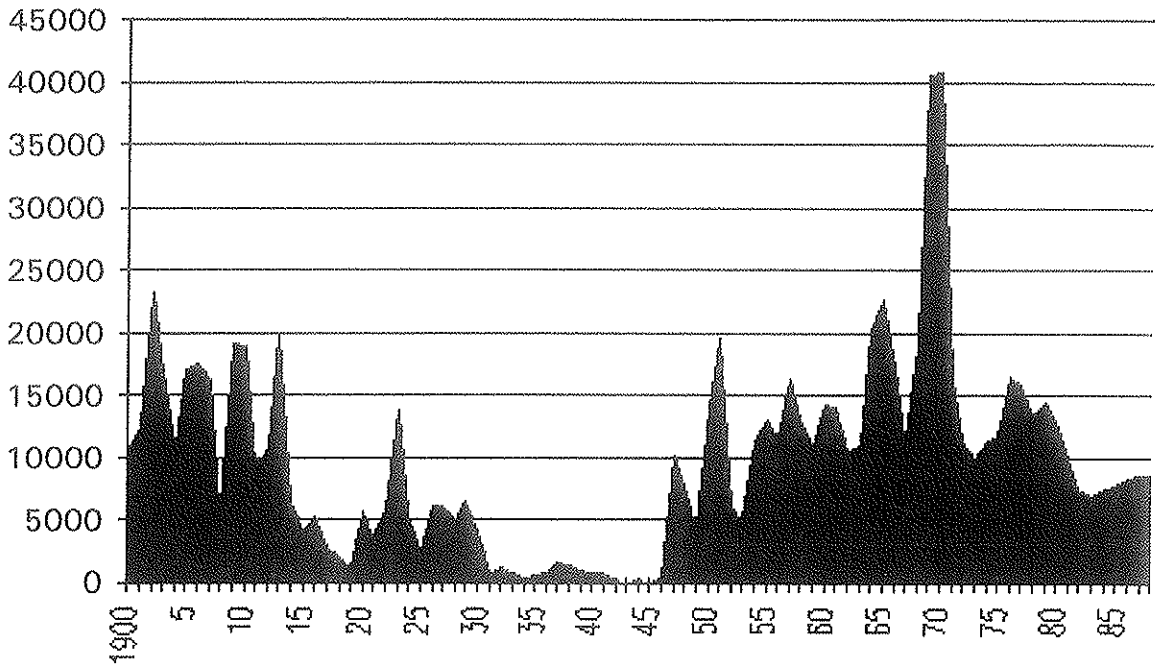
It is often difficult to distinguish between foreign vocational training, casual working abroad and emigration. A trainee may decide to settle down in a foreign country and an emigrant may change his mind and return to his home country.

In Finland, emigration to non-European countries began relatively late - only in the late 1880s - three to four decades later than in other Nordic countries. Migration to Russia was for some time a substitute to the overseas emigration. By 1914, about 300,000 emigrated from Finland to America. By estimate, 40 - 50 per cent of these emigrants returned to Finland after a few years (Gylling 1911, 40; *SYF* 1913 - 1924).

After World War I, the USA placed restrictions on immigration. The flow of people was then directed to Canada. Fewer and fewer Finns emigrated in the interwar period. While in the years 1900 - 1909, about 15,000 Finns emigrated annually, in the 1920s the corresponding figure was 6,000 and in the 1930s only 1,200. The illegal emigration from Finland to the Soviet Union accelerated during the great depression of the 1930s. Temporarily, it even surpassed the legal emigration to the West. At its highest, there were 15,000 illegal Finnish emigrants in the Soviet Union. When the depression waned at the onset of a hectic boom in the mid-1930s, emigration to the east decreased, and the remigration back to Finland increased (Kostiainen 1986, 7-12).

For a few years after World War II, emigration again picked up. It was directed first to Canada and Australia but later to Sweden. In the 1950s on average, 12,000 Finns emigrated per year, in the 1960s 18,100 and in the 1970s about 16,200 and in the early 1980s only 9,000 (Fig. 3). Emigration to Sweden was most prevalent in the 1960s. Between 1940 and 1980, approximately 460,000 Finns emigrated to Sweden and within the same period, about 40 per cent of them returned. Consequently, Finland's deficit totalled some 277,000 people (*Näin* 1987, 20-22).

Figure 3. Emigration from Finland, 1900 - 1988.



Source: *Statistical Yearbook of Finland 1913 - 1989* (Helsinki, 1913 - 1990).

In contrast to St. Petersburg Finns, most American Finns worked in heavy, unskilled jobs, such as lumberjacks and miners, and away from large business and industrial centres. Finns who returned from North America had not generally learned any new trade or profession during their emigration. That was partly caused by the fact that most of them did not aim to develop their occupational skills in the New World. Many Finns went to North America just to earn money and intended to return a few years later with a fortune. Their success was variable, and relatively few managed to realise their dream. However, some remigrants succeeded in making a marked contribution to the transfer of foreign technology to Finland and promote industry, forestry or agriculture in their home country (Heikkonen 1983, 113-14; Heikkonen 1989, 240).

The know-how of two outstanding machine workshops specialising in internal combustion engines was based largely on borrowed American technology introduced into Finland by returning emigrants. After a stay of a few years in the USA, John and Jacob Wickström came back to Finland and set up an engine

workshop in Vaasa in 1906. Their firm soon became well-known, and for several decades it was one of the most famous Finnish engine workshops. It produced various types of otto and diesel engines for boats, vehicles and factories but the firm distinguished itself due to its legendary marine engines. The last Wickström engines were made in Vaasa in the late 1970s. Within seven decades, the firm produced over 30,000 engines, a considerable number of which were exported (Kleimola 1991, 15).

Another famous engine workshop was established in Kaskinen in 1909. Its founder, G. Grönlund had also returned from the USA to his home province, Pohjanmaa. At first, his workshop produced two-stroke petroleum-oil combustion engines for boats and agricultural machines. Grönlund was convinced of the high quality of his engines, which - according to his advertisement - were manufactured to the accuracy of 0.03 mm. "All working machines in the workshop were US-made and were the best available". In the 1920s, the Grönlund engines had better thermal efficiency, at best 23%, than other domestic internal combustion engines. Nevertheless, the production of the Grönlund engines ended in the early 1950s (Kleimola 1991, 15-16).

In the post-1945 period, over 200,000 Finnish casual workers and emigrants have returned from Sweden to Finland. It is quite evident that most of them managed to improve their occupational skills during their stay in Sweden and transfered some technology over the Gulf of Bothnia. Remigrants are not, however, considered to be any special transporters of new technology into Finland. Despite the huge mass of Finns remigrated from Sweden, no similar number of legendary entrepreneurs, technical experts, scholars or craftsmen has risen from their ranks than from the cluster of remigrants from Russia or even from the group of returned American Finns. Although it might be too early to make conclusions, it seems evident at the moment that the remigration from Sweden did not have any substantial significance upon technology transfer to Finland.

