GROWTH AND INNOVATION POLICIES FOR A KNOWLEDGE ECONOMY: EXPERIENCES FROM FINLAND, SWEDEN, AND SINGAPORE

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Abstract

Technical progress is at the heart of economic growth and development. New or improved technology can be achieved through own research and innovations or through the absorption and adaptation of foreign technologies. To facilitate such technical progress requires a complex system of supporting institutions and good economic policies. This paper analyzes technical progress and innovation policies in three small open economies: Finland, Sweden and Singapore. All three economies have transformed from depending on raw material intensive or labor-intensive production to highly competitive economies with a relatively high degree of technological knowledge. We find some common determinants to the transformation, such as large investments in physical and human capital and the importance of political or economic crises in forcing through good economic policies, but there are also many country specific aspects that have been crucial in the different countries.

JEL Codes: O30; O38; O57
Keywords: Economic Growth, Innovation, Economic Policies, Technology

1. INTRODUCTION

In recent decades, economists have begun to identify technical progress, or more generally, knowledge creation, as the major determinant of economic growth. Until the 1970s, the analysis of economic growth was typically based on neoclassical models that explain growth with the accumulation of labor, capital, and other production factors with diminishing returns to scale. In these models, the economy converges to a steady state equilibrium where the level of per capita income is determined by savings and investment, depreciation, and population growth, but where there is no permanent income growth. Any observed per capita income growth occurs because the economy is still converging towards its steady state, or because it is in transition from one steady state to another. The policies needed to achieve growth and development in the framework of these models are therefore straightforward: increases in savings and investment and reductions in the population growth rate shift the economy to a higher steady state income level. From the point of view of developing countries, however, these policies are difficult to implement. Low income and development levels are not only consequences but also causes of low savings and high population growth rates.

The importance of technical progress was recognized in the neoclassical growth models (Solow 1956, 1957), but the determinants of the level of technology were not discussed in detail: instead, technology was seen as an exogenous factor. Yet, it was clear that convergence in per capita income levels could not occur unless technologies converged. From the 1980s and onwards, growth research has therefore increasingly focused on understanding and endogenizing technical progress. Modern growth theory is largely built on models with constant or increasing returns to reproducible factors as a result of the accumulation of knowledge. Knowledge is to some extent a public good, and R&D, education, training, and other investments in knowledge creation may generate externalities that prevent diminishing returns to scale for labor and physical capital.[1] Taking these externalities into account, an economy with a continuous expansion of the knowledge base may experience positive long-run growth instead of the neoclassical steady state where per capita incomes remain unchanged. This insight is one reason why the most successful modern economies are often referred to as "knowledge economies". Another reason is, of course, the increasing complexity of modern technology, where competitiveness is based more on institutional and organizational capacity and human capital than on abundance of natural resources or physical capital.

Depending on the economy's starting point, technical progress and growth can be based on creation of entirely new knowledge, adaptation and transfer of existing foreign technology, or a mix of the two. Since it is typically less costly to learn to use existing technology than to generate new technology, developing countries have the potential to grow faster than developed economies for any given level of investment or R&D spending. However, this potential for convergence is conditional on the economy's level of human capital. More specifically, as noted by Van den Berg (2001:226), "it is the quality of the labor force, its accumulated experience and human capital, its education system, and so on, that determines an economy's ability to create new ideas and adapt old ones". Consequently, improvements in education and human capital are essential not only for the capacity to develop new knowledge, but also for absorbing and adapting foreign technology and generating sustainable long-run growth.

In addition to a well functioning educational and research system, success in the knowledge economy also requires a business environment that facilitates growth and entrepreneurship. Elements such as competition, openness to international trade and foreign direct investment, well functioning factor markets, secure property rights, and appropriate incentives are necessary to transform knowledge and skills into growth and competitiveness. Most countries are struggling to create such an economic environment to promote growth, innovation and technical progress and to attract FDI. However, relatively few countries have been successful in this enterprise. One reason is that it is not entirely clear how the appropriate policy mix looks. Another reason is that it may be politically difficult to carry out the necessary reforms to create the enabling environment. While the rewards are potentially important, there are also significant costs that may not be distributed evenly across the population. In particular, it is common that economic reforms are shunned by privileged interest groups that risk losing their protected position. In some cases, they are able to mobilize sufficiently strong opposition to stop or retard the reforms.

[1] For some early contributions on knowledge and economic growth see e.g. Romer (1986 and 1990), Lucas (1988), and Grossman and Helpman (1991).

This paper will focus on economic policies and technological change in three countries, Finland, Singapore and Sweden, which have been relatively successful in implementing policy reforms over the last decades. Finland and Sweden transformed from stagnant economies with eroding industrial competitiveness in the 1980s to dynamic and competitive high-tech leaders in the 1990s. In both countries, the reforms facilitating the success were motivated not so much by expectations of potential future gains but rather by the fear of losing some of the achievements of the past decades. As a result of the increasing international (or regional) mobility of goods, services, capital, and labor, many successful Swedish and Finnish firms were reacting during the late 1980s to the non-competitive economic environment at home by moving their investments abroad. This erosion of the domestic industrial base forced politicians to react by introducing important economic and institutional reforms. The sense of urgency – clearly, the risk of losing existing wealth is a stronger driving force than the prospect of gaining something in an uncertain future – also made it possible to overrun the domestic interest groups that had opposed market oriented reforms in the preceding decades.

It is also interesting to note that the most committed reformers among the developing countries are economies where there would have been very little wealth in the absence of successful economic development. One explanation for the remarkable success of resource-poor economies like Singapore may, in fact, be that the interest groups interested in preserving *status quo* were too weak and poor to mobilize any real opposition to the reforms.

Finland, Sweden and Singapore obviously differ in several economic aspects. The two former have a long history of industrialization and development, whereas Singapore is a relatively new and late-industrializing nation. Moreover, the Nordic countries have based their initial economic development on primary products and manufacturing, while Singapore's economic development has always been directly linked to its role as a trade hub in Southeast Asia. Finland and, in particular, Sweden are also homes for a large number of multinational corporations (MNCs) that have invested massively around the world. Singapore, by contrast, has a small domestically owned industry and has instead has relied on large inflows of MNCs.

Table 1.1 World Competitiveness Ranking.

Country	Ranking in 2001
USA	1
Singapore	2
Finland	3
Luxembourg	4
Netherlands	5
Hong Kong	6
Ireland	7
Sweden	8
Canada	9
Switzerland	10

Source: IMD World Competitiveness Ranking. http://www01.imd.ch/

However, there are also clear similarities between Finland, Sweden, and Singapore. For instance, all countries are small in size and very open to international trade and investments. More importantly, all three countries have been successful in transforming their economies from labor or raw-material based manufacturing towards higher value added production.

Some of the strengths of their economies are seen in the IMD World Competitiveness Ranking in Table 1.1. The ranking of 49 countries is based on a host of factors such as the general business environment, the efficiency of the government, infrastructure, technological development and the educational level of the population. All three countries are among the top 10: Singapore is ranked the second most competitive economy after the US, Finland is number three, and Sweden is number eight.

Some of the high competitiveness of Finland, Sweden and Singapore is caused by their strong technological ability. This is illustrated in a technology index by UNDP (2001) which captures the creation and diffusion of technology in 162 different countries. Finland, Sweden and Singapore are all part of the group "technology leaders" that is shown in Table 1.2. According to the index, Finland is the most technologically developed country in the world, Sweden is ranked number three and Singapore number 10. Two interesting conclusions can be drawn from the table. Firstly, all three countries are ranked substantially higher than their rank of GDP per capita. Secondly, Singapore and another late-industrialized country, Korea, are ranked higher than mature economies like Germany, Belgium, and France. Moreover, Singapore has a very high share of its export being classified as relatively technology-intensive. Finland and Sweden seem to have an export structure that does not directly reflect their high technology ranking. The main reason for the relatively low technology content in trade is the large importance of wood based products in Finnish and Swedish exports.

Table 1.2 Income, Technological Rankings, and Exports (1999).

Ranking according to Technology Index		GDP/Capita (PPP US$)	Technology Index	High- and medium-technology exports (% of total export)
1	Finland	23,096	0.744	50.7
2	United States	31,872	0.733	66.2
3	Sweden	22,636	0.703	59.7
4	Japan	24,898	0.698	80.8
5	Korea, Rep. Of	15,712	0.666	66.7
6	Netherlands	24,215	0.630	50.9
7	UK	22,093	0.606	61.9
8	Canada	26,251	0.589	48.7
9	Australia	24,574	0.587	16.2
10	Singapore	20,767	0.585	74.9
11	Germany	23,742	0.583	64.2
12	Norway	28,433	0.579	19.0
13	Ireland	25,918	0.566	53.6
14	Belgium	25,443	0.553	47.6
15	New Zealand	19,104	0.548	15.4
16	Austria	25,089	0.544	50.3
17	France	22,897	0.535	58.9
18	Israel	18,440	0.514	45.0

Source: UNDP (2001)

Table 1.3 continues with a more detailed picture of technological capability. The numbers of patents and royalties reflect the stock of indigenously created technology, whereas the number of Internet hosts and cellular subscription rates can be seen as indicators of the technology use and technology diffusion in a country. The figures show that Japan and Korea have the highest numbers of patents per capita, but both Finland and Sweden are also fairly highly ranked. Singapore, on the contrary, does very little patenting and the low figures for royalty incomes confirm the low level of technology development in Singapore. However, Singapore, as well as Finland and Sweden, are highly ranked in terms of usage of technology as witnessed by the high number of Internet hosts and cellular mobile subscribers.

A country's output of technology is of course dependent on a host of domestic characteristics. Some indicators on countries' technological capabilities are shown in Table 1.4. Sweden has a strong position with the highest share of R&D and the second highest share of scientists and engineers in R&D. Finland is also fairly well positioned, especially in R&D expenditures as a share of GNP. The low levels of technology output in Singapore, seen in Table 1.4, are likely to be caused by the relative weak R&D base, both in terms of the number of scientists and the amount of R&D expenditures. However, one should notice that Singapore is a newcomer in technology development and, moreover, there have been some increases since 1997 as will be discussed later in this paper. Finally, all three countries seem to have an equal share of about 60 percent of the R&D expenditures taking place in the business sector as opposed to the academic or military sectors.

Table 1.3 Technology indicators in a sample of 18 countries (1999).

Rank according to Technology Index		Patents granted to residents (per million people)	Receipts of royalties and license fees (US$ per 1000 people)	Internet hosts (per 1000 people)	Cellular mobile subscribers (per 1000 people)
1	Finland	187	126	200	651
2	United States	289	130	179	312
3	Sweden	271	157	126	583
4	Japan	994	65	49	449
5	Korea, Rep. Of	779	10	5	314
6	Netherlands	189	151	136	435
7	UK	82	134	57	463
8	Canada	31	39	108	227
9	Australia	75	18	126	343
10	Singapore	8	26	72	419
11	Germany	235	37	41	286
12	Norway	103	20	194	617
13	Ireland	106	110	49	447
14	Belgium	72	74	59	314
15	New Zealand	103	13	147	230
16	Austria	165	15	84	514
17	France	205	34	36	364
18	Israel	74	44	43	459

Source: UNDP (2001)

To sum up, Finland, Sweden and Singapore have seen large structural change over the last years and the countries are today regarded as being very competitive and with a relative high degree of technological knowledge. The purpose of this paper is to summarize the reform experiences in these three countries. In addition to a detailed description of the framework for growth and innovation policy, we intend to discuss the political conditions and coalitions facilitating the reform processes. The objective is to distill some policy lessons for growth and innovation policies in Latin America from the experiences of these three countries.

Chapter 2 focuses on the case of Finland, which has been one of the fastest growing European economies during the past decade. The most particular feature of Finnish development has been the very rapid growth of a cluster of companies in the information and telecommunications (ICT) sector, with Nokia as the leading actor. One of the central questions discussed in the chapter is how a small country like Finland could become home to the most successful ICT clusters in the world. The proposed answer lies in a very conscious systems approach to economic policy, motivated by the need to strengthen the country's competitiveness in the face of internal and external shocks.

Table 1.4 Indicators on Technology Capability (1997).

Rank according to Technology Index		Scientists and engineers in R&D (per 100,000 people)	Research and development expenditures as % of GNP	Research and development expenditures in business as % of total
1	Finland	2,799	2.8	57.7
2	United States	3,676	2.6	59.4
3	Sweden	3,826	3.8	62.9
4	Japan	4,909	2.8	81.7
5	Korea, Rep. Of	2,193	2.8	84.0
6	Netherlands	2,219	2.1	44.7
7	UK	2,448	2.0	51.9
8	Canada	2,719	1.7	50.7
9	Australia	3,357	1.8	45.7
10	Singapore	2,318	1.1	62.5
11	Germany	2,831	2.4	61.4
12	Norway	3,664	1.6	49.9
13	Ireland	2,319	1.6	63.4
14	Belgium	2,272	1.6	64.8
15	New Zealand	1,663	1.0	33.9
16	Austria	1,627	1.5	49.0
17	France	2,659	2.3	48.7
18	Israel	--	2.4	35.7

Source: UNDP (2001)

Chapter 3 looks at Sweden, with a slightly different focus. The Swedish ICT sector has also been remarkably successful, partly for the same reasons as Finnish Nokia, but Ericssons development will not be discussed in any close in the paper. Instead, the emphasis will be on turnaround in the country's competitiveness from the late 1980s to mid-1990s, largely driven by the country's financial crisis in the early 1990s. The role of outward FDI – in particular, the risk that domestic multinational corporations (MNCs) move attractive and high-paying jobs out of the country – has also been important.

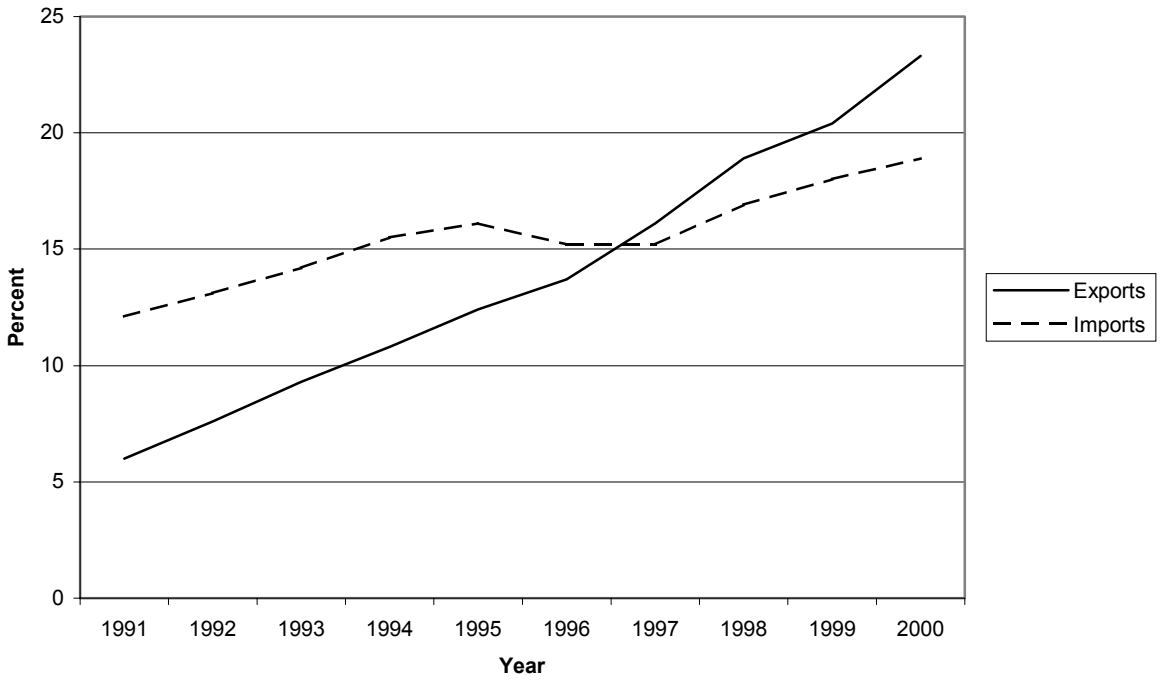
Chapter 4 turns to a discussion of developments in Singapore. Singapore managed to achieve rapid growth and transform itself from a developing country to one of the wealthiest countries in the world in a period of only about 30 years. The Singaporean development has been characterized by massive inflows of FDI, a strong reliance on international markets, but also a large degree of government involvement. The chapter analyzes why the strategy of FDI driven development was chosen and how Singapore has managed to encourage the MNCs to participate in the economic and technological upgrading of the local economy. Finally, a large government involvement has been present in many developing countries but often without any positive impacts on economic and technological development. We try to answer the question why Singaporean government transformed into a highly successful "developmental state".

Chapter 5 provides a summary and some conclusions for developing countries.

