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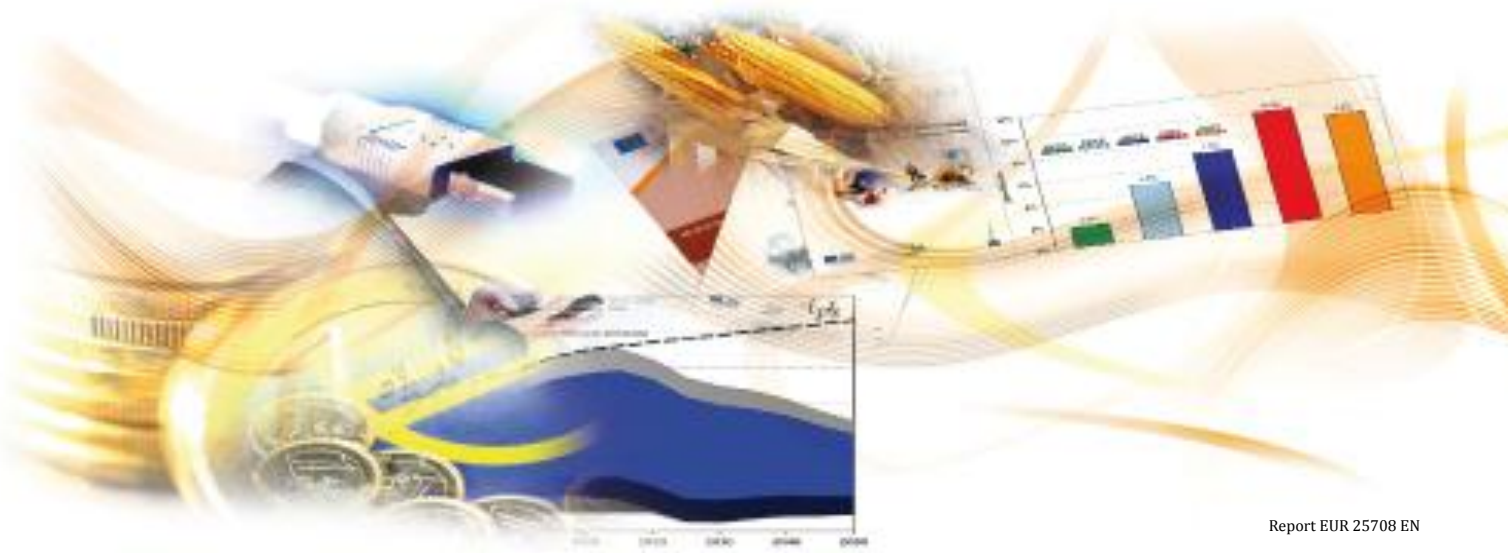

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Executive Summary

Finland is a country that ranks well in various comparisons measuring innovation and competitiveness. Finland has also been considered as one of the best innovation systems worldwide. The strengths of the innovation system include a high level of research and development (R&D) intensity, high level inputs provided by the education system, a large proportion of the labour force with a tertiary qualification (also a high level of graduates in science and engineering), and a high level of patenting.

Finland ranks in the Group 1 "Very high knowledge-intensity countries" in the latest Innovation Union Competitiveness report (2011). According to the international evaluation of the Finnish innovation system (2009) the Finnish innovation system can be considered as one of the best innovation systems worldwide. In the last decade the general performance of the Finnish innovation system has also outperformed the European Union (EU), the United States and other highly knowledge-intensive countries in Europe in many indicators, such as private and public R&D investments and the share of new doctoral graduates.

Finnish Gross Domestic expenditure on Research and Development (GERD) is nearly 4% of Gross Domestic Product (GDP) which is significantly higher than most other European countries. The economic downturn has affected the GDP growth rate negatively in 2009, which was replaced by an upward trend in 2010. Maintaining the high level of GERD is one of the policy goals of the Finnish innovation system accompanied by objectives such as the promotion of knowledge-based innovation policy; undertaking structural reforms in R&D to further foster it; as well as overall development of the operating environment of growth companies within the scope of a broad-based innovation policy.

There are several structural strengths to be seen. Finland has a high level of R&D intensity with is also above EU average growth for the period between 2000 and 2009 (3.4% versus 2.5%). The level of business enterprise R&D expenditure (BERD) is among the highest in the world (over 70% of GERD) although there has been a notable decline during the past few years as a result of the economic downturn (the tentative figures from 2011 suggest that BERD may be starting to rise again).

The education system also produces high level inputs. A large proportion of the labour force has a tertiary qualification and the public funding for education is relatively high. The number of researchers as a percentage of the labour force was nearly twice the estimated EU-27 average in 2009.There is also a high level of graduates in science and engineering in Finland with above average growth during the past ten years. Relative to the population aged 25–34, the number of new doctoral graduates is also high.

The quality of research infrastructures can be described as mediocre, because the concept has not been clear to members of the scientific and scholarly communities and because the quality of conducted research has not yet indicated a need for infrastructures at the national level (Ministry of Education, 2009). A roadmap for important research infrastructures (2009) and a new funding instrument "Research infrastructures (FIRI, 2010)", aim to improve the situation. The Finnish Minister of Education has also signed a letter of intent with Chinese Minister of Science and Technology on November 2011 that aims to produce a roadmap containing issues of mutual interest in order to deepen the scientific cooperation between the two countries.

The situation with the private sector also seems to be quite positive. The proportion of small and medium sized enterprises (SMEs) performing R&D is high (above 0.5 % GDP). SMEs with new or significantly improved products new to the market as a per cent of all SMEs with innovation activities (2006-2008) has been above the EU average (31.7% and

27.0% respectively). The innovation system is also targeting the private sector as the share of innovative enterprises that received public funding is the second highest in the EU. In general the share of state aid to R&D was 31.8% in 2009.
The rate of patenting is generally quite high. According to the OECD (2010) there were 64 triadic patents per million of population in Finland in 2008, almost double the OECD average. The number of Patent Cooperation Treaty (PCT)[1] patent applications per billion GDP (Purchasing power standard (PPS€) was 9.96 in 2008, which was also higher than most of the other leading countries in the EU as well as the United States.
Although Finland is considered as one of the leading countries in terms of research and innovation performance, several structural challenges have been identified. The most important of these are:

1. Weak internationalisation of the research and innovation system
2. The quality of scientific research and its better application
3. The fragmentation of the higher education and the public research sector
4. Strong emphasis on supply side measures
5. Concentration of private R&D to few sectors and companies

Recent changes in the policy mix include the establishment of the Strategic Centres of Science, Technology and Innovation (SHOKs), the Universities Act, mergers of universities and a renewal of Tekes' strategy. Additionally new programmes from Tekes and the Academy of Finland begin on an annual basis. Societal issues such as ageing, globalisation and the environment, an emphasis on growth companies, public procurement as well as demand and user-driven innovation have been high on the agenda.
Finland is characterised by a fairly open and increasingly internationalised research system, in which international collaboration is active and the research organisations, funding organisations as well as the private sector are relatively networked. Also the leading companies are highly globalised with extensive international R&D networks and R&D activities abroad due to Finnish economy being open with high share of exports and imports to GDP.
Although key businesses and the research performers are highly internationalised, the level of internationalisation of the Finnish research system in general is still quite low. Moreover, the system depends rather heavily on domestic human capital and the research system has had difficulties in attracting talented researchers and students. Despite efforts (such as tax reliefs in the Aliens Act), having a sufficient pool of qualified human resources remains a challenge and relatively low levels of inward and outward researcher mobility add to the challenge. The higher education system has been lacking career models for researchers whereas the private sector has been struggling in providing proper employment for PhDs.
Knowledge demand is being facilitated mainly through interactive and joint preparation of R&D programmes and other measures, especially the new research calls in the Strategic Centres of Science, Technology and Innovation (SHOKs). It has been pointed out that the Finnish innovation system is becoming too complex and especially SMEs find the measures increasingly difficult to use. Hence the lack of new policy measures can be considered a positive phenomenon.
The most pressing issues of the Finnish innovation system and its policy mix relate to emphasis on supply side instruments, lack of (growth) entrepreneurship, degree of

[1] http://www.wipo.int/pct/en/

internationalisation of the research and innovation system, the quality of scientific research and its application, the fragmentation of the higher education and the public research sector as well as concentration of private R&D to few sectors and companies. A specific policy programme promoting demand side innovation has been established to balance the emphasis on supply side. Growth entrepreneurship has been promoted by establishing the VIGO accelerator programme and the Tekes Young Innovative Enterprises funding (YIE). The strategy for the internationalisation of Universities, internationalisation of science on key objectives in the Research and Innovation Policy Guidelines for 2011–2015 and the FiDiPro-programme represent ways to increase the degree of internationalisation of science. The SHOKs invite companies to invest in R&D in their specialised fields, thus leveraging the research and development efforts of the business enterprises to larger range of sectors.

Finnish research policy developments are well-aligned with the European Research Area (ERA). The Finnish government is currently considering European instruments such as mobility schemes, ERA-NETs and research infrastructure as an integral part of the policy mix. In addition to the European dimension, opening up the national research system has developed, although with research programmes this development has been quite slow. Finland has also several bilateral research agreements with third countries. Furthermore, Finland participates in Nordic research collaboration.

All in all, research and innovation policies are changing gradually in Finland. Societal challenges have been recognised in the national policy, but there is also concern about the ability of the research and innovation system to address these issues. Several reforms have already taken place (including university reform, the structural reform of the higher education system, national innovation strategy) and more changes are underway concerning the admissions to universities and the funding models of universities.

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1 Introduction

Finland is a sparsely inhabited country with 5.3 million inhabitants (only 1.07% of the European Union (EU) population) located in northern Europe. By land mass Finland is the 8th largest country on the continent. The Gross Domestic Product (GDP) of Finland was €173,267m in 2009 while GDP per capita (in purchasing power standard (PPS)) was €29,600 thus being clearly above the EU-27 average (€23,500). The total intramural research and development (R&D) expenditure on gross domestic expenditure on R&D (GERD) was €6,786m, representing 3.96% of GDP, and being significantly higher than the EU-27 average of 2.01%. The share of business enterprise expenditure on R&D (BERD) was 2.83% of GDP in 2009 or 71% of GERD. The higher education sector R&D (HERD) reached 0.75% of GDP representing approximately 19% of GERD leaving the public sector share of R&D (Government Intramural Expenditure on R&D, GOVERD) to 0.36% (9% of GERD). The corresponding figures for EU-27 were 1.25% (BERD), 0.48% (HERD), and 0.27% (GOVERD) (Source: Eurostat).

In terms of research inputs, measured by human resources in science and technology as a share of labour force (50.7% in 2009) Finland ranks well compared to the EU-27 average (40.1%) and is on the same level with other innovation leaders (Innovation Union Scoreboard 2010).The quality of research infrastructures has been moderate but there has been relatively little funding devoted to them in the past (Academy of Finland, 2009).