A handicap for the industrialisation of Finland was a shortage of educated workforce. In the 19th and the early 20th centuries, technical education was quite limited in Finland. Therefore, a great many of the youth interested in technology or science travelled abroad to study immediately after matriculation or after completing some basic studies at the polytechnic institute or the university in Helsinki or at some technical schools. While most craftsmen went to the east for training, students of technology and science headed to the west for education. Technical schools and universities in Germany and Sweden were the most popular among Finnish students who often supplemented their studies by training in some well-established foreign factory. After graduation and perhaps practical training, most Finnish technical students returned home and received fairly high-ranking posts in their own country.

With regard to the popularity of studying at foreign technical schools, Finland fitted the Scandinavian and east European pattern well. Universities of technology in Germany experienced a remarkable expansion during the fifty years before World War I, but even more dramatic was the increase in the number of foreign students enrolled in them. Scandinavian (Swedish, Norwegian and Danish) students were well represented at the German institutions of higher education between the 1850s and

1930s. Students from the Russian Empire and the Balkans, however, formed the largest group of foreigners during that period, accounting for 30 - 60 per cent of all foreign students in the German universities of technology (*Hochschul-Nachrichten* 1901, 178-79; Remme 1926, 38-39; *Deutsche* 1930, 10).

Unfortunately, the nineteenth-century statistics on the enrollment of students at German universities do not specify the number of Finns. It has been estimated that in the period 1900 - 1914 a total of 520 Finns were enrolled at higher educational institutions in Germany. On average, 32 Finns began his/her studies annually in the Wilhelmine Reich. Most of these students (55 %) went to universities but as many as 235 (45 %) preferred universities of technology (Weill 1987; Meriläinen 1990, 18, 67-69).

When technical education in Finnish schools and universities improved in the first quarter of this century, the number of Finnish students at German higher educational institutions fell drastically. Only after Finland had gained political independence in 1917 were Finnish students classified separately in the statistics for German universities. After World War I, the number of Finnish students in German institutions did not reach the prewar record. For the interwar period, their number continued to decrease. In 1925, 105 Finns studied in German universities or technical universities. In 1930 the figure was cut in half to 53 students and three years later, when the Nazis seized power, it was only 34.

The Finns' studies in other countries have not been researched as thoroughly as their studies in Germany. However, a small case study on electrical engineers born between 1858 and 1899 shows that Germany attracted most of Finns studying technology abroad. Eighty seven of the first members of the Association of Electrical Engineers in Finland studied abroad before World War II. As many as 54 (62%) of them were enrolled in the German universities of technology. The next most popular countries were far behind: Sweden 14%, the USA 7% and France 6% (Myllyntaus 1991b, 301).

Generally, studies abroad went out of fashion among the Finnish youth in the interwar years. The change can be attributed to various political and economic factors that caused a significant change in the contextual filter. Hence, the change in social climate and economic conditions limited opportunities for nationals' studies abroad to serve as a channel for technology transfer.

In the post-1945 period, the popularity of studies abroad has not reached the same level of enthusiasm as during the later years of the grand duchy. During the past 45 years, the students of medicine, economics and business have been most keen to travel abroad to study at foreign universities. Technical students have been among the most reluctant to leave Finland, which has managed to supply increasing opportunities for technical and vocational education. With regard to technology transfer, the relative importance of nationals' studies abroad further diminished after World War II. Nevertheless, postgraduates' studies abroad are still significant for technology transfer and the flow of new influences into Finland.

Along with vocational training, remigration and graduate studies, the fourth type of nationals' studies abroad that contributed to technology transfer was educational visits (*opintomatkat*) by factory owners, businessmen, engineers and government officials. They attended exhibitions and congresses, visited factories,

laboratories or research institutions abroad systematically collected information on certain issues by travelling around Europe and interviewing various specialists. It was a common practice in the grand duchy that when some reform or a noteworthy construction project was initiated, a competent person was first sent abroad to gather information on previous experiences and various alternatives.

The government financially supported travels by civil servants, engineers, industrialists, craftsmen and artists, and these travellers were obliged to write travel accounts. Many of the accounts were published so that a wider circle of people could benefit from the information gathered. It is clear that the results of educational visits abroad varied considerably. Talented, experienced and industrious explorers managed to gather tremendous amounts of information, condense their conclusions into a compact form and make useful proposals for planned projects.

Millowners, managers and their representatives made journeys abroad at company expense. A large part of these educational visits was related to the purchases of new machinery or licences or recruiting foreign experts. Because there was a certain distrust of written information, travellers from the private sector often wished to see with their own eyes that the technology under consideration really worked. In many cases, these journeys led to contracts to import new technology into Finland, and thus they were useful and sometimes indispensable elements in technology transfer.

In the postwar period, the great development of international communication through the printed word and electronic means has not displaced journeys that businessmen, engineers and civil servants make abroad. On the contrary, they have become part of the everyday business routine. However, the term has changed; these journeys are no longer called "educational visits" but rather business trips. They have become part of a package of channels through which technology keeps flowing over borders. Human face-to-face contacts are still irreplaceable in the world of telecommunication.

2.4 The Importation of Machinery

A machine is the concrete expression of technology, a demonstration of engineering skills. Its manufacture generally stands in need of technological expertise and its appropriate use requires a certain amount of know-how. When a machine is transported from one region to another, technology embodied into the machine is transferred, too. Often, the importation of a new kind of machine has been a basic condition for the opening of a totally new branch of industry, although in addition, other types of technology transfer have been required to complement it.

In Finland, the importation of frame saw technology in the 16th century supplied the facility for mechanical sawmilling. When the papermaking machine manufactured by the English engineering works of Tidcombe and Son was introduced into the Frenckell paper mill in 1841, the mechanised production of paper

began. The production of wood-based sulphite pulp commenced in 1885, when foreign-made pulp kettles were installed in the Nokia and Kuusankoski paper mills. In all these cases, production started due to the acquisition of foreign-made machinery.

It was only after the Crimean War (1853 - 1856) when the imports of machinery to Finland began to increase. Prior to that, various institutional obstacles hindered the acquisition of foreign machinery. At the time, Britain was the leading engineering nation, and up to 1842, its government aimed to restrict the outflow of up-to-date technology. For several decades, Britain forbade exporting several types of vitally important machines and prevented skilled workers from emigrating. In addition, considerable import tariffs, high freight charges and difficult transportation conditions, such as icy sea routes, hampered the importation of machinery to Finland.

From the mid-1850s, foreign trade was liberalised in the grand duchy as well as in other countries and this stimulated imports of machinery. It was only from the late 1880s to World War I when the importation of foreign technology to Finland increased substantially. In the 1880s and 1890s, German and American technology started to gain a foothold and challenge the dominance of British and Scandinavian technology in Finland. American engineering workshops made a breakthrough in many fields with their new models of various machinery and equipment. German firms became wellknown in the field of chemical pulping and papermaking, and especially in electrical technology. In 1913 German firms supplied 71 per cent of all the imports of electrical equipment, and their proportion of the total supply (Finnish production + imports - exports) was 52 per cent (*OSF 1* 1913; *OSF 18* 1913).