2. THE FINNISH SUCCESS STORY

After a severe depression in the early 1990s, caused by the collapse of the Soviet Union and a domestic financial crisis, Finland surprisingly emerged as one of the most dynamic and competitive OECD economies during the remainder of the decade. The average annual GDP growth rate increased from –3.5 percent in 1991-1993 to 4.7 percent between 1994 and 2000. Open unemployment was halved from nearly 20 percent in 1993-94 to 9 percent in 2000. A fundamental structural transformation of the economy also began. While raw material based industry – mainly paper, wood products, and metal industry – had traditionally dominated the manufacturing sector, growth now became concentrated to high-technology products, in particular telecommunications equipment. As a result of the increasing specialization in high–tech sectors, Finland's trade balance in high-tech products turned from a large deficit in the early 1990s to a significant surplus by the year 2000, as shown in Figure 2.1. According to IMF (2001), Finland's high-tech trade surplus ratio was the largest in the world among indigenous producers by the end of the 1990s.[2]

Figure 2.1 Finland's High-Tech Trade Balance (percent of total trade)



Source: Statistics Finland.

One of the explanations for the rapid increase in growth and the shift in competitiveness is a concerted effort to raise the research intensity of the economy. The ratio of R&D investments to GDP grew from about 1.5% in the mid-1980s to over 3.5% in 2001, with large increases in public as well as corporate research. As a result, Finland is today second only to Sweden in R&D intensity.

[2] Ireland recorded an even larger high-tech trade surplus, but over 90 percent of Ireland's high-tech industry is attributable to foreign multinational corporations.

We will argue in this chapter that Finland's success is largely the result of two parallel and interrelated processes that have promoted research, innovation, and diffusion of knowledge across broad segments of the economy. Firstly, the Finnish economy has for the past decades been dominated by five strong clusters –information and communications technology (ICT), paper and pulp, metal products and engineering, food products, and construction – producing about 75 percent of the value added in Finnish industry (Luukkainen 2001). These clusters and the related networks have also been the main objects of Finnish industrial policy and technology policy. The focus on cluster policy has provided an environment with rapid technology diffusion between related firms (benefiting mainly smaller firms with limited own R&D resources) and contributed to the internationalization of many small and medium-sized enterprises that would have faced significant problems entering world markets on their own.

Secondly, Finnish technology and innovation policy has very explicitly been based on the concept of a national innovation system. This approach assumes that innovation capacity – and thereby competitiveness – is shaped by a number of different factors apart from R&D intensity, including organizational and institutional capacity. There is also much emphasis on interdependency and mutual interaction between the various factors in the innovation system (Schienstock and Hämäläinen 2001). Consequently, factors such as networks between enterprises with different competencies, between industry and government, or between industry and universities determine the efficiency of R&D investment.

The following section examines the Finnish ICT cluster in some detail, with particular emphasis on the role of Nokia as the engine of the cluster. Thereafter, we turn to a discussion of the role of public policy as a determinant of industrial development. The emphasis is on the cluster approach to industrial policy that emerged in the early 1980s and evolved into a national innovation system approach after the crisis of the early 1990s. The final part discusses the reasons for the Finnish turnaround and the relevance of Finnish experiences for developing countries.

2.1 THE FINNISH ICT CLUSTER

In the recent Finnish debate on industrial development, it has been common to point to a number of distinct industrial clusters that have generated most of the growth in production, employment, and income during the past decades. In addition to ICT, these include forest products (wood and paper and pulp), metal products and engineering, food products, and construction.[3] Since the 1970s, these five clusters have accounted for nearly 80 percent of production in Finnish industry (Luukkainen 2001, Table 2).. In addition, the ICT, metals, and forest clusters have dominated Finnish exports: altogether, these three sectors accounted for 83 percent of exports in 2000. Neither the food products nor construction clusters have been able to sell much outside the domestic market (although the Soviet /Russian market has been important at times). Unlike ICT, paper and pulp, and metals, they have also been heavily protected by various trade restrictions, which means that it is difficult to determine their true efficiency and competitiveness.

Table 2.1 summarizes some data on the development of the production and export shares of the ICT, forest, and metals clusters. One notable observation is that both the forest and metals

[3] More detailed studies sometimes identify chemicals, business services, energy, and health care as separate clusters. See Hernesniemi *et al.* (1996).

clusters remain very important, although the Finnish economy has shifted towards more technology and knowledge intensive activities during the period under study. Both sectors are based on domestic raw material supplies, and some of the success factors explaining their long-term competitiveness have been examined in some detail in a related paper (Blomström and Kokko 2001).

Table 2.1. Production and export shares of major clusters in the Finnish economy, 1980-2000 (percent)

	1980	1990	2000
ICT			
Share of manufacturing	4.6	7.6	29.4
Share of exports	4	12	30
Forest products			
Share of manufacturing	25.3	23.8	21.0
Share of exports	45	39	29
Metals			
Share of manufacturing	8.5	10.6	10.1
Share of exports	25	31	24

Source: IMF (2001), Table 2.

Three factors were identified as essential determinants of long-term competitiveness. Firstly, an appropriate institutional framework has provided the rules and incentives needed to encourage sustainable use of natural resources. Secondly, outward oriented trade policies were important to provide a larger market for output, to expose oligopolistic producers to competitive pressure, and to provide access to foreign technology. Thirdly, the long-term competitiveness of the forest and metal clusters has been upheld through the continuous generation and dissemination of knowledge and skills through a comprehensive network of universities, specialized research institutes, and companies. Blomström and Kokko (2001) place particular emphasis on the role of these knowledge clusters, arguing that even raw material based industries need to be knowledge intensive in order to remain competitive for long periods of time.

The most notable point in Table 2.1, however, is the remarkable increase in the production and export shares of the ICT cluster. Its rapid development is not based on any particular natural resources, but rather the result of comprehensive investments in human capital and technology. The industry's breakthrough was also remarkably fast. The leading firm in the ICT cluster, Nokia, was established already in the 1860s, but did not enter the electronics and telecommunications sector until the early 1960s – in fact, Nokia remained focused on pulp and paper, rubber products, and other raw material based products well into the 1980s. The real expansion of the industry did not take place until the 1990s, as shown in Table 1. This notwithstanding, it is clear that the success of the Finnish ICT industry to some extent is based on historical conditions and coincidences.

The most important institutional determinant may be the fact that Finnish telephone network operations were never monopolized by the state. When the national telephone system was initially established in the late 19th century, Finland was ruled as a relatively independent Grand Duchy under Russia. The Finnish Senate was worried about increasing Russian influence, and one of the responses was to grant numerous licences for telephone operators: this was intended as an obstacle to a Russian nationalization of the telephone system. After

independence in 1917, it turned out that a nationalization by the newly independent Finnish authorities was equally difficult. A national public telecommunications operator was established and managed eventually to set up a monopoly in long-distance and international calls, but Finland remained one of the few European countries where private operators competed with the state in local operations. Already in 1921, the private operators joined in an Association of Telephone Companies that has been able to resist several attempts by the authorities to nationalize the industry.

The existence of several telephone network operators had two important effects on the development of the Finnish telecommunications market. Firstly, the competition for customers contributed to rapid technological change in the industry. The private operators were forced to demonstrate that they were technically competent, and new solutions were therefore introduced faster than in many other countries. The public telephone company was of course forced to follow suit when the private firms upgraded their technology. Consumers also grew accustomed to relatively frequent changes in technology. Secondly, the multi-operator market attracted several foreign manufacturers of telecommunications equipment, and foreign firms like Ericsson, ITT, and Siemens set up production facilities in the country. These foreign investments were important sources of technical knowledge in the early stages of the development of Finnish equipment manufacturers. Equally importantly, they put heavy competitive pressure on the emerging domestic industry once it was established. The existence of several competing technical solutions was also an important source for specialized skills: long before Nokia's breakthrough, Finnish telecommuncations engineers were recognized as leading experts in interface technology.

The domestic Finnish telecommunications equipment industry began to emerge already in the 1920s. Three companies stood at the forefront of the development. *Salora*, established in 1928, was a producer of radios and, eventually, television sets. Focusing on consumer electronics with relatively mature technologies, it accumulated valuable expertise in serial production and marketing. The *State Electric Works* was established in 1925 by the Ministry of Defense to produce strategic radio technology. After the Second World War, the company was merged with the R&D unit of the public telecommunications operator. In the 1970s, it was renamed *Televa*, and focused on providing telecom equipment the public telecom operator. The third company, *Finnish Cable Works*, was one of the original cornerstones of Nokia Corporation (Blomström and Kokko 2001). It was set up in 1917 to produce cables for the rapidly industrializing Finnish economy. In 1960, it established a small electronics division to develop and produce a variety of electronic goods. In 1962, the paths of three firms crossed. The Finnish Army put out an invitation to the three firms (and Swedish Sonab) for tenders for a radiotelephone. Due to cuts in the defense budget, the Army was eventually not able to place any orders, but the companies found other customers for their prototypes. Televa's radiotelephones were sold to the Finnish police force, Salora sold to the coast guard and the state railway company, while Cable Works supplied the Postal authorities and exported successfully to the Soviet oil and gas industry (Pulkkinen 1997:75).

The production of radiotelephones expanded when a nationwide public radiotelephone system was established in the early 1970s. Since the late 1960s, there had also been discussions about the establishment of a Nordic mobile telephone network, and an open standard for telephones, base stations, and exchanges was eventually agreed in 1976. The cellular NMT network that was to be launched in the early 1980s in all the Nordic countries pushed all the three Finnish telecom equipment producers to develop new products for what was expected to be a rapidly growing market.

By the early 1980s, Salora was the Finnish market leader in radiotelephones and had a 30 percent market share in the Nordic region as well. Televa was stronger in telephone systems. In particular, Televa had been developing computerized telephone exchanges since the late 1960s. Unlike Siemens, Ericsson, and other large foreign competitors that focused on analogue technology in the early 1970s, Televa was experimenting with both analogue and digital systems already from the outset. Eventually, it succeeded in developing a digital telephone exchange that proved to be key to the next generation of mobile telephony, the GSM system. Finnish Cable Works, which had adopted the name Nokia Corporation after a merger in 1966, was also working hard to improve its radiotelephones, and important technical innovations were made during the 1970s. The challenge from the new NMT system that would be introduced in the early 1980s, however, seemed hard to handle. The three Finnish radiotelephone producers were not the only ones engaged in product development for the NMT system. The standard was several years ahead of developments elsewhere in the world, and most leading companies – including Ericsson, Siemens, Motorola, Hitachi, NEC, and Mitsubishi – had decided to enter in order to stay on the frontier.

Discussions about collaboration between Nokia and Salora had therefore started already in the mid-1970s, and in 1979 the two companies decided to establish a joint venture, Mobira, to pool their research and development resources. Mobira was focusing particularly on NMT terminals. Nokia and Televa had also combined their R&D resources in a joint venture some years earlier. The company, Telefenno, was emphasizing the systems side, continuing the development of Televa's digital telephone exchange.

Both ventures were successful. By 1985, Mobira had become one of the leading manufacturers of NMT telephones, with Mobira Cityman, the first handphone that could reasonably fit into a pocket, as one of its main achievements. Meanwhile, Telefenno's digital exchange had become Nokia's largest export product, and about a quarter of the world's NMT systems were supplied by the company. Continuing the Finnish tradition of managing several parallel systems simultaneously, Nokia was the only European manufacturer to aim for a global market in the 1980s. The large European companies Alcatel, Ericsson, and Siemens restricted their operations to the Nordic and Continental European standards, staying out of the US, UK, and Japanese markets (Pulkkinen 1997:104). It was believed that the tough competition and the need to adapt to all the different mobile phone standards were necessary to acquire the technical skills needed to succeed at a global scale. To facilitate this task, Nokia obtained full ownership of Mobira and Telefenno in 1987.

But there were also problems. Mobile phones and telephone systems accounted for less than 15 percent of Nokia's turnover – cables, rubber products, and forest products were more important – and the company's preferred high-tech areas were consumer electronics, in particular TV sets, and information technology (e.g. microcomputers). However, the market for television sets was saturated and several of Nokia's investments in consumer electronics were generating large losses. In addition, massive R&D expenditures were needed for the development of the digital GSM system, a process that had commenced in 1987 in collaboration with French Alcatel and German AEG. The profits made from the sales of mobile phones and telephone exchanges were barely sufficient to keep the company afloat.

The period from 1989 to 1992 can be characterized as a struggle for survival, which culminated in 1991. That year was not only marked by the beginning of the severe banking and financial crisis in Finland, but also by the collapse of the Soviet Union. This cut severely

into Nokia's cash flow, and forced the company to take extreme measures. In principle, all of Nokia was put up for sale. Nokia's Paper and Rubber divisions were sold in 1991. To cover the losses in the consumer electronics division, the production of microcomputers was also sold. The rest of the company was offered to Swedish Ericsson, but no agreement could be reached once Ericsson realized that the loss-making television division was to be included in the sale. All in all, Nokia shrank from 44,000 to 22,000 employees between 1989 and 1992.

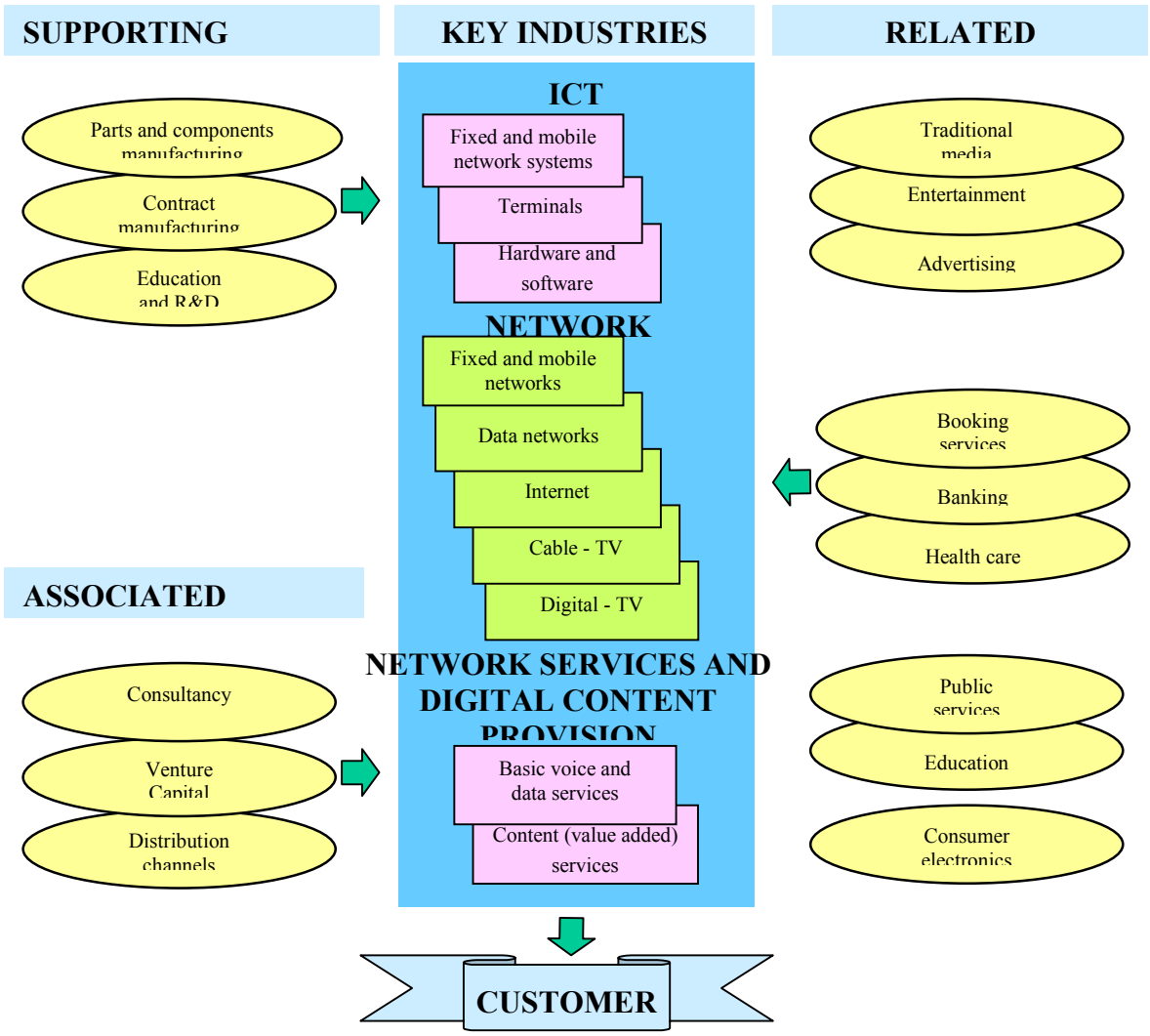
The recovery came with the breakthrough of the digital GSM technology in 1991 and a simultaneous turnaround in Nokia's mobile phone design strategy. Instead of marketing mobile phones as exclusive high-tech gadgets for professional businessmen, Nokia started targeting mass markets using design and aesthetics as the main sales arguments. The world's first GSM network was inaugurated in Finland in July 1991 by Nokia – the customer was Radiolinja, a private operator owned by the Association of Telephone Companies – and the first phone calls were made with Nokia's new digital cell phones. The following year, Nokia delivered GSM systems to 7 European countries as well as Australia, New Zealand, and Hong Kong. At the same time, orders for the old NMT systems continued coming in, mainly from the former Soviet Union and the East and Central European transition economies. During the remainder of the 1990s, Nokia expanded at an unprecedented pace, focusing narrowly on mobile phones and telecommunications systems (after having divested the television production units in 1996). While much of the success was due to Nokia's strong competitiveness, it was also helped by chance: thanks to the deregulation of the telecommunications industry in most of the OECD region, demand was booming until the late 1990s.

