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**NOKIA –**  
**A Big Company In A Small Country**

ETLA – The Research Institute of the Finnish Economy

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**ABSTRACT:** Nokia has undergone a major metamorphosis. Emerging as a conglomerate with a number of different business lines, Nokia has been transformed into a pure telecommunications company. At the same time, the company has also internationalised by investing abroad.

Despite the heavy internationalisation program, Finland still is an important place for Nokia. A large share of the company's production and research and development (R&D) is conducted in Finland. Thus, in this study, we analyse how Nokia has affected the Finnish economy. We study the impacts on exports, R&D and GDP. We conclude that Nokia has had a considerable effect on the Finnish economy.

Although Nokia is the major player within the Finnish ICT (Information and Communication Technology) cluster, it does not comprise the whole cluster. Numerous new ICT companies have been established during the past few years and other previously established companies have also grown drastically.

**KEY WORDS:** Nokia, ICT cluster, telecommunications.

**ALI-YRKKÖ**, Jyrki, - **PAIJA**, Laura - **REILLY**, Catherine - **YLÄ-ANT-TILA**, Pekka, **NOKIA – A BIG COMPANY IN A SMALL COUNTRY**. Helsinki, ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2000, 55 p. (ISSN 0781-6847; no. B162) ISBN 951-628-314-4.

**TIIVISTELMÄ:** Nokia on käynyt läpi täydellisen muodonmuutoksen. Monialayrityksestä on tullut telekommunikaatioon erikoistunut yritys. Samaan aikaan yritys on kansainvälistynyt voimakkaasti.

Huolimatta kasvavista ulkomaan toiminnoista, Suomi on yhä tärkeä alue Nokialle. Merkittävä osa tuotannosta sekä tutkimus- ja kehitystoiminnasta tehdään Suomessa. Tässä tutkimuksessa tarkastellaan Nokian vaikutusta Suomen talouteen. Erityisesti selvitetään Nokian vaikutusta Suomen vientiin, tutkimus- ja kehitystoimintaan sekä bruttokansantuotteeseen. Tarkastelut osoittavat, että Nokialla on ollut laajat vaikutukset koko kansantalouteen.

Vaikka Nokia on Suomen tieto- ja viestintäklusterin ydin, se ei ole klusterin ainut yritys. Muutamien viime vuosien aikana Suomeen on perustettu lukuisia määriä pieniä ICT-klusterin yrityksiä. Lisäksi useat aiemmin perustetut yritykset ovat kasvaneet erittäin voimakkaasti.

**AVAINSANAT:** Nokia, tieto- ja viestintäklusteri, telekommunikaatio.

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## Foreword

In the 1990s, Nokia grew to become one of the world's leading high-tech companies. This coincided with a very rapid structural change in the Finnish economy and industry. Nokia has played a major role in the restructuring process.

Nokia has become a multinational company, but a major part of its activities are located in Finland, the original home base of the company. Nokia's role in the Finnish economy is considerable, especially in exports and R&D. Since the mid-1990s, Nokia has contributed significantly to the economic growth of the country, which has been one of the fastest in Europe.

But there is more than just Nokia. The whole information and communication technology (ICT) cluster has expanded rapidly. There are hundreds of small and medium-sized fast growing companies in the cluster. Many of them are Nokia's suppliers and partners or have their roots in the same ICT-related know-how.

This is an interim report of two larger projects, which investigate the evolution and future prospects of the Finnish ICT cluster and Nokia's network companies. The projects are financed by the National Technology Agency (Tekes) and the Ministry of Trade and Industry (MTI), which we would like to thank for their support.

Helsinki, February 2000

Pentti Vartia

## **Preface**

This report is the output of teamwork. During the last couple of years, the authors have frequently been asked what is the role of Nokia – one of the biggest companies in the world in terms of market capitalisation – in a small country like Finland. What explains the phenomenal growth of the company?

To shed some light on these issues two major projects on the ICT cluster and Nokia's networking were initiated. This book reports some basic facts on Nokia's role in the Finnish economy as well as on its significance as a leading company in the ICT sector.

We would like to thank Kari Alho, Heli Koski, Olavi Rantala and Petri Rouvinen for their useful comments on the manuscript and suggestions for further research. We look forward to continuing our studies on this fascinating topic.

Helsinki, February 2000

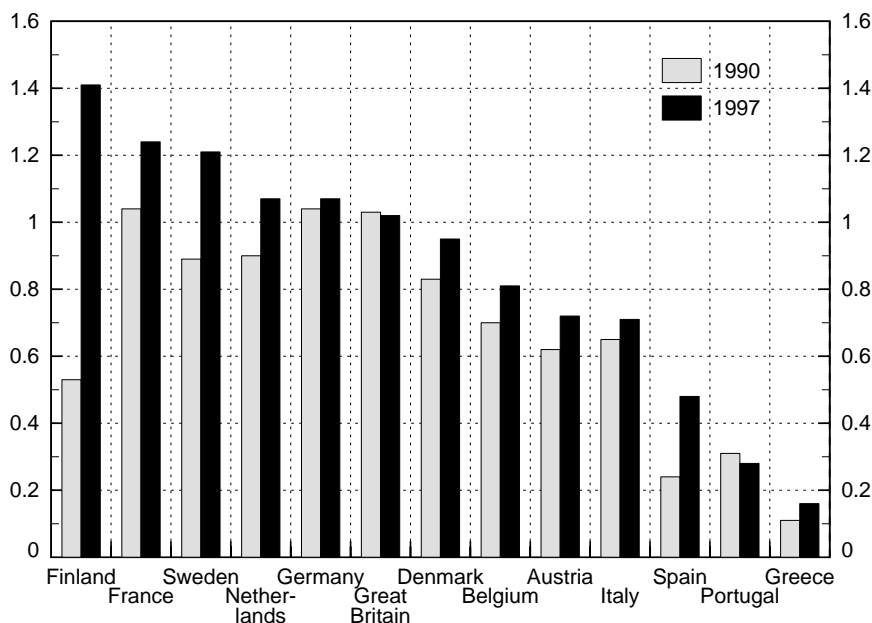
Jyrki Ali-Yrkkö    Laura Paija    Catherine Reilly    Pekka Ylä-Anttila

# I Background

## From a factor-driven to knowledge-based economy

During the past twenty years the Finnish economy and industry have undergone a major structural change. The production structure that was previously characterised by four factor intensities – capital, raw materials, energy and economies of scale – is today mainly depicted by one factor, namely knowledge. The R&D intensity (research and development expenditure in relation to GDP) is the second highest within the EU (3 percent), the share of high-tech products in total exports (about 20 percent) is one of the highest among the industrialized countries, and the high-tech trade surplus (high tech exports/imports ratio) is the highest (figure 1.1). The increase in the surplus ranking is striking. During less than a decade the country has moved from

**Figure 1.1 Exports/imports ratio of high-tech products in EU countries, 1990 and 1997<sup>1</sup>**



<sup>1</sup> Indigenous producers of high-tech products. Ireland is excluded due to dominant role of foreign firms in high-tech exports.  
Source: Statistics Finland and OECD.



the lower end of the European spectrum to the top. This is mainly due to the significant growth of electronics industries.

Today, the electronics and electro-technical industry is by far the largest export industry and accounts for close to 30 percent of the total manufacturing exports. The share almost tripled during the 1990s. In 1990 the share of the other major export sector, the pulp and paper industry, was some 30 percent. Nowadays it is less than one quarter.

Finland is among the leading producers and users of information and communication technologies (ICT). In its exports Finland is one of the countries most specialised in telecommunications equipment. It is the world market leader in cellular phones with a market share of 30 percent.

Finland was the first country to launch a digital network for mobile communication in the early 1990s. Today (in the beginning of 2000), the mobile phone penetration ratio is over 65 percent – higher than in any other country. Also in the number of Internet connections per capita Finland ranks the highest in the world.

## **Is it only Nokia?**

There is no doubt that the ICT cluster has been by far the fastest growing industrial cluster and Nokia the fastest growing major company in Finland during the past 10 years. A number of new ICT companies have been established, and furthermore, the existing companies have grown rapidly. Thus, today the Finnish ICT has a broad base and the cluster has significantly contributed to the economic growth that has been among the fastest in Europe since the mid-1990s.

The ICT cluster is an industrial cluster where knowledge capital plays a central role, and other production factors are rather insignificant. In the long run, even more important than being a leading producer of ICT is to be an efficient user of these technologies. There is mounting evidence that the advanced communications and information technologies have started to significantly change the structure and business practices of other industrial clusters<sup>2</sup>.

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<sup>2</sup> See Hernesniemi & Lammi & Ylä-Anttila (1995).

In this report we address the following questions: What explains the exceptionally rapid industrial transformation from the classical factor-driven industrial economy to one of the leading information societies? Is it a matter of a single sector or a single company boom only? What has been Nokia's contribution to the overall economic development in Finland in the 1990s? Is the current structure sustainable? Does the Finnish ICT cluster equal Nokia or are there other significant players and activities too? Are there any risks involved from the point of view of the national economy? Are there any similarities between the resource booms (like the "Dutch disease") and the single sector boom Finland has experienced during the past decade?

The structure of the study is as follows. Section two studies Nokia's role in the Finnish economy in the 1990s, section three places Nokia in the broader context of the Finnish ICT cluster, section four gives an overview and analysis of Nokia's growth and metamorphosis over the past 10 to 15 years, and finally section five concludes, evaluates and discusses Nokia's and the ICT cluster's future role in the Finnish economy.

2

# Nokia in the Finnish Economy

*Nokia has become so large that it has a clearly perceivable effect on the whole Finnish economy. In the following, we will examine the impact of Nokia on the Finnish economy in several different ways. First, we will examine its impact on GDP in terms of output share, growth and productivity. Next, we will study the impact of Nokia on R&D and employment in Finland. Finally, we will take a look at how Nokia influences aggregate production and price data for the Finnish economy.*

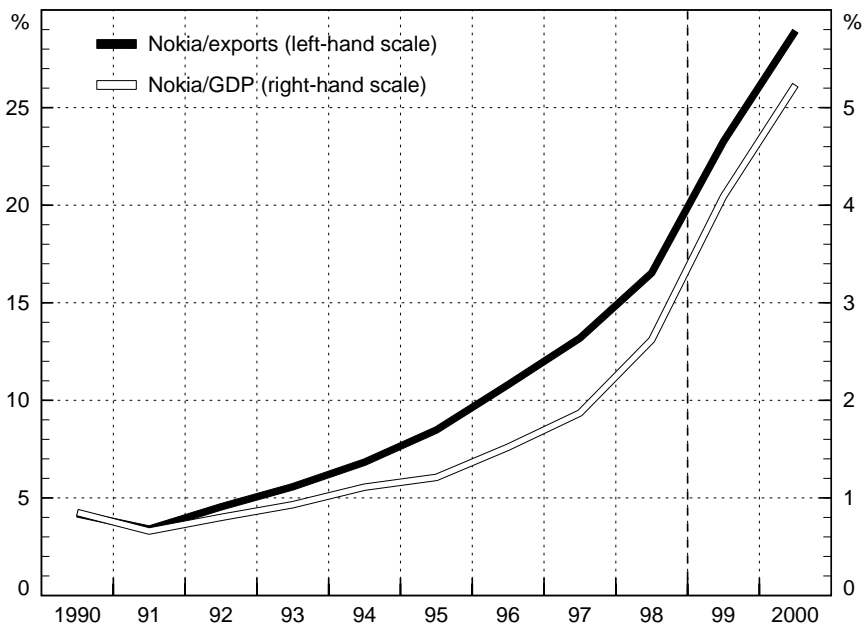
## **The impact of Nokia on GDP**

The Finnish economy experienced extremely rapid growth during the latter half of the 1990s. This can partly be explained by the recovery from the severe recession that Finland underwent in the beginning of the 1990s. Another extremely important factor is the growth of demand for telecommunications equipment which has led the Finnish firm, Nokia, to expand considerably.