External factors, such as war, have had a great impact on the importation of machinery in Finland. The country's internal factors also limited or directed imports. The contextual filter has had a marked influence on the government's policy on import tariffs. The grand duchy attempted to keep import duties low for capital goods and raw materials. Partly due to an inflexible foreign trade policy, this goal was achieved only in part. Finland was no low tariff country according to western European standards. The largest industrial centre, Tampere, however, enjoyed its status as a free city. From 1821 to 1905, its millowners and handicraftsmen were allowed to import duty-free raw materials, machines and building materials.

In the grand duchy, it was likely that the contextual filter constrained imports more indirectly than directly. This was influenced by attitudes, cultural codes and consumption habits. The intensifying friction between Finland and Russia prevented the Finns from accepting some technological innovations from the east. For example, the Finns never adopted the samovar, a symbol of the Russian tea culture, although in addition to traditional models, new electric samovars became available.

The outbreak of the First World War paralysed trade between Germany and Finland. The Russian martial law and the German navy curtailed the Finnish foreign trade through the Baltic Sea. Consequently, machinery imports from the main suppliers - Germany, Britain and the USA - stopped. During the embargo of the 1910s, Sweden became the most important supplier of machinery to Finland.

After the war, a new situation emerged. The economy of Germany revived slowly, and the country was not able quickly to regain its lost share of the Finnish

market. Therefore, Sweden could preserve its strong position as a supplier of machinery, while Britain and Switzerland increased their exports of equipment to Finland. Switzerland became a key deliverer of hydroturbines, steam turbines, various types of electrical equipment and textile machinery.

As a result of the Great Depression in the early 1930s, international trade became more protected. Like many other countries, the republic of Finland began to make bilateral trade agreements granting to its partners commitments to import their machines in compensation for its exports of processed wood products to them. The bilateral trade agreements strengthened the position of Britain and Germany in Finnish foreign trade. By contrast, the protectionist policy disfavoured Sweden because that country had no reasons to barter its machinery for Finnish timber, pulp or paper. The foreign trade policy of the 1930s was the most profitable to the wood-processing companies: they received guaranteed markets for their products and the government's guarantees for their huge investments in machinery and plants. In the 1930s, the growth rate of industrial output in Finland was one of the highest in the world.

The upturn in the economy was broken in 1939. The Soviet-Finnish war caused a slump in the output of the forest industry especially. In the same time, many investment projects were interrupted. Finnish foreign trade was quite tightly controlled from the end of the war to 1957. A permission from the governmental committee for import licences was required to obtain equipment from abroad. Several important investment projects were delayed due to the shortage of hard currency, the tight restrictions on import licences and the bureaucracy of the public administration. Since imported equipment was not available, firms attempted to purchase Finnish products and this increased the volume of orders in hand at the domestic machine workshops. The engineering industry was also busy producing two-thirds of the large war reparations to the Soviet Union. However, it was not profitable to produce all kinds of equipment in Finland. The difficulties of technology transfer during the war and the following period of tight economic regulation (1945 - 1957) slowed down the development of various industries (*Turun Sanomat* November 6, 1948; *Uusi Suomi* December 12, 1949).

In connection with the major devaluation in 1957, the exchangebility of the Finnish markka was improved, the system of importation licences was greatly liberalised and import tariffs were substantially decreased. It was a significant step that made importation much easier. In 1961 Finland became an associate member of the EFTA, and in 1973 it made a free trade agreement with the EEC, the European Economic Community.

For over a hundred years, imports of capital goods, especially machines and other equipment, were greater than exports, but in the early 1980s, a decisive turn took place. For several years in the foreign trade of capital goods, a surplus replaced the long-term deficit. It was in the 1970s and 1980s when the production of capital goods, accounting for over 60 per cent of the exports of the engineering industry, actually became an exporting industry in Finland (Luukkanen 1985, 27).

Imports of machinery are often regarded as necessary, but not a sufficient precondition for a successful transfer of technology. A firm must know how to use its productive capacity efficiently and economically. In addition, it should be able to

market its products. The imports of machinery are frequently complemented by the transfer of technological expertise. Formerly, Finnish firms recruited foreigners to work as foremen or technical directors and to instruct local workers in the use of new equipment. Nowadays, a training package for the recipient's personnel is an essential part of the hardware delivery supplied by a foreign or domestic manufacturer.

2.5 Direct Foreign Investments

Direct investments abroad made by big multinational companies are now considered one of the most important and efficient channels of technology transfer. Direct foreign investments, however, constitute no new phenomena, and they have been starting in the 16th century and in the subsequent Colonial Period.

Direct foreign investments are regarded as an efficient method to transfer new technology to a country with a low standard of technological expertise because they often contain a versatile package of technology transfer. Using direct foreign investments, companies transfer not only capital and machines but also frequently managers, engineers, workers, marketing and organisational structures with technological and economic expertise designed for them. In a developing country, experienced foreign investors or multinational companies are often able in a short time span to commission and build a factory whose financing and construction by the recipient's own means might take several years or even decades. American and British economic literature especially considers direct foreign investments by multinational companies as shortcuts to rapid industrialisation and swift economic growth in a developing country.

When did direct foreign investments become a factor in Finland and what was their technological contribution to the industrialisation of the country? Foreigners have owned manufacturing firms in Finland as long as there has been an activity that could be classified as industry. From the 16th to the early 19th centuries, industrial activity, however, was modest and did not exhibit many basic characteristics of modern industry. Because industrialisation actually began in Finland only in the 19th century, the early period of the grand duchy can be chosen as a point of departure. At the time, legislation dictated quite tight restrictions on the economic activities of foreign entrepreneurs (Mechelin 1878-79, 245-58; Mikkola 1984, 211-12).

In the grand duchy, a foreigner's economic rights were rather limited: he had no right to own land or do business. Consequently, it seemed that legislators gave him no opportunities to transfer technology through direct investments. A foreigner could, however, apply to the Emperor for an exemption from restrictions or for the privilege to set up a specific firm. Moreover, a commonly-used roundabout method was to found a firm or purchase property under the name of a Finnish strawman.

Reality did not very closely reflect legislation. In the 19th century, foreigners, mostly Russians, owned several ironworks and sawmills in Finland. During the first half of that century, foreign owners of these plants did introduce some new and important innovations, such as mechanised cotton spinning and weaving, industrial beer brewing and lithography. A part of the metal industry was carried on by private Russian entrepreneurs, and the involvement of the Imperial Government reached its climax in the early 1870s when the Russian-owned ironworks accounted for over a quarter of the output of pig iron and over a tenth of the production of bar iron (Hjerppe & Ahvenainen 1986, 286).

Relatively speaking, the Russian ownership of sawmilling was the greatest in the 1830s and 1840s. In 1835 Russians possessed in eastern Finland 16 sawmills that employed about 44 per cent of the sawmill workers of that area. Through the Russian sawmill business, more advanced felling and floating technology took hold in Finland.

Later, the Russian influence in sawmilling became weaker, whereas the investments of Norwegians, Swedes and Britons increased. The feverish timber boom of the 1870s attracted several westerners to invest in sawmilling in Finland. In 1885, foreign-owned firms produced about 16 per cent of the output of all medium- and large-scale sawmills. Norwegians especially distinguished themselves in introducing new techniques, such as the organisation of long-range timber floating, various hoisting devices, planning machines and electric railroads in the timberyards. The Norwegian firms Gutzeit & Co and Halla Ab belonged to the ten largest industrial companies in Finland on the eve of World War I (Myllyntaus 1986, 59, 66-69; Myllyntaus 1989, 11-25).