By the year 2000, Nokia had grown to more than 55,000 employees throughout the world, with more than half of total employment outside Finland. Its global market share in mobile phones was nearly one-third. The stock market value of the company had increased from around 1 billion USD in 1990 to over 230 billion USD in 2000, representing 70 percent of the total capitalization at the Helsinki Stock Exchange. At that time, Nokia was the fifth most valuable global brand (Paija 2001:27) and accounted for 70-80 percent of Finland's ICT exports, 45 percent of ICT production, and 30 percent of ICT employment.(IMF 2001:8).[4] The company had also become a key player in technology development. About a third of Nokia's worldwide employees and most of the company's 21,000 employees in Finland are involved in R&D, and the company's domestic R&D represent approximately 30 percent of national R&D investments. With 55 research centers in 15 countries, Nokia has one of the most international R&D strategies of any multinational corporation (IMF 2001:8).

While Nokia is undoubtedly the central actor in Finnish ICT, it is not alone. It is estimated that the Finnish ICT cluster employed over 110,000 people in 2000, corresponding to nearly 5 percent of total employment. Aside from Nokia, the cluster comprises about 4,000 firms (mainly small and medium sized enterprises) out of which some 350 are first-tier suppliers to Nokia. In addition to manufacturing, the core activities in the cluster include software production, network operations, and other services. As illustrated in the cluster chart in Figure 2.2, there are also important linkages to supporting sectors like components manufacturing and education, related sectors like banking and media, and associated services like venture capital and consultancy.

[4] The recent slump in the world's telecom markets has reduced the stock market value of Nokia, but the company's production and exports have continued growing.

Figure 2.2 Cluster Chart for the Finnish ICT Cluster



Source: Paija (2001).

Table 2.2 identifies some of the major firms in the core of the Finnish ICT cluster in the late 1990s. Several companies (in addition to Nokia) have managed to become competitive in world markets and many have established their own international production networks, For instance, Elcoteq is the largest electronics manufacturing services company in Europe, Benefon, established by a former Nokia manager, has captured a significant global market share with its navigator phones, and several Finnish software companies are marketing their network security systems internationally. Among the more than 120 telecommunications operators, the two dominant are Sonera, which is the partly privatized public telecommunications company and the Finnet Group, which is the former Association of Telephone Companies (made up of 46 private local operators and their subsidiaries). The most notable private telecom companies are Elisa Communications and its subsidiary Radiolinja, the world's first GSM operator in 1991. The success of the ICT cluster has also attracted numerous foreign firms to Finland. Ericssson, Siemens, ICL, and Hewlett-Packard are only a few examples of foreign firms that have located R&D facilities in the country to benefit from possible spillovers of technology and skills. Following the deregulation of the Finnish telecom sector in the 1990s, several foreign operators – most notably Telia of Sweden

– entered the market.[5] The four GSM operators in Finland were granted UMTS licences in early 1999, and it is expected that Finland will be an important test market also for the third generation of mobile telecommunications. One reason is that Finnish UMTS licences were granted free of licence charges. In many other European countries, it is expected that investments will be delayed because operators are burdened by the combined effect of the slowdown in the global telecom market and the high cost of licenses.

Table 2.2 Selected Finnish ICT Cluster Firms in 2001.

Firm	Line of business	Sales (million Euro)	Employment
Domestic companies[1]			
Nokia	Phones and network systems	31,191	53,849
Sonera	Telecom operator	2,187	10,482
Elcoteq	Electronic manufacturing serv.	1,862	8,350
Elisa Communications	Telecom operator	1,439	7,783
Tietoenator	IT solutions	1,135	10,058
Perlos	Mobile phone enclosures	431	3,538
Novo Group	IT solutions	295	2,016
Scanfil	Mech. and electronics manuf.	266	1,620
Aspocomp	Printed circuit boards	222	3,314
Eimo	Mobile phone enclosures	166	1,833
PKC Group	Communications cables	125	940
JOT Automation Group	Industry automation	70	590
Benefon[2]	Mobile phones	59	377
Tecnomen	Network service systems	57	556
Samlink	Electronic banking systems	50	251
Foreign Companies in Finland[3]			
Hewlett-Packard Finland	Information technology	541	386
Siemens	Phones and network systems	347	1,677
Ericsson	Phones and network systems	176	1,105
Fujitsu Services	Information technology	135	140

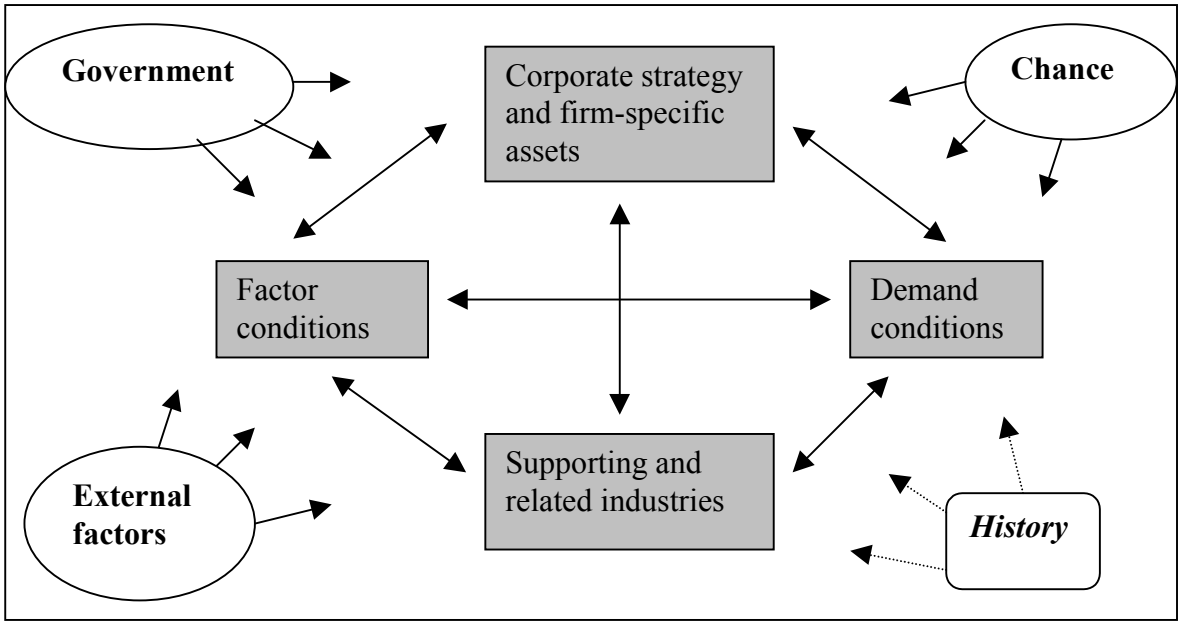
Source: Paija (2001), Table 2, updated for 2001 from Annual Reports.
[1] The data on sales and employment for domestic companies include their foreign affiliates. For some companies, employment data refer to year-end figures rather than average employment.
[2] Data for 2000.
[3] Data refer to operations in Finland only.

There is no doubt that Nokia's tremendous success – driven both by luck and conscious corporate policies to create the necessary skills and knowledge for high-tech operations (see Blomström and Kokko 2001) – is one of the major explanations for the emergence of the Finnish ICT cluster. A favorable business environment, with suitable factor conditions, demand, institutions, and policies has also played an important role. We have already noted that the absence of a state monopoly in the telecommunications market was an important determinant of the industry's development. The competition between the private operators

[5] In 2002, Sonera and Telia announced that the two companies would be merged.

and the state-owned company created a dynamic market, attracted foreign investors, and contributed to the development of essential skills and knowledge. We have also pointed to the importance of collaboration, as in the establishment of Telefenno – the joint R&D venture between Nokia and the state-owned Televa in 1979 – which contributed some of the technical innovations that laid the basis for Nokia's transformation from a raw material based to a high-tech company. However, the rapid development of the ICT cluster during the 1990s has arguably required more than healthy domestic competition and spontaneous collaboration between independent firms. Instead, the Finnish ICT cluster owes much to a comprehensive systems approach in public policy. Terms such as cluster policy and national innovation systems are today commonly used to describe best practice in industrial policy and science and technology policy, and Finland is in fact one of the countries where these concepts have been implemented most successfully. It is therefore appropriate to discuss some aspects of the Finnish policy environment.

Figure 2.3 Porter's Diamond Model of Competitiveness



Source: Adapted from Porter (1990).

2.2 CLUSTER POLICY AND A NATIONAL INNOVATION SYSTEM

Porter (1990) argues that the competitiveness of countries and industry clusters is determined by several factors related to the economic environment. While the assets and strategies of a country's companies are central for competitiveness, they cannot be used efficiently unless the companies have access to markets, inputs, and raw materials, and are able to establish well functioning networks with suppliers, subcontractors, and customers. These relations, in turn, are affected by chance, history, government policy, and various external factors. Figure 2.3 illustrates some of the interactions. To manage in international competition, companies need firm-specific assets in terms of skills, brand names, technologies, and other resources. In addition, they need labor, capital, and other factors of production at reasonable cost. Demand conditions determine not only the volume of production and the possibilities to exploit economies of scale, but also the quality of the products. Supporting and related industries are

necessary to facilitate specialization and efficiency. All of the elements making up this competitive diamond – and the relations between the elements – are continuously shaped (and changed) by factors in the economic environment. Most obviously, government policies and regulations affect all relations in the system.

The diamond can be used as a conceptual basis for the discussion of *cluster policy* and the *national innovation system* – arguably two of the key success factors in Finland's industrial policy environment in recent decade. Cluster policy can be understood as policy aiming to strengthen some specific cluster, by promoting linkages between related companies and improving factor and demand conditions for the cluster. (Conceptually, it would also be possible to include policies to create the firm-specific assets that are necessary to create any cluster, but the Finnish experience gives little evidence of such forward-looking measures. Instead, cluster policy has been based on the analysis of inter-linkages between companies, industries, factor markets, and demand conditions.) The national innovation system is a broader concept. It is largely based on the cluster model and recognizes the interdependence between the various components of Porter's diamond – with particular emphasis on the role of government policy and the creation of new competitive assets through education, learning, and R&D – but is typically not based on any specific cluster. Instead, the systems approach to innovation policy aims to create favorable conditions for whatever kind of economic activity that might emerge in the economy.

Looking at the Finnish ICT cluster against the backdrop of Porter's diamond model, it is clear that the ICT industry's success owes much to favorable conditions and developments in many parts of the system. Regarding factor conditions, the two most important developments concern the availability of venture capital and the supply of skilled labor. With a banking system model on continental Europe's main bank system and a weakly developed risk capital market, Finland had weak conditions for nurturing entrepreneurship and financing new small and medium-sized enterprises until the mid-1980s (Ali-Yrkkö *et al.* 2001). After that time, a vibrant venture capital market has emerged as a result of the liberalization of the financial sector. This has provided unparalleled financing opportunities for innovative high-tech firms, which are now able to enter the market already at a relatively early stage of product development (Paija 2001:30). The amount of venture capital investments increased more than ten-fold between 1995 and 2000, as shown in Table 2.4. It is estimated that about one-third of private equity investment in Finland during this period went to ICT (IMF 2001:11). Another notable development has been the growth and internationalization of the Helsinki Stock Exchange. With the ratio of market capitalization to GDP at below 20 percent and limited foreign portfolio investment until the early 1990s, the stock market was not a very important source of capital. After Nokia's breakthrough, foreign investors have discovered the Finnish market. The market capitalization rate had risen to well over 200 percent by 2000, around 70 percent of shares were held by foreign owners, and many other companies than Nokia had significant foreign ownership. An increasing number of venture-backed IPOs have also been listed since 1995.

Table 2.4 Venture Capital Investments in Finland 1995-2000

Year	Number of cases	Growth (percent)	Investment (million Euros)	Growth (percent)
1995	122	6	37.8	34
1996	137	12	83.8	122
1997	205	50	136.4	63
1998	265	29	192.4	41
1999	350	32	285.4	48
2000	420	20	403.7	41

Source: IMF (2001), Table 3.

Turning to labor supply, it is clear that Nokia's initial breakthrough in the telecommunications sector was made possible by the availability of specialized skills, largely built up as a result of the mix of technical solutions chosen by the many competing telecom operators. By the 1980s, however, there was already a shortage of the labor skills needed by Nokia and other high-tech firms, and the companies invested substantial funds on specialized in-house training programs, sometimes in collaboration with Finnish universities (Blomström and Kokko 2001). By the early 1990s, the shortage of educated manpower had come to the attention of the government, and a broad expansion program in higher education was initiated. The total intake in universities nearly doubled in the five years between 1993 and 1998, and the number of students in polytechnics tripled over the same period. By the end of the 1990s, 12 postgraduate schools in information technology had been established (Paija 2001:33). This increase in the supply of labor has been essential for the expansion of the ICT cluster, although further investments will be needed. The high-tech companies still suffer from a chronic shortage of educated labor, and total employment in the cluster would certainly have been much higher without this restriction.

Finland's demand conditions have been favorable to the development of the ICT cluster although the Finnish market is small, with only 5 million consumers. The main reason is that new technologies have been adopted very rapidly, so that it has been possible to use the domestic demand patterns to anticipated future trends in the world market. The mobile phone penetration rate is the highest in the world, with mobile subscriptions outnumbering fixed line subscriptions since 1998, and mobile phone replacements have exceeded the number of first-time purchases for several years. Internet penetration rates and other high-tech indicators also score high in international comparisons. The advanced home market was arguably one reason why Nokia was the first company to develop consumer-oriented hand phones, focusing on design and fashion arguments rather than technical specifications in their marketing.

The competition between several domestic operators has been an important determinant on the demand side. As a result, Finnish ICT companies have been able to sign contracts for new systems and products at early stages of product development, and have been forced to seek technical solutions to combine equipment from different manufacturers. The early decision to compete in all the major international markets, where technical specifications and standards differ, is a logical extension of the experiences gained at home (Blomström and Kokko 2001). Competition has also kept domestic prices relatively low, which has naturally encouraged early adoption of new solutions. It is likely that the introduction of the third generation of mobile telephony will follow the same pattern. Unlike many operators in continental Europe and other parts of the world that paid high prices for their licences at UMTS auctions and will

therefore have to charge high prices for their services, the Finnish licences were distributed according to the "beauty contest" model, where winning contestants receive their licences for free. Without the extra costs for licences, Finnish operators have the option to set their prices low enough to stimulate the growth demand and value-added services.

On the supply side, the main development during the last decade has been the emergence of a large number of producers of highly customized inputs. Standard components are largely imported, and the Finnish supply network built up around Nokia and other original equipment manufacturers are focusing on more sophisticated parts and services. Many of the Finnish suppliers have followed Nokia and the other leading companies abroad, extending the supply and subcontracting networks across international boundaries. This has made it possible to combine the highly specialized skills developed in Finland with low-cost locations abroad for the simpler labor intensive links in the production chain. While the collapse of the Soviet Union eliminated a highly profitable market for Nokia and many other Finnish firms, it also provided convenient low-cost locations close to home. In particular, Estonia has become a favored foreign direct investment site for many Finnish ICT firms.

The most important development regarding supporting and related firms, however, has been the massive increases in R&D and higher education – the production of skills, knowledge, and technology. The ratio of R&D to GDP has increased continuously for the past two decades, more than doubling between 1985 and 2000, as shown in Table 2.5. Nokia has accounted for a large share of Finnish R&D investment since the early 1990s, but the increasing technology and skill intensity of the Finnish economy shows also in other activities. Excluding Nokia, the Finnish R&D to GDP ratio in 2000 would have reached about 2.4 percent, which is above the OECD average. Overall, more than 70 percent of all R&D is performed in the corporate sector, which is also well above the OECD average.

