

The university-innovation nexus in Finland

August 2012

Executive Summary

The objective of this 'backgrounder' is to better understand the contributions of universities to innovation in Finland, as a means of widening the consideration of policy options in Australia.

Finland is a small but advanced industrial economy with limited resources and markets, dependent on external trade and the internationalisation of research and innovation. The metal, engineering and electronics industries account for 50 per cent of export revenues, and the forest products industry for 30 per cent. Finland is said to be 'the most online nation in the world', with more mobile phones and internet connections per capita than any other country.¹

A major policy shift in the 1990s saw the Finnish state become an active player in innovation, which changed the research-innovation nexus substantially. This shift was characterised by the introduction of differentiated tertiary education qualifications (polytechnics and universities), the consequences of which were remarkable achievements in Finland's higher education and innovation sectors.

The 'life-long-learning' concept in Finland's higher education policy plays an important role in Finland's innovation performance. The majority of higher education degrees are issued by the polytechnics, which train the middle to senior level workforce who are in turn closely linked to the applied research they perform.

The innovation policy developed by the Finnish parliament aims at keeping a highly skilled workforce satisfied through an active role by the state as an investor in emerging technologies. Alongside internal reforms, the efficiency of the research system is strengthened by its opening up and integration into the European research system. The Integration into other relevant European research and innovation organisations and scientific networks is ongoing.

¹ OECD Better Life Initiative; <http://oecdbetterlifeindex.org/countries/finland/>; 2011

Introduction

Much of Finland is comprised of a gentle plateau of worn bedrock and boreal forests. This scenic mixture of wooded hills and waters is a common beauty shared throughout Finland. An overview includes:

- Total area: 338,145 sq km [Australia: 7,682,300 sq km – Finland is 4.4 per cent the size of Australia]
- 75 per cent of Finland is covered by forests
- There are nearly 188,000 lakes in Finland (10 per cent of Finland is under water)
- 25 per cent of Finland is north of the Arctic Circle
- Total Population 5,375,276 (1.1 per cent of EU-27 population) [Australia: 22,830,992 – the population of Finland is 24 per cent of Australia's population]
- Finland is a bilingual country: official languages Finnish (spoken by 92 per cent) and Swedish (spoken by 6 per cent)
- The literacy rate is 100 per cent
- There are 5.8 million mobile phones in use by 5.4 million people.
- Half the population in Finland attends yearly adult education or training as part of the Finnish life-long-learning strategy.
- The percentage of the population aged 25-64 that has attained at least an upper secondary education is 67 per cent. The educational level of women in Finland is higher than that of men.
- According to the OECD data for 2011, participation in university-level education in Finland remains at 40 per cent of the 25-34 years age cohort.²
- About 16 per cent of young adults in Finland today can be expected to complete a higher university degree: 19 per cent of the women and 14 per cent of the men.²
- The gender distribution between various fields of education has not become more equal over the past 20 years. Men tend to favour engineering, manufacturing, construction and agriculture programs, while women favour health, welfare, education, services and humanities programs.

The Global Innovation Index 2011³ ranks Finland fifth in the world; Australia is ranked 21. In terms of scientific outputs Finland holds place three in the world, Australia is placed 33. Interestingly, in the category 'human capital & research', Finland is placed third and Australia ninth globally. Another interesting comparison is given in the categories 'governments online service' and 'e-participation'. Australia ranks fifth in 'governments online service'; whereas Finland is ranked 31st. In 'e-participation' Australia is ranked second in the global comparison and Finland is ranked 31st.

Some history

Finland was part of Sweden until 1809, and a Grand Duchy of Russia from 1809 to 1917, with relatively broad autonomy in its economic and many internal affairs. It became an independent republic in 1917. While not directly involved in World War I, the country went through a civil war during the years of early independence in 1918, and fought against the Soviet Union during

² Education at a glance 2011, OECD, ISBN 978-92-64-11743-3 (HTML)

³ www.globalinnovationindex.org/gii/main/fullreport/index.html

World War II. Participation in Western trade liberalisation and bilateral trade with the Soviet Union required careful balancing of foreign policy, but also enhanced the welfare of the population. Finland has been a member of the European Union since 1995, and has belonged to the European Economic and Monetary Union since 1999, when it adopted the Euro as its currency.

Owing to its large forest areas, forests have been and still are an important natural resource in Finland's economic development. Other natural resources are scarce: there is no coal or oil, and relatively few minerals. Outokumpu, the biggest copper mine in Europe in its time, was depleted in the 1980s. Water power is scarce, despite the large number of lakes, because of the small height differences. Finland is sparsely populated with about 0.7 people per square kilometre. Since the collapse of the Soviet Union migration to Finland has increased, and Russian immigrants have become the largest single foreign group. In recent years population has grown at about 0.3 per cent per year. The population is very homogeneous. The number of foreigners is still lower than in many other countries – there are about 120 (2 per cent) people with a foreign background in Finland.

Finland was an agrarian country in the 1800s known for efficient grain growing, despite poor climatic conditions. The vast majority of the population (70 per cent) was engaged in agriculture and forestry, and half of the value of production came from these primary industries in 1900. The nineteenth century saw the modest beginnings of industrialisation, clearly later than in Western Europe. The first modern cotton factories started in the 1830s and 1840s, as did the first machine shops. The first steam machines were introduced in the cotton factories and the first rag paper machine in the 1840s. The first steam sawmills started operations only in 1860. The first railroad shortened the travelling time from the inland towns to the coast in 1862, together with the first telegraphs. Some innovations, such as electrical power and the telephone, came into use early in the 1880s, but generally the diffusion of new technology for everyday use took a long time.

The export of various industrial and artisan products to Russia from the 1840s on, as well as the opening up of British markets to Finnish sawmill products in the 1860s, were important triggers of industrial development. From the 1870s on, pulp and paper based on wood fibre became major export items to the Russian market. In the vast Russian empire, 30 per cent of the demand was satisfied with Finnish paper before World War I. Finland became a very open economy after the 1870s, with an export share equalling 20 per cent of GDP and an import share of 25 per cent. A happy coincidence was the considerable improvement in the terms of trade (export prices/import prices) from the late 1860s to 1900, when timber and other export prices improved in relation to the international prices of grain and industrial products.

Finland came out of World War II crippled by the loss of 10 per cent of its territory, and with 400,000 evacuees from Karelia. Productive units were dilapidated and the raw material situation was poor. The huge war reparations to the Soviet Union were the priority problem of the political decision makers. The favourable development of the domestic machinery and shipbuilding industries after the war and arms deliveries to the army during the war made war-reparations deliveries possible. They were paid on time and according to the agreements. At the same time, timber exports to the West resumed. Gradually the productive capacity was modernised and the industrial sector was reformed.

Finland became part of the Western European trade-liberalisation movement by joining the World Bank, the International Monetary Fund (IMF) and the Bretton Woods agreement in 1948, becoming a member of the General Agreement on Tariffs and Trade (GATT) two years later, and joining Finnefta (an agreement between the European Free Trade Area (EFTA) and Finland) in 1961. The government chose not to receive Marshall Aid because of the regional political circumstances. Bilateral trade agreements with the Soviet Union started in 1947 and continued until 1991. Tariffs

were eased and imports from market economies liberated from 1957. Exports and imports, which had stayed at internationally high levels during the interwar years, only slowly returned to the relative levels before the war.

The investment rate climbed to new levels soon after War World II under a government policy favouring investments and it remained at this very high level until the end of the 1980s. The labour-force growth stopped in the early 1960s, and economic growth has since depended on increases in productivity rather than increased labour inputs. GDP per capita rose from \$24k in 2000 to \$44.5k in 2010 – compared to Australia \$21.8k in 2000 and \$42k in 2010.