Probably in the early 1910s, the foreign ownership of sawmilling reached its zenith. In 1913 about thirty foreign-owned sawmills operated in Finland. Their average size and capital resources were larger than those of the average sawmill possessed by Finns. They contributed a quarter of the total output of sawn timber. Moreover, they owned over 40 per cent of the land in the possession of the wood-processing companies (Myllyntaus 1986, 59).

In other sectors of industry, foreign investors controlled a much smaller proportion of the total output. Measured by the gross value of industrial production, in the 1910s foreigners owned less than ten per cent of the manufacturing industry in Finland. In Russia, the corresponding figure rose from 16 per cent to 44 per cent between 1881 and 1914. Compared to contemporary Eastern European areas, as well, the proportion of foreign ownership remained rather limited in Finland (Gerschenkron 1966, 231; Nolte 1984, 324).

In the introduction of new technology, the significance of firms owned by foreigners was greatest in the textile industry, although that sector received only a very few genuine direct foreign investments. Most of the foreigners owning textile mills in the grand duchy had raised the capital for their firms in Finland or Russia; they had no parent company abroad. In 1828, the Scottish machine builder James Finlayson set up the first cotton mill in Finland by means of credits from Russia. His firm started to enlarge after 1836 when it got new Baltic-German owners (Mikkola 1984, 233-34).

The grand duchy received portfolio investments to some extent; railway building was, to a large extent, financed by state bonds issued abroad. Furthermore, Finnish export firms funded a part of their businesses by foreign short-term credits. As a whole, capital imports and direct foreign investments were not very considerable in Finland. Nevertheless, they facilitated the transfer of technology in many respects. In various occasions, foreign entrepreneurs however gave up their factories before the new technology had proved its superiority compared to old ones. Many foreigners found that the management of a factory in Finland was an insurmountable task. As a result, direct foreign investments had a substantial impact on technology transfer in only a few industries. Sawmills were the most successful and the most long-term direct foreign investments in the grand duchy. This may be caused by the fact that foreign companies knew the Western markets well and the demand for sawn timber was steadily growing in Europe. The cotton industry belonged to the same category as sawmilling; there, foreign-owned firms had an even more central role.

During World War I, German property in Finland was confiscated by the Russian authorities. After the peace of Brest-Litovsk (1918) a great many Germans were willing to sell their property in the new republic. The Great War and the Finnish civil war (1918) seriously disrupted many other foreign investors operating in the area. During the 1910s and 1920s, several foreigners sold their firms to Finns. For instance, Norwegians gave up such companies as Gutzeit & Co, Halla Ab, T & J. Salvesen and Tornator. The Norwegian Diesen Wood Company was the only significant sawmill company that remained in foreign hands.

After gaining political independence in 1917, a strong nationalist tendency was reflected in legislation, and the attitude towards foreign-owned companies turned cool. The contextual filter then squeezed opportunities to transfer technology through direct foreign investment to the minimum. In 1919 the government prescribed a statute requiring a foreigner to obtain an official permission for setting up a firm in Finland. In addition, he had to give an advance guarantee that he was able to pay taxes to the government and the local municipality. Therefore, a foreign entrepreneur was placed in a disadvantaged position compared to a native entrepreneur who had the liberty to pursue a trade.

In the whole Europe of the 1930s, nationalism gained in popularity. In Finland, public opinion became a factor when in the middle of the decade, foreign businessmen were again interested in Finland's natural resources, primarily her forests, copper and nickel. To prevent speculation by foreign investors, the parliament accepted a bill concerning the matter in 1939. The principle of this restrictive law was that a foreigner or a foreign company could not own property (land or industrial real estate) in Finland without the permission of the government. Only now, at the beginning of the 1990s, is this law to be abolished. Although in recent years, permission has been granted quite liberally, the impact of the law on foreign investments in Finland is indisputable. Not only does it restrict foreign ownership in the country but also the opportunities of domestic companies to own real estate if the company's articles do not include the so-called clause on foreign ownership. This clause stipulates that foreigners cannot own more than 20 per cent of the company's capital stock. According to an amendment of 1987, the ministry

of trade and industry can permit, in a special case, an increase of the ceiling up to 40 per cent.

In interwar Finland, few foreign-owned companies were set up and the situation did not change much in the two decades after the war. The volume of foreign investment was, by estimate, on the same level in 1958 as in 1938.

From 1930s to the 1960s, the Finnish government followed the practice that foreign investments were not allowed at all or only to a limited amount in certain sensitive sectors, such as the forest industry, mining, banking, insurance, trading in stocks and bonds, real estate, shipping agencing, the production of energy, publishing, fishing, trading in pharmaceutical products and employment exchange (Nars 1965, 636). In the postwar period, large sawmilling companies, energy production and mining have been completely under Finnish ownership. Hence, the government has used the power provided by the law of restriction and excluded foreign companies from these sectors based on indigenous natural resources (timber, hydropower, mineral deposits).

When emigration from Finland to Sweden accelerated into a mass exodus in the 1960s, the viewpoint of the government on foreign companies was relaxed a little. In 1967 a corporate advisory committee was founded to investigate and negotiate upon the question of foreign direct investment. At the same time, the government stated that it is desirable to receive foreign investments to boost industrialisation. Nevertheless, no foreign direct investment was accepted in mining or the wood-processing industries, because the natural resources of the country are very limited. In the 1960s, some new foreign companies and entrepreneurs did appear in Finland. Between 1960 and 1987, the number of foreign-owned manufacturing firms grew by the factor of five and that of other foreign-owned firms increased by the factor of 19, as indicated in Table 4.

Table 4. The number of foreign-owned companies in Finland, 1960 - 1987 (The foreign ownership over 20 per cent of the capital stock).

Sector	1960	1967	1972	1977	1983	1987
Manu-facturing firms	45	53	105	144	207	244
Non-manu-facturing firms	69	158	349	410	829	1280
All firms	114	211	454	554	1036	1524

Source: *The Bank of Finland, Yearbook 1983 - 1990*, Helsinki 1983 - 1990.

After the change in the government's policy, Finland, due to its relatively low level of wages, managed to attract some Swedish textile and garment factories. Several of them set up their subsidiaries in the country beginning in the 1960s and 1970s. Nevertheless, the significance of foreign-owned companies remained modest. In the 1970s, they contributed only 5 - 6 per cent to the value added of the whole manufacturing industry and employed about 5 per cent of the industrial work force (Eriksson 1988).

As a whole, Swedish companies have been the most active investors in Finland. In the 1980s, about half of the foreign-owned firms were Swedish. Most direct foreign investments in Finland have been made in import, marketing, repair or service companies; foreign-owned manufacturing companies have accounted for a rather small number.