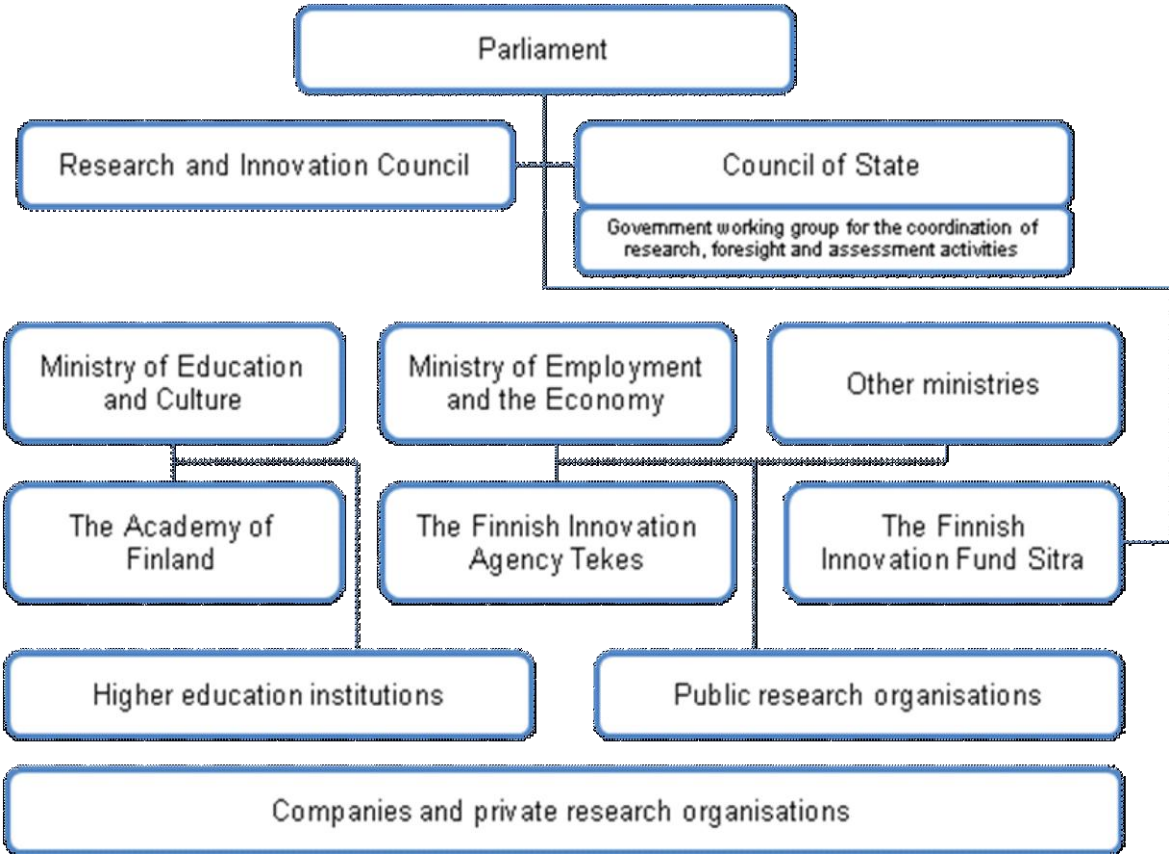
In terms of outputs, for the number of patents and publications Finland is third among Organisation for Economic Cooperation and Development (OECD) countries in terms of scientific articles and above average in number of triadic patents per capita (OECD, 2008). Moreover, the estimated number of patent applications per million inhabitants in 2007 was 253 while the estimated EU-27 average was 117. (Source: Eurostat). A recently published report (Ministry of Education and Culture, 2011) illustrates that the amount of Finnish Web of Science publications has more than doubled from 1990 to 2010. During 2006 -2009 there were more Finnish publications (per capita) than in any other OECD country. The Finnish economy is similar to other western economies. Services account for more than two thirds of production (68.5 %) whereas the share of agriculture is small (3 %). Industrial production still plays a key role especially to exports although its overall share of production (28.5 %) is decreasing slowly. Important sectors in the Finnish economy are electronics and electricity, machine and metals industry, chemistry as well as pulp and paper. Within services significant branches are retail and business services, logistics and whole sale. Life sciences, health and well-being, clean technologies as well as creative industries/services are expected to become strong sectors in the future, which is reflected for instance in the new Tekes strategy (Tekes Strategy, 2011).

Since the recession of early 1990s Finland has been a forerunner in technology-based product and process innovations and is home to well-known telecommunications corporation – Nokia. There are other ground breaking enterprises in Finland as well, including elevator company Kone, mobile game company Rovio, and others such as Metso (forestry), Wärtsilä (mechanical engineering), or Suunto (manufacturing) amongst others. Some Finnish companies have struggled with usability and user friendliness of products (the focus has been on technological innovations and too little attention has been paid to the needs of end-users) while others (especially Rovio) have succeeded in highly competitive markets. A great majority of company R&D is still

conducted by Nokia, but this is likely to change due to the increasing need of SMEs to engage in R&D in order to gain competitive advantage.
World class research also takes place in Finland, especially in the fields of medicine, biology, chemistry, neuroscience and materials research. The universities and other higher education institutions, however, need to define more distinct research profiles than what they currently possess in order to stand out in Europe or the rest of the world. At the moment the University of Helsinki is the only Finnish university among the best 100 universities in the world. Additionally the new Aalto University represents an interesting combination of disciplines following the merger of Helsinki School of Economics, the University of Art and Design Helsinki, and the Helsinki University of Technology.
Apart from universities and other higher education institutions (HEIs), facilitation of knowledge demand takes place through interactive joint preparation of various R&D programmes and other measures. The most important of these have been the new research calls in the Strategic Centres of Science, Technology and Innovation (SHOKs), which have been jointly prepared by the stakeholders from the private sector, public sector and the higher education sector. There are currently six SHOKs operating in the fields of build environment, energy and environment, forestry, health and well-being, information and communication technology (ICT) and metals and engineering competences. Cross-sectoral cooperation has increased in science and innovation related issues during the past few years despite a historically developed sectoral division of labour between the two ministries for science and technology policy.
The Finnish governance system is a strong mix of national and local administration allowing regions to have a relatively high degree of autonomy in the design and implementation of regional policies. Innovation policies and strategies, however, are guided and directed by the Finnish government, which decides on national development goals and lays down the general guidelines for regional innovation policy.
As illustrated in the figure at the end of the chapter, the Finnish research and innovation system is divided to four operational levels. The Finnish Parliament and the National government rule the highest level. In matters related to research, technology and innovation policy, the latter is supported by a high-level advisory body, the Research and Innovation Council (RIC; formerly Science and Technology Policy Council of Finland). The RIC is responsible for the strategic development and coordination of Finnish research and innovation policies and is led by the Prime Minister. The national government – regardless of its political composition – has taken part in science, research and innovation policy issues.
The second level consists of the ministries, of which the Ministry of Education and Culture (MoE)and the Ministry of Employment and the Economy (MEE) play the key role with respect to research policy. Together these ministries account for over 80% of government research and innovation funding with the MoE having around 45% of all funding and MEE around 36% of funding in 2011. The share of MoE has increased during recent years mainly due to additional funding to universities and the Academy of Finland.
The R&D funding agencies, the Academy of Finland and Tekes, the Finnish Funding Agency for Technology and Innovation, form the third level. The former funds basic research through competitive grants (worth of €384m in 2010) and the latter allocates the majority of its funds to R&D projects carried out by companies. Tekes is also a large financier of research at the universities and public research institutes. In 2010 Tekes funding decisions amounted to €633m.

Other important instruments are the planning processes of the R&D programmes by Tekes (such as the new programmes "Growth from Renewables 2010–2014", "Green Growth 2011-2015", and "Green Mining 2011-2016" launched in 2010 and 2011), the Academy of Finland and various ministries. Additionally the MEE has published an action plan for measures to support demand-led and user-driven innovation policy and the Academy of Finland has also published a strategy for research programmes.
The fourth level is comprised of the organisations that conduct research: universities (16), public research organisations (18), private research organisations and business enterprises. Due to the high number of universities, polytechnics and government research institutes the Finnish research system is rather decentralised. 84.6% of Finland's HERD was spent in universities, 9.7% in polytechnics and 5.7% in universities in 2009. The University of Helsinki, the Aalto University, the University of Oulu and the University of Turku are the largest higher education institutions in Finland and their share of external R&D funding accounted for more than 60% (over €400m) of all external R&D funding of universities in 2010 (Statistics Finland, 2011). Most of the external funding comes from public sources (Tekes, Academy of Finland and the EU). The private sector finances 6% of the R&D at the universities and 13% of the R&D at the PROs. Collaborative research projects between the private and the public sector actors are relatively common. The biggest state research organisation is Technical Research Centre (VTT) with an annual budget of approximately €290m. The sectoral research was renewed to strengthen multidisciplinary research and to support large research projects. Funding targeted to sectoral research will increase gradually to €10m by 2015. The private sector, however, is the main knowledge provider in Finland as close to 70% of R&D spending is financed by the private sector. Private sector R&D is concentrated (more than 80% in 2010) in large companies with over 250 employees. Moreover, the ten largest companies account for nearly 60% of all the private sector R&D (Statistics Finland, 2011).

Figure 1: Overview of the Finland's research system governance structure



Source: Research.fi, revised by the authors

2 Structural challenges faced by the national system

Finnish strategic objectives for research and innovation policies have undergone gradual changes during the past years. Despite a good performance in research and especially innovation, many challenges have been identified. As pointed out in the 2009 international evaluation a closer look suggests that even Finland appears to have certain structural challenges (Ministry of Employment and the Economy & the Ministry of Education, 2009). The two ministries that commissioned the evaluation wanted an independent outside view of the system. Additionally attention was to be paid to future challenges, the need for institutional and policy adjustments as well as conclusions on policy governance and steering.

The evaluation panel consisted of six foreign and twelve national innovation policy experts and was supported by a team of researchers. The assessment was built around the following topics: broad-based innovation policy, demand- and user-driven innovation, globalisation of business activities, growth entrepreneurship and finance, the geography of innovative activity, and education, research and the economy.

One of the key points identified in the evaluation was that despite having good labour productivity development and high levels of R&D, the main weaknesses of the Finnish innovation system are a lack of growth entrepreneurship and difficulties in internationalisation. Finland's rate of high-growth entrepreneurial activity lags significantly behind most of its European and all of its Scandinavian peers (Autio, 2009). Finland also faces challenges in nurturing technology start-ups with high-growth

aspirations, the use of new technologies, and the internationalisation orientation and micro-angel activity (Autio, 2009). This is a difficult paradox since at the same time Finland ranks highly in terms of attitudes towards entrepreneurship and high per capita investment in R&D. There are also several structural problems in the system with a complex support system as well as structural challenges related to research performers (universities and public research organisations).

The panel therefore called for a radical reform of the innovation system due to the lack of an international dimension, a complicated and fragmented structure and the fact that companies (especially small businesses and start-ups) find the system difficult to use. Furthermore the panel proposed to increase the mobility of researchers and strengthen international partnerships in universities and research institutions. In the business sector the more efficient promotion of international links was called for.

The Research and Innovation Council publishes its reviews every four years, which set out the guidelines for future policy. These reviews as well as the National Reform Programme (NRP) set recommendations for research and innovation policies based on current weaknesses and future challenges. In the most recent recommendations (Research and Innovation Council, 2010) the main targets have been to increase the number of companies involved in R&D work, structural reform of the public research system, structural reforms to the R&D system to promote knowledge-based growth, harmonizing the research and innovation policy strategies of various actors, the encouragement of new forms and areas of demand-based and user-oriented innovation, strengthening internationalisation, the development of the policy support system for growth companies, improving framework conditions such as a better entrepreneurial atmosphere, support for serial entrepreneurship, support for the increase in private venture capital and a stronger competence basis for growth entrepreneurship. There have also been measures to bring together scattered R&D resources to form strong national knowledge clusters. More attention has been given to the utilisation of research to respond to the grand challenges in the society, environment and business.

Based on the recent analysis in the evaluations and strategy documents the key challenges can be summarised as follows:

1. *Weak internationalisation of the research and innovation system*

Internationalisation has been a policy objective in Finland for quite some time, but so far the results of the policy measures have been modest. The degree of internationalisation of science is still considered as one of the key weaknesses. When we compare the percentage of foreign researchers and students involved in the research system of many other leading countries, Finland clearly lags behind in many respects. For example in the mobility of researchers Finland has a positive net inflow of researchers; that is, more researchers are coming to Finland than leaving the country. However, the total flows are smaller than in many other countries, which is an indicator that especially the research system in the country is not as open as it could be (Ministry of Employment and the Economy & the Ministry of Education, 2009). The share of foreign R&D-investment as a share of private R&D in Finland was 6.5% in 2007 (Eurostat, 2010), which is low in international comparison. In this light it is not surprising that specific strategies for internationalisation have been designed for the higher education sector as well as the Academy of Finland.

The structural weakness of internationalisation also applies to human resources more broadly. The international evaluation of the innovation system concluded that the “lack of global insight and foreign expertise” gained through foreign immigrant human capital, foreign R&D investments and venture capital investments is a major challenge in the global knowledge economy. In addition to that the level of foreign direct investment is

low compared to other leading countries; in terms of commercialisation there is also a visible lack of foreign co-patents (OECD, 2010).
There are many instruments and organisations supporting internationalisation in Finland but the results have been limited (Ministry of Employment and the Economy & the Ministry of Education, 2009). This may be the result of a lack of coordination between various organisations or simply a lack of understanding of the needs and best practices of supporting especially SMEs in their internationalisation.
It has been also noted that a particular challenge for Finland in its efforts to attract foreign talent relates to research environments and researcher salaries in the public and higher education sectors, which in many cases have not been competitive enough (Viljamaa et al., 2010). Many other countries have also invested more in developing national research infrastructures than Finland, for example with concrete investment programmes for several years (Viljamaa et al., 2010).. Suggestions to address this challenge includes more focused research funding, increasing the role of basic research, development of postgraduate education, the creation of a genuine research career system and enhancing mobility (Viljamaa et al., 2010)..

