Chapter 6

Innovation policy and governance in Finland

This chapter examines public sector activities that have a bearing on the Finnish innovation system. It begins with an overview of the historical evolution of science, technology and innovation policy in Finland. It then examines the main policy actors and governance arrangements. Finally, it reviews current policies in light of the observations made in the preceding chapters and concludes by identifying areas in need of policy attention.

Science, technology and innovation policy in Finland: An historical overview

Since the 1990s, Finland has been seen as an exemplary model of how to make and implement good science, technology and innovation (STI) policy. Two aspects of Finland's STI policy have been especially important: first, its commitment to public investment in R&D and education, even in the face of recession (as in the early 1990s), and the expansion of this investment in the second half of the 1990s; second, the leading role of what is now the Research and Innovation Council (RIC) in co-ordinating policies that took a systemic approach and led the development of STI policies. Finland's recovery and success through the 1980s and more than the decade before the 2008 global financial crisis was built on these policies, as well as strengths established in earlier periods. Finland initially responded to the global financial crisis in a similar way as in the 1990s. However, since the early 2010s there has been a loss of confidence in the power of research and innovation to drive development and growth and a corresponding loss of coherence in STI policy. The recent revival of the RIC provides an opportunity to establish new and systemic policies that address national needs, development and growth.

Historical background

Finding itself on the losing side in World War II, Finland was obliged to pay substantial reparations to the Soviet Union in the form of ships and machinery across a period of eight years. The need to produce these goods forced the state to set up large, state-owned companies and a stronger banking system and to promote R&D in enterprises – in effect launching a process of accelerated industrialisation that continued through the end of the 1980s. The period also saw heavy investment in education and the establishment of a Nordic-style welfare state. Restrictions on foreign ownership were lifted during the second half of the 1980s as part of a wider effort to open up the economy that culminated in Finland's accession to the European Union in 1995 and adopting the euro in 2002. This process of opening up and internationalising is still ongoing as – after markets for goods and services, company ownership and location – science and business R&D have also become increasingly globalised.

The recession of the early 1990s hit Finland peculiarly hard. The government responded by increasing public investment in education, research and innovation to compensate for reduced business R&D expenditure. In the second half of the 1990s, public and private investment in R&D increased at a fast pace. Public investments in R&D during this period were primarily channelled through the Academy of Finland and Tekes. The Academy was a traditional research council or science foundation, largely funding "bottom-up" proposals from the universities. Tekes was founded in 1983 as a technology development agency, funding R&D within companies and in academic-industry partnerships – both bottom-up and, where networks of stakeholders with common interests could be established, in the form of technology programmes. The policy focus on innovation was reflected in the fact that Tekes' budget was consistently much larger than that of the Academy of Finland. Finland's policy contributed to the rise of Nokia (Box 6.1).

Finland since the global financial crisis

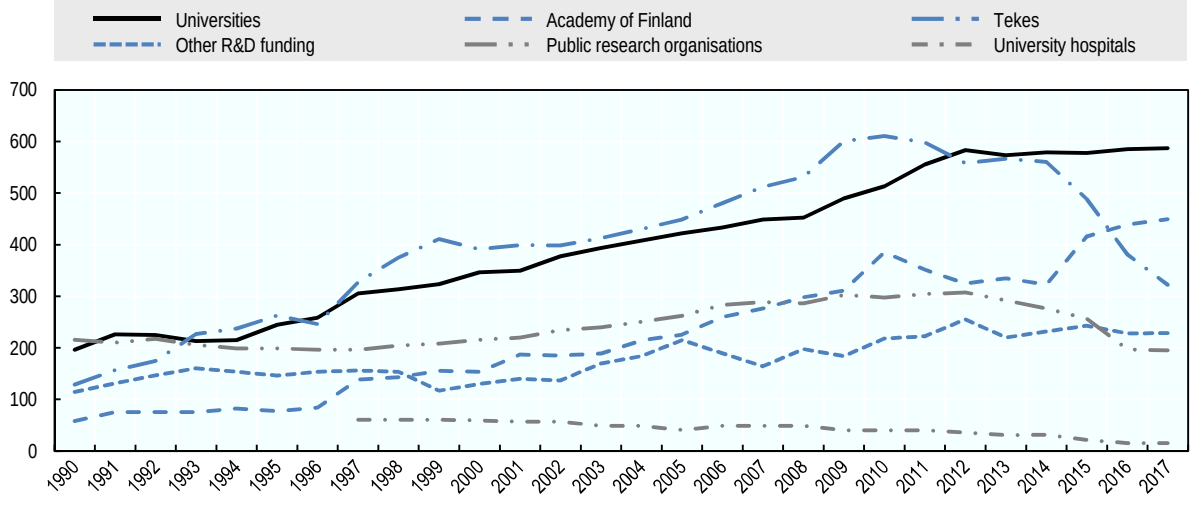
In contrast to the 1990s, there have been significant reductions in both public and business enterprise investment in R&D as economic difficulties have continued (see Chapter 2). On the business side, Nokia started to lose its position because it was unable to maintain leadership across the disruptive transition from simple mobile phones to