Exports and, consequently, the structure of the manufacturing industry were diversified following, Soviet and, later, Western demand for machinery products including paper machines, cranes, elevators, and special ships such as icebreakers. The Soviet Union provided good markets for clothing and footwear, while Finnish wool and cotton factories slowly disappeared because of competition from low-wage countries. The modern chemical industry started to develop in the early twentieth century, often led by foreign entrepreneurs, and the first small oil refinery was built by the government in the 1950s. The government became actively involved in industrial activities in the early twentieth century, with investments in mining, basic industries, energy production and transmission, and the construction of infrastructure, and this continued in the post-war period.

The population reached four million in 1950, and the post-war baby boom put extra pressure on the educational system. The educational level of the Finnish population was low by Western European standards in the 1950s, despite the high literacy rate. The underdeveloped educational system was expanded and renewed as new universities and vocational schools were founded, and the number of years of basic, compulsory education increased. Education has been government run since the 1960s and 1970s, and is free at all levels. Finland started to follow the so-called 'Nordic welfare model', and similar improvements in health and social care have been introduced, normally somewhat later than in the other Nordic countries. Public child-health centres, cash allowances for children, and maternity leave were established in the 1940s, and pension plans have covered the whole population since the 1950s. National unemployment programs had their beginnings in the 1930s and were gradually expanded. A public health-care system was introduced in 1970, and national health insurance also covers some of the costs of private health care. During the 1980s the income distribution in Finland became one of the most even in the world.

The oil crises of the 1970s put the Finnish economy under pressure. Although the oil reserves of the main supplier, the Soviet Union, showed no signs of running out, prices increased in line with global market prices. This was a source of devastating inflation in Finland. On the other hand, it was possible to increase manufactured goods under the terms of the bilateral trade agreement with the Soviet Union. This boosted export demand and helped Finland to avoid the high and sustained unemployment that plagued Western Europe.

Economic growth in the 1980s was somewhat better than in most Western economies, and at the end of the 1980s Finland caught up with the sluggishly-growing Swedish GDP per capita for the first time. In the early 1990s the collapse of Soviet trade, Western European recession and problems in adjusting to the new liberal order of international capital movement led the Finnish economy into a depression that was worse than that of the 1930s. GDP fell by over 10 per cent in three years, and the previously practically nonexistent unemployment rose to 18 per cent. The banking crisis triggered a profound structural change in the Finnish financial sector. The economy revived again to a brisk GDP growth rate of 3.6 per cent in 1994-2005. Prior to this, between 1973 and 2005, GDP growth was 2.5 per cent and GDP per capita growth 2.1 per cent, levelling off only in 2008.

Electronics started its spectacular rise in the 1980s and is now the largest single manufacturing industry with a 25 per cent share of all manufacturing. Nokia is one of the world's largest producers of mobile phones and a major transmission-station constructor. Connected to this development was the increase in the research and development expenditure to three per cent of GDP, one of the highest in the world.

The directions of foreign trade have been changing because trade with the rising Asian economies has been gaining in importance and Russian trade has fluctuated. Otherwise, almost the same country distribution prevails as has been common for over a century. Western Europe has a share of some 60 per cent. The United Kingdom was for a long time Finland's biggest trading partner, with a share of 30 per cent, but this started to diminish in the 1960s. Russia accounted for one-third of Finnish foreign trade in the early 1900s, but the Soviet Union had minimal trade with the West at first, and its share of Finnish foreign trade was just a few percentage points. After World War II, Soviet-Finnish trade increased gradually until it reached 25 per cent of Finnish foreign trade in the 1970s and early 1980s. Trade with Russia is now gradually gaining ground again from the low point of the early 1990s, and had risen to about 10 per cent by 2006. This makes Russia one of Finland's three biggest trading partners, Sweden and Germany being the other two with a 10 per cent share each.

Finnish agriculture is incorporated into the Common Agricultural Policy of the European Union and shares its problems, even if Finnish overproduction has been virtually eliminated. The share of forestry is decreasing, with 80 per cent of the wood used in Finnish sawmills and paper factories, sourced domestically and the remaining imported mainly from Russia. Future concepts suggest a new regenerative forestry-based bio-fuel industry to be established.

The share of manufacturing in GDP is somewhat above Western European levels and, accordingly, that of services is high but slightly lower than in the old industrialised countries.

Recent discussion on the state of the economy mainly focuses on two issues. First, the very open economy of Finland is very much influenced by the difficult economic situation in the Euro Zone. Accordingly, not very high growth rates are to be expected in Finland either.

The other issue concerns the prominent role of the public sector in the economy. The Nordic welfare model receives strong public support, but its high costs create tensions. High taxation is one consequence of this and political parties discuss whether or not the high public-sector share of the economy slows down economic growth. The ageing population, high unemployment and the decreasing numbers of taxpayers in the rural areas of eastern and central Finland place a burden on local governments.

Economic structure

Notable companies in Finland include Nokia,⁴ one of the market leaders in mobile telephony; Stora Enso, the largest paper manufacturer in the world; Neste Oil, an oil refining and marketing company; UPM-Kymmene, the third largest paper manufacturer in the world; Aker Finnyards, the manufacturer of the world's largest cruise ships; Rovio Mobile, a video game developer most notable for creating Angry Birds; KONE, a global manufacturer of elevators and escalators; Wärtsilä, a producer of power plants and ship engines; and Finnair, the largest Helsinki-Vantaa based international airline. Finland has sophisticated financial markets comparable to the UK in efficiency. Though foreign investment is not as high as in some other European countries, the largest foreign-headquartered companies include names such as ABB, Tellabs, Carlsberg, and Siemens.⁵

The last couple of decades were characterised by globalisation in all areas of the economy. Around 70-80 per cent of the equity quoted on the Helsinki Stock Exchange is owned by foreign-registered entities. The larger companies get most of their revenue from abroad, and the majority of their employees work outside the country. Cross-shareholding has been abolished and there is a trend towards an Anglo-Saxon style of corporate governance. However, only around 15 per cent of residents invest in the stock market, compared to 20 per cent in France, and 50 per cent in the US. It has to be kept in mind that pension schemes are a public responsibility in Finland.

Between 2000-2003, early stage venture capital investments relative to GDP were 8.5 per cent in contrast to 4 per cent in the EU and 11.5 per cent in the US. Later stage investments fell to the EU median. 'Invest in Finland' and other programs attempt to attract investment. In terms of foreign direct investment (FDI) Finland invested €20 billion overseas and from overseas €7 billion were invested in Finland in 2000.

The Finnish economy today is dominated by three almost equally important export sectors – electronics and information technology; metal and engineering; and forest industry products – which largely account for the massive increase of GNP from 23 per cent in 1990 to 42 per cent by 2001. Information technology has clearly been key to this, and in turn this has been made possible by a rapid increase in R&D spending and related innovation and product development.⁶

The unique case: Nokia

In 1865, mining engineer Fredrik Idestam set up his first wood pulp mill at the Tammerkoski Rapids in south-western Finland. A few years later he opened a second mill on the banks of the Nokianvirta river, which inspired him to name his company Nokia Ab in 1871. Nokia began by making paper – becoming one of the most influential communications technologies in those days.

In 1898, Eduard Polón founded Finnish Rubber Works, which later became Nokia's rubber business, making everything from galoshes to tyres. Nokia rubber boots become a bona fide design classic, still on sale to this day – though Nokia no longer makes them.⁷

In 1912, Arvid Wickström set up Finnish Cable Works, the foundation of Nokia's cable and electronics business. By the 1960s, Finnish Cable Works – already working closely with Nokia Ab

4 How Finland's economy became hooked on Nokia; Naomi Powell; Globe and Mail Blog, Posted on Wednesday, October 26, 2011; www.theglobeandmail.com/report-on-business/economy/economy-lab/daily-mix/how-finlands-economy-became-hooked-on-nokia/article2214216/

5 en.wikipedia.org/wiki/Economy_of_Finland

6 Statistics Finland, The growing years of Finland's industrial production; www.stat.fi/tup/suomi90/toukokuu_en.html; 2008

7 The role of Nokia in the Finnish Economy, J Ali-Yrkkö; www.etla.fi/files/940_FES_01_1_nokia.pdf

and Finnish Rubber Works – started branching out into electronics. In 1962, it made its first electronic device in-house: a pulse analyser for use in nuclear power plants. In 1963, it started developing radio telephones for the army and emergency services – Nokia’s first foray into telecommunications. In time, the company’s MikroMikko became the best known computer brand in Finland. And by 1987, Nokia was the third largest TV manufacturer in Europe. Having been jointly owned since 1922, Nokia Ab, Finnish Cable Works and Finnish Rubber Works officially merged in 1967. The new Nokia Corporation has five businesses: rubber, cable, forestry, electronics and power generation.