2. *The quality of scientific research and its better application*

There have also been discussions about the ability of the Finnish research system to produce high-level research. According to a recent study (Suomalaisten tutkimusorganisaatioiden, 2011), with 1,259 annual scientific articles per million population between 2006-2009, Finland ranks first among OECD and Brazil-Russia-India-China (BRIC) countries and contributed 0.5% of all publications. However, when looking at the scientific citations Finland ranks only 15th during the same period and is behind other Nordic countries. At the same time there has also been a concern that the R&D investments have not yet been converted into new innovations and jobs in the way it was expected.
Finnish universities in general do not fare that well in international comparisons. The only Finnish university ranked in top-100 of the Shanghai ranking is the University of Helsinki. Most Finnish universities rank average in the international university rankings. This indicates that the Finnish universities have a good basic quality of research but relative few fields of international excellence. The regional policies of Finland may have also affected the level of science in several Finnish universities while several of them have been established in remote locations based more on equal regional policy than actual demand. Currently the MoE is considering the Finnish network of HEIs and contemplating if some units should be reorganised and/or merged.
On 15 March 2011, the Ministry of Education and Culture appointed a committee to review the current university funding model and make a proposal for its reform. The proposal was to be ready to enable the new funding model to be applied in the allocation of the core funding for the year 2013. The committee's proposal is based on its vision of a good Finnish university in 2020. The aim is a better, more efficient international university system with stronger impact and a better defined profile. The new funding model is one step towards this desired state.
One key change proposed by the committee to the model used in 2010–2012 is greater emphasis on quality. Funding would no longer be allocated on the basis of target number of degrees, and the relative weight of scientific publications would grow.
The state of research infrastructures is widely considered as moderate and seen as seen as old, and highly fragmented. The organised development of research infrastructures has not been a focus in research and innovation policies (Academy of Finland, 2009; 2008). There have been investments in research infrastructure but the level of investments is considered to be behind the leading countries. In 2009 a new roadmap

for national research infrastructures was published (Ministry of Education, 2009). The project identified 24 national-level research infrastructures and proposes 20 initiatives to be included in a list of new infrastructures or major upgrades of existing infrastructures. The new research infrastructures would cost approximately €30m annually, while the costs of current national and international infrastructures are €160m a year. However, there have been difficulties to find funding for the development of research infrastructures in the national budget.
Several changes have been underway to address the problem. These include measures to improve internationalisation and especially the attractiveness of the Finnish research system as well as the development of research career system and research infrastructure and structural changes in the higher education and pubic research institute systems (Research and Innovation Council, 2008; 2010).
The need to address the situation in the public research system was already addressed in 2005 by the Science and Technology Policy Council (nowadays Research and Innovation Council). A need to develop internationalisation, the quality of science as well as the commercialisation of research was identified.

3. *The fragmentation of the higher education and the public research sector*

The quality of research and its efficient use in the society is linked with the structure of the research system. According to the international evaluation of the Finnish innovation system (Ministry of Employment and the Economy & the Ministry of Education, 2009) the Finnish higher education and public research system is fragmented, which makes it more difficult to focus resources and to provide high-level research. According to the evaluation the system can be seen as fragmented in three dimensions: firstly, resources are scattered in three different types of organisations with overlapping tasks – universities, polytechnics and public research organisations (PROs). Secondly these institutions are scattered around the country with several rather small units. Thirdly, the universities have been internally fragmented in several rather small units.
Although university reform has advanced during recent years, and many successful organisational changes have been carried out, there have been difficulties in implementing structural reforms in PROs. This sector recently has only faced some organisational mergers or regrouping of tasks. One recent example is consortium of the expert authorities for social welfare and health care. The consortium is a partnership for research between the National Institute for Health and Welfare, the Finnish Institute of Occupational Health and the Radiation and Nuclear Safety Authority, established by the Ministry of Social Affairs and Health in January 2011 to coordinate research and expert services.
However, the Government is committed in continuing the reform process. In the 2010 government programme it is stated that "The state sectoral research institutions will be combined into larger entities. The division of responsibilities in basic research activity between universities and sectoral research institutions will be clarified, facilitating the transfer of responsibilities from sectoral research institutions to universities, and cooperation between the organisations will be enhanced" (Government Programme, 2011).

4. *Strong emphasis on supply side measures*

The Finnish innovation system relies mainly on supply side instruments for R&D support. This has been effective in the past but may lack the dynamic for supporting those research fields and industry sectors that are new, on the rise and outside the scope of current strategies. There is an initiative to develop more demand-side policies to support innovation but it is still in the early stages of development. Finland also lacks

indirect instruments such as tax incentives for R&D. This significantly weakens the whole policy-mix of Finland compared with some other countries. According to the latest OECD Science, Technology and Industry Scoreboard (2011) the direct government funding for business R&D was 0.17% and there was no use of tax incentives. At the same time the leading EU country, France supported private R&D direct with 0.15% of BERD of direct funding but also with tax incentives worth 0.23% of BERD. The issue with R&D tax incentives is somewhat connected with the discussion to develop the role of the Ministry of Finance (MoF) alongside the MEE (innovation policy) and the MoE (science policy) in the development of research and innovation. Specifically the development of an innovation supportive tax system might be further developed.

In terms of policy and the functioning of the innovation system, policy makers seek to cater for the needs of a wide spectrum of potential users who operate under a range of circumstances. As a result, the enterprise support system has become excessively complex to both access and administer. From the perspective of an outside observer (such as, for instance, a potential entrepreneur), programmes often seem to overlap with other programmes and on some occasions multiple public agencies appear to work broadly in the same area and/or with the same firm (Ministry of Employment and the Economy & the Ministry of Education, 2009).

5. *Concentration of private R&D to few sectors and companies*

Since Finland is characterised by a high level of BERD it is important to notice the high dependency of the system on one specific sector, ICT and especially the cluster that has been developed around one company, Nokia. In 2010, 58% of private sector R&D was concentrated in the Electronics, computers and electronic devices sector (Statistics Finland, 2011) Companies in general have high investment rates in innovation activities (3.37% of turnover) (Statistics Finland, 2011) and there is also a high involvement of the private sector in the financing of domestic R&D activities. The number of joint publications between private and public actors is also relatively high.

Although the development of SHOKs have been considered welcome in terms of focusing resources and renewing established strong business areas, it seems unlikely that they will be able to efficiently support R&D in emerging business areas and SMEs.

Another specific feature that has been identified is that Finland is not specialising in education-intensive sectors in production (and trade) as much as some other smaller economies. There is a heavy specialisation in high-tech and especially in ICT industries and manufacturing specifically, but less so in human capital intensive production. This is also evident in the fact that the share of services and especially knowledge intensive services is lower in Finland than in other leading countries (for instance Denmark, Sweden, and Belgium) (MEE & MoE, 2009).

These lead to a general challenge in that compared with high level R&D investments and business R&D, a relatively few world class advanced class services or goods originate from Finnish innovations or Finnish entrepreneurial firms (Ministry of Employment and the Economy & the Ministry of Education, 2009).

It also seems to be that despite several instruments and organisations addressing innovative enterprises there is a lack of more general support for entrepreneurial culture and especially a culture for going global. This has been evident in the lack of support for entrepreneurship as a career choice in the university system. One idea behind the university reform and especially the creation of multi-disciplinary Aalto University may be seen to better promote innovative entrepreneurship (as well as innovation).

There are also other challenges more related to innovation and entrepreneurship. Especially growth entrepreneurship and the development of young innovative

enterprises have been considered a key challenge for policy and measures to address these issues have been planned. Entrepreneur activity has, however, risen after the economic crisis and among the 59 countries assessed in the Global Entrepreneurship Monitor (2010) Finland ranks 32nd (Stenholm et al., 2010). Overall one of the key challenges identified is the innovation system as a whole has over the decades become complex and difficult to administer. As a result, recommendations to make reforms in the whole education, research and innovation system have been suggested (see Ministry of Employment and the Economy & Ministry of Education, 2009).

3 Assessment of the national innovation strategy

3.1 National research and innovation priorities

Evaluations are seen as an effective tool for governance in Finland and they are utilised for the assessment of effectiveness of various organisations and programmes (for example by ministries, universities, Tekes, the Academy of Finland and the programmes of the two latter). Programme evaluations (ex-post) are conducted in order to monitor the impact and influence they have and to develop the operations in the future. Longer programmes are often subject to mid-term evaluations. Assessments are also a tool for developing the Finnish innovation system.

The latest National Innovation Strategy was published by the MEE in October 2008[2] based on a proposition of a Steering Group, taking a broader approach to innovation policy that goes beyond traditional R&D funding. The creation of the strategy was part of the 2007 government programme. The innovation strategy's preparation was open, being based on some 800 views contributed by experts, stakeholders and citizens through workshops and the Internet.

It was stated in the strategy that priorities of innovation policy will be "moved in the direction of markets that promote innovations, non-technological development, user-orientation and public services". The strategy formed a basis for the more specific objectives that were presented in the Finnish National Reform Programme 2008-2010:

- More companies involved in R&D work
- Government research institutes receiving more external funding for research
- Strengthen the role of VTT Finland in the implementation of innovation policy
- Knowledge-based innovation policy will be promoted and structural reforms in R&D will be made to further foster it
- Innovation policy strategies and measures of those executing them will be harmonized to the basic range of options in the national innovation strategy
- Encourage new forms and areas of demand-based and user-oriented innovation activities (incl. public and private services) within the innovation policy, such as expanding innovation policy to the service sector, including fostering innovations in social welfare and health care services
- Strengthening of the link between internationalisation and innovations

[2] There is no specific end date for the strategy.

- Development of the operating environment of growth companies[3] within the scope of a broad-based innovation policy (better entrepreneurial atmosphere, more serial entrepreneurship, more private venture capital and stronger competence basis for growth entrepreneurship)
- Bring together regionally dispersed research, development and innovation activities into networks of innovation communities and create strong regional innovation clusters on the basis of national content selection and the strategic strengths of each region

Societal issues (for example, globalisation, ageing, the environment and public health) however pose a challenge to growth and well-being and they have been recognised in national policy. At the same time concern has been expressed about the ability of the research and innovation system to address these issues. The challenges can be tackled with public sector innovation (or public procurement), growth entrepreneurship, service innovation as well as user and demand driven innovation. Tekes also has a specific programme "Innovations in social and health care services 2008—2015" targeting issues related to society and well-being.
Moreover, societal issues are emphasised in the research and innovation policy review 2011-2015, drawn up by the RIC once in every term of office. Challenging economic circumstances and the need for a more open and dynamic operational environment have been acknowledged in the review that suggests doing things in a different way (including development of structures and encouragement of experiments). The main objectives of the review are the following:

- Grand societal challenges are systematically considered in the alignments of education, research and innovation, in the resources and in the development of actions and measures
- Internationalisation will be expedited, Finland's visibility and attractiveness as a location for living and business will be strengthened

Additionally, reorganisation of resources is considered necessary in order to be able to gather an adequate level of critical mass. More funding is also called for from the private sector alongside public sector funding. The national objective is to keep the research and development funding of approximately four per cent of GDP, including a Government contribution of 1.2% of GDP.
The various strategy documents have followed a relatively consistent development path. During the past three years new measures have been introduced to support demand and user driven innovation, as well as service innovation. Societal challenges have also been addressed but to a lesser extent. The university reform (with the new University Act in 2010) has addressed the issue of universities to have more flexibility to promote high-level research, internationalisation and focusing of resources.
The key "hot topics" in Finland have been demand driven innovation, user-centred innovation service innovation and the support of enterprise growth and internationalisation (growth entrepreneurship).
Tekes has also renewed its strategy (Growth and wellbeing from renewal) in 2011 giving priority to growth-seeking, innovative SMEs. The specific thematic and sectoral focus of the research and innovation policies is also best seen in the Tekes priorities. Emphasis is placed on forerunners and strategic innovations on six focus areas: natural

[3] The OECD/Eurostat definition is used for growth companies: all enterprises with average annualised [employment] growth greater than 20% per annum, over a three-year period, and with ten or more employees at the beginning of the observation period.

resources and sustainable economy, vitality of people, intelligent environments, and business in global value networks, value creation based on service solutions and intangible assets and renewing services and production by digital means. The role of service innovation becomes even more important as they and non-technical contents are considered as important as industry and technologies. A more customer-oriented and flexible approach is also one of the cornerstones of the new strategy.

The whole national innovation system was evaluated in 2009 by an international panel (Ministry of Employment and the Economy & the Ministry of Education, 2009). The evaluation panel called for a radical reform of the innovation system due to the lack of an international dimension, a complicated and fragmented structure and the fact that companies (especially small businesses and start-ups) find the system difficult to use. As a result increase in the mobility of researchers, strengthening of international partnerships in universities and research institutions and a more efficient promotion of international links in the business sector were proposed.

The assessment and a report concerning the state and quality of scientific research in Finland (Viljamaa et al., 2010) provided a thorough analysis of the state of Finland's innovation system and focused on the relevance of innovation strategy policy guidelines from the viewpoint of the global economy, and on the innovation system's functionality. The reports were followed by the evaluation of the implementation of innovation policy (submitted to the Parliament in 2010 by the Government) stating that in order to increase economic growth and enhance wellbeing, innovation-based, sustainably targeted improvements in productivity are required among enterprises, the public sector and other organisations.