Table 2.5 R&D as a Share of GDP in Finland 1985-2001 (percent)

Year	1985	1990	1995	1997	1998	1999	2000	2001
R&D/GDP (percent)	1.55	1.91	2.29	2.72	2.89	3.19	3.37	3.59

Source: Statistics Finland.

Although the business conditions for the Finnish ICT cluster are affected by various external factors, it should be obvious from the discussion above that government policy has probably had the strongest impact on the structure of the cluster. Public policy has affected the degree of competition, the supply of capital and labor, the structure of demand, and the development of supporting and related industries. One reason for the successful outcome is that the Finnish government has adopted a cluster approach to industrial policy.

The roots for this policy approach can be found in the early 1980s, when the Finnish economy was struggling with the structural transformation necessitated by the oil crises. In Sweden, where the same problems were at the top of the policy agenda, the government's response was to implement a series of "offensive" devaluations of the currency, to recreate competitiveness in established industries that suffered from high costs and increasing international competition. In Finland, the proposed solutions focused instead on knowledge and technology. Being a relative latecomer among Europe's industrialized nations, the Finnish income level was still well below that in the other Nordic countries, and it was recognized that the only way to catch up was through increases in productivity, specialization, and

international competitiveness. A particular concern was the need to diversify the economy away from forestry and metals towards new high-tech areas like electronics and IT. There was also an emerging understanding that many policy areas that had traditionally been considered separately – education, science and technology, industrial policy, and economic policy – were closely linked and could not be viewed in isolation. Instead, policies needed to be balanced and technological, commercial, and social needs had to be addressed simultaneously (Romanainen 2001: 378).

One of the first areas where these ideas were implemented was science and technology policy. The emphasis on upgrading and higher value added in production suggested a stronger role for investments in technology creation, and several institutional changes were made during the 1980s to promote R&D, both in industry and the public sector. Until that time, universities had not been permitted to collaborate with industry, but were now encouraged to establish joint projects with the corporate sector. A National Technology Agency, *Tekes*, was established in 1983 to finance applied and industrial R&D. In 1987, the Science Council was reformed and renamed the Science and Technology Policy Council (*STPC*). Its membership was expanded to representatives from the industry and the research community, and it was given a higher status as an advisory organization. New ambitious targets for R&D investments were set up. At the time, the ratio of R&D to GDP was about 1.5 percent, and the aim was to reach 2 percent by 1990. The target for 1995 was 2.45 percent, which was expected to grow further to 2.7 percent by 2000.

With limited domestic resources for R&D, it was imperative that the available public funds were used efficiently. This mandated an explicit cluster approach in R&D policy. The knowledge created through R&D is to some extent a public good, and may spill over to firms that are related to firms: although such spillovers are inherently difficult to quantify, it is estimated that they may sometimes account for up to one-third of the original research costs (Irwin and Klenow 1994). However, spillovers are not automatic. The degree to which potential spillovers are realized depends on the intensity of contacts between innovators and related firms, and the ability of related firms to absorb the potential knowledge externalities (Blomström et al. 2000). Moreover, the leakage of knowledge introduces a wedge between the private and social returns to R&D investments, resulting in suboptimal investment levels in the absence of government intervention. The cluster approach addressed all of these concerns. By subsidizing R&D in industries and companies that belong to major clusters – where input and output linkages are strong – it was possible to concentrate resources to sectors where the likelihood for spillovers is relatively good. By explicitly including small and medium sized firms in publicly funded R&D projects – which are often dominated by large multinational corporations like Nokia – it was also possible to strengthen the absorption capacity of these firms and achieve a faster rate of technology diffusion. The support to the emerging venture capital industry was also important, and was based on another kind of market failure: the existence of external economies of scale. With more investment and more companies in the industry, each actor could become more specialized and more efficient, and the cost of intermediate goods and services could be reduced, to the benefit of the entire industry. Thus, the basic idea was to support the development of the cluster as a whole rather than supporting individual companies. The stated objective was "improving integration, collaboration, and division of labour within the whole research [and production] system" (Romanainen 2001:378).

Other policy measures introduced to strengthen industrial competitiveness during the late 1980s included a new competition policy, privatization of state-owned enterprises, and

liberalization of the capital market. The cluster approach was important in these areas as well, since many of the measures focused initially on the most promising clusters. In addition to ICT, these were forestry, metals, and engineering.

By 1990, Finland had almost reached its 2 percent R&D target, but a domestic financial crisis (see following chapter for a discussion of the causes) and the collapse of the Soviet Union threatened to interrupt the ongoing structural transformation. GDP fell during three consecutive years between 1991 and 1993, with a total contraction of 10.7 percent. Open unemployment soared from only 3.2 percent in 1990 to nearly 20 percent in 1994, and the government budget turned from a reasonably balanced situation to a large deficit. Public debt grew from 11 percent of GDP in 1990 to 64 percent in 1995. However, the R&D and industrial policy targets were not abandoned, but rather strengthened by the crisis. It was recognized that the structural transformation that had commenced was necessary to maintain the country's living standards, particularly as EU and EMU membership – Finland joined the EU in 1995 – would remove any protection offered by domestic trade and exchange rate policies. Hence, the focus on technology upgrading was maintained, and the R&D sector was one of few public expenditure areas that were protected from cut-backs during the crisis years.

There was also an increased emphasis on a comprehensive systems approach. In the early 1990s, the first Finnish cluster study had been commissioned from ETLA, the Research Institute of the Finnish Economy (Hernesniemi *et al.* 1996). The results of the study were explicitly included in the 1993 *National Industrial Strategy*, which called for the establishment of a new platform for the interaction between the actors in system. This included the relevant ministries, public and private research institutes, companies, and core actors on the demand side. Simultaneously, the concept of a national innovation system was introduced in the Finnish policy debate, further emphasizing the coordination of policies in several different areas. Yet, these new strategies did not mandate any radical new policy directions, but rather confirmed and strengthened the approach initiated during the 1980s. Both cluster policy and a national innovation system had started to emerge already at that time, although the concepts had hardly been introduced in the academic debate. Moreover, the role of government was that of a facilitator rather than a driver: it was decided that policy should not favor any cluster over other, but provide a good environment for any cluster that might emerge.

In concrete policy formulation, the systems approach gradually led to stronger efforts to improve the business environment through regulatory and institutional reform. On the institutional side, Tekes and STPC have come to play increasingly important roles. Since its establishment in 1983, Tekes has provided between 75 and 80 percent of the public R&D funding directed to the manufacturing sector. Tekes typically funds some 30 to 40 percent of total R&D costs in the product development projects it runs – in basic research, when universities and research institutes are the major project participant, the Tekes share is often larger. Its programs require cooperation and networking between business enterprises and research institutes and promote technology transfer and internationalization.

Nearly 2,400 businesses and 800 research institutes participated in Tekes' technology programs in 2000. With 3.4 percent of GDP allocated to R&D that year, Finland was second only to Sweden in R&D intensity. The increase in R&D was particularly rapid in the late 1990s, partly as a result of a joint commitment of the private sector and the government in the mid-1990s to raise R&D expenditure to 2.9 percent of GDP by the turn of the century (Asplund 2000:3). This goal was reached already in 1998. Although government outlays on

R&D increased rapidly during this period – the bulk of the revenue from the privatization of state-owned enterprises in the 1990s was earmarked for research and education – business R&D grew even faster. As a result, about almost three-fourths of all R&D activities are now undertaken by the business sector, in comparison with about half in the early 1980s. The privately funded share of R&D is twice as high as the average in the OECD area.

The available evidence indicates that Tekes' insistence on collaborative research has had the intended effects. Looking at the patterns and effects of publicly funded R&D in the business sector, Lehtoranta (2000) and Maliranta (2000) note that government support is skewed towards relatively small firms. While government funded R&D only accounted for some 1.5 percent of the total research expenditures of firms with more than 1,000 employees, the share for firms with less than 100 employees was over 10 percent. They also note that there is only weak evidence that public R&D subsidies raise the productivity of individual firms, but strong evidence that the total amount of public R&D investment matters at the industry level. In other words, public R&D policies affect productivity through various kinds of externalities. These industry-specific spillover effects benefit both supported and non-supported firms, and are particularly important for smaller firms with limited resources for own R&D.

Although the STPC is only an advisory body, it has a very profound impact on Finnish science and technology policy – the main reason is its function as a think-tank and hub with representation from all major actors in the Finnish economy. It is chaired by the Prime Minister and includes the ministers of Trade and Industry, Education and Science, Finance, Transport and Communications, Environment and Defense, as well as prominent members from industry, industry associations, labor unions, Tekes, the Academy of Finland, and the Finnish Environment Institute (Romanainen 2001: 386). Its activities revolve around a Review of Science and Technology Policy presented every third year. This Review identifies the main policy challenges facing the country and makes recommendations and suggestions for all major actors in the economy (particularly regarding the use of public R&D funds, but also matters concerning the coordination of public and corporate investment in general). As a result, information regarding investment plans and policy reforms is diffused rapidly to all the major actors.

One of the most important elements of this coordination concerns inter-ministerial collaboration. It has been recognized in Finnish innovation and cluster policy that it is not enough to coordinate the decisions of private actors, but it is also necessary to establish a strong foundation for joint policy reform within the public sector. To create a favorable business climate, it may be necessary to combine several policy areas, including industrial, financial, education and science, employment, regional, environmental, social, and perhaps even cultural policies. Consequently, in the late 1990s, the STPC initiated a process where more than half a dozen inter-ministerial cluster-based programs have been established to identify reform areas that require substantial policy coordination and fall outside the responsibility of any individual ministry.

The results of these reforms are seen not only in the tremendous success of the Finnish ICT cluster, but also in various qualitative assessments of the business environment. For instance, summarizing a survey of the Finnish economy, IMF (2001:8) notes that:

> International comparisons of the international business environment inevitably rank Finland near the top. According to the Economist Intelligence Unit (2001), in a comparison across 60 countries, Finland was ranked as the sixth most favorable overall business environment through 2005, having placed in the top three on several

indicators: political environment, macroeconomic environment, policy towards private enterprise and competition, policy towards foreign investment, financing, and information and communications infrastructure. The *2000 World Competitiveness Yearbook* paints an equally, if not more, compelling portrait of Finland's business competitiveness. In a cross-country comparison of 47 countries, Finland is assessed as being in either first or second place on a remarkably wide variety of indicators, including: gross domestic savings, real growth, restructuring of the economy, growth in direct investment stocks (both inward and abroad), globalization, public service, government decisions, political system, rights and responsibilities of shareholders, insider trading, cellular phone subscribers, connections to the internet, corporate board management, shareholder value, and university education. Finally, Transparency International has again ranked Finland as the world's least corrupt country, a feature highly conducive to encouraging innovation and investment.

This list can be extended with several indicators of the degree of collaboration and networking within the corporate sector and between the corporate sector and the university system. The ICT cluster is a case in point, where Nokia has acted as a catalyst in creating vertical relationships with suppliers and subcontractors, covering not only production but also research and product development. In many cases, this networking has been mandated by Tekes (which is co-financing Nokia's research) and it has often necessitated substantial transfers of technology from Nokia to its partners, at least in the initial stages of the relationship. Paija (2001:35) argues that the "networked production paradigm, enhanced by cooperative long-term relations, can be seen behind much of the superior performance of Nokia and the Finnish ICT sector in general". This is not only a feature of Nokia's operations: networking solutions have become increasingly common in the ICT cluster at large.

Networking between industry and science is also well developed. In the mid-1990s, 40 percent of all innovative firms reported that they cooperated with universities or public research institutions, which is among the highest in OECD (Paija 2001:36). But collaboration reaches well beyond university participation in corporate research programs. In many of the current high-tech fields, technology development is so fast that the skills demanded by companies cannot be found in textbooks. Industry is therefore actively involved in training and knowledge transfer to the universities, and a large number of internships are provided to link theoretical studies to practice. It is therefore not surprising that IMD has for the past years ranked Finland as the world leader in technological cooperation between firms and also in research cooperation between firms and universities (Asplund 2000:2).

2.3 LESSONS

While concepts like cluster policies and national innovation systems are relatively simple theoretical constructs, they are often too abstract to yield explicit policy advice (Schienstock and Hämäläinen 2001, Chapter 5). It is also complicated to define who the actors in the innovation system are. Rather than pointing to individual policy lessons from Finnish experience, it may therefore be appropriate to draw some conclusions from the processes and structures that have been successful in Finland.

First and foremost, Finnish experiences suggest that small countries with limited public resources for investment may need to focus on specific industry clusters. These clusters need to be identified on the basis of existing comparative advantages – policies aiming to create entirely new clusters are unlikely to succeed. To facilitate specialization and positive

externalities, it is also necessary to promote linkages, knowledge flows, and technology diffusion within the cluster, in particular if public resources are used to subsidize R&D. Secondly, a systems approach is necessary to use existing resources efficiently and to identify bottlenecks and obstacles growth and development. It is not enough to support the development of firm-specific assets in the chosen cluster: demand, supporting and related industries, and conditions in the factor market need to be taken into account as well. Thirdly, there is a need to establish a broad foundation for the policy debate. It is not sufficient to delegate responsibility to any individual ministry: the main actors, including industry, universities, labor market organizations and other central players should be represented in the policy discussion. Fourthly, it is likely that an international perspective is necessary. There is probably no optimal solution regarding the design of a national innovation system, and there is a need for continuous reform as demand, technology, and competition changes. Benchmarking – explicit monitoring of competing systems and comparison against the best performers in various policy areas – is the only way to gauge the strength of any national system.

Although Finland's national innovation system has been remarkably successful during the past decades, it is also pressured by the continuous changes in the international business environment. The challenges for the near future are quite substantial, as outlined in STPC's current Review of the Finnish economy (STPC 2000):

- To enable the continuing growth of the Finnish ICT cluster, with particular emphasis on the supply of skilled workers.
- To transform the entire society (including social, cultural and other sectors) into a knowledge economy.
- To facilitate the growth of future clusters (to reduce the present dependence on the ICT cluster).
- To enhance the transfer and diffusion of new technology throughout society (to avoid creating gaps between modern and traditional sectors).
- To strengthen the science base, with particular emphasis on the financing of university research.

Given that the recent success of the Finnish economy is largely dependent on one individual company, Nokia, and that Nokia's success may be due more to good fortune than conscious public or corporate strategy, it might be appropriate to judge the true strength of the Finnish innovation systems against its ability to handle these challenges. The odds are better than for most other small economies.

3. SWEDEN: THE ROLE OF THE MACRO ENVIRONMENT

Unlike Finland and most other European countries, Sweden managed to stay out of the Second World War and got a head start in the post-war economic boom when the rest of continent struggled to reconstruct their economies. The Swedish boom lasted almost 30 years, with per capita incomes peaking in 1976. By that time, Sweden had climbed to the second position in the list of per capita incomes, after the US. The following two decades were less successful. Burdened by a growing public sector and weakening industrial performance, Sweden gradually lost competitiveness and slid to the 18th position in the international incomes league by 1993. There were several reasons for this decline – in particular, incomes were eroded by successive devaluations and growth was slowed down by the world's highest income tax rates. As a result of the unfavorable business environment in the late 1980s, Swedish MNCs concentrated their expansion to locations outside Sweden and began to move attractive jobs away from Swedish production sites. Yet, in terms of R&D and various indicators of human development, Sweden remained at the top of international comparisons, clearly demonstrating that high inputs in terms of research, education, and skills are not sufficient to guarantee growth and competitiveness.

The trough in Swedish development was hit in 1991-1993, when a severe financial crisis struck the economy. However, the development during the rest of the 1990s was remarkably favorable. Sweden regained much of its lost competitiveness, and the growth in production, exports, and incomes was exceptionally high. For instance, the export share of GDP grew from around 30 percent at the beginning of the decade to nearly 50 percent in 2000.

This chapter examines the shifts in Swedish competitiveness in a systems perspective. Given that the Swedish research environment has been among the world's strongest throughout the period in study, we are particularly concerned about other crucial determinants of the strength and competitiveness of the overall business environment. Hence, the following section looks at some of the reasons for the gradual weakening of Swedish competitiveness during the 1980s. Apart from the gradual appreciation of the real exchange rate, we argue that one of the main determinants was a policy environment geared in particular to the needs of the largest multinational enterprises. This was a problem for two reasons. Firstly, although the multinationals benefited in many ways from good R&D conditions in Sweden, they were also sensitive to the worsening macroeconomic environment. When Swedish cost competitiveness in advanced production diminished, they simply decided to move their expansion to other countries that could offer a more competitive environment. Secondly, the incentives for entrepreneurship were weak and small and medium sized enterprises were underrepresented in Sweden's industrial structure. However, small and medium sized enterprises have accounted for a large share of the growth recorded in most modern economies, in particular at times of rapid technological development.