smartphones. An alliance with Microsoft in 2011 was followed by substantial lay-offs in 2012, and while Nokia continues to be a strong contender in mobile phone infrastructure, its failure in handsets took on a symbolic value. Government budget appropriations or outlays for R&D (GBAORD) as well as higher education expenditure on R&D (HERD) peaked in 2010 and have since been declining. The overall effect of policy was that – in relative terms – funding shifted away from innovation towards research policy. Tekes has been significantly de-funded while institutional research funding to the universities has remained stable at the same level and research funding through the Academy of Finland continued to increase (Figure 6.1).

Box 6.1. **The rise of Nokia**

Finland's policy commitment to innovation contributed to the growth of Nokia, which at its peak accounted for about 4% of gross domestic product (GDP) and one-third of Finland's gross domestic expenditure on R&D (GERD). As with the earlier industrialisation process, other circumstances were also supportive of growth in the mobile telephone business. The fragmented historical structure of Finnish telecommunications meant there was local strength in network interconnection issues, which are fundamental to mobile systems which initially functioned as access networks to the existing wired infrastructure. The state was part of the Nordic consortium that developed the second-generation Nordic Mobile Telephone standard, upon whose system architecture the third-generation GSM system was built. Nokia was therefore well placed to ride the wave of expansion as the technological shift to the third generation transformed the mobile phone into a mass-market product. Nokia's success further built upon existing advantages and entailed large-scale development and mobilisation of national and international stakeholders and supply chains. These ingredients will also be important in the future in identifying and seizing opportunities for innovation and growth, especially in the areas defined by the "societal challenges".

Figure 6.1. **Government R&D funding at current prices**



Source: Tekes (2015).

In the aftermath of the crisis, many countries have scaled down their public R&D budgets (government budget appropriations or outlays for R&D). However, the cuts carried out in Finland, combined with an effective reallocation of resources away from innovation, do not appear to be based on any clear rationale. This concerned above all funding through Tekes, including the withdrawal of the budget for the strategic centres for science, technology and innovation (SHOKs). The effects were to reduce R&D investment at a time when it was needed the most and to significantly reduce the national effort in applied or "strategic" research to underpin innovation. These appear to have arisen as a result of a disconnected sequence of decisions, made possible by a lack of a system perspective.