Nokia's production comes mainly under the heading of the electronics and electro-technical industry. To calculate the impact of Nokia on GDP, we use the sum of the value of Nokia's exports from Finland and domestic sales as a proxy for the value of gross domestic production. We compare Nokia's Finnish production to the value of production in the total electro-technical industry in Finland. We then assume that Nokia's share of the value-added of the electro-technical industry is equal to its share of the value of production. In this way we obtain an estimate of Nokia's value-added, which we can then use to gauge its impact on GDP.

Nokia engages in a great deal of subcontracting. However, our calculations does not take into account multiplier effects. According to these calculations, in 1999 Nokia accounted for a bit more than 4 percent of Finnish GDP and 23 percent of total Finnish exports (figure 2.1).

Nokia's exports include both goods and services. The value of Nokia's exports is clearly higher than the total value of telecommunications equipment exports from Finland. This leads us to the conclusion that approximately one fourth of Nokia's exports are services. The share of services has been steadily growing.

**Figure 2.1 Nokia as a share of exports and GDP**

The most visible impact of Nokia on the Finnish economy is through its contribution to growth. Over the last five years, Nokia's value-added and exports have increased at an average rate of 33 percent a year. This is far faster than any other sector of the economy. The value-added of the electro-technical industry has increased by about 27 percent a year thanks to Nokia's rapid growth. As a result, Nokia has contributed significantly to total GDP growth (see figure 2.2). In 1999, Nokia's contribution to GDP growth was a bit more than 1.5 percentage points. Although Nokia's growth in Finland is likely to slow over the next few years, the contribution to growth will remain stable because its share of output has risen steadily.

### **The impact of Nokia on R&D expenditure**

Nokia invests heavily in R&D and conducts a large share of its research in Finland. As Nokia does not publish country-specific data on R&D expenditure we have estimated Finnish R&D expenditure on

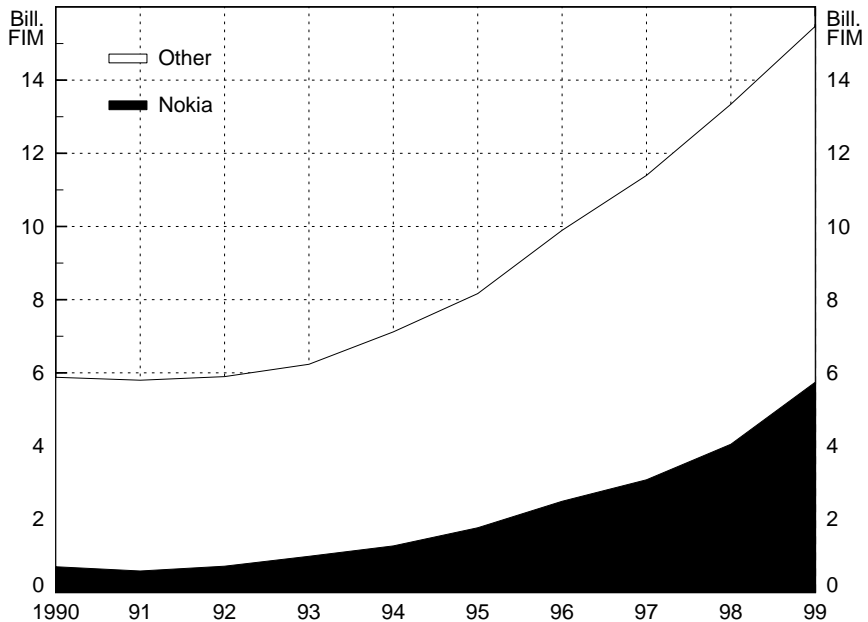
**Figure 2.2 Nokia's Contribution to GDP growth**

the basis of Nokia's Finnish personnel and a correction coefficient. We come to the conclusion that in 1999 roughly 60 percent of Nokia's R&D expenditure takes place in Finland, which seems a plausible outcome. This percentage has fallen over time, as over the last few years Nokia has expanded more rapidly abroad than in Finland.

Under these assumptions, in 1999 Nokia accounted for about one third of all R&D expenditure carried out by private enterprise (see figure 2.3). This implies that Nokia's share of total R&D expenditure (including the public sector) was more than 20 percent.

This calculation differs from the GDP calculation in that it captures only Nokia's direct R&D expenditure and does not include subcontractors. R&D outlays by subcontractors are only included if Nokia finances them directly. If the subcontractors themselves invest in R&D to develop products for sale to Nokia this comes under other business investment. The total amount of R&D that Nokia generates therefore probably exceeds these figures somewhat.

**Figure 2.3 R&D expenditure by private enterprises in Finland, 1990-1999**



R&D expenditure is not usually classified as investment under the current system of National Accounts. Instead, more than 50 percent of R&D comes under the category of wage expenses. Although Nokia has an important impact on intangible investment its impact on fixed investment, i.e. the investment component of GDP, is very small. Fixed investment in the electro-technical industry has increased at a rate of about 20 percent a year over the last five years. However, in 1998, the entire electro-technical industry still only accounted for 2.5 percent of total fixed investment. Nokia's effect on fixed industrial investment in Finland is therefore negligible.

### **Nokia's impact on employment**

Nokia's rapid growth has boosted Finnish GDP and has helped to lower the unemployment rate, which was very high after the recession at the

beginning of the 1990s. However, Nokia's direct impact on employment is actually relatively small. Nokia has slightly over 21 000 employees in Finland. This implies that Nokia accounts for 1.1 percent of total employment in Finland and for 5 percent of employment in industry. The entire electro-technical industry accounts for 3 percent of total employment. Nokia is therefore an important employer, but it is far from being the only major employer in Finland.

Obviously, Nokia's total effect on employment is much larger than simply the number of its own employees. Nokia engages in considerable subcontracting activities. In section 3, we study employment in the entire Finnish ICT cluster, which gives a better impression of the total impact on employment. Nokia's growth also has spillover effects on employment. It has increased demand for business services such as transportation or construction, which in turn has improved the employment situation in these sectors. Nokia's direct employment also has multiplier effects on consumer demand. As Nokia hires more people, these in turn spend more on other goods and services and increase demand in other sectors.

## **Nokia's impact on productivity**

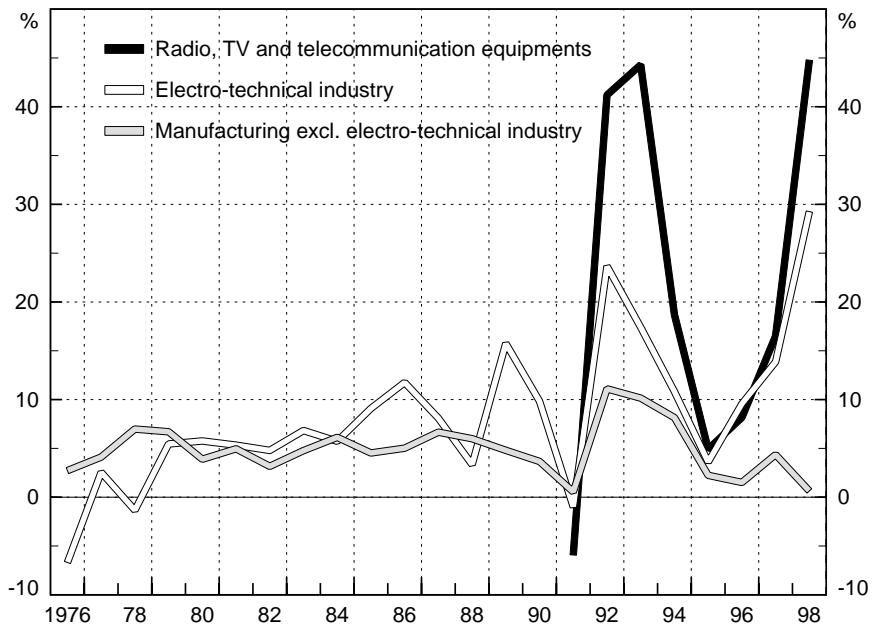
Labour productivity in Finnish manufacturing sector has been increasing at an annual rate of some 7 percent since the early 1990s. The contribution of Nokia and electro-technical industry has been significant, since the productivity in the telecom equipment industry has been growing 25 percent and in the electro-technical industry as a whole about 15 percent annually over the same period. This implies that in some industries productivity growth has remained close to zero and definitely below the long term average increase.

## **Aggregate economic indicators misleading**

Nokia's share of production is so large and its growth rate so much higher than the rest of the economy that it distorts many aggregate economic indicators. For example, Nokia currently accounts for more