The next section looks at the crisis and discusses the reform process that followed. While many of the reforms have been macroeconomic in nature – concerning inflation and government finances – there are also important microeconomic and structural reforms. The most important of these are related to Swedish EU membership. This led to increased competition in many markets that had previously been protected by various forms of non-tariff barriers, but it also opened up the EU market for Swedish producers. In addition, tax reform and increased investments in education and research have contributed to the improvement of the business climate. Still, unlike Finland, Sweden has not yet adopted any

cluster or national innovation system approach to economic policy, and the remaining weaknesses may therefore appear more serious.

The final section restates some of the main experiences and provides some lessons for developing countries.

3.1 FROM THE TOP TO THE MEDIOCRE

Although Sweden was ruled by left-wing governments during most of the post-war period, the country was never able to afford much of inward-orientation, public ownership, and state planning. Instead, productive efficiency and a liberal trade environment were important cornerstones of Swedish economic policies. In fact, until the early 1990s, the Swedish political climate and the country's economic policies were characterized by consensus and compromise between labor and big business. This unusual setting facilitated the internationalization and growth of Swedish industry in two ways. First, industrial policy supported growth with a strong bias in favor of large firms: given the limited size of the domestic market, the response of large firms was often to grow even larger by expanding foreign operations. Secondly, unlike labor unions in many other parts of the world, the Swedish labor movement did not oppose investment abroad by Swedish MNCs. The establishment of foreign affiliates was instead seen as a necessity to keep foreign competitors at stake.

In large economies like the United States or the United Kingdom, economic policy has been influenced by anti-trust ideas that stress competition in domestic factor and product markets. Small countries like Sweden can rarely afford that, because the domestic market can seldom accommodate a large number of efficient firms. Instead, the focus on market structure in the anti-trust tradition has been replaced by a focus on the efficient use of resources within the firm and structural efficiency, i.e. the efficiency of an entire industry structure. Achieving economies of scale has been more important than avoiding oligopolies - at the same time, free trade and competition from imports have been promoted to counterbalance the concentrated industry structure. Hence, Swedish industrial policy has stressed the importance of large firms that are able to survive in international competition (Hjalmarsson, 1991). The main policy instruments to achieve these goals have been tax policy, credit market regulations, and research and development (R&D) policy.

Before the Swedish tax system was reformed in 1991, it was obvious that large established corporations were supported by the tax system, at the expense of younger, smaller, and less capital-intensive enterprises (Mutén, 1968). Until about 1990, the formal corporate tax rates were quite high, between 50 and 62 per cent, but there was a large gap between formal and effective rates. The reason was that generous deductions and allowances could be made for investment in machinery, equipment, and inventories, and untaxed profits could be put aside in special investment funds for future use. The main beneficiaries were capital-intensive firms that could make large allowances, and large diversified companies that could cross-subsidize loss-making activities at very low real cost. At the same time, dividends distributed to shareholders were taxed at extremely high marginal rates. This provided another motive for successful companies to grow larger: profits distributed to shareholders would be taxed twice (once as company profit and once as the shareholder's personal income) whereas profits used for investment or to acquire a small competitor would be taxed once or often not at all. Even the shareholders approved, since the increase in the value of their shares was typically larger than the dividend net of taxes (Mutén, 1968 and Davis and Henrekson, 1995).

The regulation of the Swedish credit market also favored big business at the expense of small firms. During the whole post-war period, until the end of the 1980s, the Swedish credit market was highly regulated. The development of the welfare state meant that much credit was channeled to the public sector. Housing and construction were also priority sectors, with guaranteed access to funds and subsidized interest rates. However, lending to industry and commerce was often subject to quantitative restrictions, because the priority sectors absorbed much of the available funds and because interest rates were regulated. With this type of restrictions, it was inevitable that commercial banks directed most of their lending to the larger, older, and more successful companies, and to capital-intensive firms that could easily provide collateral (Davis and Henrekson, 1995).

Moreover, various measures were undertaken to encourage Swedish industry to increase its spending on research and development, particularly after 1967, when the Ministry of Industry was created. For example, tax incentives were introduced that allowed companies to make extra deductions for the costs of R&D and various government funds were created to encourage the build-up of competence in enterprises. In 1968, the National Board of Technical Development (STU) was created to support technical research projects, co-operative research, and industrial development. Several areas, like space technology, energy research, and micro-electronics, have received special attention during different times. Partly as a result of the public sector support to industry research, the R&D intensity of Swedish industry grew to among the world's highest already in the 1960s.

It is mainly big business that benefits from these policies, since R&D are activities with very distinct economies of scale. Of the aggregate industrial R&D undertaken in Sweden in the early 1990s, 80 percent was allocated to four product fields. Three of these fields – transport equipment, electro-technical products, and pharmaceuticals – were dominated by six company groups (NUTEK, 1994).

Another channel for Swedish industrial policy has been the direct contacts between the government and leading industrial corporations. In several advanced sectors, such as infrastructure and telecommunications, the government has been the major Swedish customer, and has taken an active role in product and technology development. MNCs like Ericsson (telecommunications) and ASEA (power plants and high-speed trains) have benefited from this type of interaction, and they have subsequently been able to market the technological innovations abroad, both through direct exports and foreign production. In fact, referring back to the discussion about *national innovation systems* in the chapter on Finland, it can be argued that Sweden had a variant of such a system during the post-war decades (before anybody talked about national innovation systems). Thanks to the intimate relations between the main actors in the national economy, information was exchanged continuously, and consensus solutions could be sought more easily than in other countries where relations between labor, capital, and government are more distant.

Thus, it is clear that Swedish industrial policies supported the development of a highly concentrated industry structure, with large, efficient firms that devoted considerable resources to R&D. These industry and firm characteristics were also strong determinants of the high level of internationalization of Swedish industry. Concentrated domestic markets provide important motives to expand operations abroad (Hymer, 1976). To become and to remain a successful MNC, the candidate must also possess some firm-specific competitive asset, such as technology, that allows it to survive in tough foreign markets.

3.2 CRISIS AND RECOVERY

By 1992, it had become clear to most observers that the "Swedish Model" was no longer sustainable. The collapse that occurred during that year was hard to accept for many Swedish observers, who had grown accustomed to thinking of Sweden as the leading welfare state. Yet, the macroeconomic mistakes made during the 1980s had weakened industrial competitiveness, with a growing current account deficit as the most obvious sign of the imbalances. The gradual outsourcing of attractive jobs by the Swedish MNCs was another clear indication of the state of affairs, although the full picture was still unknown to most. One reason for the lack of more substantial warning signs was that demand had been kept high. In the private sector, tax rules promoted borrowing – all interest expenses could be deducted from taxable income – and the public sector savings started falling as expenditures were maintained in spite of stagnating tax revenue. The five related crises that hit the Swedish economy in rapid succession in 1992-93 shed all doubts and exposed the weaknesses of the economy.

Firstly, there was a collapse of the Swedish real estate market. Real estate prices had risen continuously for a period of 15 years, to a peak that was reached in 1989. Over the following five years, property prices fell by 75 per cent. *Secondly*, the stock market bubble burst. Between 1980 and 1989, prices on the Stockholm Stock Exchange rose by 1,144 percent, compared with a world average of 333 percent. Over the next three years, the index fell by 50 percent. *Thirdly*, the financial market went into deep crisis. Weighed down by substantial credit losses from bad loans on real estate and for share purchases, three out of the five major banks went bankrupt and 200 of the 300 finance companies disappeared from the market. Total credit losses during the period 1990-1993 are estimated at roughly 10 percent of GDP. *Fourthly*, there was a currency crisis. The fixed exchange rate, which was seen as an anchor for Swedish economic policy, could no longer be maintained, given that overheating and the financial crisis had weakened the economy. Despite the stubborn defence of the *Krona* - with short-term interest rates reaching 500 percent, several crisis packages intended to strengthen Sweden's international competitiveness, and the commitment of around USD 30 billion in defence of the currency, the Swedish Central Bank was forced to abandon the fixed rate for the *Krona* on November 19 1992. Over the next few months, the floating *Krona* fell by 40 percent against the US dollar.

The *fifth* part was a crisis in the real economy and in government finances. The banking crisis led to a tougher credit policy, with higher interest rates and stricter requirements for collateral. At the same time, the collapse in asset values led to a reduction in private consumption and a reduced willingness to invest on the part of companies. For example, the level of industrial investment halved between 1989 and 1993. The result was a fall in total demand on the domestic market, with a consequent reduction in the demand for labor. The stimulus from the export sector, which benefited from the devaluation, was not sufficient to "restart" domestic demand for several years. Open unemployment rose from 1.1 percent in June 1990 to 9 percent three years later, and real GDP fell every year during the period 1991-1993, by six percent in all. This led in turn to problems with government finances. The rapid growth in unemployment raised public spending, at the same time as tax receipts fell. At its peak, during 1994, the Swedish public sector's budget deficit had grown to almost 12 per cent of GDP.

With an economy falling apart and a bankrupt financial sector, it was clear that something radically new had to be implemented. The banking sector came to play a central role for the recovery, just as it had been the center of the crisis. All the large Swedish banks were burdened by heavy losses. The loss of foreign credits not only led to a weakening of the *Krona* when the inflow of foreign currency slowed, but it also threatened the liquidity of the financial system. In September 1992, therefore, the government introduced a bank guarantee that meant that all creditors - apart from shareholders - were protected against loss. A special Bank Support Board was established to administer the guarantee. The aim was to avoid a liquidity crisis - Central Bank used a great part of its foreign exchange reserves for deposits in the banks - and to maintain or restore confidence in the Swedish banking system. For this latter aim, transparent accounting of problem loans was particularly important.

The recovery of the financial system was surprisingly quick. After 1993, no new commitments were made by the government, and the banking sector as a whole showed a profit as early as 1994. One reason was that the banks' interest margins rose substantially. Other important reasons were that the tight economic policy caused real interest rates to fall and that an upturn in the international economic situation contributed to an expansion in the export sector. Most important, however, was that the restructuring of the banking system was both rapid and radical. In the Swedish debate, it has been suggested that the emergency treatment and aftercare given to cure the Swedish crisis were comparatively successful for four reasons:

- Firstly, a political consensus was created around a broad solution to the crisis.
- Secondly, the authorities encouraged the greatest possible openness about the problems and the financial situation of the individual banks.
- Thirdly, bad loans and property values were entered in the accounts in an open and transparent way, and the banks and finance companies that were not likely to recover from the credit losses were liquidated.
- Fourthly, bad loans were transferred to special companies, but at realistic market values.

The reforms in the financial sector were accompanied by comprehensive reforms in other parts of the economy as well. One important determinant of the sweeping reforms undertaken in the aftermath of the crisis was the “window of opportunity” provided by the crisis itself. Up until the crisis, reforms were difficult because of the opposition from various interest groups to any changes in *status quo*. In fact, the interest groups were so well organized and their relative positions so well defined that Sweden was sometimes referred to as *corporativist* society. However, with a clear crisis sentiment in society, no individual interest groups had the strength to oppose what was clearly necessary reform. Another important explanation was external pressure. In the short run, it was important to reform the financial system to keep up the inflows of foreign capital, which had become essential during the deficit years of the late 1980s. In the medium term, the toughest pressure was exerted by the EU. Sweden had applied for membership in the midst of the financial crisis, and membership required that the convergence criteria be fulfilled. The most important of these was the demand for balanced public finances. With an upper limit on government spending, it was easier to resist the calls for compensation from all the interest groups that lost some their privileges in connection with the reforms.

Looking at the many changes in the Swedish business environment since the early 1990s – including both the institutional setting and the supply and demand conditions in important factor markets – there is reason to single out five separate areas: macroeconomic conditions, the labor market, taxation, education, and R&D.

The key reform area has arguably been the overall macroeconomic environment. As we noted earlier, the late 1980s marked the peak of the Swedish bubble economy, with full employment, high asset prices, and high inflation. The combination of an inflation rate that was higher than that in the rest of Europe and an exchange rate fixed to the ERM was rapidly eroding Swedish export competitiveness. Sweden had no intention to join the European Community, which was busy establishing the Single European Market. In this environment, it was difficult and expensive to expand Swedish production, and the position outside the Single Market raised fears about Fortress Europe. Foreign locations were the only viable alternatives for many new ventures, not only because production costs were lower and fixed assets were cheaper than in Sweden, but also because locations in the 12 EC countries could guarantee access to the European market. The boom in Swedish outward investment, mainly in the EC region, appeared to be a rational reaction to differences in production conditions.

The situation changed dramatically with the financial and currency crisis. For instance unemployment increased from less than two percent to well over 10 percent in less than two years. This improved the opportunities to find attractive employees as well as the possibilities to avoid rapid wage increases for several years. The fixed exchange rate was abandoned, and the currency was allowed to float. It quickly depreciated by some 25 percent against the German Mark and 40 percent against the US dollar, and restored export competitiveness. Price stability became the new dominant objective in macroeconomic management, and was quickly achieved: annual inflation was kept below two percent in spite of the increase in import prices. The new macroeconomic regime simply provided a better investment climate, and it is likely that this explains much of the differences in the production decisions of Swedish MNCs between the late 1980s and the mid-1990s.

The situation remains favorable in terms of macroeconomic conditions. However, the reduction in unemployment that has been achieved in recent years, and the slow increase in the rate of wage inflation suggests that some institutional reform in the labor market may be needed if Sweden is to remain competitive in the long run. Two issues appear particularly important. Firstly, it is important to maintain a low level of equilibrium unemployment. This reduces the pressure on the government budget, and facilitates future reductions of the overall tax burden, which is significantly heavier than in most other European countries. Secondly, a high degree of flexibility is needed to facilitate the adjustment to a changing international environment. This is particularly important, since it is not possible to actively use the exchange rate as an instrument of adjustment. The Krona is floating, and the scope for intervention is very limited: with possible future membership in the European Monetary Union, exchange rate changes will be ruled out per definition.

It is likely that roughly the same reforms are needed to achieve both low equilibrium unemployment and higher labor market flexibility. Calmfors and Holmlund (1999) point to a number of specific reform requirements: lower compensation levels and shorter compensation periods in the unemployment insurance, clear links between the overall level of unemployment and the contributions to the insurance system, investments in tertiary education as well as adult education, and reductions in personal income taxes. In addition, Blomström (1999) calls for larger wage dispersion and less ”solidarity” in wage negotiations. He argues that wage increases for key personnel or even individual experts often lead to demands for wage increases throughout the organization, because of the egalitarian Swedish traditions. This feeds wage inflation, and tends to raise the costs for high-tech investments in Sweden.

Apart from the overall macroeconomic environment and the tight labor market, it is possible to point to several other factors that reduced the attractiveness of Sweden as an investment location in the late 1980s. Taxation is one such area. Regarding corporate taxes, it should be noted that Sweden now compares favorably with most OECD countries. The nominal corporate tax rate, at 28 percent, is relatively low in an international comparison, but it should be noted that effective taxation of corporate profits is even lower. After various deductions, Swedish firms pay an average profit tax of 14 percent, to be compared with effective tax rates in e.g. the U.S. and France of over 30 percent. Swedish MNCs on average pay less than 10 percent, which clearly shows that high corporate taxes do not contribute much to making Sweden unattractive for modern industry (Strandell 1999).

The aggregate tax burden, and in particular the taxation of personal income and wealth, however, has been higher in Sweden than in most other countries. Before a radical tax reform around 1991, high-income earners typically faced marginal income tax rates exceeding 70 percent. The heavy taxation of personal incomes arguably had a significant impact on the corporate sector. For instance, high Swedish income taxes have been identified as major motives for the relocation of various advanced functions to foreign affiliates. These relocations have allowed many Swedish key employees to move to the foreign affiliates, where they have benefited from very large increases in net incomes thanks to lower foreign income taxes (Braunerhjelm och Lindqvist 1999). It is also clear that several foreign investment projects have been motivated by the shortage of skilled professionals in Sweden: the high and progressive income taxes reduced the return to education, and contributed to relatively low enrolment rates in tertiary education, particularly technical universities. Moreover, several large family controlled MNCs have chosen to relocate their headquarters abroad in order to facilitate the transfer of ownership to younger generations, which is difficult in Sweden because of high inheritance taxes – Tetra Pak and IKEA are the prime examples. It is likely that the 1991 income tax reform, which reduced the highest marginal income tax rates to 50 percent (subsequently raised to 55 percent), contributed to an improvement in the Swedish business climate for advanced manufacturing operations. Further reductions are probably necessary to improve the possibilities to compete for MNC investments in the future (Blomström 1999).