Currently there are several ongoing evaluations that will be finalised by the end of the year. These include institutional evaluations of the major funding organisations (the Academy of Finland, Tekes Finnvera [a specialised financing company owned by the State of Finland], and the SHOKs. The R&D and innovation activities of Finnish Universities of Applied Sciences are being evaluated. In addition to these, Tekes and the Academy of Finland commission several evaluations of their programmes on an annual basis. The Academy of Finland will also publish its next triennial review of the state and quality of scientific research in Finland in late 2012.

As a whole when assessing the importance of various policy mix routes in Finland, stimulating greater R&D investment in R&D performing firms and increasing extramural R&D carried out in cooperation with the public sector are by far the most important routes. Most of the Tekes instruments and SHOKs (also partly financed by Tekes) are the key measures for this route. Promoting the establishment of new indigenous R&D performing firms has become increasingly important and increasing R&D in the public sector has also been on the agenda for a long time. However, in absolute terms these routes are still relatively small. Attracting R&D performing firms from abroad is also in the discussion and there is some inward investment activity both at the national and local level but investments in these activities is still relatively low. These actions are necessary steps in addressing the challenge of private sector R&D concentrating on few sectors and companies.

The administrative and legal frameworks have been relatively stable. The business environment is also quite open and competitive and public procurement has increased during recent years. New legislation related to the environment and energy has recently supported innovation indirectly by introducing new tax models favouring low energy solutions and taking environmental aspects into account in public procurement when possible. The emphasis placed on public procurement counterweights the structural issue of emphasising supply side measures.

One area that has witnessed growth during recent years has been the support for scientific (public) research. This route has been traditionally weaker in Finland than in many other countries but investments in university reform as a general focus on strengthening academic research has increased public funding for universities and the Academy of Finland. The support for scientific research is linked with three of the structural challenges of Finland – weak internationalisation of the research and innovation system, the quality of scientific research and its better application, as well as the fragmentation of the higher education and the public research sector.

3.2 *Trends in R&D funding*

Alongside Israel, Sweden and Switzerland, Finland has been one of the top countries in R&D investments for a long time. Public R&D funding has increased in Finland regardless of the economic crisis and especially in 2010 public R&D funding increased substantially. The impact of slight decrease in the private sector R&D has been reversed by the rise in the public sector funding. The challenging economic situation has however affected the GDP growth rate negatively in 2009, but in 2010 Finland experienced an upward trend again. In terms of total intramural expenditure on R&D (GERD) the figures have decreased slightly from 2009 to 2010, but have remained above the level of 2008 and well above the EU average (Tilastokeskus, 2011).

According to the research and innovation policy review 2011-2015 (Research and Innovation Council of Finland, 2010), maintaining the current R&D funding share of GDP (almost 4%) in the 2010s remains an objective for Finland as well as a strong public commitment to increase R&D funding in the future. The recent Europe 2020 target for Finland is to have 4 per cent expenditure to R&D as a proportion of GDP by 2020.

The effects of the economic downturn to private sector R&D funding were visible in 2009 resulting in a five per cent decrease from 2008 to 2009, with the most notable decline in the machinery and chemical industries as well as services. This was not reflected in the BERD as a percentage of GDP figure however, which rose from 2.76% to 2.83% between 2008 and 2009. In 2010 the figure returned to 2.76% even though BERD (€million) increased from the previous year (Tilastokeskus 2011; Eurostat, 2011).

R&D is performed increasingly by HEIs and PROs whereas the share of R&D performed by the business enterprise sector (BERD) is decreasing. This trend has been affected by the recent reforms (university reform and reform of sectoral research) as well as the establishment of the SHOKs. Of all R&D 69.6 % was performed by the business sector while the share of HEIs exceeded 20 per cent for the first time in 2010. A little less than 10 per cent (9.9%) of R&D was performed by the public sector.

The main funding instruments in Finland include institutional and competitive funding. In 2010 the higher education sector experienced notable growth (11% or €140m) in the research and development funding, totalling €1420m. In recent years institutional funding has declined while competitive has increased. In the university sector R&D funding amounted to €1200m, of which €570m was institutional and €630m competitive. More than half (53%) of competitive funding derives from Tekes and the Academy of Finland (Tilastokeskus, 2011). In Finnish polytechnics 34% of all R&D is funded institutionally and 25% of competitive funding comes from EU funds. The growth of competitive funding has resulted in debates concerning the inadequate level of university basic funding, and as a consequence it has been suggested that the share should be increased in the near future.

A considerable amount of project-based research funding (or competitive funding) is granted in Finland annually by Tekes, the Academy of Finland and Sitra, the Finnish Innovation Fund. There are several instruments for project-based funding including

general research projects, targeted research programmes and the Centres of Excellence (CoE) programme. Most of the project/programme based funding provided by the above mentioned organisations is thematic. Additionally some ministries also have research programmes with thematic funding.
The thematic R&D priorities focus e.g. on services, well-being and environmental technology (Finnish Government, 2011). Thematic instruments are mainly financed by Tekes, although Sitra also has specific programmes that are based on specific themes. Additionally there are sectoral policies concentrating on the focus areas of the SHOKs. In 2010, 16% (€99m) of Tekes funding went to the following areas: forestry, mechanical engineering, information and communication technology, health and wellbeing, energy and environment and built environment. Furthermore, 36% of the funding was channelled to thematic Tekes programmes while 48% went to non-thematic innovation support. Almost all Sitra funding for innovation is channelled through various development programmes. In 2010 the budgets for the programmes was €16.2m. Other instruments (such as Structural Funds support) are not as tightly thematically focused
The importance of public-private partnerships has increased after the introduction of the SHOKs. In 2010 the Tekes funding decisions for the SHOKs exceeded €98m while the figure for 2011 was above €80m. However, the role of public-private partnerships in leveraging new funding has been an important part in the Finnish R&D funding policy for a long time since most of the Tekes funding has been based on collaborative funding models. As a whole the business enterprises fund approximately 5.7 % of R&D in HEIs. There have not been any notable alterations in the funding share of the private sector during the past few years.
As funding instruments the relative importance of EU instruments is modest, although not insignificant. For instance in 2008, EU funding for RR&D in Finland was €114.8m, which was 7.2% of all public R&D expenditure. Moreover, the Structural Funds have a notable role in funding research infrastructures and research environment in general. Approximately 6 per cent of the research funding of universities comes from the European Union. Nordic R&D funding through joint Nordic funding organisations (for instance, Nordforsk and the Nordic Innovation Centre) is an additional component in the Finnish policy mix, although the role of these funding sources is relatively modest.
Subsidies and tax incentives, on the other hand, are rather insignificant in Finland. Until recently the aim of corporate taxation has been to remain neutral and not to affect the decision-making in companies. The need for change, however, has been acknowledged. Corporate taxation should be developed in order to encourage entrepreneurship and risk taking. According to some recent analyses it has been suggested that tax incentives should be introduced to support more active research, development & innovation activities in SMEs (Growth Company Review 2011).
All in all the changes that have occurred during the past three years have been quite small. More important is that the levels of R&D investments have remained more or less the same regardless of the economic crisis.

Table 1: Basic indicators for R&D investments in Finland

	2008	2009	2010	EU average 2010
GDP growth rate	1.0	-8.2	3.6	2,0
GERD as % of GDP	3.72	3.96	3.88	2.0
GERD per capita	1,296.3	1,274.1	1,302.7	490.2

	2008	2009	2010	EU average 2010
GBAORD (€ million)	1,813,816	1,928,414	2,055,192 p	92,729.05
GBAORD as % of GDP	0.98	1.13	1.14 p	0.76
BERD (€ million)	5,101,986	4,847,164	4,854.4	151,125.56
BERD as % of GDP	2.75	2.8	2.69	1.23
GERD financed by abroad as % of total GERD	0.25	0.26	0.27	N/A[4]
R&D performed by HEIs (% of GERD)	17.2	18.9	20.4	24.2
R&D performed by PROs (% of GERD)	8	9.1	9.3	13.2
R&D performed by Business Enterprise sector (as % of GERD)	74.3	71.4	69.6	61.5

s = Eurostat estimate
p = provisional value

3.3 *Evolution and analysis of the policy mixes*

No major changes have taken place in the policy mix of Finland over the past few years. This has been reflected in the absence of new innovation support measures in 2011. On the other hand there has not been a true need for measures that would make the Finnish national innovation system even more complicated. However, as stated earlier, several reforms and changes in priorities are underway, which will affect the policy mix in the near future. There is a clear aim to strengthen the role of demand and user-oriented innovation policy instruments as well as increase the focus on growth companies. An action plan and policy framework for demand and user-driven innovation was outlined by the MEE in 2009. The framework includes the key elements of a demand and user-driven innovation policy in 2010 while the action plan 2010-2013 covers the action points that promote policy implementation in the private and public sectors. Tekes, on the other hand, has reformed its strategies and instruments aimed at better supporting new growth enterprises

Several instruments (such as those for supporting new R&D performing firms) have existed in Finland for some time. One of them is the R&D project funding of Tekes that consists of grants and loans and plays an important role in the policy-mix. In the projects Tekes is responsible for half of the funding is provided while a corresponding proportion of private funding is also required. In 2010 Tekes invested altogether €382m in enterprise research, development and innovation and €251m in research projects in universities and research institutions.

Some weak indicators reflecting the forthcoming changes in policy priorities can be depicted from the instruments of Tekes (new programmes begin annually while others come to an end). Themes covered in the instruments include sustainable economic development, health and welfare of children and young people and electrical vehicle systems. Another shift (although not visible in the policy measures but their funding) is the increased fraction of R&D-funding allocated to SHOKs. This increase mirrors the efforts of focusing national strengths and top know-how to some key areas that are hoped to be competitive in global networks.

[4] 8.4 (2009), 9.04 (2005)

The renewed Tekes strategy also implies future trends in innovation funding. Tekes project funding for enterprises, according to the new strategy, will be targeted in the following ways:

- 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

Funding will be channelled through different operating methods, which are:

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

Even though funding for innovation policy has stayed as a priority despite the economic downturn, the tightening public economy may also affect the funding of innovation policy in the future and can be considered a minor threat. Although the total share of innovation funding in the state budget is not likely to decrease substantially, the absolute share may decrease and more care will be given to the effectiveness of the support instruments.

A few changes or increases in emphasis can be identified in the innovation policy mix. For instance a somewhat increasing focus on welfare issues in the research side can be identified. Additionally there is an increasing focus on partnerships and collaboration is visible as more SHOKs have been able to launch their activities in full scale.

The MEE has established a Growth Enterprises group within the Innovation Department, which bears responsibility for structuring, developing and implementing the growth enterprise policy, as part of the broad-based innovation and industrial policy. The emphasis on growth enterprises has led to the establishment of the VIGO accelerator programme (launched by MEE in 2009) designed to complement the Finnish innovation ecosystem by bridging gaps between early stage technology firms and international venture funding. Through VIGO, target companies can gain access to both private and public funding sources. The programme is coordinated by Tekes. Other notable incubators aimed at supporting growth companies are, for example, the Spinno Enterprise Center and the Aalto Start-Up Center.

Alongside Tekes, the Growth Company Service of EnterpriseFinland provides funding instruments to support SMEs. Additionally Finnvera (a specialised financing company owned by the State of Finland), VeraVenture (subsidiary of the former), Finnish Industry Investment and regional ELY-Centres all have instruments that support innovative start-ups. Most of these instruments are related to general funding support for companies but in many cases these also target (innovative) start-ups.

Public sector financing support has also been directed towards seed-financing and loans. Finnvera plc, Sitra and Tekes represent public financing on equity terms. Seed financing is provided, amongst others by Seed Fund Vera Ltd and the Finnish Industry Investment through the Financing Programme for Early Stage Companies. Tekes has a wide range of funding instruments to support innovation in companies. Tekes provides for instance, funding for start-up companies through the “Young Innovative Companies -programme”. Innovation is one of the key criteria for funding as the firms operations have to be based

on an innovative business idea based on specific expertise or new technology. Another instrument launched by Tekes is the Funding for the purchase of innovation services that aims at promoting business development of innovative SMEs.
One of the Tekes programmes also targets innovative public procurement since 2009. Its main aim is to encourage companies to develop new innovations, renew public services, increase productivity, and to create new markets. An additional aim of the programme is to promote the use of public procurement as a tool for innovation policy as well as to develop good practices.
Prior to 2009 the role of innovation oriented public procurement had been quite modest in Finland but currently the development of public procurement in research and innovation policies is high on the political agenda. For instance the national innovation strategy placed emphasis on public procurement by referring to it as one of the key tools of demand driven innovation policy. The development of public procurement is also one of the key themes in the action plan and policy framework for demand and user-driven innovation.
The main key barriers in implementing demand-side policies in Finland are the small domestic markets and to some extent the dispersed local government sector. As a result active participation of Finnish organisations to the EU Lead Market is seen as a very important approach in the action plan by the MEE. On the other hand the small markets can possibly work as an efficient pilot market for global innovations.
In the education sector several changes affecting the national innovation system have taken place. Since 2009 the Universities Act has enlarged the autonomy of universities, making them autonomous legal entities. This has been followed by mergers of several universities decreasing the amount of universities to 16. The admission of students at higher education institutions will also be reformed in 2011-2014. Additionally a proposal has been made to alter the funding models of the universities in 2013. These changes and reforms represent an important opportunity for the higher education sector and the whole national innovation system.
In terms of human resources, the amount of researchers (FTE) in Finland rose to 41,425 (2010). The number of researchers as per cent of labour force was 2.1 in 2009 being nearly twice the estimated EU-27 average (source: Eurostat). The large number of researchers and doctoral degrees is partly explained by the Finnish graduate school system consisting of 110 graduate schools with about 1600 graduate students. Despite the increasing amount of researchers, having a sufficient pool of qualified human resources is one of the key challenges in Finland. There is an increasing need to attract foreign researchers and other experts to the country in order to maintain the high level of R&D and innovation activity due to worsening age structure and decreasing levels of Finnish citizens reaching the graduation age.
Additional weaknesses exist in the Finnish research system for attracting researchers from abroad. These include limited career opportunities for researchers with few permanent positions and therefore a dependence on short term funding, the remuneration level has been lower than in many other European countries, families and especially spouses have had difficulties in getting a job, and the administration issues have also been seen as a challenge.
There are rules and practices to help foreign researchers to work in Finland. Information is fragmented however and there has not been a dedicated programme to facilitate the immigration of foreign experts. This is a challenge that the innovation system needs to address. Another issue has been the insufficient willingness of the private sector to recruit foreign researchers except for the few international companies.