From the standpoint of technology transfer, the significance of direct foreign investment has varied depending on the sectors of the economy and the periods under study. It undoubtedly provided valuable incentives and introduced brand new technology in some sectors; thus it has acted as an example for domestic companies.

2.6 Foreign Patents and Licences

In the modern world, the exchange of patents and licences constitutes an important channel of technology transfer. In the cases of patents and licences, technology is transferred in the form of written documents and blueprints of devices. The exchange of patents and licences is especially lively between highly industrialised countries. The more actively two developed economies communicate with each other, the more vigorous is the exchange of technological know-how between them in the form of blueprints.

In a way, a patent is an official institution: it means that the government grants sole rights to an applicant to utilize his invention for a certain period. A licence means a permission that a manufacturer purchases from the owner of a particular technology in order to benefit commercially from the latter's production method, trade mark and other associated rights. It is a mutual commercial agreement between a supplier and a recipient of technology.

In various countries even before their respective industrial revolutions, the government began to support and stimulate people to make inventions and innovations by granting them privileges. The benchmark for modern patent legislation was the English statute of 1624 on monopolies, which warranted sole rights of 14 - 21 years for an inventor to benefit from his inventions. In Finland, patenting dates from the royal statute of 1739 on the privileges concerning manufacturing and handicraft workshops. The government of the Swedish-Finnish kingdom as a rule granted these privileges to foreign entrepreneurs whom it had invited to the country. To receive a privilege it was not required that technology introduced by an entrepreneur was invented by himself or that it was brand new. It was enough that it was not widely utilized in Sweden-Finland.

The senate of the grand duchy granted the first genuine Finnish patent in 1842. Then the mechanic L.G. Ståhle received sole rights to produce blowers of iron. In 1876 the patent was clearly defined and institutionalised by the statute on patent rights. At the time, patenting had become an international issue and the Finnish statute was formulated according to foreign models. The Finnish statute took account of foreign applicants of patents. They were granted the right to receive a Finnish patent for an invention patented earlier abroad. In 1898 the Finnish patent legislation was modernised following the models of the Swedish patent law of 1884 and the Russian patent law of 1896 (Kero 1987, 127). Later, the modernisation of the legislation has continued. A peculiarity of the Finnish legislation has been that until now it has not been possible to patent medical and food products, only their production methods.

Table 5. The patents granted in Finland, 1739 - 1914

Period	The number of patents granted					Total
	to foreigners		to Finns		to persons with a unknown nationality	
	no.	%	no.	%	no.	no.
1739-1841	"	"	"	"	"	(20)
1842-1874	"	"	"	"	"	145
1875-1894	237	60	153	38	8	398
1895-1914	3,962	73	1,457	27	21	5,440
1875-1914	4,199	72	1,610	28	29	5,838
1842-1914	"	"	"	"	"	5,983
1739-1914	"	"	"	"	"	(6,003)

" No data available

Source: Reino Kero, "Ulkomaisen teknologian patentointi Suomessa ennen ensimmäistä maailmansotaa", *Historiallinen Arkisto* 90 (Helsinki, 1987), pp. 121, 136-137.

Before World War I, about 6,000 patents or corresponding sole rights were granted in Finland, as shown in Table 5. Most of them were granted to foreigners. Between 1875 and 1914, foreigners received about 4,200 patents or three times more than Finnish applicants (1,610). In principle, a Finnish patent gave to a foreign firm the advantage over local firms to produce new innovations in Finland or to import them into the country. Hence, it provided a channel for technology transfer that was supported and protected by the government. However, not in all cases was the goal to transfer technology into Finland. On the contrary, most patents filed by foreigners aimed to postpone the introduction of new technology in the country and prevent Finnish firms from competing with similar products. A relatively small number of patents was meant for sale on the Finnish market, and in even more rare cases, the applicants themselves had plans to start production based on patented technology.

In the grand duchy, most of the know-how included in patents was left idle; they did not contribute to economic activity. An annual fee was paid for at least four years for only 41 per cent of 4708 patents granted between 1876 - 1914. Most (59%) of the patented inventions remained protected for a short time or just for 1 to 3 years; after that their owners neglected the annual fees.

In the period of 1876 - 1914, just 74 or 2 per cent of all patents granted to foreigners were sold to Finnish individuals or firms. The engineering industry was the most active in purchasing foreigners' patents. In contrast, the wood-processing industry obtained surprisingly few of them.

A typical patent that the Finns bought from foreigners was cheap and it yielded a modest return. Among the minor patents, there were, however, a few pearls representing a real move towards technology of a new kind. An example of notable, long-lasting technology transferred into Finland through a purchase of a foreign-owned patent was electric welding. In 1906 the Swedish inventor Oscar Kjellberg visited Finland to demonstrate his arch welding technology. The representative of the Swedish Sandviken company bought Kjellberg's Finnish patent and sold the sole rights for its use to the Helsinki Shipyard and the Pori engineering workshop (Herranen 1986, 36; Kero 1987, 181).

Why did the Finns not buy more patents granted to foreigners? First, foreign firms and individual inventors filed Finnish patents partly at random. They did not know well enough Finnish circumstances and local demand for new technology. In contrast, a great many inventions important for Finland were not patented in Finland at all. Therefore, there was no opportunity to obtain them in the form of patents.

Second, Finnish firms circumvented or imitated without permission the technology contained in foreign-owned patents and this decreased the number of patents purchased by Finns. For example, American agricultural equipment such as harrows, mowing machines and threshing machines, were copied with rather slight changes in Finland. Granting patents to foreign innovations and importing products patented abroad, however, promoted technology transfer even in these cases because they made innovations known in Finland.

Third, the extensive transfer of foreign technology through patents was not possible because the technological standards of Finland were still too low to adopt and to utilise it efficiently. The same handicap also hampered any benefit of "natural diffusion". A recipient ought to have a fairly high level of technological expertise if it attempts to adopt know-how in the form of written documents and blueprints. Developing countries - such as Finland was in the nineteenth century - generally lack basic educational, scientific and productive prerequisites for the transfer of sophisticated foreign technology.

During the interwar period, the relationship of plausible patentees to Finland changed. The country was no more a potential entryway to the large Russian market. Opportunities to trade with the Soviet Union through Finland then disappeared. In this respect, Finland's value diminished from the viewpoint of foreign patentees. Despite profound changes in foreign trade relations, the Finnish economy thrived in the 1920s and 1930s. Its demand for certain types of technology, such as wood-processing machines and electrical equipment, was

considerable. In the same time, the total number of patent applications was increasing.

During World War II in 1942, the National Board of Patents and Registration was founded. In the 1940s and 1950s, the number of patents granted did not increase much. The scrupulous regulation of foreign trade and the whole economy did not provide favourable circumstances for patenting. After the economic liberalisation started, patenting increased notably. In the 1960s, the annual number of granted patents doubled. In the 1970s, the activity slowed down: the increase was just 39 per cent. During the prolonged upturn of the 1980s, patenting increased by 50 per cent (SYF 1980 and 1991).

During the past 150 years, almost 85,000 patents have been granted in Finland. Nearly 93 per cent, or about 79,000 of them, were filed after 1914. Most of patented inventions and innovations have been foreign, because roughly only 40 per cent of all patents have been granted to Finnish applicants (Åkerblom and Virtaharju 1987, 23; *Helsingin Sanomat* January 24, 1992).