The area where the shortcomings in the Swedish business environment were perhaps most notable in the early 1990s was higher education. In comparison with other OECD countries, Swedish manufacturing exhibited a low ratio of professionals with tertiary education to total employment, partly because the public sector had absorbed a high share of the educated labor force. In particular, there was a lack of employees with higher technical, mathematical, and scientific education among the younger cohorts, aged 25-34 years (NUTEK 1999). The reason was mainly the low return to higher education because of the progressive income taxes, in combination with limited public investment in qualified university programs. In fact, Björklund (1999) reports that the return to education fell between the late 1960s and the 1980s. In the 1960s, an extra year of higher education led to an average increase in hourly earnings (for men) of 9 percent. Two decades later, this figure had fallen by half. Moreover, public investments were biased towards primary and secondary education rather than higher academic programs. It has often been pointed out that the costs per child in the public day care system were several times larger than the costs for an average university student.

Internationalization has already led to significant reforms in the educational system. In particular, investments have been made to expand small and medium-sized regional

universities and colleges, and the great majority of unemployed people have been retrained in various adult education programs. Although these measures have undoubtedly had some beneficial impact, it is not likely that their full effect has materialized yet. Yet, there is reason to doubt whether an expansion of the public education system will be sufficient to strengthen the human capital base of Swedish industry. It is unlikely that increasing the capacity of universities and colleges will automatically create the right mix of skills and capacities. Instead, it is imperative to improve the incentives for young people considering enrolling in demanding higher education programs. Higher returns to education - through higher wages for qualified professionals - should be preferred before increases in subsidies to students: one of the main objectives is to allow demand conditions to influence the return to education.

In this context, it is also necessary to comment of the high Swedish investments in research and development (R&D). Total Swedish R&D investments have been very high for several decades, and Swedish MNCs belong to the most R&D intensive companies in the global market. There is an obvious contradiction between these massive R&D investments, and the relative shortage of highly skilled professionals in industry (and the bias towards low-wage jobs during the late 1980s). A possible explanation is offered by Jakobsson (1999), who argues that R&D and other strategic company functions are concetrated to Sweden for historical reasons. It is tradition rather than superior conditions for advanced R&D that has explained the decision to continue using Sweden as the R&D base of Swedish MNCs. Moreover, Jakobsson points out that these investments are not equally distributed across firms, but that the four leading MNCs account for two-thirds of total R&D in manufacturing. His conclusion is that the exceptional position of Sweden is not likely to survive in the future, unless the conditions for high-tech operations are improved.

Another paradox related to Swedish R&D is the weak export performance in advanced industries. The returns to R&D in the form of growth or development of high-tech production have been considered disappointing. The reasons for this have been examined in a number of studies. The studies receiving most attention to date of Sweden's low return from R&D have focused on the character of the R&D activities that have been undertaken. For example, OECD (1986) claimed that Swedish research has been relatively ineffective and has not focused enough on high-tech industry. It has also been claimed that an excessive share of Swedish R&D has been devoted to rationalizing the production of low-tech and medium-tech products, such as paper and pulp, and to other activities that do not generate high-tech production and exports, e.g. housing and energy research (Blomström et al. 1990). A further explanation for the low technology content of Swedish exports is based on the "technical balance of trade". According to a government committee analyzing economic growth issues (the "Swedish Productivity Delegation"), the fact that Sweden is a net exporter of licenses, patents and "know-how" suggests that Sweden's exports are more high-tech than they may seem from studying the normal trade statistics (SOU 1991:82).

One common element linking all of these explanations for the Swedish "R&D enigma" is the view that as long as companies' research is successful (in the sense that it generates new, high-tech products), then Sweden's high-tech production should increase (given than production rights, for example in the form of licenses, are not sold abroad). However, it is clear that there is no immediate correlation between the two. We have argued above that competitive assets such as research results, which are transferable within a firm over national borders, and which can be utilized for production both in the home country and abroad, cannot guarantee the long-term competitiveness of the home country. A few decades ago, it could be expected that successful MNCs would locate a large share of their advanced and

strategic operations in the home country. Various natural and man-made trade barriers made it relatively expensive to extend the production chain across international boundaries and long geographic distances, and contributed to a concentration of activities in the home country. This is no longer the case. MNCs will consider several alternative locations for all of the individual links in their production chain, and the home country will be chosen only when the production conditions in the home country are at least as favorable as the conditions elsewhere. In other words, it is becoming increasingly important for the home country to be able to offer an attractive and competitive business environment.

3.3 LESSONS FROM SWEDEN

The Swedish experiences provide at least three interesting lessons for growth and innovation policies. The *first* is that competitiveness requires flexibility. Sweden had a very competitive system for a long period after the Second World War and grew very fast, but the policy environment was designed to benefit a small number of large actors at the expense of domestic heterogeneity, competition, and entrepreneurship. The concentration of economic power in the hands of government, labor unions, and a small number of large multinational companies created an environment where the distribution of profits overtook growth as the main objective, and where costs increased rapidly since no party was interested in disruptive conflicts. Despite the fact that this was obvious already in the mid-1970s, no change in the overall policy environment took place until the early 1990s. Various interest groups wanted to keep the system intact, with detrimental effects on long run growth.

The *second* lesson is that globalization has made governments more and more dependent on the international environment. The business environment is no longer assessed on the basis of its absolute merits alone, but rather in comparison with other economies. The liberalization of international trade and investment, together with advances in telecommunications and information technology, have made it possible for MNCs to divide their production chain into several individual components that can be located in different countries. By setting up international production that exploit the comparative advantages of several countries, firms can maximize their efficiency. They may also force governments to adjust to the competition between alternative locations, and create a more favorable business environment. Sweden is probably the best example of that. The stagnant Swedish model survived as long as multinational corporations were still tied to their home country by various restrictions on the international mobility of goods, services, capital, and labor. As these restrictions were reduced, in some cases at the regional rather than the global level, the high costs and other weaknesses of the Swedish model became critical, and motivated firms to move attractive jobs out of the country. This, in turn, forced the government to start reforming the system.

The *third* lesson from the Swedish experience concerns the opportunities for change. Although many of the weaknesses of the Swedish model were well known and widely discussed for many years, nothing happened until the financial crisis interrupted the fixed positions between various interest groups. Many of the reforms introduced in the wake of the crisis would not have been politically viable only a few years earlier. The point to note is that crises provide rare opportunities for reforms in societies with strong established interest groups. Continuous monitoring of an economy's relative strengths and weaknesses is particularly important at these times: the economies that have a ready-made blueprint for reform are clearly in a stronger position than countries where the reform agenda must be decided in the turbulent environment following the crisis.

4. SINGAPORE: FROM STAPLE PORT TO KNOWLEDGE HUB

Singapore's economic development since independence in 1965 has been remarkable, with an average annual economic growth rate of around eight percent (Table 4.1). As a result of the high growth rate, per capita income doubled between 1960 and 1970, more than tripled between 1970 and 1980, and increased four-fold between 1990 and 2000. By the late 1990s, Singapore's real per capita income level matched that of most EU countries.

The high growth was fuelled and accompanied by large structural changes of the economy. From being a staple port during the colonial days, the city-state rapidly transformed into a base for labor intensive manufacturing that was gradually upgraded to increasingly higher value added production, and eventually into a location for regional headquarter services of foreign multinational companies as well as a financial center. Moreover, from having benefited from an inflow of technology from abroad, Singapore has in recent years invested substantial resources to increase indigenous technology development.

The rapid growth and transformation of Singapore can only be matched by the other Newly Industrialized Economies (NICs). Although the NIC countries share some characteristics, such as strong export orientation, Singapore's development has some unique characteristics. Most importantly, Singapore has relied to a great extent on large inflows of foreign MNCs rather than on indigenous companies. For instance, about 75 percent of Singapore's manufacturing output and 80 percent of exports are from foreign MNCs. Accordingly, large parts of the service sector, such as financial services, hotels, and transports, are mainly foreign owned.

Another key feature of Singapore's economic development has been its strong reliance on international markets. Unlike many other countries at the time of independence, Singapore chose to industrialize through export orientation rather than through import substitution. Exports today amount to an astonishing 200 percent of GDP.

Singapore's economic history is also one of massive government intervention. The city-state is often described as "corporate Singapore", run by a number of highly qualified technocrats. These technocrats belong to the PAP government and intervene in the economy by allocating resources into sectors that are believed to have a high growth potential, by facilitating and closely regulating skill formation, and by providing various institutions that support a constant upgrading of production.

Singapore's development raises a number of questions that are addressed in this chapter. For instance, why did Singapore rely on FDI and how did it manage to attract such large inflows? The constant upgrading of the MNCs production raises questions about economic policies and incentives: how does a country encourage foreign MNCs to contribute to technological and economic upgrading of the local economy? Finally, large government involvement has been present in many developing countries, but often without any positive impact on economic development. Why did the Singaporean government transform into a highly successful "developmental state"?

The chapter is structured around a chronological description of Singapore's economic development, with special emphasis on the roles played by international trade, FDI, and

government intervention. The first section includes a description of the early industrialization after independence. Thereafter, we look at why and how Singapore started to upgrade its economic activities in the 1980s. Finally, we discuss the last decade's efforts to transform Singapore into a "knowledge-based economy".

Table 4.1 Economic growth in Singapore 1960-2000.

	1960-70	1970-80	1980-90	1990-2000
GDP average annual real growth (%)	8.7	9.4	7.5	8.4
	1960	1970	1980	1990
GNP per capita (current prices Singapore dollars)	1,330	2,825	9,941	42,212

Source: Yearbook of Statistics Singapore (various issues).

4.1 THE INDUSTRIAL KICK-OFF

Singapore gained independence in 1965 after two years of troublesome efforts to coexist in a union with Malaysia. The main reason for the split with Malaysia was the difficulties in achieving an acceptable balance of power between the predominantly Malay Peninsula and the Chinese Singapore. The new nation faced great challenges, but was also better equipped for economic development than many other new nations (Huff 1995:1422). On the positive side, Singapore was relatively affluent; it was the only country in Southeast Asia with a substantial middle class and poverty was less of a problem than in other parts of the region (Huff 1994). Moreover, Singapore had a reasonable human capital base, a well-trained bureaucracy, and good institutions. Moreover, Singapore had for a long time been the prime location for trade with and within Southeast Asia; the large deepwater port, the efficient administration, and the strategic location in the middle of the Malay Archipelago made it the favorite choice for traders.

Despite these advantages, the country faced a number of economic and political challenges in the early years of independence. Firstly, the split with Malaysia made Singapore lose most of its domestic market. The problem was aggravated by the confrontation with Indonesia under President Sukarno. Indonesia has always been of prime importance for Singapore's trade and the confrontation had therefore a severe negative effect on the economy. Secondly, Singapore was rocked by domestic political conflicts between what was sometimes described as Chinese nationalist groups and groups lead by the British-educated Singaporean elite. Another major concern was the high rate of unemployment. About 9 percent of the population was unemployed at the time of independence, but the problem was getting worse every year because of a rapidly growing labor force – the population growth rate was one of the highest in the world. The problem with unemployment was worsened with the British withdrawal of their armed forces in 1968. The British military expenditures in Singapore were of great importance – roughly 16 percent of GDP and 20 percent of employment.

Hence, the main challenges that faced the independent nation were to achieve political stability, to find an alternative to the Malaysian (and Indonesian) market, and to generate rapid employment and economic growth. These challenges all interacted to shape the policy choices of the new government.

The lack of a sizable domestic market, together with the asset of being the prime location for trade in the region, convinced Singapore to abandon an initial attempt of import substituting industrialization. Singapore became instead one of the very first developing countries to

attempt the path of export orientation, aiming to overcome the constraint of a small domestic market and to supply the world with labor intensive manufactures. The question was who the industrialists were that should provide the export? The early years witnessed a struggle for power between on the one hand the PAP under Lee Kuan Yew and on the other hand leftist and Chinese nationalists groups. Lee Kuan Yew managed to secure power by a combination of repression against political opponents and measures to win over substantial parts of the Chinese community. However, a large part of the local Chinese business community opposed the PAP, partly due to PAP's strong British-educated elite. The PAP was therefore reluctant to rely on the domestic business community after it secured power. Instead, a deliberate effort to attract FDI was launched (Huff 1994). One additional advantage with FDI was the perceived notion that the impact on growth and employment would be faster if foreign firms stood for the increases in production, since these firms were already hooked up to the world market. It would arguably have taken longer time for domestic entrepreneurs to gain access to foreign markets, since they would have had to learn about foreign preferences, distribution systems, and regulatory frameworks.

Moreover, many of the trade unions were political opponents to the PAP. The government's response was to jail some of the leaders and to eventually close down the existing unions in order to set up a new one that was closely controlled by the PAP. By distancing itself from the domestic business community, and from the labor movement, the government became autonomous from two of the strongest domestic interest groups. This autonomy was crucial in the subsequent development of Singapore, since it enabled the government to make policy decisions that would typically be difficult in many other countries where labor and business interests are more directly involved in the decision-making process. The main constraint on the government was instead the need to provide rapid growth of incomes and employment to avoid protests from the broad masses of the population. The situation has sometimes been described as an implicit contract between the population and the government where (most) of the former accepted restrictions on their personal freedom in return for economic progress and income growth. In any case, it is clear that the government has been very focused on economic growth and see this growth as a way to legitimize its hold on political power.

The strategy to rely on foreign MNCs was fortunate by its good timing, since it coincided with an increased interest among electronics firms to located labor intensive parts of production outside their home countries. Two of the first firms to outsource production to Singapore were Texas Instruments and National Semiconductors, who entered the economy already in the1960s. Their choice was determined by several factors, such as the uncertainty of locating on Taiwan, Hong Kong, or Korea, which were though to be too close to an unstable China. There were also strong government incentives to locate in Singapore. The entrance of Texas instruments and National Semiconductors was soon followed by a large inflow of other MNCs, many in the electronics sector, which developed into the most important part of manufacturing.

The main difficulty in the early attempts to attract FDI inflows was the relatively high costs of production in Singapore (Huff 1995:1424). Labor costs were roughly 20 percent too high to compete on the world market with labor intensive manufactures. The government changed this by taking firm control of wages and labor in 1967-68 with a new labor legislation, which transferred bargaining power from workers to employers (Lim and Pang 1986:11). The reform was possible because of the neutralization of the independent old trade unions, and the changes led to a substantial improvement in cost competitiveness. For instance, productivity levels in the electronic assembly industries were as high in Singapore as in Hong Kong, South

Korea, or Taiwan, but wages were lower. The annual wage increases were from 1972 and onwards decided by the National Wage Council, which was controlled by the government and the employers. The wages increased more slowly in Singapore than in its main competitors throughout the 1970s, which together with the total absence of strikes and the political stability was part of the country's attraction for foreign MNCs.

Table 4.2. Spending on FDI Promotion (1999).

	Annual FDI promotion (US$ million)	Population (million)	Per Capital Budget (US$)
Ireland (IDA, including grants)	213	3.7	57.6
Ireland (IDA, excluding grants)	41	3.7	11.2
Singapore (EDB)	45	3.2	14.1
Costa Rica (CINDE)	11	3.5	3.1
Mauritius (Exp. and Dev. Inv. Authority, 1996)	3.1	1.2	2.6
Dominican Republic (IPC)	8.8	8.4	1.05
Malaysia (MIDA)	15	22.7	0.66
Zimbabwe (ZIC, 1996)	1.2	11.9	0.10
Philippines (BOI)	3	76.8	0.04
Indonesia (BKPM)	2.8	207	0.01

Source: Te Velde (2001).

Other factors than labor costs were also important in Singapore's success to attract FDI. More specifically, MNCs were offered tax exemptions, subsidies, help with building factories or finding suitable land, and training programs for employees. The policies were engineered by the Economic Development Board (EDB) and were highly successful. One of the main characteristics of the EDB was the large budget that it had at its control, over four percent of GDP a few years after its establishment in 1959 (Te Velde 2001). It also had relatively large discretion over the budget and could, for instance, attract high quality Singaporeans by paying very competitive salaries. The large spending on FDI promotion has continued, as seen in Table 4.2. Singapore spends substantially more on FDI promotion than other countries, with the exception of Ireland. For instance, Singapore's outlays on promotion are over 20 times higher on a per capita basis than neighboring Malaysia's, which is also a country that relies to a large extent on FDI inflows. Another strength of the EDB was that it worked closely with foreign MNCs that were represented in its advisory board. Hence, EDB had direct information from the MNCs on their preferences, business obstacles, and desired policy changes. Moreover, the efficient bureaucracy was handling FDI application with relative little red tape and with remarkable speed. For instance, Texas Instrument could start their production in Singapore only 50 days after their investment decision (Huff 1994:325). The rapid process of approving FDI is still much quicker in Singapore than in most other countries: it takes less than 3 weeks to get an investment approval in Singapore compared to, for instance, up to 30 weeks in Mauritius (Lall 2000). This speed in dealing with FDI applications is due to EDB's "one-stop shop" approach, where they deal with all aspects of FDI inflows, including promotion, screening, approval and obtaining permits from various other government institutions. Moreover, there are no restrictions on equity participation and most MNCs that locate in Singapore are 100 per cent foreign owned. Accordingly, there are no restrictions on

technology content, use of foreign personnel or suppliers, or any other form of restrictions of the types that are common in developing countries.