The administrative limitations at the universities have also made it more difficult to compete internationally (for instance on salaries).

3.4 Assessment of the policy mix

Evaluations and assessments are a widely used tool for governance in Finland. These tools are utilised to assess the effectiveness of various organisations and programmes (for instance, by ministries, universities, Tekes, the Academy of Finland and the programmes of the two latter). The programmes are evaluated in order to monitor the impact and influence they have and to develop the operations in the future.
Currently several important actors of the innovation system (such as Tekes and Finnvera) are conducting or have commissioned large evaluations, including the effectiveness of the organisations. Tekes monitors and assesses the results and impacts of the projects that it funds. External researchers conduct various effectiveness studies on the Tekes project portfolio and also evaluate Tekes programmes. In 2011 the whole of Tekes will be evaluated and as a result more comprehensive information will be available in the future.
Furthermore, as mentioned earlier in this report, the Finnish National Innovation System has also been under evaluation. The assessment identified both strengths and weaknesses. Among the former are very positive labour productivity, continuous rise on Finland's share of the applications at the European Patent Office (EPO), and R&D working hours declined in 2005 and 2007 for the first time in the post-war era. The latter include for instance a lack of growth entrepreneurship and difficulties in internationalisation.
For many years (especially since the publication of the latest assessment of the state and quality of science in 2009) there has been a rather consistent policy to increase both the quality of research as well as its application. There has been a gradual shift from funding for applied research (for instance from Tekes) towards more funding for academic research (funding for universities and the Academy of Finland). Both issues can be considered strengths in the policy mix. The next review of the state and quality of scientific research in Finland will be published by the Academy of Finland in December 2012.
In 2010 the Academy of Finland commissioned a study that benchmarked the research policy mix in Finland to five other countries in order to find good measures to improve research performance. The new proposed funding model for the universities emphasises more research performance than previously. Starting from 2010 increased emphasis for the development of research infrastructures has been initiated (FIRI-project). There have also been some recent measures to make research more focused to strong areas (definition of strategic research areas in the university strategies, establishment of thematic research networks by the Academy of Finland).
Internationalisation is among the greatest challenges in Finnish research policy. As mentioned before, Finland is rather internationalised in terms of publications but less so in researcher mobility and the share of foreign researchers as a proportion of the workforce. New developments have taken place especially in the strategies and development plans but in terms of actual measures the development has been slow. Increased independence of universities has allowed increasing possibilities for attracting foreign researchers. New funding models also support international publications.
Finnish research and innovation policies have been quite dominated by supply side instruments. The introduction of a number of new demand based instruments in 2009 (such as the funding for innovative public procurement) and 2010 and with the specific

Framework and Action Plan for Demand and User-driven Innovation Policy in 2010 have increased the role of demand and user-driven approaches in the policy mix. However, the introduction of new measures has been slow and at the moment these elements still play a rather small role in the policy framework as a whole. No national evaluation has been carried out yet since these policies are relatively new.

Furthermore the policy mix has been criticised for already being too complicated. Not much has been done to decrease the complexity of the national innovation system, but it has been stated on the Government programme (Finnish Government, 2011) that the division of labour between public sector actors contributing to growth and R&D funding needs to be clarified calling for improved co-ordination between various instruments that promote business R&D investments. Research and innovation in businesses in general is however of relatively high quality while the selection criteria remain open and straightforward.

If the importance of various routes in stimulating private sector R&D in Finland is assessed, stimulating greater R&D investment in R&D performing firms and increasing extramural R&D carried out in cooperation with the public sector are the most important routes. Increasing R&D in the public sector has been on the agenda for a long time while the importance of promoting the establishment of new indigenous R&D performing firms has increased. Discussions have also taken place related to attracting R&D performing firms from abroad and there is some invest-in activity both at the national and local level. The investments in these activities however are not as substantial as in some other countries.

The two previous governments have paid increasing attention to activities supporting growth companies, resulting for instance in the establishment of the VIGO accelerator programme. Several targets have been actively in progress, but due to the weakened state of the state economy all of the necessary reforms have not been implemented at the intended time frame. There has also been increasing debate concerning the role corporate taxation for growth companies and utilisation of research, development and innovation in SMEs (Growth Company Review 2011).

During two years VIGO has steered 40 companies to the growth path. Currently these companies provide employment to hundreds of professionals and have attracted funding worth €40 million, of which nearly €40 million is private risk funding. Based on a survey (undertaken in October – November 2011) the companies participating in the accelerator programme have been satisfied especially with the business strategic competences, contacts and ability to internationalise the incubator. Time spent per company and building of a clearer funding model was seen as activities to be developed in the future (Kauppalehti 2011).

Other incubators, especially Spinno Enterprise Center, have succeeded in reaching good results as well. 22 start-up companies supported by Spinno have grown and developed so rapidly that they have gained additional funding from the Young, Innovative Enterprises programme operated by Tekes. This demonstrates that incubators and provided services help start-up companies to remain on the path of growth towards internationalisation and global markets. Moreover, several of the Spinno backed companies (Eniram, Analyse and Retail Logistics Excellence – RELEX) are among the fastest growing technology companies in Finland (Technology Fast 50 2011 listing made by Deloitte).

It can be concluded that the lack of (growth) entrepreneurship has been taken seriously and has resulted in various actions, which are beginning to create positive outcomes. It is too early to assess if the actions have been sufficient or not. The direction, however, seems to be right.

Other polices affecting R&D investments have not changed much recently and the administrative and legal frameworks have been relatively stable. The business environment is also quite open and competitive and public procurement has increased during recent years. New environment and energy related legislation has recently supported innovation indirectly by introducing for example new tax models favouring low energy solutions and taking environmental aspects into account in public procurement when possible.

Table 2: Assessment of policy mix

Challenges	Policy measures/actions[5]	Assessment in terms of appropriateness, efficiency and effectiveness
Weak internationalisation of the research and innovation system	Strategy for the internationalisation of Universities Internationalisation of science on key objective in the RIC Research and Innovation Policy Guidelines for 2011–2015 FiDiPro-programme Plans to renew the education legislation to better support both export of education and to attract international students to Finland.	Finland is rather internationalised in terms of co-publications but less so in researcher mobility and the share of foreign researcher workforce. The implementation has been rather slow, although developments have taken place in many areas. Increased independence of universities has allowed increasing possibilities for attracting foreign researchers. New funding models also support international publishing. FiDiPro –programme has worked well in attracting foreign top researchers. However the volume is rather small when looking at the broad picture.
The quality of scientific research and its better application	Increased funding to the Academy of Finland to support research excellence; New funding model of the universities has a performance based component in it. Increase in Tekes funding and the creation of the Strategic Centres of Science, Technology and Innovation Specific funding for research infrastructures (FIRI)	There has been a gradual shift from funding for applied research (for example, from Tekes) towards more funding for academic research. Together with new funding models for the universities this seems to indicate that there is a real commitment to invest in better research performance. The increased emphasis on the quality of science is also visible in the new funding for research infrastructures, besides working actively within the ESFRI framework national specific funding for infrastructures has finally been introduced.

[5] Changes in the legislation and other initiatives not necessarily related with funding are also included.

Challenges	Policy measures/actions[5]	Assessment in terms of appropriateness, efficiency and effectiveness
The fragmentation of the higher education and the public research sector	The implementation of the university reform continues (e.g. new proposed funding model) The decision to carry out reform in the polytechnics in 2012 (new legislation planned)	University reform has given universities more possibilities to organise their activities; most universities have used this opportunity to renew their organisation as well as strategies, which may decrease fragmentation. A reform similar to universities is planned for polytechnics by the MoE. This may have positive effect but it is yet too early to make judgements on the issue. The reform in PROs still underway and the general fragmentation of research between 3 different kinds of institutions exists.
Strong emphasis on supply side measures	A specific policy programme promoting demand side innovation has been established	The approach is very appropriate since Finland has very few demand side instruments and at the same time established instruments focus more on existing strong sectors. The initiatives are still in their very early stages so the effectiveness cannot be determined yet.
Concentration of private R&D to few sectors and companies	Establishment of the VIGO accelerator programme Tekes Young Innovative Enterprises funding (YIE)	The VIGO programme targets start-up companies in the very vulnerable phase. The programme has not been evaluated yet. YIE has brought a specific funding for specific set of key enterprises. The instrument is not yet evaluated.

4 National policy and the European perspective

National policy can be assessed in the light of the European perspective by utilising the seven dimensions of the European Research Area: Labour Market for Researchers; Cross-border cooperation; World class research infrastructures; Research institutions; Public-private partnerships; Knowledge circulation across Europe; and International Cooperation.

Finland has generally taken an active role in participating in the ERA. The European dimension is seen as a natural extension of the national policy for a small country with limited resources. In the recent report setting the research and innovation policy guidelines for 2011-215, the Research and Innovation Council stated that "Finland is a proactive and influential partner in the EU and in the initiatives of the European research and innovation policy, such as in deepening cooperation within national R&D programmes and promoting top-level European research".

In terms of the first dimension, there is a need to attract more qualified researchers and other labour in order to support and sustain the relatively high level of Finnish innovation system. The amount of researchers has risen during the past few years due to an efficient graduate school system. This has not, however, been reflected in the share of foreign researchers or in the mobility of either students or staff at Finnish HEIs. Several weaknesses (for instance, limited career opportunities for researchers with few permanent positions and therefore a dependence on short term funding) hinder the recruitment of foreign professionals. The FiDiPro –programme is one of the tools established in Finland to tackle the issue of attracting talent from abroad alongside the rather new four-tier career model. Additionally Joint Degree Programmes have been

initiated in Finnish universities to target foreign students aiming at Master's Degree level. So far the actions taken have not improved the situation and therefore other policies or measures should be considered.

Despite the above mentioned challenges and weaknesses, Finland is well represented in the European research landscape, being a member of all major European research organisations (European Organisation for Nuclear Research, European Molecular Biology Laboratory, European Space Agency, European Organisation for Astronomical Research in the Southern Hemisphere, European Synchrotron Radiation Facility). Additionally Finland is active in both participating and coordinating European ERA-Net projects. The level of activity has also been good in Joint Programming Initiatives (JPIs), Joint Technology Platforms (JTPs) and Joint Technology Initiatives (JTIs). Therefore cross-border cooperation is on a good level, but there is still room for improvement due to underutilised European opportunities.

Finland also lacks the funds for major investments in research infrastructures. This has resulted in a tradition of utilising the infrastructures and experimental arrangements of other countries until recently. In 2009 a new roadmap for national research infrastructures was published consisting of 20 proposals for significant national research infrastructures, of which thirteen are associated with the European Strategy Forum on Research Infrastructures (ESFRI) roadmap projects. In has also been acknowledged in Finland that further development of research infrastructures requires additional funding. The work started towards new national research infrastructures is a step into the right direction, but it is still too early to judge the success of the actions taken.

The Finnish university system – closely linked to research infrastructures – has been under several reforms during the past few years. The Universities Act enlarged the autonomy of universities and made them autonomous legal entities in 2009. Rather unexpectedly the increased autonomy has somewhat challenged by the structure of research funding. The structural reform decreased the number of universities from 20 to 16 via three mergers. Additionally the admission of students at higher education institutions will be reformed in 2011-2014 and a proposal have been made to alter the funding models of the universities in 2013. The reforms and the changes are in line with the deficiencies detected in the international evaluation of the Finnish national innovation system (Ministry of Employment and the Economy & the Ministry of Education, 2009).