As the 1980s came into view, an entirely new industry made Nokia a household name around the world. In 1987, GSM (Global System for Mobile communications) was adopted as the European standard for digital mobile technology. With its high-quality voice calls, international roaming and support for text messages, GSM ignited a global mobile revolution. Since 1971, Finland had been actively involved in the COST network⁸ delivering the scientific foundations for the GSM standard.

The rapid development of the market resulted in a substantial change to the Finnish economy. In 2000, Nokia produced 21 per cent of Finnish exports and paid €1.1 billion or 20 per cent of all corporate tax revenue. By 2010, when the smart phone competition began, prompting the rapid loss of market share to Apple’s iPhone and Google’s Android platform, Nokia generated 13 per cent of Finnish exports and paid out just €100 million in taxes.⁹

“Nokia was growing so fast in the 1990s and was absorbing so many graduating engineers that it may have crowded out other companies,” said Mr. Yla-Anttila. “Now these experienced people are finding new jobs and starting new companies. This is a great opportunity for Finland’s economy to transform.”

Today, Nokia is struggling to compete with more robust mobile platforms like Apple’s iOS and Google’s Android after failing to foresee shifting consumer demand from so-called feature phones to smartphones. Although Nokia has lost market share, particularly in the U.S., and is being squeezed at both the low and high ends of the market, it remains the world’s largest phone manufacturer by units sold in 2011.

To catch up with global trends, Nokia has opened a new ‘research lablet’ (small, highly specific research unit) on the Otaniemi campus of Helsinki University of Technology. Nokia Research Centre and Helsinki University of Technology have also announced a joint strategic research program in the field of new mobile communications technologies. This establishes joint research activities and daily interaction between Nokia and university researchers who are sharing the same facility. Nokia is looking forward to future collaboration with a new structure called ‘Innovation University’ – consisting of Helsinki School of Economics (HSE), University of Art and Design Helsinki (TAIK) and Helsinki University of Technology (TKK) – after their merger in August 2009. Nokia hopes the ‘Innovation University’ will be a leading innovation hot spot in mobile technologies and systems. The Nokia Research Centre has chosen to work with Helsinki University of Technology because of its expertise in wireless technologies. This builds on over 10 years of partnership between the two organisations.

⁸ www.cost.eu

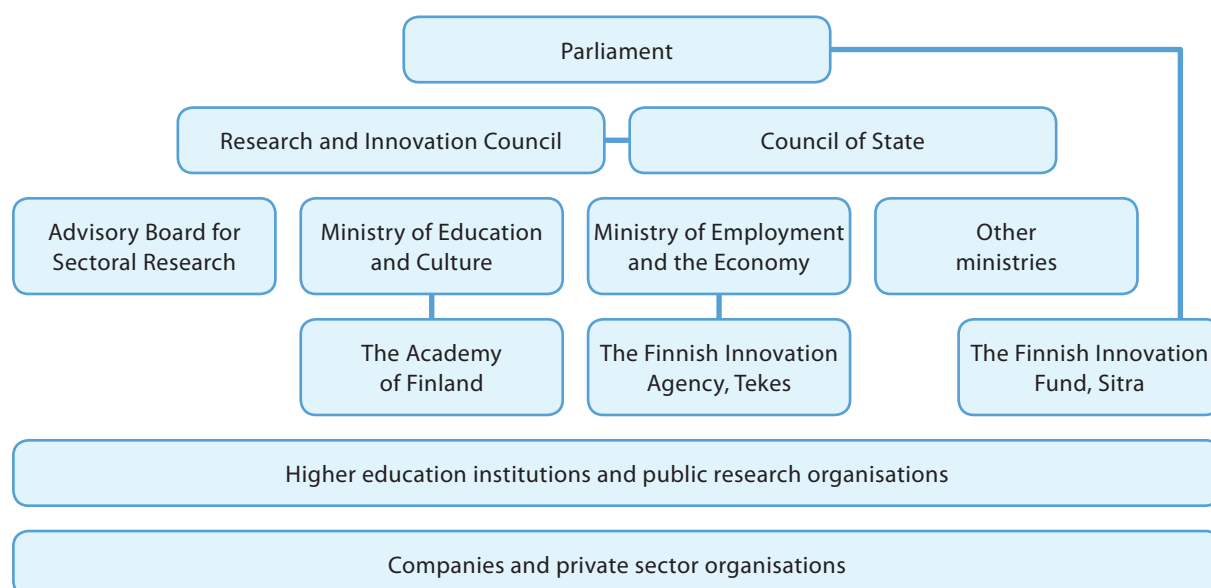
⁹ en.wikipedia.org/wiki/Economy_of_Finland

The Finnish innovation system

The Finnish parliament considers the higher education system as key to the innovative policies implemented since the 1980s. It comprises two kinds of institutions operating in parallel: universities and polytechnics. Universities are characterised by scientific research and the highest education based thereon. Polytechnics are oriented towards working life and base their operations on the high vocational skill requirements set by it. Higher education is very popular, and the number of applicants is consistently several times higher than the annual intake. Adult education and 'Life-long-learning' are also popular in Finland, with adult education leading to certification and re-employment education free of charge.¹⁰

Three intermediary institutions play key roles in the Finnish innovation system: The Academy of Finland, the Finnish innovation agency, Tekes, and the innovation fund, Sitra. These agencies are highly intertwined with companies and other public agencies and actually drive the economy, together with the HE institutions, to adopt an 'innovative mindset'.

The structure of the innovation system in Finland:



From: www.research.fi

Strategies and policies of the Ministry of Education and Culture

The Ministry of Education and Culture 'Strategy 2015'¹¹ addresses future challenges in the sector and its operational environment, Finnish society and the international environment. It takes a long-term view of the objectives and the means whereby the vision, the operational idea and values are realised. The strategy outlines future developments in the Ministry of Education sector. The key objectives for the sector are:

- to secure equal opportunity in education and culture
- to promote intellectual growth and learning
- to promote participation and inclusion
- to boost the educational, cultural and economic competitiveness of Finnish society

¹⁰ Evaluation of the Finnish National Innovation System – Policy Report; Reinhilde Veugeler et al; Helsinki University Press; ISBN 978-951-628-490-6; 2009

¹¹ www.minedu.fi/OPM/Koulutus/yliopistokoulutus/?lang=en

- to ensure Finland's influence in international contexts
- to improve the performance of the sector.

The more detailed sector-specific strategies and development programs are informed by the Ministry of Education Strategy.

The Finnish higher education system

The Finnish tertiary education system comprises two parallel sectors: universities and polytechnics.¹² Universities focus on scientific research and education and have the right to award doctorates. The first university degree, Bachelor's, can generally be attained in three years of full-time study (180–210 ECTS credits) and the higher, Master's degree (120–150 ECTS credits), in two years. There is an optional intermediate postgraduate degree of licentiate, which can be completed in two years of full-time study after the Master's degree. Full-time study for a doctorate takes approximately four years following the Master's degree.¹³

In the late 1980s, the Finnish polytechnic system was set up over a period of ten years, which comprised a pilot phase and a subsequent stage in which the operations were given their final form. In the reform, the vocational colleges joined forces and formed larger entities, upgrading their education to the tertiary level. The first polytechnics gained a permanent status in 1996 and the last five as recently as August 2000. A polytechnic degree requires 3.5 – 4.5 years of full-time study. The admission requirement for polytechnic Master's programs is a bachelor degree or equivalent, plus a minimum of three years of work experience in the field concerned.