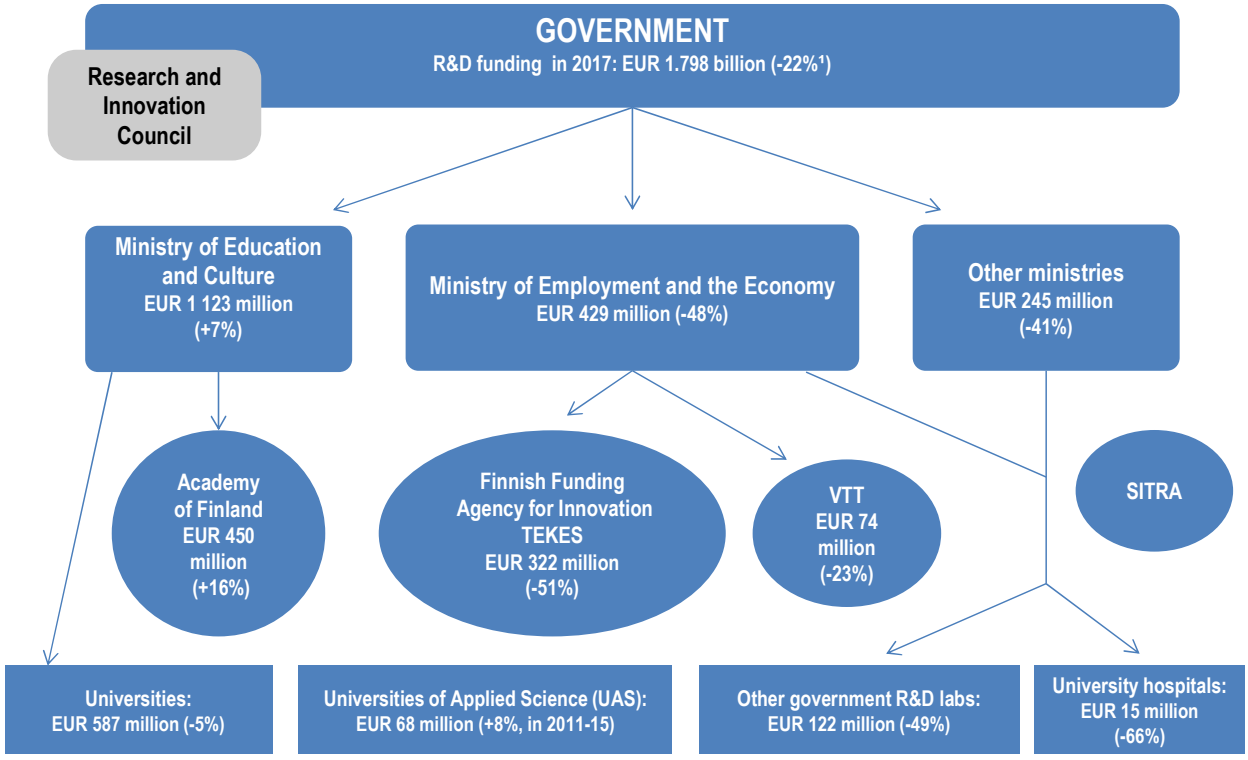
Both the university and the university of applied sciences (UAS) systems have been under reform since 2010. The two sectors have been encouraged to form closer links and even "consolidated corporations" (see Chapter 4). Restructuring reforms were finally launched in the public research institute (PRI) sector in 2014, responding to the recommendations of the earlier systems evaluation and of a panel of Finnish experts (Lankinen, Hagstrom-Näsi and Korkman, 2012) with the intention of rationalising the structure and making the institutes more effective.

The strategic objectives of Prime Minister Sipilä's government (in office since 2015) are: 1) improving employment and competitiveness; 2) reforming knowledge and education; 3) promoting welfare and health; 4) facilitating the bio-economy and clean solutions; and 5) reforming ways of working through digitalisation, experimentation and deregulation. Each of these objectives has been allocated to a group of ministries to work together on. They are, inter alia, to be reached via 26 "spearhead projects" with a collective budget of EUR 1.6 billion. Ten of these projects include aspects of research and innovation. The government programme aims for a clearer division of labour between the higher education and the public research sectors (accompanied by greater co-operation) and to increase the economic and social impact of R&D. At the same time, the government intends to further reduce public R&D spending by 5% to 10% compared with 2015. A Strategic Research Council (SRC) was added to the Academy of Finland in 2015 to fund policy-relevant research, with money formerly allocated to government research institutes' core funding, further decreasing the amount of R&D and innovation funding.

The resulting changes are illustrated in Figure 6.2, which also reflects the research and innovation content of the spearhead projects. The expansion of the total budget for the Academy of Finland is caused by the reallocation of money from the government lab sector and Tekes to the new Strategic Research Council within the Academy and the transfer of money for "profile" projects in the universities, encouraging rationalisation and more specialisation. In 2015, the government abruptly decided to terminate the Innovative Cities Programme (INKA) by 2017. This programme aimed to generate new business and facilitate job growth by creating a test bed for new technologies and services, as well as new operating models for competence-based entrepreneurship. Organized around regional hubs, new development environments were piloted in co-operation with users, companies and the public sector. It was decided at the same time to discontinue the substantial system of public-private partnerships (PPPs) or competence centres (SHOKs) that had been established in preceding years with the intention to advance the relevance of research and science-industry co-operation in areas of economic importance to Finland.