The public-private partnerships are mainly facilitated through the Tekes R&D programmes as well as the SHOKs. Instead of being only a shareholder the private sector is also involved in planning the strategic research agenda for the research programmes coordinated by the SHOKs. Since 1993 Tekes and the Finnish Technology Park Association have run a dedicated TULI-programme for supporting the commercialisation of research. There is still room for increase in the public-private partnerships, although the SHOKs have already generated notable joint projects under the research programmes.

The Universities Act (reform) allows external stakeholders to have a greater role in university governance thus increasing the influence of the private sector on universities. The aforementioned proposal concerning the funding models of universities is on the other hand likely to have an effect on knowledge circulation. In the suggested new model a total of 13% of funding is based on publications.

International cooperation is considered important in Finland because it is closely linked to the degree of internationalisation of science and the mobility of researchers. The Academy of Finland has a commitment to promoting the internationalisation of Finnish

science and research by establishing bilateral agreements with countries and regions. The Academy also provides funding for the Finnish CoEs in order to support international cooperation in research. More could still be done, however, as Finland is not considered a hotbed of scientific research and fails to attract foreign researchers on a larger scale.
The other important funding agency in Finland, Tekes has collaborative partnerships with several countries, such as the USA, Japan, China and European countries. The FinNode Centres (global network of Finnish innovation organisations operating via nodes in global innovation activity) in China, India, Japan, Russian and the USA are tools for international cooperation.

Table 3: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA dimension	Main challenges at national level	Recent policy changes
1	**Labour Market for Researchers**	Lack of qualified human resources; increasing need to attract foreign researchers and other experts Inability to attract foreign experts	Establishment of the FiDiPro –programme; Introduction of the four-tier career model for researchers
2	**Cross-border cooperation**	European opportunities still under utilised	Participation in Joint Programming Initiatives
3	**World class research infrastructures**	Need for a more centralised research infrastructure policy and for additional funding for the development of research infrastructures	A roadmap for national research infrastructures in 2009 (connected to ESFRI strategy)
4	**Research institutions**	Fairly little success in international comparisons; Negative effects of increased autonomy	University reform; Structural reform of the higher education system
5	**Public-private partnerships**		Establishment of Centres of Science Technology and Innovation (SHOKs)
6	**Knowledge circulation across Europe**	Lack of researcher mobility and low level of foreign researchers.	Proposal for a reform of the university financing model
7	**International Cooperation**	Too much emphasis on European research.	A contract signed between China and Finland to strengthen the scientific cooperation between the two countries

Annex: Alignment of national policies with ERA pillars / objectives

1. *Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers*

1.1 Supply of human resources for research

The amount of researchers (FTE) in Finland has risen from 39,000 (2007) to 41,425 (2010) while the number of researchers as a per cent of the labour force was 2.1 in 2009. The latter figure was nearly twice the estimated EU-27 average of 1.07 and is distributed among different sectors as follows: business enterprises 1.14%; government 0.26%, and higher education 0.67% (source: Eurostat). During the past decade (2000- 2009) the number of researchers has increased rapidly resulting in impressive growth of 32% in the number of researchers, while the total amount of doctoral degrees increased by 42% (source: KOTA database, 2011). The share of female researchers (as a per cent of total researchers) has remained slightly above 30% from 2005 to 2009, being 31.4% in 2009 (source: Eurostat).

The large number of researchers and doctoral degrees is partly explained by the Finnish graduate school system. In 2010, the system comprised 110 graduate schools. The schools had about 1600 graduate students who were paid for working full-time on their doctoral dissertations. The goal is that the students complete their doctoral dissertations in four years. All of Finland's 16 universities house one or more graduate schools, often in collaboration with other universities or research institutes.

Having a sufficient pool of qualified human resources is one of the key challenges in Finland since the number of Finnish citizens reaching the graduation age will become smaller. Hence there is an increasing need to attract foreign researchers and other experts to the country in order to maintain the high level of R&D and innovation activity. Private sector has also increasingly employed PhDs (Sainio, 2010). The abundant supply of PhDs in the labour market has caused the unemployment rate of PhDs to increase during the past year. The amount of unemployed PhDs has risen by 15 per cent in a year and there are currently (December 2011) 460 unemployed PhDs in Finland.

In international comparison the inwards mobility and immigration of foreign professionals has been relatively low in Finland, although increasing. In 2009, there were 6,984 foreign graduate or postgraduate students in Finland while the amount in 2000 was 3,732 representing a massive increase of 87%. The number of foreign doctoral students was 2,153 (KOTA database, 2011).

In the same way as with researchers, the students' interest to undertake studies abroad (outflow) has declined. The visits of university teachers and researchers abroad have been in decline (except the technical fields) since the beginning of 2000s. The inflow of foreign researchers and teachers to Finnish universities was 1,706 people (2,012 in 2000) in 2009. At the same time the outflow of domestic teachers and researchers was 1,289 (1,467 in 2000). There has, however, been a small increase (5.3%) in the outflow of domestic teachers and researchers from 2007 to 2009 (Source: KOTA-database, 2011).

Noki & Kovanen (2008) have identified several weaknesses in the Finnish research system for attracting researchers from abroad. These include for example, limited career opportunities for researchers with few permanent positions and therefore a dependence on short term funding. The remuneration level also has been lower than in many other European countries. In some studies it has been noted that often the families and especially spouses have had difficulties in getting a job.

Additionally the administration has proved to be a challenge. Basically there are rules and practices to help foreign researchers to work in Finland but information is fragmented and there has not been a dedicated programme to facilitate the immigration of foreign experts. The private sector has also not been very keen to recruit foreign researchers except for the few international companies. The administrative limitations at the universities have also made it more difficult to compete internationally (such as salaries).

1.2 Ensure that researchers across the EU benefit from open recruitment, adequate training, attractive career prospects and working conditions and barriers to cross-border mobility are removed

Finland renewed the degree structure at HEIs in 2005 to correspond with the Bologna structure to improve the comparability and recognition of degrees awarded in various Member States. The uniform European Credit Transfer System and the Diploma Supplement were also adopted. In this context the implementation of the national degree frameworks as well as the recognition of prior learning practices is on the agenda.

Finland does not have many specific instruments for attracting experts from abroad but some changes have been made to indirectly render the Finnish labour market more open for foreign researchers and other experts. The Aliens Act has a specific route for experts with a fixed period tax relief programme for foreign experts. The universities have also been given more opportunities to operate in the international educational markets. However, there are still many obstacles and issues that need further development:

"International competitiveness of income taxation must be ensured when it comes to non-Finnish key individuals and experts. We must introduce a proactive employment- and competence-oriented immigration policy and legislation to support it. Comprehensive implementation of the integration policy requires considerably increased resources. Preparation of a policy promoting multiculturalism must be commenced" (Science and Technology Policy Council Review, 2008). These issues are still in the policy agenda since developments have been slow.

With respect to mobility of researchers also a specific Mobility portal has been established. The EURAXESS Finland portal provides information (concerning Finnish research, job and funding opportunities) for foreign researchers planning to come to Finland or already staying. Finland has also been active in the Bologna process in opening up universities and the changes in legislation have been carried out to facilitate the process of internationalisation. The Academy of Finland and the Universities Finland UNIFI (representing all universities) have signed the European Commission's Recommendation: The Charter for Researchers and the Code of conduct for the recruitment of Researchers. Academy of Finland has a specific strategy for the development of research careers (2006) and most of the universities have stated in their recent strategies that specific attention is paid to the career prospects of young researchers. Although there have been developments in the research career system, work is still underway. In the 2010 report by the RIC "creation of a genuine research career system" is still on the agenda.

It has been acknowledged also that since Finland cannot compete very well directly for researchers it is important to attract foreign potential future researchers already at the stage when they are still studying. As a result the MoE and the universities have agreed that more Master's degree programmes in English shall be established. There are also some joint study programmes with foreign universities (such as Lappeenranta University of Technology and Russian universities from St. Petersburg as well as the University of Tampere and the Russian universities of St Petersburg State University and the Petrozavodsk State University). The accession by Russia to the Bologna Process has made it easier for Finnish universities to jointly plan educational programmes with Russian partners.

It has also been discussed that the most promising stage for attracting researchers is typically the post-doc phase when young researchers are more mobile than during a more established phase in their careers. The four-tier researcher education model and increasing funding opportunities at the postdoctoral phase have been developed to address this issue. The tiers consist of Doctorate candidate/Researcher training, Postdoctoral Researchers, Academy Research Fellows/Team leaders and Academy Professors/Professors/Research Directors. Although the development of the researcher career opportunities is targeted to all researchers it will also open up new possibilities for foreigners.

The benchmarking study by the Academy of Finland (Viljamaa et al., 2010) revealed that a particular challenge for Finland in its efforts to attract foreign talent relates to researcher salaries, which significantly lag behind those of the many other European countries. The average weighted total yearly salary in terms of purchasing power standard was 36,646 in Finland in 2006. The corresponding figures for the other Nordic countries were 43,669 (Denmark), 41,813 (Norway), and 47,143 (Sweden) (CARSA, 2007). This refers both to the public sector, universities and the private sector. The university reform has given universities more freedom in the matter and the average salaries have increased during the past few years. Moreover, the Government aims at decreasing the differences in the wage levels between men and women to 15 per cent by 2015. However, at the moment it is too early to assess if the situation has improved significantly.

One of the most important instruments to attract foreign researchers has been the FiDiPro-programme established in 2006. FiDiPro aims specifically to world-class researchers with well-established scientific expertise. The incentives for international mobility of senior researchers are attractive research environments and infrastructure as well as competitive salaries. Experts to be hired will have to be of high

international level both in regard to scientific competence and experience in providing researcher training. A new FiDiPro Fellow -programme was also started in 2009. It targets young promising researchers in addition to professors that were the target of the original programme. Funding for FiDiPro –programme can be applied either from the Academy of Finland or from the Finnish Funding Agency for Technology and Innovation (Tekes), while Tekes is solely responsible for funding the FiDiPro Fellow –programme.

According to first informal feedback based on applications and user comments the FiDiPro programme has been well received and has had active participation. However there has been concern about the administrative burden as well as the ability of the programme to attract truly first class researchers. However, the initiative has not yet been evaluated so whether it has been successful is not yet known.

Another interesting initiative invites NSF Graduate Research Fellows to team up with leading Finnish research groups. The Nordic Research Opportunity in Finland initiative encourages companies to recruit international researchers or consultants to their projects in Finland, and to engage in research carried out by research teams abroad. The NSF Graduate Research Fellows are provided with contacts with Finnish graduate schools and with projects run by the Academy of Finland's CoEs and Academy Professors. The Finnish host institutions are prepared to cover the Fellow's living costs as well as the costs related to the research to be conducted in Finland.

1.3 Improve young people's scientific education and increase interest in research careers

The scientific education taught in Finnish schools is generally at a good level, which is also evident in the international PISA student assessments. In the recent assessment (2009) Finland outperformed all other EU-countries in average science performance with the score of 554 (501 in EU-27). There is discussion on the educational curricula on the state of natural sciences but there have not been any recent major changes in the educational curricula.

According to Eurostat (2007) 11.2% of the students participating in tertiary education were in the fields of science, mathematics and computing, which was slightly above the EU average (10.5%). The general attainment in scientific education has been rather high but when looking at the applications it is clear that other fields of study are generally more popular.

The Ministry of Education and Culture aims to ensure the appropriate mix of skills among the population by continuously monitoring the supply and demand of various fields of study. Especially the vocational qualification has been designed to respond to labour market needs. Specific bodies, such as the Finnish Education Evaluation Council and the Higher Education Evaluation Council assist in this task.

There is a specific organisation, the national LUMA (LU stands for 'luonnontieteet', natural science in Finnish, and MA for mathematics) centre, which works as an umbrella organisation for the cooperation of schools, universities, business and industry to support and promote the teaching and learning of science, mathematics and technology, at all levels. There are also some specific measures such as Science Circus, a travelling science education event at schools provided by the Finnish Science Centre. Some other smaller projects have been also carried out in Finland. However, as a whole there has not been any dedicated science education in the curricula.

In the higher education sector one of the key challenges for science has been lengthy graduation times as well as the fact that many people change subjects during their studies resulting in low graduation rates. The Ministry of Education and Culture has responded to this challenge by decreasing the amount of intake rates and addressing the quality of education at the same time (Ministry of Education, 2011).

At the universities, the key instrument for promoting research careers has been the Doctoral programmes that were established in 1995. In 2008, the MoE delegated the decision-making and responsibility for the development and monitoring of doctoral programmes to the Academy of Finland. The number of these programmes has rapidly increased and was 112 in 2010. The four-year doctoral programme positions funded by the Ministry are intended for full-time work on a doctoral dissertation, and doctoral candidates are generally hired to positions for the entire four-year term.