The universities

Finland's first university was founded in Turku in 1640. At the beginning of the 19th century, it was moved to Helsinki and it remained Finland's only institution of higher education until 1908, when the present Helsinki University of Technology was founded. Between 1910 and 1920, a Finnish-language and a Swedish-language university were both established in Turku. The new needs of business and industry were answered in the 1950s and 1960s with the creation of institutions specialising in the fields of economics and technology. Only the 1960s and 1970s witnessed rapid growth and regional expansion of the higher education system. The pressure to expand educational opportunities was fuelled by rapid economic growth, an increase in the number of people with general secondary education, high demand for academically educated labour in working life as well as demand for educational equality. Other important educational decisions were also being made: all teacher training was incorporated into universities and education in the arts was introduced at university level.

There are 16 universities in the Ministry of Education and Culture sector; two of them are foundation universities and the rest are public corporations. Their operations are built on the freedom of education and research and university autonomy. Universities confer Bachelor's and Master's degrees, and postgraduate licentiate and doctoral degrees. There are universities in 11 different cities and towns, which offer education in altogether 23 localities in Finland. The higher education system is being developed as an internationally competitive entity capable of responding flexibly to national and regional needs.

¹² www.minedu.fi/OPM/Koulutus/koulutusjaerjestelmae/?lang=en

¹³ OECD (2011), Education at a Glance 2011: Highlights, OECD Publishing; http://dx.doi.org/10.1787/eag_highlights-2011-en

Under the Universities Act (2009)¹⁴, universities must promote free research and scientific and artistic education, provide higher education based on research and educate students to serve their country and humanity. In carrying out this mission, universities must interact with the surrounding society and strengthen the impact of research findings and artistic activities in society.¹⁵

The polytechnics

The structure of higher vocational education was reformed in the late 1990s. New polytechnics, the so-called ammattikorkeakoulu (AMK institutions), were developed from former colleges of vocational education. In this reform process, the vocational colleges joined forces and formed larger entities, upgrading their education to the tertiary level. There are 25 polytechnics in the Ministry of Education and Culture sector:¹⁶ four are run by local authorities, seven by municipal education consortia and 14 by private organisations. In addition there is the Åland University of Applied Sciences in the self-governing Province of Åland and a Police College subordinate to the Ministry of the Interior. These institutions provide for the majority of bachelor and master degrees in Finland.

Polytechnics are multi-field regional institutions focusing on contacts with business and on regional development. Polytechnics are professionally oriented higher education institutions. In addition to their educational role, polytechnics conduct applied research and development which serves teaching and the innovation process.

Some figures on the higher education sector

The total number of post-compulsory certificates and diplomas awarded annually in Finland is 110,000–120,000, two thirds of which are upper secondary qualifications and one third tertiary degrees. The number of polytechnic degrees is 18,000; more than the 11,500 university degrees.

The labour market situation for the graduate workforce in the 2000s has been quite reasonable (Ministry of Education, 2005). The unemployment rate for graduates in 2001 was 6 per cent, as compared favourably to the overall unemployment rate of 12 per cent and 19 per cent among those with no post-compulsory qualifications. The annual income of tertiary graduates is €36,000, whereas the general level is € 27,000. University graduates earn €45,000 a year. The income of polytechnic graduates is lower than that of those with higher vocational qualifications. One explanation is that since the polytechnic system is fairly recent, the graduates are still quite young and have not yet fully established themselves in the labour market. The deep economic recession of the early 1990s is clearly reflected in the graduate employment situation. The overall unemployment rate was at an all-time high of 23 per cent in 1993. University graduates and postgraduate degree holders did fairly well during the economic crisis. Polytechnic graduates and those with equivalent qualifications were not as fortunate – at its worst, their unemployment rate was 15 per cent.¹⁷

The Academy of Finland

The Academy of Finland's mission is to finance high-quality scientific research, act as a source

¹⁴ www.minedu.fi/OPM/Koulutus/koulutuspolitiikka/Hankkeet/Yliopistolaitoksen_uudistaminen/index.html?lang=en

¹⁵ The Role of the University in Economic Development: an Analysis of Six European Universities of Science and Technology; Sigmund J. Waagø (Editor), Einar Rasmussen, Thomas Kvaal, Magnus Gulbrandsen, Eilif Trondsen; GREI, NTNU; Oslo, Norway 2001

¹⁶ www.minedu.fi/OPM/Koulutus/ammattikorkeakoulutus/ammattikorkeakoulut/?lang=en

¹⁷ CHEPS: Higher education in Finland, IHEM Country report, Hans Vossensteyn, Twente, 2008

of science and science policy expertise, and strengthen the position of science and research. It is a governmental funding body contributing to the renewal, diversification and increase in internationalisation of research in Finland. Its operation covers the entire spectrum of scientific disciplines. The Academy emphasises the importance of the impact of research and breakthrough research by encouraging researchers to submit boundary-crossing funding plans that involve risks but that also offer promise and potential for scientifically significant breakthroughs.

The first 'State science policy board' was founded in 1918, and the first Act regarding the Academy of Finland was promulgated in 1939, although its enforcement had to be postponed because of the outbreak of World War II. The so-called "old Academy" was launched in 1948 and the Academy of Finland in its present constitution was established in 1970. The role of the Academy of Finland as a research funding body has grown more significant since the government launched an additional funding program in 1997–1999 to increase research intensity.¹⁸

The Academy funds research with €340 million annually (2012). The success rate for applicants is about 30 per cent. Funding is provided for research projects, research programs, Centres of Excellence in research, research posts, foreign visiting professors' work in Finland, researcher training, international networking and research collaboration between universities, research institutes and business companies. Each year Academy-funded projects account for some 3,000 researcher FTEs at universities and research institutes.¹⁹ The Academy also evaluates research projects. All evaluations are commissioned out to third-party experts, who normally come from outside Finland.²⁰

In a different role, the Academy supports the development of science policy strategies, issues statements on questions of science policy and compiles and commissions science policy reports. It is an integral part of European and global science networks.

Tekes

Tekes, the National Technology Agency funding innovation in Finland has proved very valuable in increasing the country's knowledge and skills, boosting exports, creating new jobs, and preserving existing ones. Tekes' mission, as a publicly funded institution, is to promote the competitiveness of Finland's industry and service sector by enhancing its technological potential, through such areas as diversifying production structures, increasing output and exports, and creating a more solid foundation for employment and well-being. An annual budget of €400 million is allocated to Tekes, funded from the state budget through the Ministry of Trade and Industry. Today, Tekes has 265 employees, together with 74 people based at regional Centres for Employment and Economic Development. Tekes granted €392 million to 2,196 research and development projects with a total budget of close to €800 million, in 2003. Close to two-thirds of Tekes' funding went to corporate projects, and a third to universities, research institutes, and polytechnics.²¹

Tekes' technology programs cover a broad range, and consist of numerous projects focused around key technologies. At present, Tekes has over 20 technology programs running, representing a total investment of €1.3 billion. In addition to funding research and development, Tekes plays a role in fostering innovative ways of thinking, through increasing emphasis on linking know-how to innovative activities, particularly with SMEs. Tekes is also strengthening its focus on service-related areas, such as health care.

¹⁸ R&D intensity is often defined to be the ratio of gross national expenditures on research and development to the GNP

¹⁹ www.aka.fi/en-GB/A/Academy-of-Finland/

²⁰ erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/fin/organisation/

²¹ www.tekes.fi

To offer a comprehensive level of service to its partners, Tekes works in close cooperation with the Academy of Finland, venture capital investors and Finland's regional Centres for Employment and Economic Development and technology centres. Programs offered by Tekes are one of the main drivers of cooperation between the public and private sectors in Finland.²²

Financing through Tekes, as a publicly funded organisation, can be awarded to foreign-owned organisations registered in Finland, with or without Finnish partners. Over half of Tekes' funding in 2003 was allocated to projects involving an international dimension. Tekes is responsible for a wide range of international activities, including enhancing cooperation within the European Framework Programs, the European Space Agency, the International Energy Agency (IEA), COST, EUREKA, and the Innovation Relay Centre (IRC).