Tables 5 and 6 indicate that the proportions of foreign and domestic patents have been fairly stable since the mid-1870s. Another long-lasting feature has been that most patent applications come from those countries that also have close and brisk trade connections with Finland. Foreign enterprises protect their own marketing prospects by filing patents in the country. Traditionally, Swedish, German, American and British applicants have been the most active foreigners to apply for Finnish patents. Recently, the Swiss have increasingly filed patents in Finland. In the early 1980s, these five nations together submitted about two-thirds of all foreign applications (Åkerblom and Virtaharju 1987, 25).

Table 6. Patent applications in Finland, 1938 - 1990.

Year	Applica-tions, in total	From Finland	From Sweden	From Britain	From Germany	From USA	From other countries	Granted patents	Valid patents
1938	1,464	676	255	35	191	44	263	455	2,852
1945	1,585	1,184	259	1	2	4	135	592	2,565
1950	1,797	1,154	270	38	45	61	229	722	3,542
1955	1,942	916	315	95	162	137	317	679	3,691
1960	2,158	714	306	130	297	192	519	709	4,220
1965	3,145	819	453	187	462	470	754	812	5,379
1970	3,528	861	431	185	633	507	911	1,372	6,420
1975	3,761	1,164	502	188	508	511	888	1,361	7,964
1980	4,090	1,356	370	175	583	636	970	1,906	8,386
1985	5,199	1,727	412	245	648	899	1,268	2,161	11,275
1990	6,469	2,054	317	313	724	1,360	1,701	2,467	16,576

Source: *Statistical Yearbook of Finland 1980 - 1991*

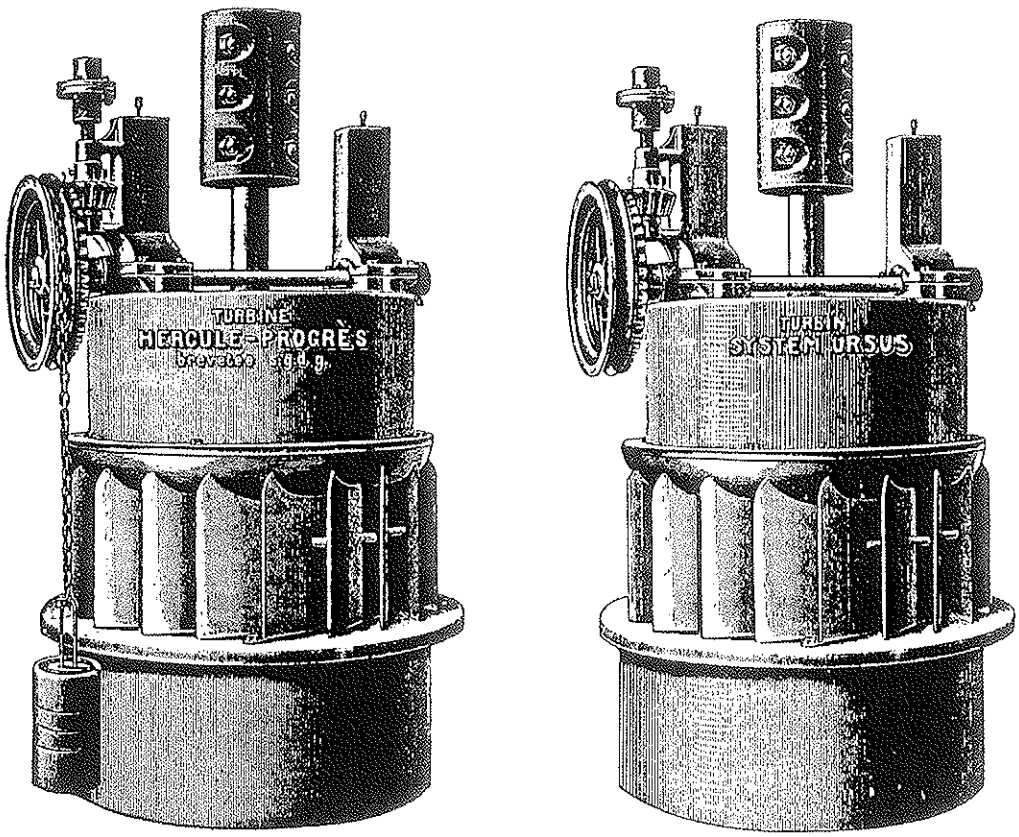
The annual number of both domestic and foreign applications tripled from 1960 to 1990. During the same period, Finnish patenting abroad accelerated. In the USA, the number of Finnish patents per year was more than six times higher in the 1980s than in the 1960s. No other Western European country was then capable of equal growth. Among the world's market economies, Finland was the fourth fastest - after South Korea, Taiwan and Japan - in increasing its patenting activity in the USA. According to this indicator based on the official US patent statistics, the level of Finnish inventing activity has surpassed, for example, that of Denmark and Norway. In per capita terms, Finland is, however, still far behind the activity of Switzerland, Germany, Sweden and Japan, which were the leading foreign nations patenting in the USA in the 1980s (Ray 1990).

These recent developments show that Finland is no longer just a recipient of foreign technology; it has become a supplier of technological expertise. The country is capable of exporting its own innovations even to the USA, which constitutes the largest and most sophisticated market in the world.

In many cases, the purchase of a licence to produce an advanced product with a good reputation is a more purposeful vehicle for technology transfer than searching for a new patent. By means of a licence, the recipient of a technology

often receives an opportunity to utilise a production process that has been well developed and also tested in practice. In Finland, there is no documentation on licences that would cover a period of several decades. Nevertheless, there is scattered information on the Finnish experience with foreign licences (Myllyntaus 1991a, 32-33, 174, 180). Purchases of licences provided opportunities for Finnish engineering shops to manufacture almost exact copies of foreign products, as described in Fig. 4.

Figure 4. The American Hercules hydroturbine and its Finnish imitation Ursus turbine by the Karhula engineering works in the early 20th century.



Sources: *Keksintöjen kirja*, Ed. Vihtori Peltonen (Porvoo 1907 - 1908); *Teknikern* 17 (1907), p. 507.

The importance of foreign licences was perhaps relatively highest in the late 1940s and in the 1950s, i.e. the period of war reparations, reconstruction and the regulated economy. Because foreign manufacturers were not able to import their

products to Finland due to the latter's tight control of foreign trade, many of them were willing to sell licences to Finnish machine shops. The production of a great many electrical appliances, such as televisions, washing machines and refrigerators, started in Finland on the basis of foreign licences. At the time, there was a real danger due to the insufficient imports of capital goods that Finland would be left behind other Western European countries. For that reason, the acquisitions of foreign licences were of great significance in attempts to bridge the technological gap.

From the late 1950s, Finland has liberalised its foreign trade and has become integrated more closely, first with the EFTA countries and then with the EEC, via the free trade agreement of 1973. The relative importance of foreign licences has diminished somewhat compared to the peak of the reconstruction period, although their absolute number has remained fairly high. During the past 25 years, Finnish firms have become technologically more competent to apply and utilise foreign patents and licences. Therefore, this channel's role in future technology transfer is likely not to decrease - on the contrary, it will probably increase.