The largest absolute cut was imposed on Tekes, where the ratio of loans to grants had already been rising and where a big cut in grants is to a considerable extent a result of the government's decision to cancel the SHOK programme. VTT's budget was cut by 23%, but the funding for the government laboratories and for research in the university hospitals was more dramatically reduced. Individual institutes such as that for public health have been laying people off as a result. In addition to reducing the amount of research carried out in government labs, the government also decided to further reduce the amount of research and innovation funds channelled to large companies, instead focusing further on small and medium-sized enterprises (SMEs) and start-ups. The government is committed to supporting SME growth and development, for example through Finpro's Growth Programmes and the Team Finland co-operation among the innovation and business support agencies. Expenditures in these areas have to some degree displaced parts of the earlier applied research effort devoted to existing industry (for more detail see the section on "Supporting business R&D and innovation" below).

Figure 6.2. **Government R&D funding budget for 2017, main funding flows and percentage changes compared with 2011**



Note: 1: Volume of government R&D funding in 2017 and the development of funding in 2011-2017 in real terms.

Source: Statistics Finland (2017).

The period since the 2008 global financial crisis has seen considerable reflection at the policy level in Finland, responding to an increasing sense of uncertainty whether the institutions and policies which were effective in the past, continue to be relevant. An international evaluation of the Finnish innovation system carried out in 2009 (Veugelers at al., 2009) highlighted a number of issues, including the fragmented structure of the research and innovation system in Finland, the fact that 40% of professors

would be retiring within ten years, the low degree of internationalisation and concerns about the quality of research.[1] Concerns about the continued relevance of established institutions appears to have underpinned the RIC's recommendation in 2010 that international evaluations of the Academy of Finland and Tekes should be launched in 2011 and 2012 (Research and Innovation Council, 2010). These were followed by evaluations of Sitra, Finnvera, the Finnish Industry Investment and the RIC itself in the period up to 2014 so that within a short period of time all the funding organisations key to research and innovation in Finland were evaluated.

Taking stock of developments in recent years, it appears that the global financial crisis and the decline of Nokia shook Finland's faith in its established and successful strategy of systemic use of research and innovation to drive growth and economic performance and in its research and innovation institutions such as the RIC and Tekes in a way that does not do justice to either the successes or the lessons of the past. As the strategic perspective weakened, so decisions were increasingly taken that were inconsistent with national needs and sometimes mutually inconsistent, reducing the research and innovation effort in ways that undermine future growth. Successful research and innovation policy depends on using these lessons in the new circumstances of the 21st century.

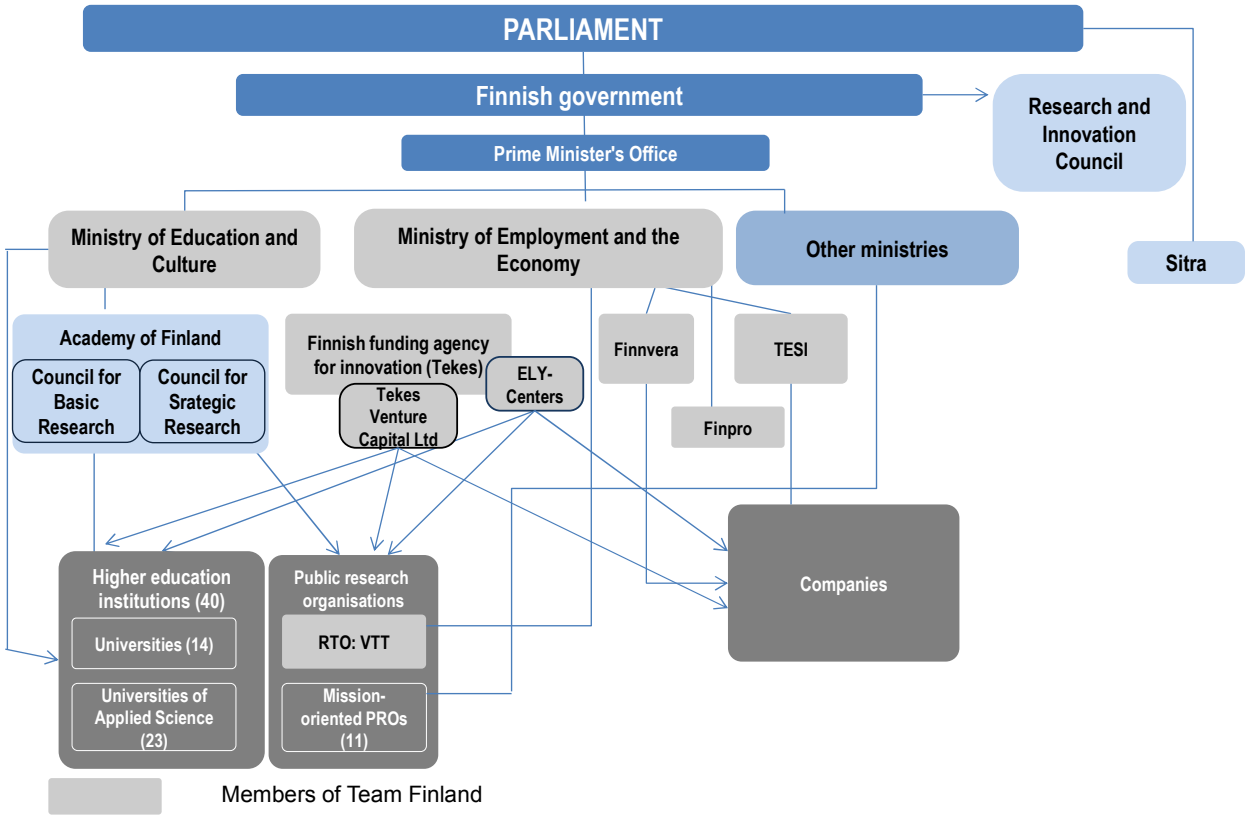
Main policy actors in innovation in Finland