Tekes has also built up significant cooperation with numerous organisations further afield, in the US, Japan, and China and has cooperation agreements with bodies such as the University of California, Berkeley and Stanford University in the US, and with the National Institute of Science and Technology Policy (NISTEP) and NEDO in Japan.

Sitra

Sitra, the Finnish Innovation Fund, was founded in 1967 as a part of the Bank of Finland. Currently it is an independent public foundation which operates directly under the supervision of the Finnish Parliament. Sitra's mission is part of the Finnish legislation.

Sitra's mission is to adopt a project-based organisational model that focuses on three core themes throughout Finland: sustainable lifestyles and smart use of natural resources; renewable leadership and well-being services; and identification of bottlenecks of economic growth and new opportunities. These three themes are implemented through tangible projects of two or three years in duration. To succeed internationally, Finland needs healthy and sustainable businesses. Sitra promotes this by investing in innovative companies with development potential. Sitra does not grant subsidies to companies, but it invests in shares and contributes to the development of companies as an active owner.

In 2011, Sitra revisited its strategy and operational model and set the objective of becoming a pioneer in sustainable well-being. Due to the uncertain market situation, 2011 was a year of challenges for Sitra's endowment capital investments. To ensure the strategic agility of Sitra's operations, a new project organisation with a variety of sustainable well-being themes was designed to be adopted in 2012. The program-oriented operational model, active since 2004, will be terminated by the end of 2012. In 2012, the primary projects of the various programs will be carried out within the new themes.

Sitra mainly finances its operations with the yield from its endowment capital but also from capital market financing activities. Due to the uncertain market situation 2011 was a year of challenges for Sitra's endowment capital investments, and investments had to be adjusted according to the new financial position. On the other hand, the rapid changes in the operational environment emphasised Sitra's role in foresight and practical operations. The market value of Sitra's endowment capital at the end of 2011 was €627 million. The uncertain market situation affected the yield of invested assets, resulting in losses of -8.0 per cent, whereas the yield in the previous year was +9.3 per cent. During the year, Sitra fully withdrew from 16 companies and partly from one company. New corporate investments were targeted at the strategic program areas. Initial investments were made in three companies. At the end of the year, Sitra's portfolio contained 36 companies.²³

²² Network governance and the Finnish Strategic Centres for Science, Technology and Innovation, Tekes Review 280/2011; ISBN 978-952-457-518-8; Helsinki 2011

²³ www.sitra.fi/en/news/2012/board-report-2011-sitra-set-objective-becoming-pioneer-sustainable-well-being

Innovation policies

At the parliamentary level, a special 'Committee for the Future' evaluates and assesses ongoing processes and trends in society including issues related to innovation. The Committee has focused especially on information society issues, assessing wider societal impacts of technological development. The main governmental advisory body responsible for Research, Technological Development and Innovation (RTDI) policies is the Research and Innovation Council. A new decree on the Research and Innovation Council came into force at the beginning of 2009. Based on the development guidelines presented in the National Innovation Strategy, the decree stipulates that the new Council replaces the former Science and Technology Policy Council which had a narrower scope in its tasks and composition. The Council, chaired by the Prime Minister, advises the Council of State and its Ministries in matters concerning research, technology and innovation and their utilisation and evaluation. The Research and Innovation Council is responsible for the strategic development and coordination of Finnish science and technology policy as well as the national innovation system as a whole. The Advisory Board for Sectoral Research, established in 2007, is another governmental advisory board. It is the responsibility of the Board to coordinate the overall steering of state sectoral research. The aim is to improve ministries' commissioning know-how, enhance the targeting of sectoral research and step up the utilisation of research over administrative boundaries.

The key ministries with responsibility for science, technology and innovation policy include the Ministry of Employment and the Economy (MEE), and the Ministry of Education and Culture (MEC). In 2008 the Ministry of Employment and the Economy assumed responsibility for the duties of the former Ministry of Trade and Industry, Ministry of Labour and the Regional Development Unit in the Ministry of the Interior and deals with, among others, matters relating to industrial technology and innovation policies. The administrative field of the Ministry of Employment and the Economy includes Tekes, the Finnish Funding Agency for Technology and Innovation, and a number of public innovation service organisations and public research institutes. The Ministry of Education and Culture is in charge of matters relating to education and training, science policy, institutions of higher education, and the Academy of Finland. The administrative branches of these two Ministries receive the bulk, over 80 per cent, of government research and development funding.

In January 2009 the government agreed on a stimulus package, the main focus of which was on measures that directly promote employment, including investments in transport infrastructure and broadband, support to construction and raising social insurance contributions. As part of implementation of the stimulus package, Tekes received additional resources for research grants, as well as development and innovation grants, in order to secure the continuity and level of research, development and innovation operations.²⁴

At the end of 2009 the Ministry of Economy and the Employment published an evaluation of the Finnish innovation system conducted by a panel of both Finnish and international innovation experts. The evaluation was based on the innovation strategy published in 2008 and it was built around the following six topics:

1. Broad-Based Innovation Policy;
2. Demand- and User-Driven Innovation;
3. Globalisation of Business Activities;

²⁴ Mini Country Report – Finland, Thematic Report 2011 under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012); Kimmo Viljamaa and Annu Kotiranta, Ramboll Management Consulting; December 2011

4. Growth Entrepreneurship and Finance;
5. Geography of Innovative Activity;
6. Education, Research and the Economy.

As the evaluation comprised the whole national innovation system, its conclusions and recommendations are manifold. In the evaluation it is suggested that the present, complex and in many places overlapping, system is the result of a long evolution, where new instruments have been implemented without demolishing and/or examining the possibilities of the existing ones. Thus one cross-cutting recommendation of the evaluation is the simplification of the national innovation system, including the clarification of the roles of the national innovation organisations and national programs, reduction in the number of organisations, including the funding organisations, public research organisations, and universities. The role of the public sector as a customer is also emphasised, especially in the development of demand and user driven innovations. However, in general the main role of the public sector is seen to be in ensuring the existence of a well-functioning, fair and competitive marketplace for the companies to operate on.

Since the release of the evaluation, several strategies and guidelines concerning the implementation of the national innovation policy have been published. In August 2010 the National Research and Innovation Council accepted the guidelines for innovation policy for 2012-2015 and the priority areas for 2011.²⁵ The document is the single most important guideline in forming the future innovation environment in Finland in the following years. The themes of the national innovation strategy published in 2008 and the recommendations of the evaluation of the national innovation strategy are well reflected in the guidelines of the National Research and Innovation Council. The main themes, which are also adopted by the most recent government program, are summarised below.

The development of an innovation system that supports the national strategy implies that:

- Structures will be renewed and organisational, functional and geographical fragmentation will be reduced;
- The coordination and guidance of policy measures will be strengthened on the level of the government / council of state;
- Choices and prioritising concerning the contents and themes will be executed;
- The utilisation of education, research, and innovation activities (ERI) will be promoted broadly;
- The specialisation and profiling of universities, polytechnics and research institutes to their core competence areas will be supported; the quality of research will be improved;
- The manifold co-operation will be tightened and the allocation of tasks between higher education institutes, research institutes, and trade and industry will be clarified;
- Guiding methods, incentive schemes, and the regulatory environment will be further developed;
- The functionality and effectiveness of the company and innovation service systems will be improved;
- The position of SMEs in the national innovation system will be strengthened;
- A long term infrastructure policy will be built and the use of public data will be enhanced;

²⁵ Esko Aho et al, Finland's National Innovation Strategy – preparatory paper, Helsinki, Finland, 2008

- The evaluation know-how and the use of evaluation knowledge will be strengthened;
- The funding base of research and innovation activities will be diversified;
- The internationalisation of the whole innovation system's ERI will be accelerated;
- The methods and instruments of the follow-up of politics will be improved.

In addition new guidelines have been published for the promotion of the internationalisation of companies and trade in the period 2011-2015. The implementation of the national innovation strategy has been strengthened by launching an action program for demand and user driven innovation. In addition, the national Intellectual Property Rights (IPR) strategy and the guidelines for utilising bio-innovations give directions for future development.