2.7 Joint-ventures

Joint-venture is a fairly new term pertaining to technology transfer. It describes a business where foreign and local partners join their resources in a common firm. Generally, technology and financial arrangements constitute the foreign partner's primary contributions to a new project, whilst the local partners master public relations, the acquisition of local workforce and raw materials.

As a phenomenon, joint-venture is quite old. In Finland, where legal, linguistic and psycho-social circumstances have been complicated, many foreign entrepreneurs have needed local partners in their businesses. The idea of "traditional joint-venture" was frequently utilised in the 19th century when foreigners registered their firms under the name of Finnish strawmen if they had failed or had otherwise no opportunities to get a privilege to own a firm or real estate under their own name.

Genuine joint-ventures have been rare in Finland. This is partly caused by legal reasons limiting foreign ownership in Finnish companies. In the postwar period, the number of joint-ventures has, nevertheless, been increasing. They have, as a rule, brought new technology in the country and diversified the structure of manufacturing.

A good example is the joint-venture of the Swedish SAAB and the Finnish state-owned company Valmet Oy. In 1969 they jointly opened an automobile factory in Uusikaupunki. It was the first, and up to now, the only plant manufacturing passenger cars in Finland. The Swedish partner provided all technology for the model SAAB 96, which had earlier been made only in Sweden. Valmet Oy and Prime Minister Johannes Virolainen's government initiated the joint-venture that aimed at creating new jobs, improving the trade balance through exports, setting up a

subcontracting industry and transferring the know-how of car manufacturing into Finland. Saab was the only company of several foreign automobile manufacturers that accepted the conditions of the Finnish government. The Swedish company acquired the extra capacity it then needed by purchasing 50 per cent of the new company's stocks (Björklund 1990, 298-305).

Joint-ventures with the scale and success of SAAB-Valmet Oy have been rare in Finland. Another large-scale joint-venture was the Valco Oy plant for making television picture tubes applying the Japanese Hitachi's technology. It was initiated by the Finnish private company and the left-centrist government, but it failed even before the commercial production of tubes actually started. The factory's technology stumbled and the calculation of its profitability soon proved unrealistic.

Joint-ventures have not been a very important channel in transferring foreign technology in Finland. Foreign companies have not been interested in joint-ventures in the country on the one hand. On the other hand, joint-ventures have all been very dependent on the policies of the current government, whose approval has been needed for most joint-ventures. Sometimes even the state's active participation in the planned project has been necessary. Therefore, joint-ventures have not been simple projects because of the necessary institutional and political continguencies.

2.8 Turnkey Plants

A turnkey delivery means a complete manufacturing plant for which the vendor supplies all necessary machinery, technological software, training of employees and documentation so that the user can commence operation immediately. Turnkey deliveries have become quite common just in recent decades. Their idea was, however, invented long ago (Clapperton 1967, 315).

In Finland, turnkey deliveries are a recent phenomenon. The small number of direct foreign investments and joint-ventures is one reason for this. The second reason is Finnish economic nationalism. The Finns believe that they know best the country's idiosyncracies. It has been considered a question of national pride that, even if the Finns adopt and use foreign technology, they want to plan how to apply it themselves. In the early 20th century, foreign contractors designed and built several concrete bridges, houses and other reinforced concrete structures in Finland, which nationalist engineers felt humiliating. It has been a basic doctrine of Finnish economic nationalism that decision making on and the application of foreign technology must be under national control. This feature of the socio-cultural filter has substantially limited the utilisation of turnkey deliveries in technology transfer.

There are, however, sporadic cases - even rather marked ones - of turnkey deliveries to Finland. The largest one of them is the construction of two nuclear power plants at Olkiluoto on the western coast. In 1969 a group of private, state-owned and municipal firms set up a power company that ordered plants with boiling water reactors from the Swedish Ab ASEA-ATOM.

In the mass media, these plants have been contrasted to the Loviisa nuclear power plants that represent an alternative, the 'Finnish way', to build industrial facilities. The Loviisa plants were built by Finnish engineers who also mostly designed them. In construction, domestic equipment was used as much as possible. Generally only those components, such as nuclear reactors and turbogenerators, which were not produced in the country were imported. In the style the Loviisa nuclear power plant was built, there was a question of both rational strategy and national self-esteem. This construction project perpetuated the Finnish tradition, which dates from the 19th century, a period of rising economic nationalism.

In Finland, turnkey deliveries constitute another neglected channel for technology transfer. If they had been utilised more frequently, industrialisation would have probably speeded up and competition would have increased in designing factory buildings, building construction and the manufacturing of machinery. Finland has, however, not been a sufficiently open economy to allow free competition. It must be noted that the reluctance concerning foreign turnkey deliveries has not generally led to poor quality of industrial plants. The problems have often related to the long planning period, high construction costs and sometimes to the lack of the most recent and most efficient technology.

3. THE EVOLUTION OF THE FINNISH MODEL

While characterising the features and profile of the Finnish model, an important task is to evaluate and to compare the significance of various transfer channels. How much technology did each channel transmit to Finland during the past two centuries, and how valuable was it? The answers to these questions define the impact of transfered technology on industrialisation and modernisation. In the factual national transfer model, a decisive factor is not the theoretical potential of some channels but their actual function in the particular country during various periods. It is difficult to measure the function and importance of an individual channel. Because a rough evaluation is the only method to estimate the contribution of each channel and to sketch out the profile of the Finnish model, the results can be only tentative. Despite their flaws, such results may help to outline national characteristics of the development of technology transfer into Finland and to stimulate discussion and further research.

The Finnish model of technology transfer was shaped in the circumstances of the grand duchy. Political, social and cultural factors had a great impact on the peculiarities of the model. Besides the contextual filter, economic opportunities also confined and configured the model's function. In the early phase of industrialisation, the model emphasised the ordinary importation of foreign machinery on the one hand, and the transfer of unembodied technology through travelling nationals and individual foreign experts on the other. Natural diffusion became increasingly

important towards the close of the grand duchy period (1809 - 1917). Other channels remained underused and direct foreign investments were eschewed and sometimes even opposed. The government's measures to promote technology transfer were inadequate. At the time, it was preoccupied with improving the infrastructure by building channels and railways or acquiring icebreakers (Myllyntaus 1992b, 37-42).

The contextual filter greatly influenced technology transfer in Finland. The authorities' involvement in the immigration of the workforce is an illustrative example. In the first half of the 19th century, the Russian tsar stipulated statutes that prevented Finnish millowners from recruiting foreign craftsmen and workers in groups. It was, however, possible for industrial plants to hire individual foreigners, but even these people came under suspicion of the Russian authorities. The tsarist regime, however, did not stop Finns from studying and training abroad. For a few decades prior to World War I, the Finnish government encouraged such travelling by granting scholarships for studies abroad. Perhaps this contributed to the fact that study tours abroad became fashionable among young Finnish intellectuals. Consequently, the filter promoted Finns' study trips abroad (channel 7) but disfavoured recruiting foreign craftsmen and technical experts to the grand duchy (channel 6).