**Figure 2.4 Labour productivity in manufacturing, %-changes**

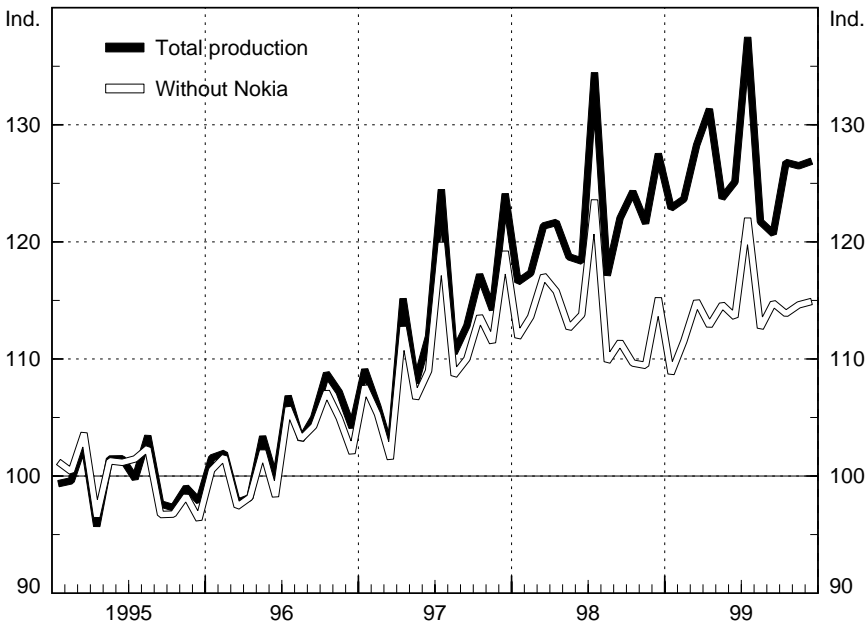


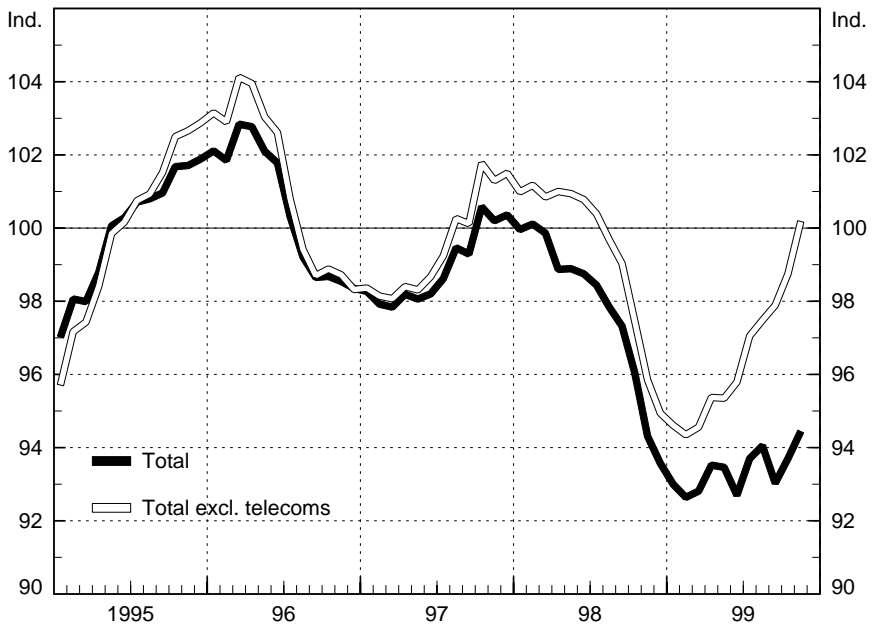
than 60 percent of the market capitalisation of the Helsinki Stock Exchange. As a consequence, Nokia dominates the HEX index. The total index does not give much information on the share price performance of the other sectors of the economy.

Finnish industrial production has increased extremely rapidly over the last few years. In the monthly index of industrial production Nokia's production is mainly included in product group of Manufacture of television and radio receivers (MTR), which is a sub-category of the electro-technical industry. We can study Nokia's impact on industrial production by comparing the total monthly index to an index from which we have eliminated product group MTR. Once we have removed this product group from the aggregate figures, we find that production in the other industries has not risen since the beginning of 1998. In fact, in the first eight months of 1999, total industrial production increased by five percent, but industrial production without Nokia was actually one percent lower than in 1998 (figure 2.5).

Nokia also distorts the export price index. Finland is a small open economy and exports account for 40 percent of GDP. The terms of trade, i.e. the export price index divided by the import price index, have always been an important indicator of the health of the Finnish economy. Traditionally, the terms of trade “improve” when export prices rise more rapidly than import prices, because this indicates that Finland will have to export less in order to pay for its imports. However, the increasing importance of telecommunications exports has also undermined this relationship. The export prices of telecommunications equipment have fallen extremely rapidly. In September 1999, export prices of telecommunications equipment were 18 percent lower than the previous year. This lowers the entire export price index. However, if we eliminate telecommunications equipment from the export price index, we find that export prices in the other industries have risen quite rapidly since February 1999 (figure 2.6).

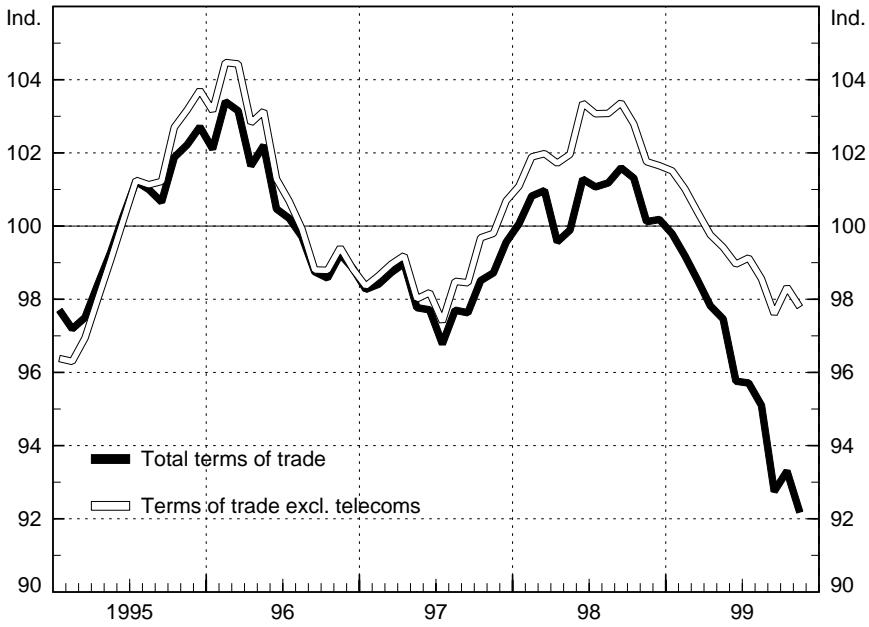
**Figure 2.5 Seasonally adjusted volume of industrial production with and without Nokia (1995=100)**



**Figure 2.6** Export prices (1995=100)

The falling export prices in the telecommunications industry are mainly due to productivity enhancements and short product cycles. As a consequence, the interpretation of the terms of trade index has changed. Because volume growth in the industry is high, export earnings increase even though export prices fall. Therefore, a deterioration in the terms of trade is no longer as alarming an indicator as when the Finnish economy depended mainly on the forest industry for its export earnings.

We can also eliminate the telecommunications industry from the terms of trade index (figure 2.7). Here we see that the terms of trade still have deteriorated in 1999 compared to the previous year, but the rate of deterioration is far lower. The terms of trade have fallen mostly because the world price and consequently the import price of oil has risen.

**Figure 2.7 The terms of trade (1995=100)**

3

Nokia in the Finnish  
Information and  
Communication  
Technology (ICT) Cluster

*Not only by size but also by influence, Nokia is the core firm of the Finnish ICT cluster. In what follows, we shall first define the cluster notion, and see which sectors or industries are included in the ICT cluster. Second, the relevance of the Finnish ICT cluster will be assessed by its competitive advantage in the export market. Third, we shall consider the multiplier effects of Nokia on the cluster, since by extensive outsourcing Nokia has transferred a significant amount of business to its partnership network. Finally, we shall introduce some successful ICT cluster firms to indicate that there are other players in the game, too.*

## **What is a cluster?**

In a knowledge-based economy, firms are dependent on the knowledge resources of other firms, to which they seek to get access. This is done by inter-firm contracts, or networking. The importance of network relations is measured by their strategic importance, not by the volume of product and money flows between the interacting firms. Fruitful inter-firm activities induce knowledge spillovers and technology transfers, which in turn stimulate innovations. A network relationship is more than the sum of its components.

Micro-level networks are interconnected and overlapping. Networks of interdependent organisations can develop into a cluster, or “network of networks”, which has economic importance at the macro level. Firms operating on different sides of the cluster do not necessarily have any direct relation with each other, but the spillovers and positive externalities generating from the intra-cluster interactions upgrades the whole system. A cluster contains both business enterprises and non-business organisations (e.g. universities).

The competence of a cluster depends on different environmental factors. These are: factor conditions (quality and availability of resources), demand conditions (demanding customers), internationally competitive related and supporting industries (complementary products, as well as cost effective and innovative inputs), and firms strategy, structure and rivalry. In addition, government and chance are exogenous factors that affect the conditions in which firms operate.<sup>3</sup>

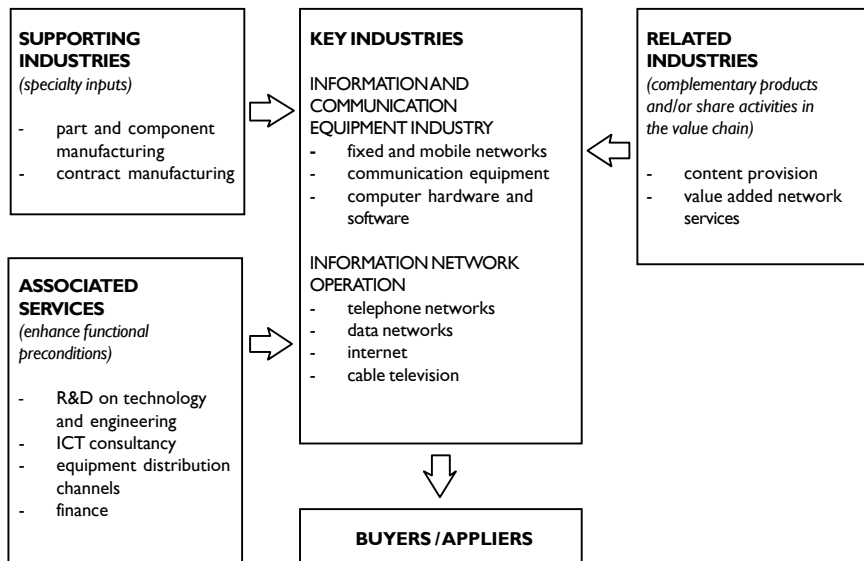
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<sup>3</sup> The cluster approach is based on Porter (1990) who has done influential work in operationalising the network concept as a tool for assessing competitiveness of national economies. The approach has been widely applied and adopted as a policy tool by governments.

## The ICT cluster: equipment, services and content<sup>4</sup>

A cluster consists of different interactive categories of sectors (figure 3.1). In the core of the ICT cluster, there are the *key industries* which manufacture information and communication equipment and networks, and provide network services.<sup>5</sup> The *supporting industries* supply the key industries with specialty inputs and manufacturing services. These are mainly provided by the electronics industry. *Associated services*, in turn, enhance the functional preconditions of the cluster firms. These services are provided by e.g. the financial sector, regulatory bodies and universities and other units of the national knowledge infrastructure. Content industries (e.g. media, news agency services, entertainment) represent *related industries* which complement the key products and boost

**Figure 3.1 ICT cluster chart**



<sup>4</sup> This chapter is based on an ongoing research project in ETLA.

<sup>5</sup> Due to the convergence of technologies, TV sets, radios, VCRs and record players are also regarded as information and communication equipment.

their demand.<sup>6</sup> Finally, demanding and advanced *buyers and applicers* of the ICT products and services have an important role in spurring manufacturers in innovation and quality improvement.

In 1997, the total turnover of the Finnish ICT cluster was about FIM 80 billion. The domestic employment of the cluster approached 70 000 persons.<sup>7</sup> However, without the chronic shortage of skilled labour, the employment potential of firms would have allowed much higher recruitment. Table 3.1 lists some major firms operating in the ICT cluster.

The competitive advantage of a cluster depends heavily on created and specialised input factors, especially on intellectual capital (R&D, national innovation systems, knowledge infrastructure and skilled labour). One of the main indicators of a viable cluster is its performance in the international markets. It can be evaluated by measuring the specialisation of a country in the cluster products.<sup>8</sup>

Next, we shall assess the performance of the Finnish ICT cluster in the OECD export market.