Improving the attractiveness of research careers is also one of the aims of the Academy of Finland, especially encouraging post-doctoral researcher careers and to support women's careers in research. During recent years the Academy has developed its research funding so that the forms of financing reflect these objectives. There is, for example, a specific funding instrument for Postdoctoral Researchers.

1.4 Promote equal treatment for women and men in research

In 2009 the share of female researchers (headcount) was 31.4% in Finland. This was slightly below the EU-27 average (32.9%, Eurostat estimate). The Finnish figure has remained almost the same for several years, but the EU-27 average has increased steadily. In the business enterprise sector the share of female researchers decreased to 17% in 2009 leaving Finland below the EU-27 average, which was 19.3% by Eurostat estimate. In the government sector (42.4%) and higher education sector (46.6%) the share of women is relatively high. However, compared with the share of women of university students (53.5%) women are still underrepresented in the research labour force. The situation is even more biased, when looking at the share of women holding professorships (24.4%) (source: KOTA database, 2011). The share of women holding professorships is however amongst the highest in Europe.
There has been a notable amount of research on the situation with women in the research profession but not many specific measures have been introduced. The legal position of women having career breaks for family reasons is fairly good with the restoration back to the same work guaranteed by the law (this also applies to men) and contract extension for fixed-term contracts is also possible. According to some practices the role of women is mainly compromised by the increased demands from the work itself with increasing amount of work to be done, which causes problems to all researchers with families but particularly women. In this way it could be argued that the real world working life imposes more challenges on the position of women than the formal structures.
Most of the universities as well as the Academy of Finland have also introduced specific equality plans (that also cover women). At the University of Helsinki, for example, an Equality Plan has been adopted, as stipulated by the Act on Equality between Women and Men (Act No 609/1986), to advance gender equality and prevent discrimination. There are also specific equality committees that oversee the development of equality issues. The impact of these policies remains unclear as there has not been any systematic monitoring of these activities.
The Academy of Finland also has an Equality Plan, which is applied to people working on Academy funding, to Academy research post holders (Academy Professors and Academy Research Fellows) and to the staff at the Academy's Administration Office. When making decisions regarding research posts and research funding, efforts must be taken to establish an open, transparent expert review procedure in which the qualifications of applicants of either sex are evaluated equally and fairly (this also applies to other equality issues than gender equality).
In 2011 the Ombudsman for Equality made a study on equality in the management of universities and the result was that equality is realised quite well in the Finnish universities.

2. *Facilitate cross-border cooperation, enhance merit-based competition and increase European coordination and integration of research funding*[6]

The general policy in Finland is to promote cooperation. The recent statement by the Research and Innovation Council (2010) states that the "development of the European research and innovation area is promoted by opening up national programmes and national funding. Programmes are opened up in a way that makes room for voluntary joint pilot projects of member states. Effective principles, procedures and criteria are sought and legislation is harmonised". In practice this policy is still in early stages. Most of the effort recently has been to promote active participation in the European research programmes and other joint instruments.
Finland is a member of all major European research organisations (European Organisation for Nuclear Research, European Molecular Biology Laboratory, European Space Agency, European Organisation for Astronomical Research in the Southern Hemisphere, European Synchrotron Radiation Facility) and is additionally very active in both participating and coordinating European ERA-Net projects. This has been especially the responsibility of the Academy of Finland. At the end of 2011 the Academy was a coordinator for one ERA-Net project (BONUS) and involved as a partner in 16 others. Also Tekes has been involved

[6] Promote more critical mass and more strategic, focussed, efficient and effective European research via improved cooperation and coordination between public research funding authorities across Europe, including joint programming, jointly funded activities and common foresight.

- Ensure the development of research systems and programmes across the Union in a more simple and coherent manner.
- Promote increased European-wide competition and access of cross-border projects to national projects funding

actively in ERA-Nets (participating in 11 projects and coordinating one in 2011). This policy promoted by the key policy documents at the strategic level.

Information is not available of the involvement of Member States in all of the JPIs. The need to be active in this regard has been noted by the Academy of Finland and Finland is currently participating in the "Agriculture, Food security and Climate change", "Healthy and Productive Seas and Oceans" as well as "More Years, Better Lives" JPIs.

Additionally, other cooperative frameworks for implementing cooperation at the European level (for example, JTIs, bilateral and multilateral research programmes) have been initiated. The Academy of Finland carries out both multilateral and bilateral cooperation with European and non-European countries. Finnish companies are also active in European initiatives such as European Technology Platforms (ETP's) and JTIs. Finland is also involved in some of the Art. 185 projects (mainly through Tekes). Some of the key activities are EUROSTARS, AAL (Ambient Assisted Living) and BONUS (Joint Baltic Sea Research Programme). Outside the large European multilateral initiatives and broad international cooperation schemes, Finland is especially active in the Nordic research co-operation. Research cooperation with areas adjacent to Finland includes Nordic cooperation, which is expanding to the Baltic States, arctic research and cooperation with Russia. Finland as well as other Nordic countries has been very active in promoting bilateral cooperation involving Nordic research institutions. A specific organisation – NordForsk (established in 2005) - is a Nordic research board operating under the Nordic Council of Ministers for Education and Research and responsible for Nordic collaboration in research and research training. The objective of NordForsk is to support co-operation in the fields of scientific research and science policy. Nordic co-operation covers several different instruments. In 2011 there are eight ongoing projects, of which several are co-financed for instance by the Academy of Finland (eScience globalisation initiative and Nordic Centre of Expertise Programme on Food, Nutrition and Health) or Finnish Ministry of Transport and Communications (Sustainable Freight and Logistics in a Nordic Context).

Furthermore foreign companies with R&D activities in Finland do not need to have a Finnish partner to be eligible for funding because Tekes can finance R&D projects undertaken by foreign-owned companies registered in Finland. The funded project is however expected to contribute to the Finnish economy. Tekes funding for researchers becomes available for foreign researchers if they team up with a Finnish research group or a company to carry out internationally challenging research project. Tekes can fund the Finnish partner in joint projects.

3. Develop world-class research infrastructures (including e-infrastructures) and ensure access to them

Finland has not had the funds for major investments in research infrastructures which have resulted in a long tradition of utilising the infrastructures and experimental arrangements of other countries (Ministry of Employment and the Economy & the Ministry of Education, 2009). With the national infrastructure policy the situation has been less than satisfactory as Finland has not had any centralised research infrastructure policy prior to 2009 but the establishment and development of research infrastructures has been decentralised to various organisations such as ministries, universities and research institutes.

Based on the recommendations of the Science and Technology Policy Council in 2006 the Ministry of Education (currently known as the Ministry of Education and Culture) and the Ministry of Trade and Industry (nowadays the Ministry of Employment and the Economy) appointed a Committee to prepare a proposal that identifies important research infrastructure, a system of funding for research infrastructures and procedures for identifying and evaluating the need for establishing new infrastructures.

The work of the Committee resulted in a roadmap for important national research infrastructures that was published in 2009 with proposals for organising a national research infrastructure policy in the future (Ministry of Education and Culture, 2009). The steering committee identified 24 projects and accepted 20 proposals for significant national research infrastructures. Thirteen of the selected projects are associated with European Strategy Forum on Research Infrastructures (ESFRI) roadmap projects integrating the European dimension in the roadmap. Meanwhile the Education and Research 2007-2012 plan stated that Finland will also actively participate in the planning and implementation of the projects initiated by ESFRI.

In 2010 the Academy of Finland invested €2m to two nationally significant research infrastructure projects: Greenhouse gases Observation System (ICOS, Integrated Carbon Observing System) and life sciences projects as a whole (European Advanced Translational Research Infrastructure in Medicine, Biobanking and

Biomolecular Resources Research Infrastructure and European Life Sciences Infrastructure For Biological Information). These projects are also in the ESFRI Roadmap.

Alongside the expressed need for a more centralised research infrastructure policy a need for additional funding for the development of research infrastructures has also been addressed. According to estimates Finland spends approximately €130m annually of public funding for the upkeep of the national research infrastructures and around €30m for the membership fees in international research infrastructures. Although it has been a quite difficult road to increase the amount of R&D funding dedicated to research infrastructures in the scale that the plan requires, the RIC proposed an additional €120m for research infrastructures between 2011 and 2015 in its 2010 review.

Research infrastructure policy has been recognised as an integral part of national research and innovation policy and in this way the development of research infrastructures is expected to be a more central part of the policy mix. Based on recent developments, Finland has also developed active collaboration within the ERA in the development and use of European research infrastructures and aims to coordinate the related national activities. The planning of the development of the national research infrastructures is aimed to accommodate to the European developments. Generally the research infrastructures are open to external partners.

4. Strengthen research institutions, including notably universities

Finland has an exceptionally large network of universities and polytechnics. The Finnish higher education system comprises 16 universities and 25 polytechnics under the auspices of the MoE. In 2009, there were 168,475 degree students in 20 universities and 111,220 students in 23 polytechnics (Ministry of Education and Culture, 2010). The higher education system is considered an essential element of Finland's national and regional innovation systems. The number of universities and polytechnics has been reduced to 16 in 2011 as a result of structural reforms during the past few years (such as three mergers) implemented to reorganise higher education to be more efficient.

The university system has also been reformed in 2009 to increase the autonomy of universities and make them autonomous legal entities. In this way the aim of the reform is to ensure that the universities will be better placed to make the best use of their income from capital and to better supplement their basic financing with donations and business activities. Under the new Act, the universities are independent corporations under public law or foundations under private law. Their mission has remained mostly intact but the new legislation provides more freedom to organise the activities of the universities.

Additionally the admission of students at higher education institutions will be reformed in 2011-2014 according to the latest government programme. The aim of the reform is to make the access to higher education more seamless and the main options for student choices are reserved for applicants with no prior degree or equivalent level of education. At the same time the electronic application and selection system will be developed.

Finnish universities have traditionally enjoyed a great degree of academic autonomy while research groups have had a relative large autonomy in designing research activities. The university reform has further increased autonomy for universities, which have much higher financial freedom compared to the previous situation. Governance and authority relationships have changed both between universities and the government, and within universities. The increased autonomy provided by the new legal status had granted the universities the right to decide how their assets are managed and how they use capital income and decide independently their business activities. This highlights the importance of strategic management.

The university reform has also caused a challenge to academic autonomy in terms of research. The new legislation requires universities to have a majority of external board members, which can have adverse effect on university autonomy.

The academic autonomy is somewhat challenged by the structure of research funding. The share of thematic competitive funding is relatively high in Finland compared with block funding or non-oriented research funding. General university funds comprised 47% of HERD in 2009, which is below the EU average. At the same time other public funding (38%) together with funding from the private sector, non profit sector and abroad is quite big. Private enterprises finance a quite significant amount of HERD compared to many other countries although the absolute share is not that big (6%). The share of foreign funding (9%) is also relatively high (Finnish science and technology information service). Collaborative research funding (mainly through Tekes) and industry funding also forms a considerable part of external research funding. The same tendency can be seen in the growing number of external funded research professorships.

The state funding to universities follows the same principles for all universities (polytechnics follow a different funding model). Starting from 2010 the universities in Finland follow the following structure for block funding:

- Basic funding based on the breadth and impact of activities (75%)
  - Education 55% (extent of operations 85%, quality and impact 15%)
  - Research 45% (extent of operations 75%, quality and impact 25%)
- Other objectives in Education and Research policy
  - Education and discipline structure (75%)
  - Strategic development (25%)

The majority of funding (75%) is allocated on the basis of calculations concerning the core elements and 25% based on the university policy and strategy considerations. The share of block funding that depends on the quality and impact assessment is mostly based on the number of degrees and number of publications. The university funding model is going to be reformed. It has been planned to include international research in the funding criteria. In this new model a total of 13% of the funding is based on publications of which international, cited publications cover 10% and other scientific publications 3%.
When looking the broader situation in the funding structure of the universities it can be seen that the share of external funding is quite big. In 2009 budgetary funding encompassed 64% of the university budget. For the research activities the budgetary funding covered 52%. In research activities related to doctoral education the share of budgetary funding was 66% and in other research 44%.
There is a specific evaluation body, the Finnish Higher Education Evaluation Council (FINHEEC), assisting higher education institutions and the MoE in matters relating to evaluation. The Council members represent universities, universities of applied sciences, students and working life. Decisions made by the Council are prepared and implemented by Secretariat, led by Secretary General. The FINHEEC conducts three principal types of evaluations:

- Audits of quality assurance systems of Higher Education Institutions (universities and polytechnics)
- CoEs evaluation in education
- Programme and thematic evaluations

Some of the most recent evaluations carried out by FINHEEC are the Evaluation of RDI-work of Finnish Universities of Applied Sciences and Evaluation of the Bologna Implementation and Degree Reform in Finland. These evaluations are still underway.
In a more general level higher education sector has been evaluated as a part of the whole innovation system. This was carried out for the last time in 2009 as part of the international evaluation of the Finnish innovation system (Ministry of Employment and the Economy & the Ministry of Education, 2009).