The concrete implementation of the guidelines is outlined in the most recent government program published in 2011. According to the program, the sufficient level of funding will be ensured also in the next four years and the target level of research, development and innovation expenditure in terms of GDP is set at 4 per cent. The focus of the funding will be shifted to small and medium sized, growth seeking, employing, and internationalising enterprises. Companies in different phases of the growth period will also be taken into consideration. Emphasis will be on both technological and social innovations and their integrated development, commercialisation and use. Also the possibilities of creating new tax-incentives for accelerating research, development and innovation operations will be examined.

Innovation strategies

The Finnish research and innovation system is characterised by a strong commitment both from the public and private sectors to increase research and innovation and education investments that has led Finland to lead in the rankings in terms of research and development intensity, share of researchers and skilled human resources in the economy and levels of new academic oriented tertiary education degrees. The country set a target to reach at least 4 per cent of research and development intensity by 2020. It achieved 3.93 per cent in 2009 confirming a front leading position of Finland in terms of research and development investments not only in the EU, but also in the world.²⁶

However, the future looks more uncertain due to increased global competition, the ageing Finnish population and ICT sector developments, showing the need for structural changes in the economy. The development of Nokia has led the high-tech ICT cluster to dominate the Finnish economy. ICT related growth has, to some extent, overshadowed the development of prior traditional sectors, such as Machinery and Equipment, which have however managed to increase their research and development intensity. Large sectors such as Construction and Fabricated metal products have demonstrated their capacity to raise their research and development intensity and to translate this in additional growth; the pulp and paper sector might get similar benefits over the years to come.

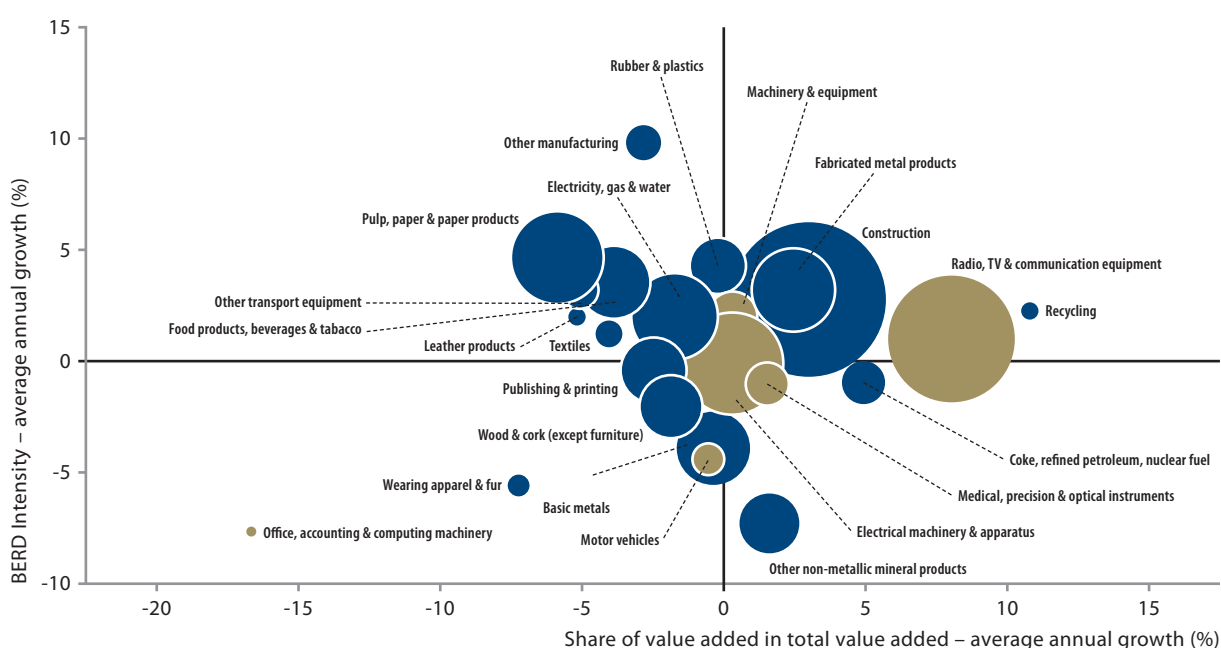
In Finland it is acknowledged that the emergence of new research and innovation intensive sectors and growth companies are crucial for the future well-being of the country and in this respect Finland expects service innovations and design to play a significant role. Another structural challenge is the relatively low level of internationalisation of the Finnish research and innovation system. This is demonstrated both by the lack of foreign experts and researchers and relatively few foreign direct investments and research and innovation activities for developing

²⁶ Finland's National Innovation Strategy 2010; Ministry of Employment and the Economy, Helsinki, Finland

globally competitive innovation environments. Therefore, a stable public funding environment is considered to be a decisive factor increasing the impact of these measures and of the other growth enhancing policies.²⁷

Finland is leading in terms of research and development intensity and human resources. A distinctive characteristic is the high dependency of the system on Nokia, which accounts for nearly 50 per cent of the total business sector research and development investments, which in turn accounts for 71 per cent of the total research and development investment. The large research and development investments and favourable framework conditions in terms of macroeconomic stability and relatively easy access to venture capital result in important scientific and technological outputs. This is reflected in the recent analysis of the total value added impact in the specific fields, as compiled by the European Commission.

Share of value added versus BERD Intensity – Average annual growth 1995 to 2007



Source: DG Research and Innovation; Data: OECD

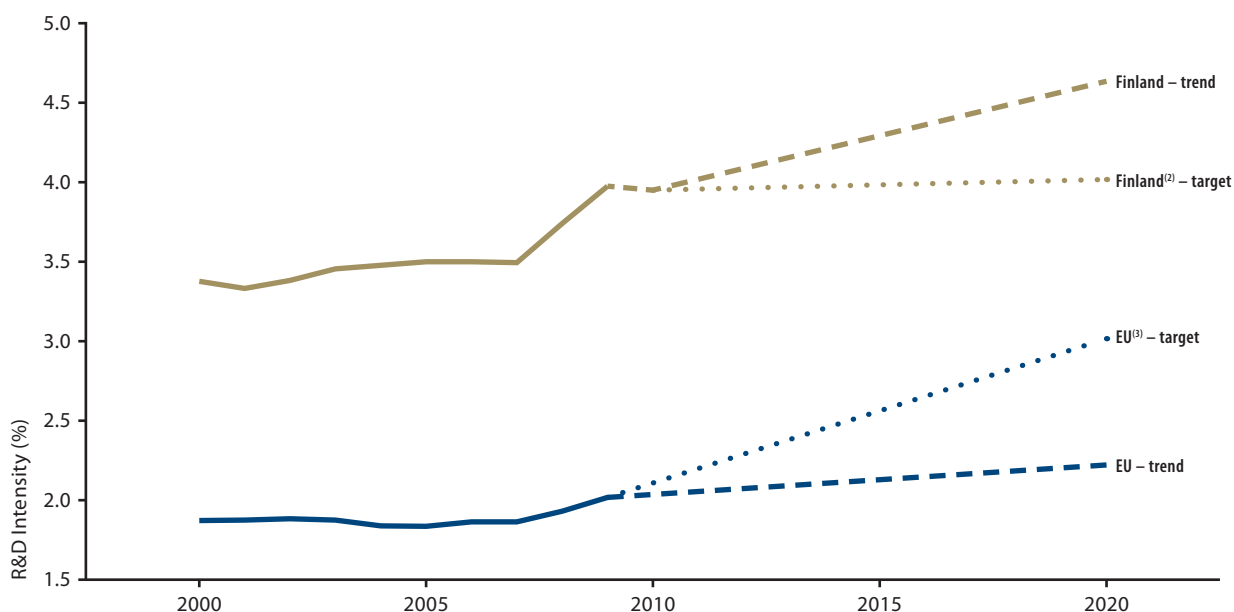
Notes: (1) High-Tech and Medium-High-Tech sectors are shown in gold. 'Other transport equipment' includes High-Tech, Medium-High-Tech and Medium-Low-Tech. (2) 'Chemicals and chemical products' is not visible on the graph.