## **Finland ranks the second in the ICT product specialisation**

In 1998, the value of ICT product exports<sup>9</sup> was around FIM 42 billion, which was almost 20 percent of the total export value. In 1990, ICT exports made up only five percent of total exports.

In comparison with the OECD, Finland ranked second in exports specialisation in 1997, sharing the position with the US (figure

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<sup>6</sup> Content provision and other (non-electronic) input industries, e.g. plastics, metals, and mechanical engineering, are excluded from the ICT cluster figures below owing to statistical limitations.

<sup>7</sup> These sums are related to the Production Value Chain in figure 3.4. Thus, they do not include all the sectors included in the ICT Cluster Chart in figure 3.1.

<sup>8</sup> The specialisation of a country in the ICT cluster's exports is measured here by the RSCA (Revealed Symmetric Comparative Advantage) index, which compares the export structure of a country to that of the OECD. If the RSCA index equals zero, the country is as specialised as the OECD countries on average in the ICT cluster's exports. If the RSCA exceeds zero the country is regarded as specialised in the cluster's exports (see Appendix).

<sup>9</sup> Product exports do not include services.



**Table 3.1 Finnish ICT cluster firms, 1999**

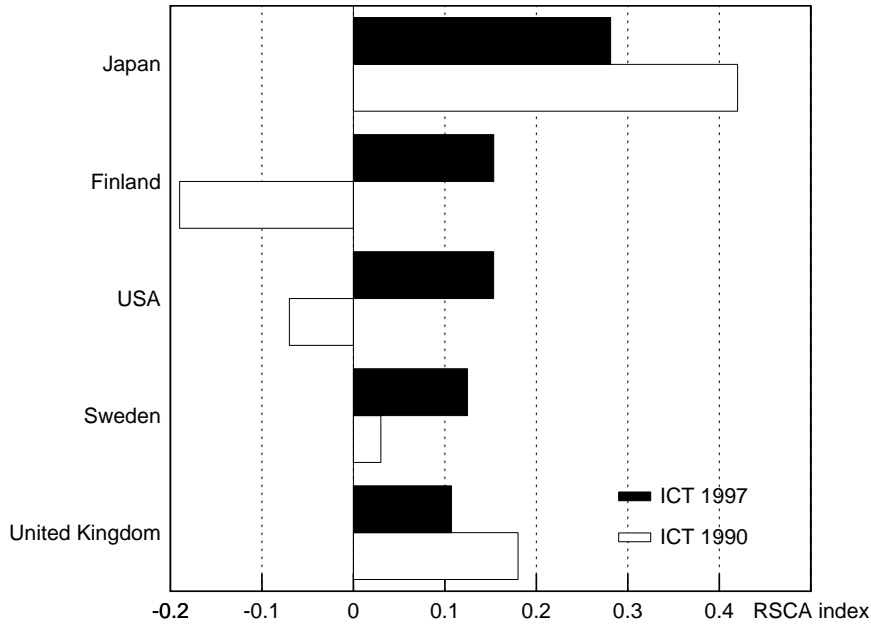
	Main products/services	Sales, Mill. FIM	Staff
<b>Finnish firms</b>			
Nokia Oyj*	telecom equipment	116 654	51 177
Sonera Oyj*	telecom operator	10 991	9 270
Tietoenator Oyj*	IT solutions	7 251	11 058
Elisa Communications Oyj*	telecom operator	6 364	5 489
Elcoteq Network Oyj*	electronic manufacturing services	4 439	4 733
Novo Group Oyj	IT solutions	1 841	2 100
Perlos Oyj*	mobile phone enclosures	1 674	1 378
Aspocomp Oyj*	printed circuit boards	1 186	1 886
PKC Group Oyj*	communications cables	673	730
Scanfil Oy	mechanics and electronics manufacturing	631	756
JOT Automation Group Oyj*	industry automation	586	565
Eimo Oyj*	mobile phone enclosures	460	681
Datatie Oy	data network services	420	255
Tecnomen Oy	enhanced network service systems	301	430
Samlink Oy	electronic banking systems	268	229
Benefon Oyj	mobile phones	233	296
<b>Foreign acquisitions (acquirer/new name in parentheses**)</b>			
Nokia Data Oy ( <b>ICL Invia Oy*</b> )	information technology	2 099	2 000
Martis Oy ( <b>Tellabs Oy*</b> )	network access and transfer systems	2 088	902
<b>NK Cables Oy</b> (Draka Holding NV)	communications cables	1 638	1 221
Kyrel EMS Oy ( <b>Flextronics Intl. Finland</b> )	electronic manufacturing services	861	532
Salora-Luxor Oy ( <b>Semi-Tech Turku Oy</b> )	televisions	711	700
Nokia Maillefer Oy ( <b>Nextrom Oy</b> )	communications cables	697	390
<b>LK-Products Oy</b> (Filtronic Plc)	RF filters, access products, antennas	496	849
Solitra Oy ( <b>ADC Telecommuni- cations Oy</b> )	integrated RF solutions	382	802
Enviset Oy ( <b>Essex Communication EMS Oy</b> )	electronic manufacturing services	349	278
<b>Foreign firms with R&amp;D</b>			
Hewlet-Packard Oy	information technology	2 230	na
ICL	information technology	2 099	1 902
Siemens Oy	telecom equipment	1 774	1 329
Ericsson LM Oy	telecom equipment	1 140	1 056

\* = Consolidated figures.

\*\* = Figures apply to the bolded companies.

Figures in italics are 1998 data.

**Figure 3.2 Specialisation in the ICT product exports (OECD average equals zero)**



Source: OECD.

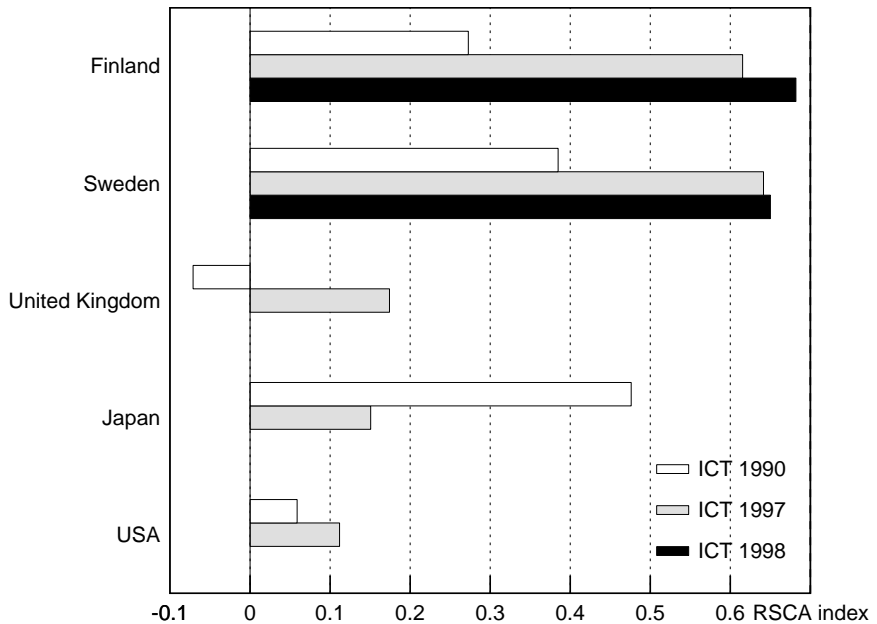
3.2).<sup>10</sup> However, the assortment of the ICT exports of Finland and the US differs in that Finland is focused on telecommunications equipment, while the US is specialised in information technology.

The level of Finnish specialisation has increased considerably between 1990 and 1997. In fact, with the applied definition of ICT products, Finland has exceeded the average OECD specialisation level during the past decade. Japan, instead, has been losing its relative lead.

To see the extent to which Finland has specialised in the telecommunications products, we have depicted in figure 3.3 the specialisation indices excluding other ICT products (information technology, consumer electronics and electro-technical inputs). During the 1990s,

<sup>10</sup> The comparison is limited to indigenous producers of ICT. Thus Ireland, Hungary, Korea and Mexico are excluded in spite of their high share of ICT exports which owes, however, mainly to foreign firms' exports.

**Figure 3.3 Specialisation in the telecommunications equipment exports (OECD average equals zero)**



Source: OECD.

Japan has lost its lead to Scandinavia, where Finland and Sweden have been racing for the leading position. In 1998, Finland finally surpassed Sweden in the specialisation in telecommunications equipment.

The share of the telecommunications products of total exports was 14 percent in 1998, thus the significance of other ICT products in the Finnish exports is minor (around 4 percent).

### **The ICT cluster – Finnish by name, international by nature**

The Finnish ICT cluster is, in fact, very international. In contrast to many other countries, the Finnish telecommunications market has been open to foreign equipment manufacturers from the early outset, which can be seen as one of the reasons for the Finnish technological competence in the telecommunications.

Nokia itself is a prime example of a multinational Finnish company. In the footsteps of Nokia, many Finnish subcontractors have been investing in foreign markets. This has been done, not only to follow the important customer, but also to expand market potential and customer base. This is essential for many small Finnish firms for whom the only way to succeed in global competition is to specialise in a narrow product sector.

Likewise, foreign firms have entered the Finnish ICT cluster by acquiring innovative and advanced technology firms (see table 3.1). Many established multinationals have intensified their R&D activities and cooperation with local firms during the past decade. For some, Finnish subsidiaries are considered as training centres from which employees are sent to other units to distribute the latest information on technological innovations, especially in wireless communication technology.

Unlike in the past, the primary motivation of multinational firms for R&D activities in host countries is no longer related to production and product adaptation. Rather, partnerships in favourable innovation systems and an access to prime resources are nowadays main incentives to engage in cross-border R&D. With innovative firms, a high level of R&D, and an educated labour force, Finland is regarded as a centre of excellence where foreign firms seek to settle to absorb technology spillovers. Especially in electrical engineering, foreign-owned R&D units serve multinational firms' global operations in their special fields.<sup>11</sup>

Consequently, it is to a certain extent artificial to talk about *national* clusters since cross-border interaction and global network strategies are characteristic to firms networking. However, if competitive, the home market can provide globally operating firms with a home base in which they locate their core activities (e.g. headquarters and R&D units).

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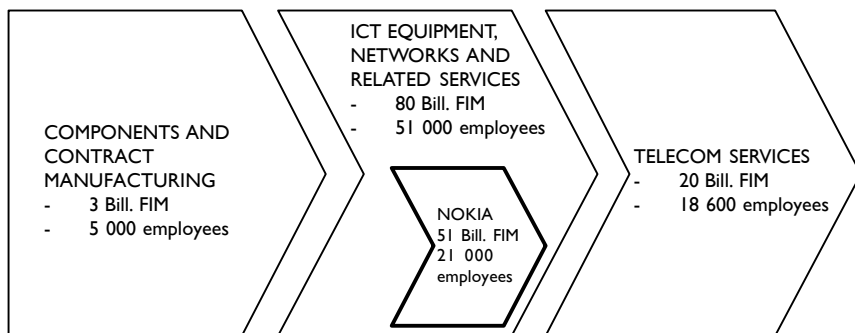
<sup>11</sup> See Pajarinen & Ylä-Anttila (1999).