5. Facilitate partnerships and productive interactions between research institutions and the private sector

There are several policy measures in Finland facilitating the partnerships and interactions between the private sector and research institutions. The most established instruments are the Tekes programmes and Tekes project funding, where collaborative research and networking are encouraged. The more recent instruments are the SHOKs, where the private sector is not only a shareholder in the SHOKs but is also involved in planning the strategic research agenda for the research programmes coordinated by these SHOKs.
Tekes facilitates collaboration and networking between industry and academia and is the main support provider for R&D activities in Finnish SMEs. In 2009, more than 61% of Tekes funding was allocated to SMEs. The share of funding targeted for SMEs has been increasing for the past 10 years (Tekes, 2011). Although much of the support goes directly to the support of in-house R&D it is also typical that the support goes for collaborative projects between universities and SMEs or that an SME buys research services from HEIs or PROs.
Additionally Tekes and the Finnish Technology Park Association have had a dedicated TULI-programme for supporting the commercialisation of research since 1993. These TULI programmes aim at supporting

commercialisation of publicly funded research results, developing commercialisation services in universities, polytechnics and research institutes, promoting cooperation between research organisations and companies, as well as creating viable businesses through start-ups, spin-offs and technology transfer. Projects funded by the programme are run by 40 universities, polytechnics and research institutes. In the 2008 -2013 period, the programme budget is approximately €50m. In 2009 a total of 1,600 project ideas were evaluated and 748 were granted funding for further development. A total of 80 licensing and technology sales were reported with the revenue of €2m to the universities and research institutes.

The Finnish IPR strategy was published in 2009 and it identifies four trends in the field of intellectual property rights (IPR): globalisation, digitalisation and convergence, politicisation of intellectual property rights, and expansion in scope. The strategy states that the operating environment for intellectual property rights should be improved especially in relation to competence, efficiency of rights, competition law and the functionality of the markets as well as efficiency of administration. Accordingly key reforms concern competences and education. Development of financial analysis related to IPR has also been discussed.

In Finland the IPRs have generally been divided into two main areas: industrial property rights and copyrights. Industrial property rights include for example patents, utility models, trademarks, and trade names. Protection against unfair business practices is also counted among industrial property rights. The two ministries responsible for the Finnish science and innovation policy are also in charge of issues related to IPR. Legislative matters pertaining to industrial property rights fall within the administrative branch of the M EE and copyright matters within that of the MoE.

The law on university inventions entered into force on 1January 2007. The Act aims to promote the identification, protection and recovery of inventions born in Finnish universities. The Act applies to inventions made by the staff of the universities. The Act also applies to the Academy of Finland's researchers working on universities. The Act divides research into open and contract research. The inventor is required to report a discovery, if it falls within the scope of the Act. If the university takes the right to the invention, the inventor is entitled to reasonable compensation.

In contract research the university can take the right to the invention within six months of notification of the invention. The HEI can take right to the invention during contract period, even if the inventor announces willingness to exploit the invention.

Mobility between sectors faces relatively few formal constraints between business and academia. It has been noticed however in the past that the industry does not always appreciate researchers' education as much as expected and PhDs are mostly employed by the public and HEI sectors. There have been a few instruments to support the employment of researchers to the private sector but these have been mostly ended.

All the Finnish universities have services related to research and innovation and they have obtained a suitable size in order to function well. On average, there are two or three persons working mainly with commercialisation issues within the Finnish Universities, equivalent to the USA. The European average in technology transfer offices (TTO) is slightly higher. The comparison of the figures is difficult due to the fact that the persons employed in TTOs have various work descriptions and tasks in different countries (Kankaala et al. 2007).

Public-private co-operation also takes place in various incubators activities (such as business development and networking services as well as programme and project co-operation) mainly maintained by various local and regional Science parks and Technology Centres. As opposed to some other countries the incubators have gathered their financing from various sources on project basis and there has not been a centralised funding model for the incubators although the regional ELY-centres are a key supporter of incubator activities. Some incubators are also co-financed by the European Social Fund.

In the regional ERDF-programmes one key policy line is to support for cooperation and networking of innovation actors and SMEs, the improvement of the availability and efficiency of innovation services, the development of business incubators, the development of special knowledge in areas, the development of activities that support R&D, the development of electronic advisory and customer service systems and the utilisation of applied research. The second main line of ERDF is dedicated for promoting innovation and networking, and strengthening competence structures.

According to the Finnish National Reform Programme 2008-2010 more ERDF action plan appropriations than in the past have been allocated to supporting key business activity and clusters of expertise in terms of regional development and competitiveness as well as to projects promoting regionally more comprehensive expertise, innovation and networking. The key aim of the plans has been to promote business and enterprise

as well as innovation, networking and expertise structures. A preliminary estimate indicates that at least 80% of the available ERDF funding will be directed to measures in accordance with these priorities.

The private sector is increasingly involved in the governance of HEIs. According to the new Universities Act (2009), external stakeholders have been afforded a much greater role in the university governance and a great minority of board members come from the private sector. Moreover, the private sector has a substantial representation of the public research organisations (PROs). In the biggest PRO in Finland, VTT, a majority of the board members are from the private sector. In other PROs the role of the private sector is smaller but nevertheless a notable one. Typical for the boards is that representatives of various stakeholders are present. These include universities, the responsible Ministry, companies and key interest groups or associations relevant to the field.

6. Enhance knowledge circulation across Europe and beyond

There are not any specific policies promoting international knowledge circulation, although publications especially in international journals are increasingly encouraged. In the plans for the future university funding model knowledge circulation and international research is included in the funding criteria. In this new model a total of 13% of the funding is based on publications of which international, cited publications cover 10% and other scientific publications 3%. At the moment of writing the decision on the model is yet to be made. The model reflects somewhat the model used for instance in Denmark and Norway.

Improving access to knowledge has also been facilitated by increasing international collaboration in research programmes. Recent examples include the international BONUS programme which was launched at the beginning of 2009 and funded by the countries around the Baltic Sea (Academy of Finland is the Finnish partner) as well as by the European Commission. Another example include the Academy of Finland SALVE research programme (national health), which is carried out in collaboration with Canada, the UK and Norway.

Nordic collaboration continues to facilitate access to international knowledge. Recent developments in the research cooperation in the Nordic countries include the graduate schools and CoE Programmes. The programmes are funded by the Nordic Research Councils, the Nordic Council of Ministers and NordForsk. This Nordic support supplements the basic funding of the Nordic Centres of Excellence (NCoEs), which comes from national sources, among them the Academy of Finland. The Finnish participation has been active also in other instruments such as the ERA-NET schemes.

Finnish researcher mobility has decreased steadily throughout the 2000s. Students' interest to undertake studies abroad has also declined. One reason behind this trend may have been the increasing competitiveness of the Finnish research system. On the other hand the forms of international research activities have changed. Short-term visits and continuous cooperation through the internet may have reduced longer-term researcher mobility.

7. Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world

Finland does not have a dedicated strategy for international cooperation. The Academy of Finland has a strategy for international activities 2007-2015 (Academy of Finland, 2008). The higher education sector also has a dedicated strategy for internationalisation (Ministry of Education, 2009). The main objective of the strategy is that in the future the higher education institutions will offer high-standard education in foreign languages and increase the share of foreign teachers, researchers and degree students.

There are not any specific rules regulating the national collaborations with third countries. In the national innovation strategy (2008) it was stated that European research cooperation is not enough. The strategy also notes that there is international cooperation with third countries but that the cooperation is still rather small scale and fragmented and that there is a need to “strengthen strategic partnerships” with countries and economic areas that are interesting for Finland.

Furthermore the MEE has adopted the basic approach of the “Finnish interest” to results. Hence public innovation support measures are expected to enhance economic development in Finland, regardless of the ownership base of enterprises. In addition to European cooperation, the Ministry has general connections and co-operation at the strategic level with several countries such as India, Israel, Japan, China, Republic of Korea, Ukraine, Vietnam and the United States. Of the above mentioned countries, especially China can be

perceived as a priority country. In December 2011 Finland and China signed a contract to strengthen the scientific cooperation between the two countries.

Finland and Russia have developed specific co-operation during the past years aiming to strengthen the competitiveness of both countries within the global economy by creating a framework for closer co-operation between enterprises, research institutions and development organisations. This has resulted in few initiatives since the first agreements in 2005. MEE and the Russian capital investment company Rusnano (Russian Corporation of Nanotechnologies) started co-operation in 2008, with the objective of promoting co-operation in nanotechnology development.

The Academy of Finland has expressed a commitment to promoting the internationalisation of Finnish science and research. In concrete terms the Academy has established bilateral agreements with 26 countries and regions as well as with 42 foreign organisations. Although most of the agreements deal with mobility, there is also joint research activity. In the international strategy of the Academy it has been stated that the Academy will create strategic partnerships with foreign funding organisations in order to create opportunities for researchers to engage in joint projects as well as enhance the impact of international activities in general and to support research infrastructures and environments of higher quality.

Funding is also provided for the Finnish CoEs to support international cooperation in research. In the international strategy of the Academy it has also been stated that the Academy will create strategic partnerships with foreign funding organisations in order to create opportunities for researchers to engage in joint projects as well as enhance the impact of international activities in general.

In practice this has occurred in the Sustainable Energy Research Programme. Discussions on international funding cooperation resulted in an agreement with Chile, China, Denmark, Estonia, Germany, Iceland, Norway and Sweden. Additionally Poland and Luxembourg joined in through the MATERA ERA-NET and a joint call was opened together with Brazil in 2008.

Similar to the Academy, Tekes has collaborative partnerships with several countries, such as the USA, Japan, China and European countries. Important tools for international cooperation are the FinNode Centres in China, India, Japan, Russian and the USA. FinNode stands for a global network of Finnish innovation organisations operating via nodes in global innovation activity. The nodes actively reveal new openings for Finnish business and research organisations and support their internationalisation by connecting Finnish and international experts and the know-how required to promote innovations.

The cooperative agreements do not specifically address grand challenges, although issues related to these issues such as cooperation with Brazil in the research on sustainable energy and health research with Canada.

Tekes has lately developed the international dimension of its programmes. Many of the programmes are open to foreign participants (although not typically funding) and international co-operation within research projects is actively encouraged. Truly open initiatives with open funding opportunities for foreign participants do not exist at the moment. Instead the joint innovation policy initiatives have been carried out by active participation in EU level instruments, such as ERANETs.

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List of Abbreviations

BERD	Business Expenditures for Research and Development
CERN	European Organisation for Nuclear Research
CoE	Centres of Excellence
COST	European Cooperation in Science and Technology
EMBL	European Molecular Biology Laboratory
EPO	European Patent Office
ERA	European Research Area
ERA-NET	European Research Area Network
ERDF	European Regional Development Fund
ERP Fund	European Recovery Programme Fund
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Organisation for Astronomical Research in the Southern Hemisphere
ESRF	European Synchrotron Radiation Facility
ETP	European Technology Platform
EU	European Union
FP	European Framework Programme for Research and Technology Development
EU-27	European Union including 27 Member States
FDI	Foreign Direct Investments
FiDiPro	Finland Distinguished Professor Programme

FINHEEC	Finnish Higher Education Evaluation Council
FIRI	Funding Instruments for Research Infrastructure
FP	Framework Programme
FP7	7th Framework Programme
FTE	Full-time equivalent
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
ICT	Information and Communication Technology
IP	Intellectual Property
JPI	Joint Programming Initiative
JTI	Joint Technology Initiative
JTP	Joint Technology Platform
MEE	Ministry of Employment and the Economy
MoE	Ministry of Education and Culture
MoF	Ministry of Finance
NCoEs	Nordic Centres of Excellence
NRP	National Reform Programme
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PISA	Programme for International Student Assessment
PPS	Purchasing Power Standard
PRO	Public Research Organisations
RELEX	Retail Logistics Excellence
R&D	Research and development
RI	Research Infrastructures
RIC	Research and Innovation Council
RTDI	Research Technological Development and Innovation
SF	Structural Funds
SHOK	Strategic Centre for Science, Technology and Innovation
Sitra	Finnish Innovation Fund
SME	Small and Medium Sized Enterprise
S&T	Science and technology
Tekes	Finnish Funding Agency for Technology and Innovation
TTO	Technology Transfer Offices
VC	Venture Capital
VTT	Technical Research Centre of Finland
YIE	Young, Innovative Enterprises –programme

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Abstract
The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. EW Country Reports 2011 identify the structural challenges faced by national innovation systems. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. The annex of the reports gives an overview of the latest national policy efforts towards the enhancement of European Research Area and further assess their efficiency to achieve the targets.

These reports were originally produced in November - December 2011, focusing on policy developments over the previous twelve months. The reports were produced by the ERAWATCH Network under contract to JRC-IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl.

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