Finland scores well above the EU average in terms of high quality scientific publications, patents and their contribution to a knowledge-based economy. In dynamic terms, in the last decade Finland has outperformed the EU, the United States and other highly knowledge-intensive countries in Europe in terms of private and public research and development investments and the share of new doctoral graduates. However, this rosy picture in terms of increasing input does not find its immediate translation in terms of growth in scientific and technological output, especially in terms of patents, where the country seems to lose ground vis-à-vis these reference countries.²⁸ This relatively weaker growth performance may be evidence that some areas could be improved. In this sense, the recent review of the 2011-2015 Research and Innovation policy guidelines of the Prime Minister draw attention to the need for boosting the effectiveness of public investments.

²⁷ Research and Innovation Policy Guidelines for 2011–2015; The Research and Innovation Council of Finland; Helsinki, Finland; ISBN 978-952-485-998-1(pdf); 2011

²⁸ Trends and Challenges in Demand-Side Innovation Policies in Europe, Thematic Report 2011 under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012); Kincsö Izsak & Jakob Edler, technopolis, 2011

R&D Intensity projections, 2000 to 2020⁽¹⁾



Source: DG Research and Innovation; Data: DG Research and Innovation, Eurostat

Notes: (1) The R&D Intensity projections based on trends are derived from the average annual growth in R&D Intensity for 2000-2009 in the case of the EU and for 2000-2010 in the case of Finland. (2) FI: This projection is based on a tentative R&D Intensity target of 4.0% for 2020. (3) EU: This projection is based on the R&D Intensity target of 3.0% for 2020.

The European context

The Innovation Union Competitiveness report²⁹ illustrates several aspects of scientific and technological cooperation. European-wide maps demonstrate that Finland is connected to the main nodes of the networks, which are located in major research-intensive countries of Western and Central Europe. The strongest links of the Finnish science and technology cooperation are with the main EU trade partners, especially Germany, Sweden and the United Kingdom, but some cooperation is also visible with Southern and Eastern European countries.

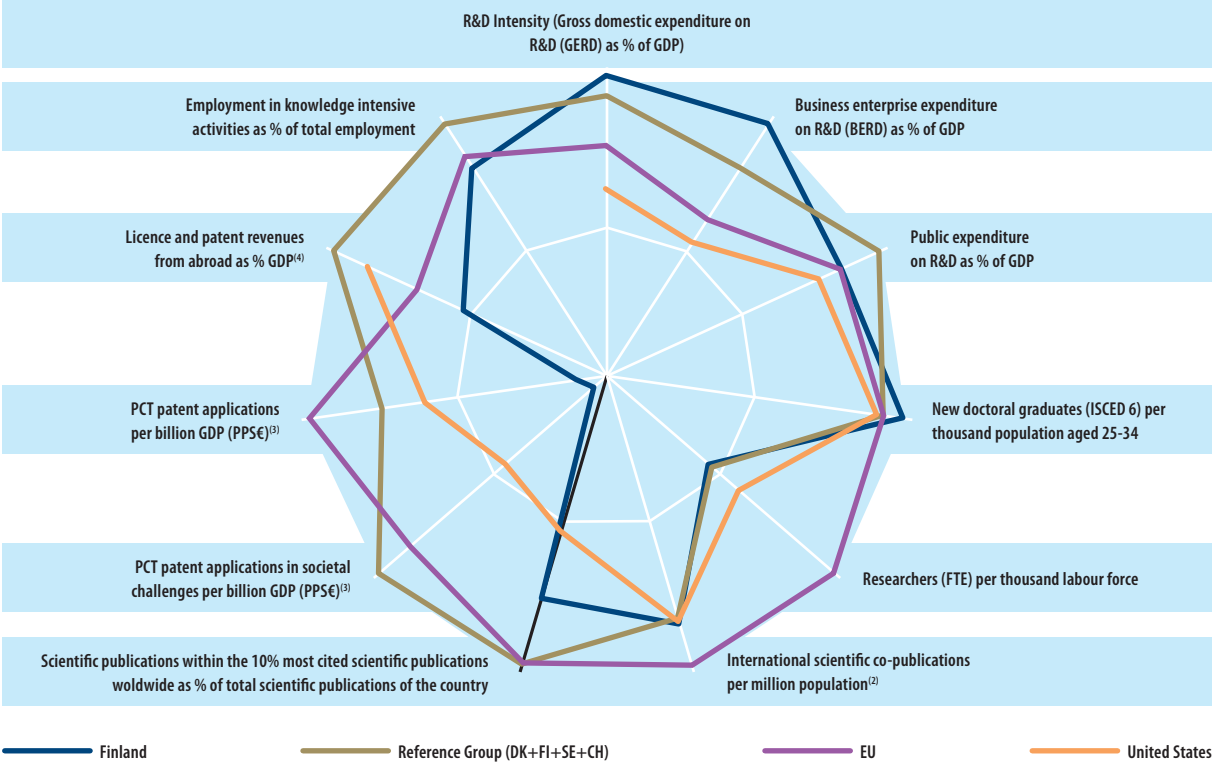
More generally, Finnish researchers are integrating in the international scientific knowledge flows as evidenced by the international co-publications including cooperation with the United States and Asia. However, despite being among the scientific and technological leaders in Europe, Finland's internationalisation in science and technology still remains behind the reference group including Sweden, Denmark and Switzerland, notably in terms of technological cooperation. This may signal an untapped potential for progress that could benefit future competitiveness and growth of the country.

In the last fifteen year, Finland has become a research intensive economy, with an important increase in terms of private research and development investments. The development of Nokia has led the High-tech ICT cluster to dominate the Finnish economy. ICT related growth has, to some extent, overshadowed the development of prior traditional sectors, such as Machinery and Equipment, which have however managed to increase their research and development intensity, measured as the share of research and development investment over total value added. Large sectors such as Construction and Fabricated metal products have demonstrated their capacity to raise their research and development intensity and to translate this in additional growth. The

²⁹ Innovation Union Competitiveness Report 2011, Overall review of EU Member States and Associated countries, Country Profile, FI – Finland; ec.europa.eu/research/innovation-union/index_en.cfm?pg=country-profiles§ion=competitiveness-report&year=2011

Pulp and Paper sector might get similar benefits over the years to come. However, it is widely acknowledged in Finland that the emergence of new research and innovation intensive sectors and growth companies are crucial for the future well-being of the country. In this regard, Finland expects service innovations and design to play a significant role. Conversations on how to foster this structural change are currently ongoing among major national stakeholders.

Average annual growth (%), 2000 to 2009⁽¹⁾



Source: DG Research and Innovation; Data: Eurostat, OECD, Science Metrix/Scopus (Elsevier)
 Notes: (1) Growth rates which do not refer to 2000-2009 refer to growth between the earliest available year and the latest available year over the period 2000-2010. (2) (i) The EU value refers to the median rather than to the average; (ii) CH is not included in the Reference Group. (3)

New instruments – SHOKs

Despite the recognised needs for change, the Finnish innovation system has remained rather stagnant since 2009 in terms of governance. The main developments will be the shift in the allocation of Tekes’ funding, which will in future be allocated through the Strategic Centres for Science, Technology and Innovations (SHOKs), rather than in the “traditional” programs. In 2010 the SHOKs received roughly 15 per cent (€99m) of all Tekes’ funding. The share of Tekes’ funding allocated to SHOKs will be raised to 20 per cent in the following two years.³⁰

An obvious shift, although not visible in the policy measures but in their funding, is the increased fraction of research and development-funding allocated to SHOKs. The increase of SHOK funding mirrors the efforts of focusing the national strengths and top know-how to some key areas that are hoped to be competitive in the global networks. SHOKs are clusters made up of large, multinational companies. Other instruments focused even more specifically at promoting SMEs

³⁰ Network governance and the Finnish Strategic Centres for Science, Technology and Innovation, Tekes Review 280/2011; ISBN 978-952-457-518-8; Helsinki 2011

and growth companies remain in operation. For example, the Tekes funding allocated for young innovative companies has nearly quadrupled since 2008. In 2010 roughly €19.5m were allocated to enhancing the capabilities of young innovative companies. The future trends of the innovation funding allocated through Tekes can be read in its renewed strategy. Tekes' project funding for enterprises under the new strategy will be targeted as follows:

Targeting of project funding for enterprises:

- one third for young SMEs;
- roughly one third for established enterprises with less than 500 employees;
- less than one third for enterprises with more than 500 employees if external impacts on other actors are significant, or if the company is essentially reinventing its business operations.