## Nokia in the core of the cluster

It is clear that Nokia has functioned as an engine for a whole emerging cluster.<sup>12</sup> The pace and intensity of the growth process has been extraordinary: Ten years ago there was nothing out of the ordinary in the electronics industry. Even though the whole cluster has soared in the wake of Nokia's growth, the growth rate of Nokia is in a class by itself. But, how large is Nokia as compared to the rest of the cluster?

In figure 3.4, the ICT cluster is illustrated as a production value chain (excluding content provision). In 1998, the turnover of the ICT cluster was about FIM 103 billion. Thus, with the turnover of FIM 51 billion generated in the Finnish subsidiaries, Nokia's contribution to the cluster sales is 50 percent. Nokia accounts also for an even larger share (in the order of 60-70 percent) of cluster exports. However, reliable comparison is not feasible due to inconsistencies between public statistics and corporate accounting practices.

**Figure 3.4 The production value chain in the ICT cluster – turnover and employment in 1998**



Note:

Due to statistical classification practices an important share of contract manufacturing is included in the ICT equipment manufacturing figures (the middle arrow).

Nokia is included in the total figures in sector 'ICT equipment, networks and related services'. Related services include IT consultancy, computer hosting, data processing and equipment maintenance.

Sources: Statistics Finland, Ministry of Trade and Industry, Nokia.

<sup>12</sup> In 1995, the Finnish telecommunications cluster was evaluated as a *potential* cluster, in which the cluster structure was still incomplete and the development of sustainable competitive advantage was under way (Hernesniemi et al., 1995).

Nokia is a typical network company which outsources the majority of the production process and concentrates on its key competence areas, namely product design, R&D and brand management. One of its key strategies is to engage actively in R&D co-operation with technology firms to induce innovation and to stay in the technological lead. It has many strategic R&D partnerships, not only with large leading ICT companies, but with a number of smaller enterprises.

Nokia has engaged the majority of the Finnish electronics industry – directly or indirectly – in the production process, and it is constantly looking for suitable new candidates to be attached to its network. The number of first-tier subcontractors is estimated to total some 300 companies.

In 1997, the estimated value of partnership outsourcing was FIM 3 billion in Finland, thus almost 10 percent of the turnover.<sup>13</sup> The corresponding figure for 1998 was more than twice as high, reaching FIM 7 billion, and the share has risen to 14 percent of the Finnish subsidiaries' sales.<sup>14</sup>

The cluster employs some 75 000 persons. Nokia's multiplier effects on employment are manifold. First, since the heavy lay-offs around the turn of the decade, Nokia has created 9 500 jobs in-house between 1992-1999 (figure 4.3). Moreover, Nokia has contributed to the employment of many small and medium sized enterprises. It has been estimated that the first tier subcontractor employment reached some 14 000 employees in 1998. Further, as the production network consists of several tiers, Nokia has important multiplier effects in the cluster that cannot be readily quantified.

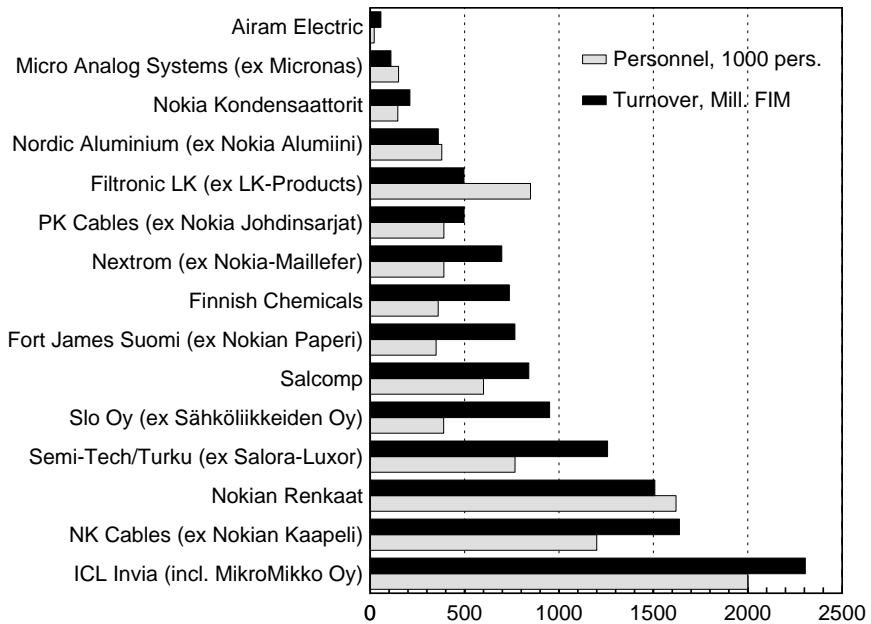
Finally, in focusing on the telecommunications business Nokia has disengaged itself from a number of firms (figure 3.5). Most of them have developed successfully, and today, half of them are under foreign ownership. In other words, Nokia has given birth to a number of new growth companies.

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<sup>13</sup> Partnership outsourcing involves customised solutions and co-operation between the buyer and the subcontractor. It is distinguished from standard outsourcing which refers to the purchase of "catalogue products".

<sup>14</sup> Data source: Nokia.

**Figure 3.5 During the 1990s divested business units of Nokia, and their turnover and personnel in 1998**



Source: Lemola & Lovio (1996), updated by ETLA.

On the other hand, Nokia has acquired, mainly abroad, recently established small firms operating in its present strategic areas to absorb and induce future technology.

### **Are there other players in the game?**

Measured by size, there are no peers to Nokia in the cluster (table 3.1). A closer look reveals, however, many globally successful firms in the shadow of Nokia (see box 3.1 Sonera).

Global competence can be found, for instance, in network operation, which has a long and special history in Finland. From the very outset, the telephone network was built by both private and public operators, which contributed to swift technological development. (In the 1930s, there were no less than 815 operators in the market). This

**Box 3.1 Sonera**

*Sonera* (former Telecom Finland) has undergone a major metamorphosis that has changed it from a “clumsy” Post and Telecom Office (PTO) to a technological forerunner in the opening mobile communications market. In 1998, it was separated from the Finland Post, after which state ownership was reduced and the company was listed on the Helsinki Stock Exchange and NASDAQ.<sup>15</sup> In the same event, it changed its name to Sonera.

Sonera has been the first in the world to launch a mobile portal (Zed) and a security solution for mobile commerce (SmartTrust), and it is seeking actively its way in the international mobile and media communications markets. In the traditional business, it concentrates on the domestic and neighbouring markets. Sonera has succeeded in getting allied with leading ICT companies as well as content providers which give essential support to the company’s headway.

Owing to its remarkable kick-off as a “reborn” public operator, the company received the World Communications Award for the best brand in the telecommunications market.<sup>16</sup> In addition, Sonera’s market capitalisation grew ten fold in the first year as a public listed company. Now, it is the second largest Finnish company by market capitalisation after Nokia.

However, with the turnover of FIM 11 billion (in 1999), Sonera is a minor operator in the world scale, and thus, establishment of a global position is full of hazards. For example, launching SmartTrust, a product that can revolutionise the way people do business is not easy for anyone, and certainly not for such a small player as Sonera. The legislative and network security issues have delayed the adoption of electronic payment standards. Such delays allow other companies, like Nokia and Ericsson, develop their own secure mobile commerce solutions which may eventually gain the status of standard due to their market dominance. It is obvious that Sonera’s competitors are also developing their own versions of mobile commerce platforms that will erode the market under Sonera Zed.<sup>17</sup>

After further privatisation, Sonera will also run the risk of being swallowed by a large international competitor. A large parent company might ensure better marketing channels and ample financial resources, but it might also dampen the innovative and energetic spirit that has allowed a former PTO to join the forerunners in a new era in communications.

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<sup>15</sup> The state share is 59.7 percent. The government has indicated to reduce its stake further to 34 percent in due course.

<sup>16</sup> The other finalists were leading telecom companies MCI WorldCom and Orange.

<sup>17</sup> British telecommunications giant Vodafone AirTouch has announced an alliance between dominant ICT companies (Nokia, Ericsson, Sun Microsystems, IBM, Psion and Palm Computing) whose intention is to launch a mobile internet portal.



explains, to a large extent, the competence of the telecommunications technology. Only six years after the invention of the telephone, the first telephone company was founded in Finland. Furthermore, in 1922, Helsinki became the first European capital with fully automated exchanges. Finland was also the first country to introduce a digital mobile network.

The public operation in Finland was built on the telegraph line network inherited from the Russians in connection with the independence in 1917. In the past, the public operator was behind the private carriers in technological progress, but today, after a significant transformation, *Sonera* (former Telecom Finland) is among the world leaders in the development of mobile technology.

There are various estimates of tremendous future growth rates in the e-commerce market. It is clear, however, that data security is the key issue that has to be solved for the e-commerce to speed up. Furthermore, Internet based inter-firm communication (Virtual Private Networking, VPN) is creating a huge market for security solution providers.

### **Box 3.2 SSH Communications Security**

In a market where the established ICT companies race for technological breakthroughs and standards, a Finnish company SSH Communications Security (SSH) has developed cryptography and authentication technology (SSH Secure Shell application) for Internet, and it has become a de-facto standard for logins. In 1998, among other acknowledgements, SSH IPSEC Express™ was awarded the European IT Prize by Esprit programme of the European Commission as being “a representative of Europe’s strengthening position in information technology and telecommunications”.

Despite its recent foundation (1995), the company has collected an impressive list of references. Nokia, Ericsson, Sun Microsystems, Compaq, Lucent Technologies, and Cisco have embedded SSH application into their products. Also, Sonera’s SmartTrust mobile security solution (see box 3.1 Sonera) utilises SSH technology. The two companies are engaged in long-term co-operation to develop technology solutions that secure wireless Internet services.

There are several Finnish firms that have found narrow but fast growing niches in the highly fragmented data security industry, and in fact, network security solutions are becoming the backbone sector of the Finnish software industry.

Another ICT business area in which Finnish firms have perceived significant growth potential is contract manufacturing. Owing to equipment manufacturers' (OEM<sup>18</sup>) growing need to outsource production, the value of gross production of the Finnish electronic manufacturing services (EMS) sector has expanded at the average rate of 25 percent over the last five years, reaching an estimated FIM 4 billion in 1998. It represents over one percent of the world market.<sup>19</sup>

There are around 240 EMS providers in Finland, of which 7-8 are large companies. For EMS providers, size is a critical factor to be able to satisfy the fast growing capacity and service demands of the telecommunications manufacturers.<sup>20</sup> Customers' requirements of

### **Box 3.3 Elcoteq Network**

By the sales of FIM 4.4 billion in 1999, Elcoteq Network (Elcoteq) is among the 10 largest electronic manufacturing service (EMS) providers in the global market which is dominated by large multinationals. Elcoteq has been effective in its growth and globalisation strategy. Since its foundation in 1991 (by MBO), its capital expenditure has been around 10 percent of annual sales, and it has followed its customers in ten countries. In addition to green field investments, it has expanded its production capacity by acquiring operating plants of customers.