In the interwar period, economic nationalism gained strength, which meant a marked change in the contextual filter. On the political level, direct foreign investment in Finland was opposed more openly. The opposition lead to very restrictive legislation in the late 1930s. For various reasons, the ownership structure of the economy became more Finnish in the early interwar years.

The imports of western machinery continued and even increased during the interwar years. This channel did not lose its importance. In contrast, the role of both recruiting foreign experts and supporting nationals' journeys abroad met a relative setback in the early 1920s when postwar migration was over. The socio-political atmosphere was not as favourable for the international movements of technical personnel as it had been before World War I. This drawback was partly offset by the increased exchange of foreign licences and patents and reliance upon natural diffusion. In Finland, the use of these channels was improved essentially due to better educational standards for the population and the more developed R & D facilities of Finnish firms. Compared to the earlier period, the volume of technology transfer to Finland probably increased although the diversity of easily available channels diminished. During World War II, the volume of technology transfer decreased, too.

After 1945, the arsenal of transfer channels slowly broadened. The fairly extensive regulation of the Finnish economy continued into the late 1950s and through this policy, the government restricted technology transfer into the country. Some areas were clearly left behind the corresponding development in western Europe because imports of up-to-date capital goods were cut to a minimum. Economic nationalism hampered foreign direct investments up to the early 1990s. In the early postwar years, the country's industry was concentrated in Finnish hands more than at any time after 1809. In contrast, the acquisitions of foreign licences and patents rapidly grew in prevalence. Natural diffusion preserved its importance.

Nationals' journeys abroad slowly revived and acquired new features due to the considerable development in communication facilities. The ordinary imports of western technology in the form of capital goods increased, whilst the country managed to earn hard currency. As a whole, the profile of the channel system diversified. Some technology was transferred through joint ventures and turn-key deliveries, although it belonged to the Finnish national style of technology transfer that nationals designed and headed the construction projects.

Alongside the recovery and economic growth, the relative importance of foreign specialists has considerably waned in the post-1945 period. The contributions of foreign technical experts were no longer so vital as they used to be before World War II. Finnish engineers replaced foreigners in nearly all fields of engineering. No substantial immigration to Finland took place. The proportion of foreigners diminished to its lowest level ever during industrialisation.

The last two decades have seen an epochal turn. While Finland matured into a developed industrial nation, it started to balance the transfer of foreign technology with exports of its own technology.

In a simplified way, Table 7 illustrates the evolution of the Finnish model. It shows that during industrialisation, the imports of foreign machinery have been the most important transfer channel. Both nationals' journeys abroad and natural diffusion ranked next. Acquiring foreign licenses and patents, and recruiting foreign experts have had contrasting development effects. In a long-run evaluation, the latter channel's valuable contributions before World War II probably give it an upper hand compared to the impact of foreign licences and patents.

The modest role of direct foreign investment is a peculiarity of the Finnish model of technology transfer. It is partly attributed to strong economic nationalism that also restricted the utilisation of foreign turn-key deliveries and joint-ventures.

Table 7. The significance of channels in the Finnish model of technology transfer during three periods.

Channels for technology transfer	Periods		
	1809-1917	1918-1944	1945-1992
1 Receiving direct foreign investments	1	1	1
2 Importing foreign machinery and equipment	3	3	3
3 Acquiring turn-key plants	0	0	1
4 Acquiring foreign licenses and patents	1	2	3
5 Setting up joint-ventures with foreign entrepreneurs or companies	1	0	1
6 Recruiting skilled workers, artisans, engineers, teachers and consultants from abroad or permitting mass immigration consisting of a large spectrum of people ranging from unskilled labour to various craftsmen and professionals.	3	2	1
7 Encouraging and supporting nationals' journeys abroad for studying at foreign schools and universities, or training in factories, visiting international congresses and trade fairs, making contacts with foreign experts, etc.	3	2	3
8 Utilising "natural diffusion" or the low-cost diffusion of easily accessible technology: the spread of know-how through trade and scientific publications, analysing foreign products, etc.	2	3	3

0 - 3 scores for the channels' significance; 0 the lowest, 3 the highest score.

In transferring technology into their country, the Finns used no shortcuts but chose instead fairly slow, roundabout and uncertain channels. That choice probably delayed industrialisation in 19th-century Finland. The Finnish model did not exploit the available collection of transfer channels as efficiently as those of some more successful countries (Myllyntaus 1990b, 625-43). One feature, however, is noteworthy: during the turbulent periods of the 20th century, transfer models that based on extensive dependence on the foreign suppliers of technology faced difficult times. Compared to those models, the Finnish model worked best during turmoil while suffering from certain drawbacks during periods of peace. As a result, it is likely that the Finnish model of technology transfer has stabilised economic development during this stormy century.

Since its early decades, the Finnish model encouraged Finnish engineers and businessmen to obtain new foreign technology as well as adapt it to the Finnish circumstances. In adopting foreign technology, the Finns concentrated on technology that could be fairly easily and quickly utilised in production.

The technology strategy of Finnish firms was focused on organising the activities in manufacturing plants. The goal was to become capable of competing internationally by means of adopting foreign technology efficiently. By applying foreign technology to local circumstances and relative prices, production was to be more economical than in competing countries. As a result, Finnish engineering has been oriented toward making clever, small improvements on the shopfloor level (Myllyntaus 1992a, 51).

In the countries that are leading in technological development, large corporations have directed their strategic efforts to the planning section of the head office and to research and development departments. The goal of business is to compete by creating new innovations. Firms have aimed at cutting out competitors with new types of processes and products.

Another peculiarity of the Finnish model has been the strong emphasis to promote nationals' role in the transfer and practical application of foreign technology. At the beginning, this meant choosing a long and slow road to industrial and technological modernisation. A basic reason for this was to keep technology transfer under the recipient's control. This could be called a cornerstone of the Finnish model of technology transfer.

Besides the delayed start in industrialisation, the disadvantage of the Finnish model was the slow diversification of the production structure. Its advantage was that the country avoided becoming a periphery economically dominated by some metropolis. From the late 19th century, political sovereignty has been such an important priority for the nation that it has affected technology transfer as well as other things.

The surprising thing is that although the country was a latecomer and an odd man out in technology transfer, Finland succeeded fairly well in its industrialisation. The research of Finnish economic history has provided no plausible explanation whether the success resulted from precious natural resources, the enterprising spirit of the population, appropriate economic policy or just "lucky coincidences" (Myllyntaus 1990a, 17-55). Whatever the basic cause of the long-lasting success story, the Finnish model of technology transfer was no failure, even though it

differed from the most common models. In contrast, it co-existed with the steady growth of the Finnish economy over a hundred-year period. By means of the model, the country managed to bridge the technological gap to more advanced countries. Only now in the early 1990s, when Finland has caught up with many earlier industrialised countries, has its technology transfer model matured and become partly outmoded and inadequate. Unless the model will be reorganised, the country will lose the opportunity to develop into a high-tech economy and face a potential fate of stagnation (Klus 1985, ix-x, 83-85).

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