The inflow of foreign multinationals in labor intensive sectors managed to fuel rapid growth and to solve the unemployment problem by the early 1970s. Most of the expansion took place in the manufacturing sector which increased its share of GDP from around 15 percent in the early 1960s to about 30 percent in the late 1970s (Table 4.3). Moreover, manufactured exports increased from about 10 percent of GDP to almost 50 percent over the same period.

Table 4.3 Sector distribution of Singapore's GDP 1960-2000 (percent).

Industry	1960	1970	1980	1990	2000
Agriculture and Mining	3.9	2,7	1.5	0.4	0.1
Manufacturing	11.7	20.2	28.1	28.0	25.9
Utilities	2.4	2.6	2.1	1.9	1.7
Construction	3.5	6.8	6.2	5.4	6.0
Commerce	33.0	27.4	20.9	16.3	19.1
Transport and Communication	13.6	10.7	13.5	12.5	11.1
Financial and Business Services	14.4	16.7	18.9	25.5	25.3
Other Services	17.6	12.9	8.7	9.9	10.9
Total	100	100	100	100	100

Source: Yearbook of Statistics Singapore (various issues).

Although the initial efforts to industrialize through inflows of foreign MNCs took place in labor intensive sectors, there were soon demands for an upgrading of various skills in the economy. For instance, even if the processes were labor intensive, there was a need for technicians and engineers to supervise production. Such skills were in severe shortage in the 1960s, but the government responded quickly by setting up an engineering faculty in 1964 and by increasing the enrolment in polytechnics. One cannot, however, say that there was a general emphasis on higher education in Singapore. On the contrary, there was a concern about possible unemployment of white-collar workers in case of a general, rather than a directed, expansion of higher education, a problem that was present in many other developing countries. As a result, the focus of the educational system was in particular to supply a literate labor force with a reasonable knowledge in basic numeracy. There was also a focus in higher education on supplying skilled technicians and, eventually, engineers, whereas higher education in arts and social sciences were deliberately restricted. In addition, special training institutions that focused on practical skill development were set up, often with the assistance of foreign governments. Another effort by the government was to improve the understanding and use of English. In the late 1950s, more Singaporeans were literate and educated in Chinese than in English. Moreover, many Singaporeans spoke various dialects such as Hokkien, Hakka, and Cantonese, rather than Mandarin, which was an additional obstacle in inter-personal communication. The government decided to change the school curriculum and forced through the use of English as the sole language in teaching. The reforms had presumably initial negative effects on the educational standard, since they meant that most Singaporeans were taught in a language other than the one they spoke at home, but it also meant that there was soon a large pool of workers that understood and spoke English. This was, of course, valuable for foreign MNCs and gave Singapore a competitive edge over many other countries in East Asia.

4.2 MOVING UP THE QUALITY-LADDER

The rapid growth of the economy led to upward pressure on wages. The National Wage Council tried to keep wage increases in check and, the employers typically followed the non-mandatory recommendations from the Council. Still, the rapid employment generation in the manufacturing sector started to give rise to labor shortages, an increasingly less willing attitude among private employers to follow the guidelines, and therefore increasing upward pressure on wages. In 1975, the actual wage increases were almost seven percentage points lower than the ones recommended by the National Wage Council. In 1984, the actual wage increases were instead more than four percentage points higher than the recommended ones (Lee 1987). The problem was aggravated by the sharp fall in inflation, which meant that real labor costs increased by more than 10 percent annually between 1979 and 1984. Average labor costs had then increased to a level that was 57 percent higher than in South Korea and also higher than in the other NIC countries (Krause 1987).

In addition, the success of Singapore and the fall of prices on oil and other raw-materials encouraged neighboring countries like Malaysia, Thailand, and Indonesia to liberalize their economies in the 1980s. Singapore benefited from this liberalization, because it was the dominating trade hub in the region. On the other hand, the liberalizing economies soon became strong exporters of labor intensive goods. Hence, the competitive pressure on Singapore's production and export intensified. The situation deteriorated and resulted in an economic recession in 1985-86, which was the first time Singapore experienced negative growth rates since 1964. The crisis made it clear that the country needed to upgrade its production and start producing goods and services of higher value added that would allow for relative high wage levels.

The upgrading took place on three different levels. Firstly, there was a focus on improving the technological content of manufacturing production in Singapore. Secondly, there were efforts to outsource labor intensive parts of the production chain to Malaysia (Johor) and Indonesia (Batam) but to keep more skill and capital intensive parts in Singapore. Finally, there was a deliberate effort to strengthen the service sector.

The upgrading and technological improvement of Singapore's production required new skill formation, in which the government played an active role in. For instance, EDB introduced a program called LIUP (Local Industry Upgrading Program) in the early 1980s, where it selected a few local supply industries that were described as pivotal for the upgrading of activities in the foreign MNCs. EDB then provided financial assistance to the MNCs for training of the local firms' workers. Hence, the government financed the project but decided to leave the training to the MNCs, rather than setting up own training centers and schools. One reason was that the required skills could differ substantial between sectors and even firms, and it was viewed as difficult for the bureaucracy, without own experiences of manufacturing, to work out appropriate training programs. The direct participation of MNCs in the project, including firms like ABB, Philips, and Seiko, and foreign industrial training institutes, such as French Electrical Industry Federation and the German Agency for Technical Cooperation, guaranteed that the right sorts of skills were developed. It should be noted that the overall importance of local firms in Singapore's manufacturing sector did not increase despite the efforts to support local suppliers. As seen in Table 4.4**,** wholly domestically owned firms constituted only about 16 percent of value added and 8 percent of exports in 1990. The local share of value added was actually lower than in 1980 before the

LIUP program. This decrease in the relative size of the local sector was partly due to the success of the program, since it made existing MNCs upgrade their production and thereby value added, and it also helped to attract new MNCs in relatively skill-intensive industries.

Table 4.4 Singapore Manufacturing by Ownership (1968-1990).

	Establish-ments No. and %	Workers No. and %	Output $m and %	Value Added $m and %	Direct Export $m and %	Capital Expendi-tures $m and %
1968						
Total	**1,586**	**74,833**	**2,175.7**	**611.8**		**89.6**
Wholly local	80.5	58.7	41.1	40.8		33.2
Major. local	7.8	15.1	12.8	15.2	n.a.	24.3
Majority for.	11.7	26.2	46.1	44.0		42.5
1975						
Total	**2,385**	**191,528**	**12,610.1**	**3,411.1**	**7,200.7**	**622.6**
Wholly local	66.9	32.8	18.0	24.3	8.9	20.7
Major. local	11.1	15.2	10.7	13.0	7.0	14.7
Majority for.	22.0	52.0	71.3	62.7	84.1	64.6
1980						
Total	**3,355**	**285,250**	**31,657.9**	**8,521.9**	**19,172.9**	**1,861.9**
Wholly local	64.2	28.2	15.6	19.1	7.1	14.2
Major. local	11.0	13.4	10.7	13.5	8.2	11.2
Majority for.	24.8	58.4	73.7	67.4	84.7	74.6
1990						
Total	**3,703**	**351,674**	**71,333.2**	**21,606.8**	**46,999.5**	**4,184.4**
Wholly local	67.7	29.0	15.1	16.4	7.8	17.8
Major. local	8.9	12.0	9.0	10.9	6.4	11.5
Majority for.	23.4	59.0	75.9	72.7	85.8	70.7

Source: Huff (1994), Table 11.11.

The government also pursued various educational reforms. For instance, the National University of Singapore was established in 1980 by merging the University of Singapore and Nanyang University. This move enabled the government to eliminate one of the last main pockets of opposition against the PAP regime, which was in the Chinese founded Nanyang University. Nanyang was instead transformed into a technological institute in 1981 and there were also two new polytechnics set up during the next decade. This amounted to a very substantial increase in the capacity to train technicians and engineers. The enrolment in the university system more than doubled, from 9,200 students in 1980 to 24,300 in 1990, and the enrolment in polytechnics nearly tripled, from 9,900 to 29,500 students (Lee 1992).

The provision of a more skilled and educated labor force was accompanied by fiscal incentives for the MNCs to locate high value added production in Singapore. For instance, the EDB wanted the foreign MNCs to locate their regional headquarters in Singapore since it was widely perceived that this would not only be beneficial for growth and incomes, but also because this type of activity was presumably less footloose than simple assembly activities.

Therefore, MNCs could be offered Operational Headquarters status and a concessionary tax rate of 10 percent if they made Singapore their regional headquarter. There were also additional tax reductions for foreign firms in international trading or oil trading activities (Lee 1992:39).

The outsourcing of labor intensive parts of the production chain took two different forms. Firstly, there was a continuation of the historically strong links with the southern Malaysian state of Johor. The integration was improved by infrastructure improvements on both sides of the border, together with simplified border procedures and trade liberalization in Malaysia. Goods were frequently shipped back and forth between plants belonging to the same foreign MNC but located on the two sides of the border. The second main flow of outsourcing went to the two Indonesian islands of Batam and Bintan in the Riau province. The islands were located only half an hour by speed-boat from Singapore and had the advantage of an abundant supply of uncultivated land. Several industrial parks were set up as in a collaboration program between Singapore and Indonesia, and a large number of foreign MNCs, especially in the electronics industry, located assembly lines in these parks. The increased integration between Indonesia, Malaysia, and Singapore benefited all of the involved countries and has been widely labelled as the Singapore-Johor-Riau growth triangle. For Singapore, the main gains from the integration were, that it enabled to reduce the drawbacks related to the small size of the domestic market, and that it showed foreign MNCs that it was possible to keep headquarters and skill intensive activities in the country and still have the labor intensive parts of production in the near vicinity.

The attempt to transform Singapore into what the planners called a “brain center” did not only focus on high value added activities in the manufacturing sector, but also on the expansion of other knowledge and skill intensive activities. These activities were typically located in the service industry, which played an increasingly important role in Singapore. The service sector grew with more than 10 percent annually throughout the 1980s and its relative size increased substantially (Table 4.3). The fastest growing part of the service industry was the financial sector and Singapore was soon established as a major international center in several different areas of finance. Other knowledge intensive parts of the service industry also grew rapidly, including accounting, marketing, legal services and computer and management consultancy (Huff 1994:305). The growth of the financial sector was a result of both lucky circumstances and deliberate government initiatives. On the fortunate side, Singapore’s position in a time zone between London/New York and Tokyo/Hong Kong made it an attractive place for traders who looked for the possibility of 24 hour trading. Still, it would be wrong to mainly attribute the success to luck. On the contrary, deliberate government efforts developed Singapore into a financial hub, often after long consultations with domestic and foreign financial actors. For instance, the early and foresighted liberalization of the currency trading regime, various tax incentives, as well as a host of other policies were crucial in establishing a large foreign exchange market in Singapore rather than in, for instance, Hong Kong. By the 1990s, Singapore was the fourth largest foreign exchange market in the world.

4.3 FROM FACTOR ACCUMULATION TO TECHNOLOGY DEVELOPMENT

Singapore’s high economic growth has been achieved through a combination of large inflows of MNCs and rapid factor accumulation. However, the past strategy may not provide future growth. Politicians and policy makers seem to agree that Singapore needs to upgrade its production, increase technological innovation, and enhance creativity and entrepreneurship to secure future growth. One problem with the past strategy was made apparent with the “total

factor productivity (TFP) controversy" in the early 1990s. Alwyn Young (1992, 1995) showed that all of Singapore's growth could be explained by factor accumulation and that there was no, or perhaps even negative, technological progress as captured by TFP growth. This raised widespread concerns, since growth through factor accumulation is not sustainable; diminishing marginal productivity will bring less and less growth effects from additional investments or increases of the labor supply. Technological progress is therefore crucial for sustainable growth. Young's study provoked strong reactions from the Singaporean government and from other academics. For instance, Nelson and Pack (1999) have questioned the results on methodological grounds. However, studies by Kim and Lau (1994), Collins and Bosworth (1996), and Bloch and Tang (2000), among others, confirm that growth in Singapore is largely caused by factor accumulation rather than by technological progress. Hence, a fair interpretation of the literature seems to suggest that massive investments, in particular, and rapid growth of the labor supply have been the most important determinants of past economic growth.

Such increases in investments and labor supply will be difficult to maintain. Firstly, Singapore's investments amount today to about 50 percent of GDP. To increase savings and investments further does not seem possible, and to maintain them at the same level will not be sufficient to secure high economic growth if there are diminishing returns to factor accumulation. Secondly, Singapore had among the world's highest birth rates in the 1950s and 1960s, which led to a rapidly expanding labor force. However, recent years have seen a dramatic reversal in birth rates and Singapore is now facing an aging population. One way to increase the labor supply further would be to increase immigration. Such a strategy is likely to be difficult since foreign workers already account for about 30 percent of the labor force and the government seems worried that further increases would put stress on the "social cohesion" of Singapore.

Paradoxically, one of the reasons for the lack of technological improvements might be the success of the government in achieving rapid structural change. It has been argued that the different types of industrial activities have never been present long enough to allow for learning-by-doing, technological improvements, and increased efficiency (Young 1992). On the contrary, before the firms have learned how to excel in production, the government has tried to lure them into new production activities with higher value added, where the learning process has had to start all over again.

Hence, it will be difficult to rely on factor accumulation to secure future growth. Instead, there will be growing demands for technological progress and for industries with a high knowledge content. The government has since the early 1990s been trying to transform the economy into "a knowledge based economy". The exact nature of such economy is not clear but EDB's Industry 21 strategy in 1999 describes it as:

> "…the vision of Industry 21 for Singapore to be a vibrant and robust global hub of knowledge-driven industries. We want to develop manufacturing and service industries with a strong emphasis on technology, innovation and capabilities. We also want to leverage on other hubs for ideas, talents, resources, capital and markets. To be a global hub and to compete globally, we require world-class capabilities and global reach. The goal is for Singapore to be leading centre of competence in knowledge-

driven activities and a choice location for company headquarters, with responsibilities for product and capability charters".[6]

The desired transformation seems to be partly a continuation of the previous trend of a constant shift into more and more high value added activities, but the emphasis on innovation, which means a break with the reliance on inflow of foreign ready-made technologies, is a new and important aspect of the strategy. Education and R&D are two features at the heart of any innovation system. The new strategy might also require a change of the mindset of the workforce, when the requirements for creativity are raised.

Singapore has traditionally conducted very little R&D, substantially less than other NIC countries like South Korea or Taiwan. The government has over the last decade tried to increase the amount by both strengthening intellectual property rights and by providing large subsidies to domestic and foreign firms. The financial incentives for conducting R&D in Singapore include provision of land and housing, training programs, and financial assistance for purchase of scientific equipment. It has been estimated that the government pays roughly 30 cent for every dollar that companies invest in R&D (Amsden *et al*. 2001:13).

The incentives have increased the amount of R&D conducted in Singapore, from about 0.8 percent of GDP in 1990 to about 1.9 percent in 2000 (Table 4.5). Accordingly, the share of the workforce engaged in R&D increased three-fold over the same period. Most R&D is, not surprisingly, conducted within the manufacturing sector, and electronics together with IT and communications account for about 64 percent of total R&D in Singapore (Year 2000 National Survey of R&D in Singapore). Moreover, most R&D comes from the private sector (about 63 percent) and foreign firms account for more than half of industry R&D expenditures. It seems that the government effort has had positive effects and Singapore's strong points seem to be its ability to use technology, including information and communications technology, the quality of basic education, thes widespread licensing of foreign technologies, and the use of advanced process technologies and process management capabilities (Wong 2001).

Table 4.5. Development of R&D in Singapore 1981-2000.

	1981	1990	2000
R&D expenditures as a share of GDP	0.26	0.84	1.89
No of personnel engaged in R&D per 10,000 workforce	10.6	27.7	83.5

Source: Source: National Survey of R&D in Singapore (various issues).

The increased R&D is argued to have had some tangible output results. For instance, Hewlett Packard is reported to have completely developed a new hand-held computer in the company's Singaporean branch (Ong 2002:7). It is uncertain, however, whether such frontier research is actually carried out in Singapore or whether it is something that is reported to please the government agencies that supply the massive subsidies to MNC's R&D. It has, for instance also been reported that Hewlett Packard was conducting cutting edge research in the field of printers at its Singapore R&D facility. A study by Amsden *et al.* (2001) asserted that in reality, all core technology was still transferred from the US. It seems, hence, that Singapore's ability in technology creation is less impressive than in technology using.

[6] Quoted from Olds and Thrift (2002).