Elcoteq is focused on the telecommunications market: Nokia and Ericsson account for 80 percent of the turnover. It is quite conservative in expanding customer base, relying on long-term partnership relations and "co-evolution" with customers, especially Nokia. In fact, Elcoteq has become a symbol of the Nokia-lead industry.

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<sup>18</sup> An OEM (original equipment manufacturer) is a company that uses components from other companies to build a product that it sells under its own company name and brand.

<sup>19</sup> Ministry of Trade and Industry (1999).

<sup>20</sup> Advanced EMS companies provide complete production services, from component sourcing and production design to production, testing and delivery to the customer's distribution channels. The OEM does not necessarily need to take in the end product at all.

world wide delivery has obliged EMS providers to establish plants in customers' main markets.

*Elcotec Network* is the leading Finnish EMS company that has shown the way in an industry that has actually emerged in 10-15 years. During the last year, Elcotec Network grew from a three-plant company into a nine-plant corporation (see box 3.3 Elcotec Network).

In all, these few cases imply that the Finnish ICT cluster is more than Nokia alone. The competitive advantage of the cluster has been built by a large number of advanced companies, which are qualified at the global scale.



4

# Development of Nokia

*This section describes some recent development and restructuring of Nokia. We start by considering Nokia's road from a highly diversified conglomerate to the focused telecommunications company that it is now. Next, we examine the company's internationalisation process and the development of its technology. The final part of this section considers Nokia in the global competition by comparing Nokia to its main competitors.*

## **From an industrial supermarket to a focused telecommunications company**

At the beginning of the 1980s, Nokia started to strengthen its position in the consumer electronics and telecommunications market by acquiring several electronics companies including Luxor, Salora and Standard Elektrik Lorenz's consumer electronics industry.

Due to the historic background and acquisitions, Nokia had no less than eleven business lines during 1986-88. Figure 4.1 shows how the significance of major lines has shifted over time.

A former president of Nokia (Kari Kairamo) forecast expected coming changes in 1984 (Nokia's annual report):

*"We have attempted to change the structure of the group by directing investment and research and development activities towards high-tech products and production methods. This structural change has been supported by corporate ac-*

### **Box 4.1 History of Nokia**

The roots of Nokia go back to 1865 and the establishment of a forest industry enterprise in south-western Finland by mining engineer Fredrik Idestam. This enterprise ran a groundwood mill on the Nokia river, hence the company name.

Elsewhere, the year 1898 witnessed the foundation of Finnish Rubber Works Ltd, and in 1912 Finnish Cable Works began operations. Gradually, the ownership of these two companies and Nokia began to shift into the hands of just a few owners. Finally in 1966 the three companies were merged to form Nokia Corporation.

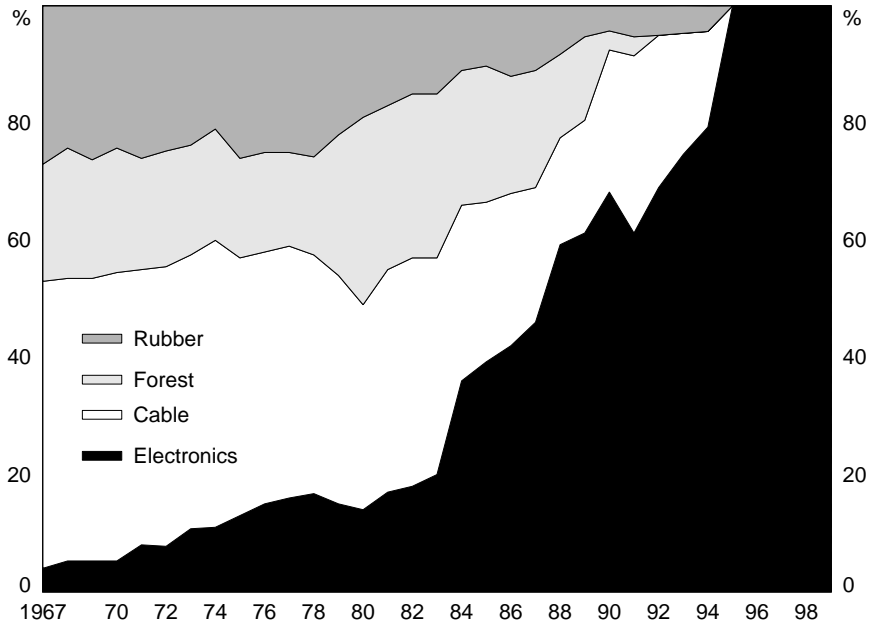
Source: <http://www.nokia.com/inbrief/history>.

*quisitions at home and abroad. At the same time, internationalisation has also been promoted.*<sup>21</sup>

Since then, Nokia has gone through a comprehensive metamorphosis. The company has acquired and, on the other hand, sold several business units. From a conglomerate with a high number of different business lines Nokia has been transformed into a pure telecommunications company.

The example of Nokia shows how the focus of a company may change over time. In order to focus on telecommunications, Nokia has divested all of its previous core competence businesses. In fact, Nokia has reinvented itself so many times that it seems almost impossible to forecast what kind of structure or core competence Nokia will have in five to ten years' time.

**Figure 4.1 Sales of Nokia by industrial group, %**



Source: Lemola & Lovio (1996), updated by ETLA.

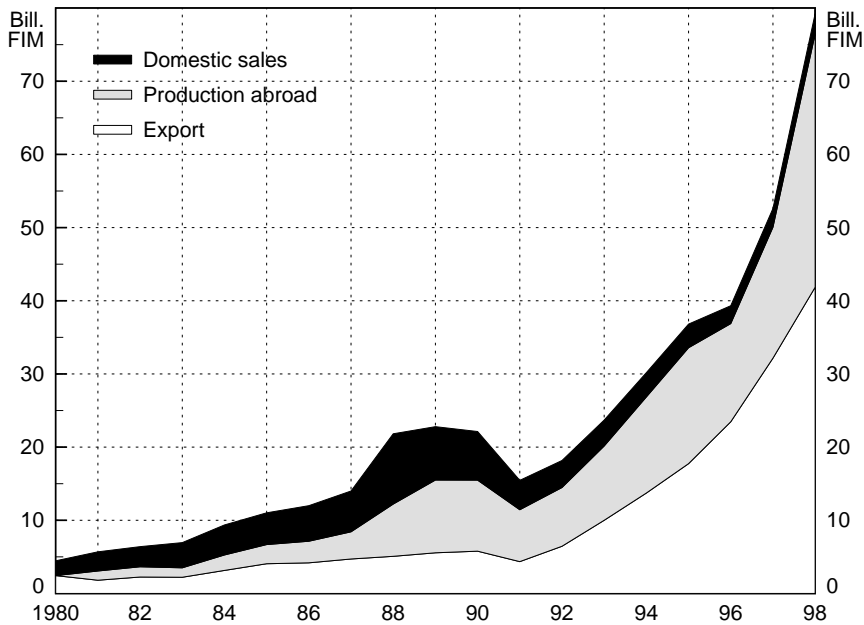
<sup>21</sup> Translated by authors.

## Customers and employees all over the world

Up till 1980, Nokia sold approximately half of its products to the domestic market and the rest was exported. In the early 1980s, however, Nokia started to strengthen its international operations (figure 4.2).

In addition to exports, Nokia proceeded in its internationalisation by acquiring production units abroad during the 1980s. The aim was to grow rapidly and expand operations to new lines of business. According to this strategy, Nokia acquired a number of foreign subsidiaries; hence net sales and employment increased rapidly (see figures 4.2 and 4.3). The acquired units operated mostly in the electronics industry, and many of these new subsidiaries manufactured products (televisions, monitors and videos) directed to consumers. Thanks

**Figure 4.2 Net sales of Nokia, bill. FIM<sup>22</sup>**



<sup>22</sup> Production abroad has been calculated by subtracting exports from foreign sales.



to acquired units, Nokia became the second biggest electronics company in the Nordic countries.

The acquired companies were mostly located in Europe. However, Nokia's mobile phone unit, called Mobira at that time, expanded by making more global alliances. Together with Tandy Corporation, Nokia established a joint venture in Korea. Tandy had experience in Asian operations, but more importantly, it had an extensive distribution network in the United States.

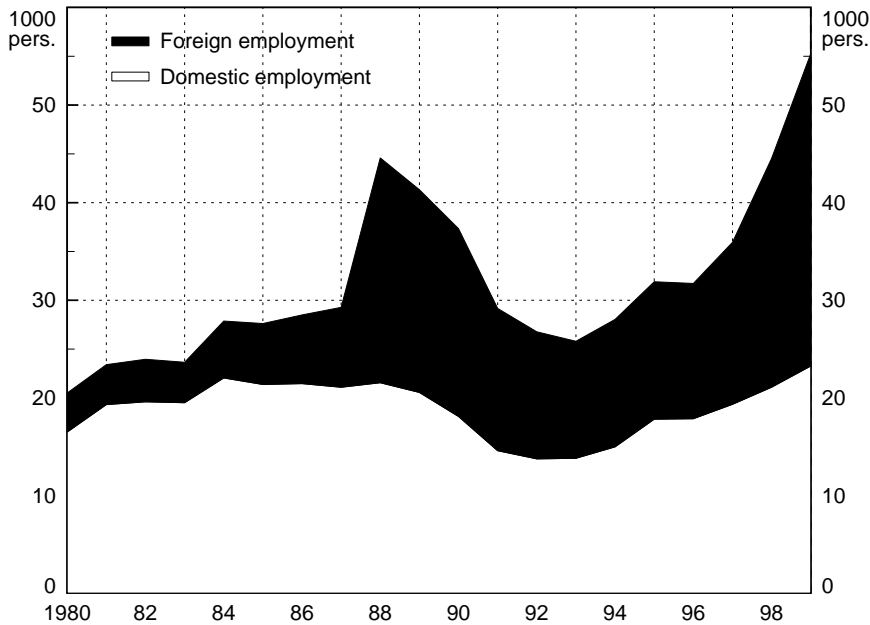
Thus, the 1980s were a decade of growth and internationalisation for Nokia. Net sales grew five-fold during ten years, and a substantial amount of this growth was obtained by acquiring foreign companies.

Today, Nokia is a highly internationalised company with a number of production and R&D units in Europe, Asia and America. Furthermore, the company sells its products in to more than 130 countries. Its increased foreign activities have been mirrored in the location of personnel. Thus, more and more employees are working in business units outside Finland. However, despite the rapid expansion of foreign production, Nokia has increased its exports from Finland, as well. Therefore, Finland remains an important place for Nokia to create value-added.

Figure 4.3 shows how the number of personnel has developed during the past twenty years.