The funding will be channelled through different operating methods as follows:

- around 40 per cent for customer initiatives based on demand;
- around 20 per cent for research programs of the Strategic Centres for Science, Technology and Innovation (SHOK);
- around 25 per cent to focus areas through Tekes programs;
- around 15 per cent to other strategic choices.

The approach of SHOKs has been to concentrate efforts to a few areas of top expertise. However, at the same time there is an increasing focus on developing new, more broad based innovation policy instruments. When analysing the main changes in the innovation policy mix since 2009 a few obvious changes or increases in emphasis can be identified. Firstly, several new measures related to green innovation on environmental technologies have been introduced. This is not only a thematic focus but is also somewhat linked to the demand side since the government has been increasingly active in these measures to combine the research and development efforts with supportive regulation efforts. On the research side a somewhat increasing focus on welfare issues can be identified. There is also an increasing focus on partnerships and collaboration as more SHOKs have been able to launch their activities at full scale.

When comparing the developments in Finland with the priority areas of the EU's 'Innovation Union' objectives, at least two priority areas stand out. Firstly, although Finland has for a long time promoted collaboration between public research and private development activities there has been an emphasis on further developing activities to get ideas to the market. This includes not only measures to support commercialisation of research but also other measures to support especially young innovative companies. Another important field is the continuing support for innovation in services.

Skilled labour

The success of the Finnish information and communications technology industry was to a large extent dependent on the availability of flexible skilled labour. The Nokia case shows that the initial breakthrough in the telecommunications sector was made possible by the availability of specialised technical and research competencies, largely built up as a result of the mix of manufacturing solutions. The 1980s were characterised by a shortage of the labour skills needed by Nokia and other high-tech firms, and the companies invested substantial funds in specialised in-house training programs, sometimes in collaboration with Finnish universities and polytechnics.

By the early 1990s, the shortage of tertiary educated labour 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. This increase in the supply of labour has been essential for the expansion of the information and communications technology cluster.

It should be noted that Finnish high-tech companies still suffer from a chronic shortage of skilled labour, and total employment in the cluster would certainly be much higher under changed conditions. This underscores the requirement for the government to ensure a sufficient supply of skilled labour if it wants industry to offer sustainable employment for the benefit of the country.³¹

Innovation nexus

Finland is a clear lesson in the need to encourage networking. Networking between industry and science is so well developed in Finland that in the mid-1990s, 40 per cent of all innovative firms reported that they cooperated with universities or public research institutions, which is among the highest in the OECD. Collaboration reaches well beyond university participation in corporate research programs. In many of the current high-tech fields (including information and communications technology), 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.

The information and communications technology 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. The networked production paradigm, enhanced by cooperative long-term relations, can be seen behind much of the superior performance of Nokia and the Finnish information and communications technology sector in general. This is not only a feature of Nokia's operations: networking solutions have become increasingly common in the information and communications technology industry at large.³²

More generally, Finnish researchers are integrating in the international scientific knowledge flows as evidenced by the international co-publications including cooperation with the United States

³¹ National Innovation Systems: Finland, Sweden & Australia Compared - Learnings for Australia; Göran Roos, Lisa Fernström, Oliver Gupta, Intellectual Capital Services Ltd, London; 2005

³² National Innovation Systems: Finland, Sweden & Australia Compared, ABF report, 2005

and Asia. However, despite being among the scientific and technological leaders in Europe, Finland's internationalisation in science and technology still remains behind the reference group including Sweden, Denmark and Switzerland, notably in terms of technological cooperation. This may signal an untapped potential for progress that could benefit future competitiveness and growth of the country.

Finland's innovative potential relies to a large extent on the openness of all actors, political decision makers, higher education and industry on a flexible approach to adapt to changes in global market constellations. The interdependency within the innovation triangle is accentuated in the small country with a homogenous population expecting a lot from the state. Therefore, the unique understanding that the state is an active player in the innovation process forms the basis for the success of this country.

Conclusion

Finland is unique in many respects: its geographic location, its relative lack of natural resources, its homogenous and egalitarian societal structure, its linguistic isolation and its role in the European Union.

The success of the Finnish innovation system is a result of coherent and strategic policies in higher education, fiscal policies, industrial policies and foreign policies. The Nokia story contributes to an almost mystical perception of the Finnish innovation system.

The success of innovation policies is largely dependent on factors such as macro-economic conditions and capabilities development potential. The Finnish example of a functioning university-innovation nexus demonstrates that the framework conditions are set in an appropriate way, closely linking the policies and funding opportunities. This framework is supported by the European Union through its programs. The responsibility for improving a nation's level of innovation, with the consequent benefits it brings to global competitiveness, jobs and enhanced productivity, is a task that the Finnish government shares with the private sector and the higher education sector.

The development of a successful national innovation system in Finland demonstrates how vital it is to give priority to coherent innovation and technology policies as a key driver of a country's economic growth. It is also vital that these policies are complemented by investment in innovation and technological development. Furthermore, these policies must be focused on deliberate and coherent implementation actions over a longer timeframe. Such a holistic approach allows Finland to capitalise and build on the nation's strengths and specific circumstances to create self-sustaining innovation capabilities in its companies, improving global competitiveness.

Within such a framework and focus, nations can make choices about where to allocate resources in a way which most potently enhances their industrial capability, their economic prosperity and their social wellbeing.

The public investment in research funding is observed as the main driving force for university/industry cooperation, on the institutional level and among researchers. The relationship between the universities and the nearby/on campus research institutes seems to be particularly fruitful when the roles of both on institutional and project level are clear with respect to: division of work and budget, publishing, intellectual property rights and guidelines for contacts with industry.

When the general demand in existing industry for innovative impulses from universities is low, government funding can stimulate the universities through specific programs to contribute to the process of developing new knowledge-based industries in an investment friendly environment. Benchmarking informs policy, but it cannot substitute for a democratic process of decision making. The Finnish example displays a broad political debate among stakeholders (business, professional associations, unions, and academia) to explore the acceptability of the policy options available.³³

Investment in education has responded to the needs of national development. The outcome has been a high quality but diverse system with specialised institutions using the best pedagogical approaches from around the world and working to clearly defined educational objectives. Vocational education has the same status as university education because both are seen as

³³ The role of the University in Economic Development: an Analysis of Six European Universities of Science and Technology, Sigmund J. Waagø (Editor), Einar Rasmussen, Thomas Kvaal, Magnus Gulbrandsen, Eilif Trondsen, GREI, NTNU, Norway 2001

necessary; and the institutions responsible for each complement each other and collaborate in many ways. The clearly defined and differentiated missions of the various teaching and research institutions meet the different needs within the innovation system. The diversity of roles, responsibilities and approaches facilitates specialisation and differentiation, fostering innovation in Finland. Nevertheless, the resilience of the system, given its high dependence on a single company which is now operating in a more competitive environment might again require similar far reaching decisions. In this context the relative importance of polytechnics and universities in meeting the broader skill needs of the Finnish innovation system might become a key factor for the further development of Finland.

Considering all the boundary factors it is apparent that the policies and programs developed in Finland build on the particular characteristics of that country. Nevertheless, it appears that the strong national vision and an acceptance of the need for national investment building on human capital rather than natural resources has been an important factor in promoting and facilitating flows of information, technology and funding between the education sector and business.