The figures on patenting in Singapore show an increasing trend but are still very modest in size (Table 4.6). For instance, the number of granted patents increased from 52 in 1993 to 285 in 2000, an almost six-fold increase, but the corresponding figures for other small countries such as Sweden and Finland are substantially higher (see Table 4.3). This suggests that a high share of the R&D conducted in Singapore is more development than research. This is confirmed by Amsden *et al.* (2001) who find R&D in Singapore to be engineering rather than science and conducted by relatively low skilled personnel.

Table 4.6. Patenting in Singapore 1993-2000.

	1993	1994	1995	1996	1997	1998	1999	2000
No. of patents applied for	142	263	242	316	490	579	673	902
No. of patents awarded for the year	52	58	51	91	132	136	161	285

Source: National Survey of R&D in Singapore (various issues).

There are strong governmental attempts to make Singapore an educational hub in the region, both by expanding the activities of domestic universities and by attracting foreign educational institutions. The goal is to attract 10 world-class educational institutions to set up branches in Singapore by the year 2008, primarily by offering various subsidies and financial incentives. Several foreign institutions have already located in Singapore including Wharton, INSEAD, Chicago Business School, Johns Hopkins, and the MIT. The modes of entry vary substantially, but most institutes establish themselves in Singapore either on a very small scale (Chicago) or in collaboration with a Singaporean counterpart (Wharton, MIT, Johns Hopkins). There are several advantages with the inflow of foreign schools, one being the ability to attract students from the region, who might stay after graduation and thereby contribute to the economy. For instance, the Singapore Management University, which collaborates with Wharton, will have about one-third local students and the rest mainly from other parts of Asia (Ong 2002). The domestic universities will also increasingly target foreign students and plan to have a student body that is one-fifth foreign. It is, in particular, the hope of the government that some of the foreign students who choose to stay in Singapore will set up their own companies. This inflow of foreign students is really only a continuation of the traditional openness and reliance on foreign economic actors – the difference is only that this time is it individuals rather than firms that are targeted. One can only speculate about whether the strategy will be successful, and it will depend on whether the economic returns, living environment and other "welfare" aspects are better than what this group of foreigners will experience in other parts of the world. A cautious impression is that Singapore might have some success in attracting people from China, India, and other countries in Southeast Asia, but that foreigners from Europe and U.S. tend to stay for only a short period of time.

Creativity is to be encouraged through a new school curriculum that moves toward critical thinking and discussions rather than memorization. All levels of education are said to face this change of focus, but the exact nature of the change is still not clearly defined. Suggestions include a broader set of criteria for university entrance than only grades from the A-level exam. However, there have also been clear signs that much of the present characteristics of Singapore's educational system will remain unchanged. The most important part is the early streaming process of school children into different educational programs. This takes place continuously and starts already after primary three, when a small number of the highest achieving students are invited to a special program. The streaming continues after primary four when the remaining students are divided into three different groups according to their academic capability. The outcome of the streaming is important for the children since it is

difficult to get back to the "fast track" or the "main stream" once you have been found to be suitable for the "slow track". The next streaming occurs with the so-called public exam after primary six. The result of the public exam determines which secondary school the children can enter and it is often said to be of importance for the future career. The streaming has encouraged students to study very hard. For instance, children at the age of 10-12 years spend about 3 hours a day studying after school, and 70 percent of them receive extra tuition.[7] Moreover, parents are frequently taking several weeks or even months off from their jobs in order to prepare their children for the exams. The positive aspects of the system are clear from international comparisons of school children's knowledge of mathematics and science, where Singaporean children always are among the best performers. However, it has frequently been argued that the system might not encourage creativity since students are too focused on preparing for exams rather than to develop own interests, reflect upon the knowledge, or take part in activities outside of school.[8] To develop a system that encourages creativity but without sacrificing the average high standard is not easy, but it might be desirable to at least postpone the streaming until a later age, which would put some pressure of the youngest children.

Other policies than educational changes are likely to be important in developing creativity in Singapore. For instance, Singapore is lagging behind many other East Asian countries in the pace of political liberalization. Whereas countries such as Korea, Taiwan, the Philippines, and Indonesia have achieved or been moving towards democracy in recent years, Singapore still has limits on the freedom of media, the cultural sphere, civil society, trade unions and political activities. The result has been a society where people are said to be cautious about expressing own ideas and views and where most people opt for the safe strategy to follow officially sanctioned paths.[9] A society that oppresses alternative views is obviously not encouraging independent thinking and creativity. It is also uncertain if the government can expect people to think independently and to be creative in some areas such as in science or businesses, without allowing them to express independent views on for instance politics.

One reason for the low amount of basic and even applied research in Singapore could be the dependence on foreign firms. Most late-industrializing economies that have managed to promote any more substantial amount, breadth, and depth of R&D have typically relied on nationally controlled business groups (Amsden *et al.* 2001). Examples include countries like South Korea, Taiwan and India. On the contrary, late-industrializing countries that have been more reliant on FDI, like Argentina, Brazil and Mexico, typically conduct little R&D. The reason is that most R&D is still conducted in the MNC's home countries. For instance, only 12 percent of R&D in MNCs belonging to the OECD countries is conducted in countries outside of their headquarters (OECD 1998).

[7] The Straits Times February 24, 2001.

[8] See for instance the interview with Arnoud de Meyer the Dean of the INSEAD Singapore in Straits Times, 9 February 2001, "What strikes me about those I meet is that many are very good at solving a problem but very bad at defining a problem. I have noticed if I say "This is the problems solve it", they are very dedicated, intelligent and come back faster than I expected. But if I say, "I am not sure what I would do here, how do you define the problem?" then they have problems".

[9] See for instance Cherian (2000), and Gomez (2000).

Hence, it might be desirable with more domestically owned firms to enhance technological development. A few private Singaporean firms have emerged in recent years, such as Creative Technologies and Aztec Systems, and they have been both reasonably successful and engaged in R&D. Still, the lack of a strong domestic business community is apparent in Singapore and there are few countries that are equally reliant on foreign direct investment. The foreign domination of the Singaporean economy may seem peculiar since the overseas Chinese have shown a strong entrepreneurial ability in other countries. The reason why the same Chinese immigrants have failed to form a significant business community in Singapore is primarily found in the previously discussed historical and political circumstances around independence in 1965, when the government did not want to rely on the local business community. Singapore's strategy served its purpose of achieving strong economic growth but it may be less successful in the future. All of Southeast Asia, including Singapore, is facing increased competition from Northeast Asia in attracting FDI.

A second problem is, as previously discussed, that it might be difficult to persuade foreign MNCs to locate high value added activities in Singapore. These activities do not only include R&D but also, for instance, management, marketing, and design. One illustrative example of this is found in the hard disk drive industry (HDD). There were almost no Singaporean, or other Southeast Asian, controlled HDD companies in 1995. Almost all major foreign firms in the industry, however, had assembly plants in Southeast Asia (primarily in Singapore) and the region accounted for as much as 64 percent of final global assembly and 44 percent of total global employment (Amsden *et al.* 2001:3). Still, the region only received 13 percent of the industry's wages which is a clear sign of a division of labor where high value added activities are maintained in Europe, Japan and the US.

The lack of vibrant domestically controlled firms is something that increasingly bothers the government. A host of policies have been introduced to address the problem. For instance, there are various attempts to change the mindset of the population to make them more willing to take risks, including attempts to "educate for entrepreneurship". How the government should be able to address the issue via the school system is still a bit unclear, but initiatives include the possibility for university students to spend time in foreign places such as the Silicon Valley, and programs in technopreneurship. One crucial issue is if it is possible to teach people to become entrepreneurs. A core element of entrepreneurship is risk taking, which is not present in the government-sponsored visits to foreign centers of excellence.

Entrepreneurship is, of course, also dependent on factors other than the educational system. For instance, the economic literature stresses the importance of incentives in the formation of a strong entrepreneurial community (Baumol 1990, Murphy *et al.* 1991). People will allocate their talent where the return is the highest. Depending on the institutional setting, the return could be highest in entrepreneurial activities or in the government sector. The latter seems to be the case in Singapore. The Singaporean government and public bureaucracy pay high wages, among the highest in the world. In addition, the government, the public sector and the government-linked companies are closely conencted. People move frequently between these three institutions, which increase the return to people in the government sphere (Hamilton-Hart 2000).

The government has explicitly stated that the argument for high government wages is to attract the most talented Singaporeans. As has been repeatedly described in this chapter, it seems likely that the resulting strong Singaporean administration has been one important determinant of the fast economic catching-up with the developed world. However, it is

uncertain if the most talented people will continue to be best used in the government sector at a time when Singapore has to rely on domestic innovation and entrepreneurship. To encourage entrepreneurship is likely to require changes in the relative reward of joining the public sector versus setting up own businesses. It is not obvious that the government will be willing to lower own relative rewards.

A final and related issue is that many of the brightest Singaporean students are financing their university studies through bonded government scholarships. These scholarships are distributed by various government ministries and require the students to serve with the ministry for a period of about five years after graduation. Again, it is not obvious that the brightest students are best used for Singapore by being employed in the government rather than the private sector. The scholarships have recently been much debated in Singapore since many scholarship holders feel deeply unhappy with the bond. However, Prime Minister Goh Chok Tong has made it clear that the government bond will remain in place.

4.4 CONCLUSIONS

This chapter has described how large reliance on international markets and FDI together with active and successful government intervention can explain Singapore's economic development during the last 40 years. We have described how historical circumstances forced Singapore to rely on export orientation rather than on import substitution, and on FDI rather than on indigenous companies. The lack of a sizable domestic market after the separation with Malaysia necessitated the export orientation and the political turbulence made the government mistrust the domestic business community. Given these circumstances and policy choices, the government acted with pragmatism and efficiency to maximize the economic benefits of the nation. The ability to act on opportunity has been a characteristic of the Singaporean government, as witnessed by the initial efforts to attract foreign electronics companies when they became interested in outsourcing labor intensive production, or the formation of an international currency trading market when international actors were looking for the opportunity of 24 hour trading.

We have also described the different reasons why the Singaporean government has been able to make politically difficult policy choices and why it has been development oriented. Firstly, the government's autonomy from important interest groups has been crucial for its ability to shape the economic policies without much domestic interference. When the domestic business community and the labor movement became marginalized because of political conflicts, it made the government autonomous from the strongest interest groups in the society. Still, there is nothing that guarantees that an autonomous government will always act in a growth-enhancing way rather than enriching itself through various rent-seeking activities. The reason why the Singaporean government became development oriented is twofold. Firstly, its public legitimacy has largely rested on provision of increased living standards – most Singaporeans seem to have accepted restrictions on personal freedom as long as there is a continuous increase in incomes. Secondly, given the choice of becoming outward oriented and to rely on FDI, there is much less room for policy mistakes. The international market would immediately punish Singapore through lower investment or exports if there was a relative deterioration in the business climate, and this has worked to discipline the policy makers. Hence, the strong international dependence in Singapore has perhaps been the most important guarantee for keeping a check and balance on the government's economic policies.

There are clear lessons from Singapore's policies towards FDI. For instance, Singapore managed to get access to foreign knowledge and technology through a *laissez-fare* policy towards MNCs rather than by various requirements focusing on their operations. Since foreign MNCs started to locate in Singapore, the government has constantly been encouraging them to upgrade their activities. The government has repeatedly used strong economic incentives rather than legislation or requirements to achieve this upgrading. The economic incentives have ranged from tax exemptions to training of workers and local suppliers, and the local MNCs have responded positively.

Recently, Singapore has tried to transform itself into a knowledge-based economy that builds upon own innovations and technology rather than on import of ready-made technologies through the foreign MNCs. The policies have, once again, been based on financial incentives both to create a domestic business community in technology intensive sectors and to make the MNCs locate R&D in Singapore. Whereas the domestic business community is still rather weak, the amount of R&D conducted in Singapore has increased substantially during the 1990s. Much of this R&D is taking place within the MNCs. Singapore has made clear technological progress, especially in areas of technology-using but the technological development is still lagging behind that in most countries at a similar income level. Most R&D that takes place in Singapore is advanced development rather than basic or even applied research.

One might speculate on what the requirements are for Singapore to continue its development. It seems likely that it would be beneficial with a more creative and entrepreneurial population but this might require political changes. Paradoxically, the government has been able to pursue a developmental oriented economic policy in the past because of its autonomy from various interest groups. However, future growth might require less of a role in the economy for the most important interest group in Singapore, the government itself. Whether the government will be ready to accept a less dominating role is probably the main future policy challenge in Singapore.

5. LESSONS AND POLICY CONCLUSIONS

While the experiences of Finland, Sweden, and Singapore differ in many respects, they do suggest some policy lessons and conclusions for today's developing countries. First and foremost, the experiences of all three countries clearly demonstrate that there are opportunities for relative latecomers to catch up. With suitable policies and investments in human and physical capital, even small economies are able to upgrade their industry from raw material intensive and labor intensive activities to knowledge and technology intensive sectors. Many of the policy prescriptions followed in the three countries are very orthodox – in particular, the emphasis on human capital, institutions, and outward orientation – but some their experiences also highlight the great importance of political will and commitment in providing a suitable environment for growth and development. In all three countries, policy reform has been important, and the support for reform has been strong because of severe economic circumstances. In Finland and Sweden, reform was driven by the deep financial crisis of the early 1990s, and the realization that the multinational companies that dominate industry may decide to move production away from their home country if the business environment is not competitive. Both of these phenomena are clearly related to the increasing globalization of the world economy. In Singapore, the same pressure from international markets has driven reform for a long time: without any sizable domestic market, Singapore's development strategies had to be based on exports and international competitiveness from the late 1970s.

There are also some more specific points to note from the experiences of the different countries. The discussion about Finnish development suggests that small countries with limited public resources for investment may need to focus on specific industry clusters. To facilitate specialization and positive externalities, it is necessary to promote linkages, knowledge flows, and technology diffusion within the cluster. A systems approach may also be useful in identifying bottlenecks and obstacles to growth and development. To manage this, there is a need to establish a broad foundation for the policy debate. It is not sufficient to delegate responsibility to any individual ministry: all the main actors, including industry, universities, labor market organizations and other central players must be represented in the policy discussion.

The discussion of Swedish experiences points in particular to the need for flexibility. It is likely that the Swedish model developed during the decades after the Second World War was an optimal system for a long time. The emphasis on large companies that were able to exploit economies of scale, the intimate contacts between different actors in the national economy, and emphasis on consensus and an egalitarian distribution of the benefits were probably appropriate choices – perhaps even optimal choices – at some time, but changed into weaknesses as the degree of globalization and technical progress increased. The redistributive character of the Swedish state became particularly troublesome when the reduction of trade and investment barriers raised the level of competition in the economy, and when many of the large MNCs realized that they could move their production to other more competitive locations. The lack of support for domestic entrepreneurship and small and medium sized enterprises meant that the outflow of MNC production and value added was not compensated by the emergence of new domestic companies.

It is remarkable that the reform of the Swedish model did not commence until the financial crisis of 1991-93 forced the government to reduce the tax burden and to cautiously increase the emphasis on growth rather than distribution in its overall policies. To remain competitive,

it is necessary for both Sweden and Finland (as well as other countries) to adopt an international perspective on their business environment. There is no optimal model that will fit in spite of changing international conditions, but instead a need for continuous reform as demand, technology, and competition change. The explicit monitoring of competing economies and comparison against the best performers in various policy areas – benchmarking – is probably the only way to measure the strength of the national system.

Singapore has proved to be one of the most successful economies in this respect. The ability to act quickly as competitive conditions change and new opportunities arise has been one of the main features of Singaporean policy and reform history. This ability is to a great extent due to the government's autonomy from important interest groups, which gives it the means to act in the national interest, and the development orientation of the Singaporean nation state, which explains why policies have focused on growth rather than rent-seeking. The extreme outward orientation of the Singapore economy lies behind both of these features. Almost all the wealth created in Singapore stems from international markets, and the costs of a deterioration in the business environment (in terms of lost investment and export revenue) would probably exceed the gains that any major interest group could make through redistribution. The strong international dependence of Singapore has perhaps been the most important guarantee for the government's growth oriented economic policies.

Singapore's policies towards foreign direct investment are also interesting in a broader perspective. Instead of focusing on regulations, Singapore managed to get access to foreign knowledge and technology through an incentives-based policy towards foreign capital. The government has continuously encouraged the foreign MNCs operating in Singapore to upgrade their activities using economic incentives, such as tax exemptions for training of workers and local suppliers, with significant success. Similar incentives have been used recently to upgrade Singapore into a knowledge-based economy that builds upon own innovations and technology rather than on imports of ready-made technologies through foreign MNCs. This is one of the future challenges for the Singapore economy, with new demands for individualism, pluralism, and entrepreneurship rather than order, discipline, and learning ability which have perhaps been the country's main features in recent years. While it is far from certain how well Singapore is able to tackle these challenges, it is clear that some of its earlier achievements in the areas of human capital development, infrastructure and investment, and economic policy are still of great relevance for most developing countries.

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