However, in the early 1990s Nokia ran into a crisis. It had just invested heavily in new businesses when the Finnish economy went into a severe recession. As a result, the CEO at that time, Simo Vuorilehto, started streamlining Nokia's emphasis towards the electronics industry. Due to heavy losses and the decreased strategic significance of some business lines, the company decided to sell a number of business groups. The business lines to be sold included, for example, the forest industry, distribution of electricity and the rubber industry businesses. The heavy divestment program was also reflected in the number of employees which decreased by 15 000 between 1989 and 1993.

In 1992, Jorma Ollila was appointed CEO. Under his leadership Nokia made a major strategic decision to focus on telecommunica-

**Figure 4.3 Foreign and domestic employment of Nokia**

tions by divesting its non-core operations. The most recent large divestments took place in 1995 and 1996, when Nokia sold its cable industry operations and television business. Thus, Nokia focused more and more on the telecommunications industry.

A booming telecommunication business has pushed Nokia to rapid growth. During the past five years (1995-1999), the company has grown on average more than 30 percent a year. Furthermore, instead of acquisitions, Nokia has grown internally without major acquisitions in that time. In fact, they have acquired only few companies whose contribution to group net sales or personnel is slight. The acquired companies have been small firms specialised in Internet technologies.

The high growth rate has become a challenge for Nokia. The increased sales have reflected in increases in capacity. In addition to the fact that Nokia has outsourced more and more its operations, the company has also increased its own capacity. As a result, the company

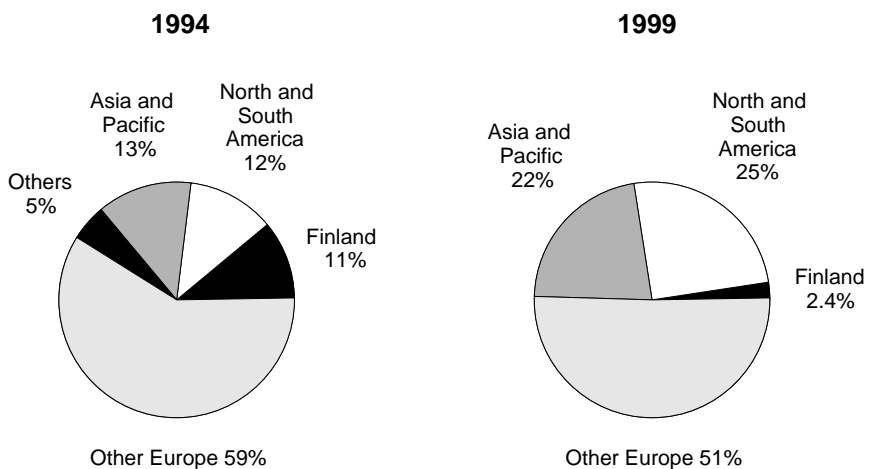
has recruited several thousands of employees in the past few years. Nokia has increased its personnel in Finland, but now the focus has become more international.

The fast growth of the telecommunication industry has led to a situation where there is a shortage of qualified engineers in Finland. As a consequence, companies operating in the ICT cluster have difficulties in finding new employees.

Thus, it hardly surprising that the number of Nokia's staff outside Finland has increased. Furthermore, Nokia's market focus is increasingly global, for currently the company sells less than 2.5 percent of its products in the domestic market.

Figure 4.4 shows how net sales were distributed in 1994 and 1999. Europe still brings more than a half of Nokia's net sales and South and North America account for nearly one fourth. However, the significance of the Asia/Pacific region has substantially increased during the past few years. While in 1994 its share was 13 percent of net sales, in 1999 the share had risen to 22 percent. The United States, China, the Great Britain and Germany were the most important individual countries.

**Figure 4.4 Net sales of Nokia by market area**



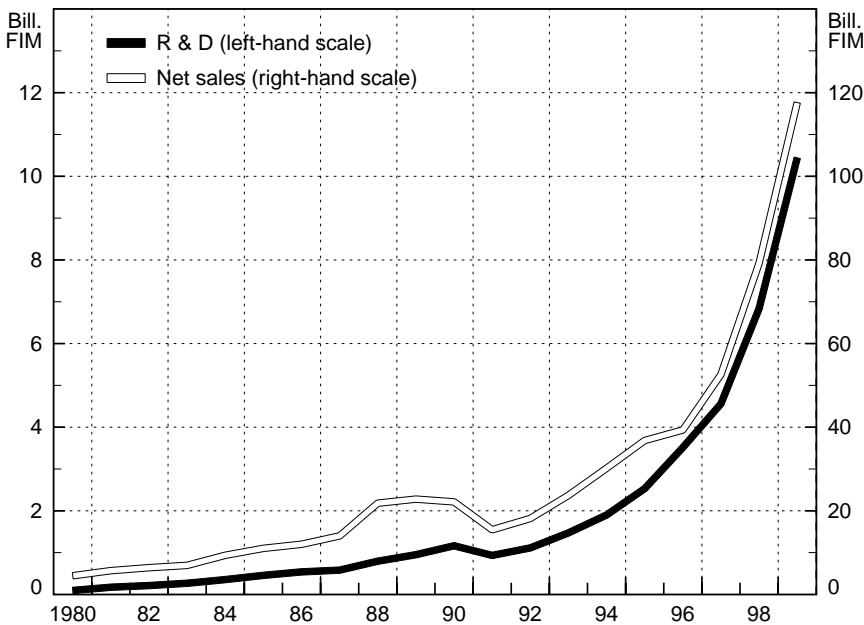
## Increasing research and development efforts

Nokia's investment in R&D increases year after year following closely the growth rate of company net sales. In the past few years, the growth rates of both net sales and R&D have accelerated.

Developing new models and technologies for the third generation mobile systems has required additional R&D investments including new R&D centres. In addition, the company's R&D personnel has grown by some 5 000 annually during the past two years, and currently roughly 30 percent of the total personnel work in R&D.

The growth rate of R&D investments has been particularly fast during the end of the 1990s as Nokia has focused more and more on telecommunications. Furthermore, the increased growth rate of technology development has forced Nokia to increase its R&D efforts in order to respond to tighter competition.

**Figure 4.5 R&D and net sales of Nokia, bill. FIM**



**Table 4.1 R&D by business group, mill. FIM**

	Mobile phones	Networks
1992	264	552
1993	386	752
1994	661	992
1995	967	1 274
1996	1 376	1 926
1997	1 714	2 556
1998	3 103	3 353

The company has expanded its global R&D network. As a result, with R&D units in twelve countries, Nokia has 44 R&D centres (in 1998).

During the 1990s, the share of Nokia Mobile Phones of total R&D costs has grown. While in 1992 the R&D costs of Nokia Networks (before Telecommunications) clearly exceeded those of Mobile Phones, in 1998 the shares were almost equal. Thus, the development of cellular phone models has required more and more R&D efforts.

### **Advanced branding – a key to success**

Investment in R&D alone does not guarantee success in the market, for this depends heavily on marketing. The high growth rate of Nokia's net sales shows that the company has advanced well in selling and marketing. It has created a well-known brand.

An American company called Interbrand ranks companies according to their brand values. As the first non-American company, Nokia has been ranked in 11<sup>th</sup> position, while the top of the list is dominated by American companies, such as Coca-Cola, Microsoft and IBM.

Generally, successful branding is an endorsement and indication of quality. Thus with a well-known and respected brand image a company can mark its selling price above those of its less known compet-

itors. Brands, then, are one of the most important and valuable assets for many companies.

In addition to technology, Nokia's success is a consequence of understanding consumer needs. Unlike its competitors, Nokia understood rather early that in order to make mobile phones desirable, one also has to make them look attractive. Accordingly, Nokia put a lot of effort into designing their products. They replaced the former angular appearance with a rounder design.

Moreover, an effort was made to make the user interface of mobile phones easy to use – to make a phone as simple to use as possible. Another noteworthy change of direction was seen in Nokia's style of marketing.<sup>23</sup> In the early 1990s, the advertising style for cellular phones was changed. Instead of advertising the mobile phone as a status symbol, Nokia began to market it as a regular consumer product without the stamp of luxury.

The change of marketing style was revolutionary, for, after that, not only businesses but also private individuals bought more cellular phones.

## **Nokia and its competitors**

Heavy investment in telecommunication R&D, successful marketing and rapid internationalisation have made Nokia to one of the leading telecommunication companies in the world. This subsection compares Nokia to its major competitors, Ericsson and Motorola.

Measured by net sales, Nokia is currently smaller than its main competitors (table 4.2). However, the company is more focused on cellular products than Ericsson or Motorola. Contrary to its main competitors, Nokia does not manufacture semiconductors. Thus, the company has chosen the strategy of buying semiconductors from the market instead of producing them itself.

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<sup>23</sup> Pulkkinen (1996) in Lemola & Lovio (1996).

**Table 4.2 Major telecommunication companies in the world, 1999**

	Nokia	Ericsson	Motorola
Net Sales, bill. FIM	117.6	144.9	172.5
Return on investment, %	55.4	19.0	5.5
Earnings before taxes, bill. FIM	23.3	11.0	6.5
% to sales	19.8	7.6	3.8
R&D expenditures, bill. FIM	10.4	19.0	19.2
% to sales	8.9	13.1	11.1
Year-end employment	55 260	103 290	na
Market capitalisation, bill. FIM (at the end of 1999)	1 256.0	466.7	518.7
Global market share of mobile phones (1-3/2000)*	27.9	11.5	16.0

\* Source: Dataquest.

Due to the high growth rate of Nokia, however, the size differences between the companies are narrowing. The growth rate of Nokia is considerably faster than its main competitors. There are at least two reasons for this. First, as mentioned earlier, Nokia is more focused on the fast growing cellular business. Second, Nokia has managed to expand its market share. The demand for Nokia's cellular phones has been particularly brisk in the past few years. As a result, the annual growth rate of Nokia Mobile Phones averaged approximately 50 percent during 1997-1999.

There are notable differences between the profitability of the three companies. Measured by ROI (return on investment) or by operating profit, the yield of Nokia is clearly above its competitors.

Next, we consider the investments of Nokia and Ericsson by measuring total investment as a sum of marketing and selling expenses, R&D, fixed investments and education expenditure. All these expenses may influence the company's operation in the long run. Thus, these elements are considered as investments.

A comparison of investment expenditure between Nokia and Ericsson reveals some interesting differences. First, while Ericsson

**Table 4.3 “Total investments” in 1998, mill. FIM**

	Nokia	Ericsson
Marketing and sales	5 381 (6.8 %)	16 256 (13.1 %)
R&D	6 838 (8.6 %)	16 985 (13.7 %)
Fixed investments	4 527 (5.7 %)	6 045 (4.9 %)
Education	750 (0.9 %)	2 023 (1.6 %)
Total investments	17 496 (22 %)	41 310 (33 %)

Values in parenthesis are in relation to net sales.

invests as much as one third of its net sales, Nokia’s investments in relation to net sales stay at one fifth. The most significant differences seem to be in marketing and selling expenses and in education expenditure (table 4.3). Second, Nokia’s R&D investment is considerably lower than Ericsson’s. The gap between the companies has narrowed during the past few years, however. While Nokia’s R&D investment in relation to net sales was on average roughly 8 percent during 1994-1998, Ericsson’s corresponding value reached 14.4 percent in the same period.

According to the figures in this subsection, it can be concluded that the size of Nokia is still smaller than its main competitors. The difference, however, is decreasing. Furthermore, Nokia does not invest as much as Ericsson or Motorola, but Nokia clearly outperforms its competitors in financial terms.



5

## Summary and Discussion

## **ICT and Nokia – the two alone?**

Nokia is a multinational giant in a small open economy. Its share in total Finnish GDP is as much as 4 percent, in total exports more than 20 percent and in business sector R&D as much as one third. Measured by market capitalisation, Nokia is the largest company in Europe and among the top ten in the world.

Nokia is by far the most important company contributing to the rapid restructuring of the Finnish economy. Information and communication technologies (ICT) have been by far the fastest growing industrial cluster or competence block in the Finnish economy during the past ten years. The production volume of the electronics industry has been growing at an annual rate of some 30 percent since the early 1990s and electronics exports have grown even faster. In the Finnish case electronics consist to a large extent of telecommunication equipment. Most of telecommunication equipment originate from Nokia, whose sales have increased close to 40 percent annually over the same period. Nokia's contribution to the GDP growth of Finland in the latter part of 1990s (almost 5 percent on average), has been more than 1.5 percentage points. This is exceptionally high in industrial countries. It has led many to ask whether Finland has become a one sector, or even one company country within the single European market – in a similar way we had one company towns and communities in past within national economies.

Although Nokia is the major player within the Finnish ICT cluster, it is not the whole cluster. Nokia's share of the total ICT sector's sales is about 40 percent. The ICT cluster in this report is defined to consist of components and contract manufacturing; ICT systems, equipment and related services; and telecom operations and value added network services. Of this whole entity Nokia accounts for clearly less than a half; of the ICT systems, equipment and related service production Nokia accounts for two thirds. Hence, Nokia is a dominant player, but not the only one. As a matter of fact, a number of new ICT companies have been established during the past few years and, besides Nokia, other previously established companies have also grown drastically. The number of Finnish companies serving Nokia as first-

tier suppliers alone is some 300. These companies – mostly small and medium sized firms – are, of course, quite dependent on Nokia's success. They are, nevertheless, only a fraction of the total amount of the cluster firms (more than 3000).

Many of the firms that are not dependent on Nokia have, however, their roots in related grounds, i.e., in research and development in communications technologies. The most prominent examples are the software companies which produce security products for communications (e.g., F-Secure, SSH, and Stonesoft). Another example is a group of firms producing advanced manufacturing automation based on ICT (e.g. JOT Automation).

Thus, the ICT cluster today has both depth and width, although it is dominated by Nokia and its suppliers and partner companies. All in all, the Finnish ICT cluster looks like a good example of the dynamic gains from technological specialisation: Self-reinforcing advantages are created through technological spillovers and other positive externalities. Accumulation of knowledge and human capital in a specific area exemplify the case of increasing returns.

Furthermore, there is a growing amount of evidence that the advanced production of ICT has embarked new innovations and business opportunities in other industrial clusters, i.e., in the sectors using modern information and communication technologies. One interesting example is the well-being cluster, which is developing new products and services in the interface of telecommunications and the health care sector. The diffusion of ICTs has been quite rapid also in many other sectors like banking and insurance, engineering and machinery, and in the traditional forest-based and related industries, which still form – as a whole – the largest industrial cluster in Finland. From the point of view of future growth it is, naturally, the utilisation of the ICTs and the productivity gains stemming from it that are decisive. It was only in the 1990s when the impacts of ICT started show in the productivity figures of the industrial economies. According to recent studies Finland is among the leading countries to reap the benefits from IT capital.<sup>24</sup>

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<sup>24</sup> See Niinen (1999).

## Can we explain it?

There is no single explanation for the success story of Nokia and the Finnish ICT cluster. Rather it is an interplay between several technological and economic factors that contributed to the birth and growth of the sector. Studies show that among the major factors have been the industry structure and the early liberalisation of the telecommunications market.<sup>25</sup> First telephone companies were established in the late 1870s by domestic (and partly foreign) equipment suppliers and the number of private independent operators increased steadily throughout the early 1900s. The decentralised structure of the operators sector remained, although initiatives were taken to nationalise and harmonise the network in order to promote interconnection and technical progress. However, nationalisation proposals were fiercely rejected by the Parliament. The number of operators was its highest over 800 in the 1930s and reduced gradually to some 50 by the mid-1990s. The large number of local operators meant that equipment suppliers were put into constant competition with each other and different terminals formed a challenge to interconnection and automation of exchanges. Domestic equipment producers were not sheltered from foreign competition unlike in most other countries.

The real competition between the operators started in the mid-1980s when the competition in long distance operations was allowed. By 1994 the local and long-distance call provision as well as international telecommunications were opened practically to full competition.

Today, the number of operators has been reduced significantly as a consequence of a wave of mergers and acquisitions, but Nokia and other equipment suppliers are globally competitive which is partly an outcome of free equipment market and demanding and advanced customers in the operators sector.

An important milestone in the development of the Finnish as well as the Nordic ICT sector was the introduction of the Nordic Mobile

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<sup>25</sup> See, e.g., Pajja & Ylä-Anttila (1996) and Hernesniemi – Rouvinen & Ylä-Anttila (1996).

Telephone (NMT) standard in the early 1970s, which created a single integrated cellular system. The initiative for the common system was taken by the Nordic Telecommunications conference in 1969. A final agreement was reached in 1973 in the meeting of the Nordic PTTs. The NMT standard was the impetus for the rapid growth of the analogue mobile telephone market. It spurred the technological development by solving a number of practical problems related to, e.g., roaming and equipment specifications. Hence, the Nordic telecommunication equipment producers got a much better ground for their business than producers in many other countries.

Industrial, technology and educational policies have played a role too. Industrial policies changed clearly in the early 1990s. The role of innovation policies was underlined and the need to set national priorities was recognised in allocating scarce R&D resources. At the same time it was emphasised that it is the market that pick the winners in the product market.<sup>26</sup> ICT was seen as one of the national strongholds.

Following these general guide lines information and telecommunication technologies have been one of the priority areas in the technology programmes of the National Technology Agency (Tekes). Also in higher education ICT has received special attention.

## **Too much of a good thing?**

The impacts of a single sector boom in the economy have been widely discussed and analysed in the economic literature. The discussion has, however, concentrated on the effects of resource booms rather than on the quite different expansion of a knowledge-driven sector. The basic issue is, nevertheless, the same: Is the booming sector crowding out other potential growth sectors by attracting too many resources and causing real wage pressures in the economy? The usual story in the case of the resource boom is that the increasing export revenues

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<sup>26</sup> See Rouvinen & Ylä-Anttila (1999).

are spent on non-traded goods. This leads to a rise in the relative prices of these goods – and this, in turn, draws resources out of the other traded goods industries into the non-traded sector. The Dutch, UK, and Norwegian economies have suffered this type of decline in their traded goods sectors.

Are there any similarities between these resource booms and the current Nokia led ICT boom in Finland? The simple answer is no. The raw-material based sectors are typically subject to decreasing or constant returns to scale, which is the basic feature of the models analysing the impacts of the booming sector. By contrast, a knowledge-driven sector, especially if it is based on a generic-type technology, is likely to induce growth in other (traded) sectors through technological spillovers and other positive externalities. The increasing rather than the decreasing returns prevail.

Furthermore, within the integrated Europe, the scope for expanding the non-traded sector through national policies is significantly smaller than in the 1970s and the 1980s.

No real wage pressures due to the booming ICT sector have been identified so far. However, some pressures are likely to occur, since the shortage of skilled labour has become a major problem not only in Nokia but in the ICT sector as a whole.

There is, of course, always the risk that a decentralised economy may engage in too much R&D in some sectors due to patent races and parallel research programs. However, both theoretical and empirical research tends to show that this risk is very small. On the contrary, it is argued that economies typically underinvest in R&D. There is, nevertheless, a possibility that focusing on particular technologies has a negative impact on the long run growth potential by reducing investment in possible future growth areas. Specialisation has its limits, too. As argued by scholars in technology studies, in the (very) long run the lack of diversity in technological development will impair the growth prospects of nations and regions.

However, it is well known that R&D and technological infrastructure alone are not sufficient to explain the economic and industrial performance of firms and nations. Sweden and the UK invest

large portions of their GDP in research and development while achieving only moderate productivity performance. Comparing Nokia and Ericsson tells a similar story at the firm level. Ericsson spends 15-16 percent of sales to R&D, Nokia less than 10 percent. In spite of this, Nokia's financial performance has been much better in recent years. The explanation apparently lies in Nokia's capabilities to better manage its mass production capacity and internal organisational processes as well as its ability to understand consumers' needs. Maintaining its lead is crucial not only for Nokia but also for Finland.

## **Future of Nokia-led Finland**

In less than a decade Nokia has become a major multinational company. It has operations in more than 130 countries all over the world. Nokia's production units and R&D centres are located in Europe, North-America and Asia. As much as 45 percent of production and some 60 percent of R&D are still carried out in Finland. During the past few years, however, most of the company's growth has taken place outside its original home base.

This trend is likely to be reinforced in the future for obvious reasons. There are not sufficient domestic resources – i.e. skilled labour force – available for the rapid growth. Even up to this point the growth has been possible only through accelerated outsourcing. Nokia has actually “lent wings” to several small and medium sized enterprises (SMEs) some of which have already been quoted on the Helsinki Stock Exchange and abroad. Many of the SMEs are highly dependent on Nokia's current and future success.

From the point of view of the Finnish economy one of the crucial questions is, how rapidly and to what an extent these firms are able to internationalise, widen their customer base and grow to be global suppliers in their own niches. We will return to this issue in our final report of this research project (forthcoming in January 2001). Of course, many of these firms face, possibly even to a larger extent than Nokia, the problem of lacking domestic resources.

The next challenge for the Finnish ICT industry is the third generation mobile communication and further convergence of media, information technologies and communications, which are creating completely new possibilities for variety of firms. According to a widely shared view, most of the personal communication will soon be based on a cellular phone. In this phase of the ICT revolution it is services producers and content providers who are taking the lead. Most of these firms are giant multinationals which are strengthening their positions in the ICT value chain. The chances of the small companies depend on their ability to find appropriate niches and keep their technological lead.



## Appendix

### Measuring the export specialisation of a country

Specialisation of a country in product exports can be measured by RCA (Revealed Comparative Advantage) index, which is calculated as follows:

$$RCA_{ij} = \frac{X_{ij} / \sum_i X_{ij}}{\sum_j X_{ij} / \sum_i \sum_j X_{ij}},$$

where  $X_{ij}$  is the exports of the cluster  $i$  from the country  $j$ , and  $\sum_i X_{ij}$  is total exports from the country. The nominator calculates the share of the OECD cluster  $i$  (the sum of the cluster  $i$  exports from all the OECD countries) of total OECD exports.

RCA can be scaled between -1 and 1, which yields RSCA (Revealed Symmetric Comparative Advantage) index. If RSCA index equals zero, a country is as specialised in the cluster  $i$  exports as the OECD in average. If RSCA index exceeds zero, the country is specialised in the cluster exports.

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