Finland is sometimes described as a "two pillar" system where the ministries of education and economic affairs dominate research and innovation policy, and control key research agencies and organisations (Figure 6.3). The Finnish government has been advised for some time by the RIC and its predecessors, but the Prime Minister's Office has started playing a role in policy co-ordination, operating at the level of government itself. At the second level are first and foremost the ministries for education and industry that form two central actors in the Finnish innovation landscape. "pillar". Other ministries also fund research and innovation, while some have affiliated government labs.

At the third level are a number of funding agencies, reporting to the respective ministries. Central funding agencies are Tekes, affiliated with the Ministry of Economic Affairs and Employment, and the Academy of Finland under the Ministry of Education and Culture. On the fourth level are universities, research institutes and hospitals performing R&D activities. Finally, the independent innovation fund Sitra reports directly to the parliament, and stands apart from the government system.

This section describes the different levels of innovation policy actors, before discussing key ministries and their agencies. Finally, the independent innovation fund Sitra and its role in the Finnish innovation system is explained.

Figure 6.3. **Main innovation policy actors in Finland**



Notes: Sitra: Finnish Innovation Fund; Finnvera: a specialised financing company owned by the state, it is the official export credit agency of Finland; TESI: Finnish Industry Investment Ltd, a government-owned investment company; ELY-Centres: centres for economic development, transport and the environment, responsible for the regional implementation and development tasks of the central government; Finpro helps Finnish small and medium-sized enterprises go international, encourages foreign direct investment in Finland and promotes tourism; RTO - Research and Technology Organisation; VTT: Technical Research Centre of Finland.

Source: Halme, K., V. Saarnivaara and J. Mitchell (2016), *RIO Country Report 2015: Finland*, https://rio.jrc.ec.europa.eu/en/library/rio-country-report-finland-2015.

The Research and Innovation Council

In recent decades, monitoring and soft governance of the Finnish research and innovation system as a whole has focused on the Research and Innovation Council (RIC) and its predecessors. After a period of inactivity, it has been reconstituted by the government and is currently redefining its new role. With growing concern of how "societal challenges" can be better addressed by innovation, a need for broader and deeper innovation system governance was formulated, involving the breadth of government and a wider range of stakeholders than has traditionally been the case. With its pivotal position, the RIC is well positioned to take the lead in this change.

Finland has had some form of Science Policy Council since 1963, and following several changes in its name and structure, it became "Research and Innovation Council" in 2008. Pelkonen (2006) argues that initially the Council was to mediate between academic research and industrial innovation, represented by "their" respective ministries. Recent generations of the RIC included two sub-committees, one on science and

education and the other on technology and innovation – reflecting the interests of its ministry affiliations. The current RIC does not have a sub-committee structure.

Beyond the involvement of ministers that are central to research and innovation policy, the RIC is chaired by the Prime Minister. In addition to the ministers, it includes five members chosen on the criterion that they widely represent the research and innovation system as a whole. The heads of key agencies, notably Tekes and the Academy of Finland and three permanent secretaries from the ministries are present in the meetings as permanent experts. Generally the RIC had been seen as a high-level key co-ordinating mechanism in the national innovation system. Its permanent tasks included:

- directing and steering research and innovation policy
- developing research and innovation funding, increasing the impact and effectiveness of research
- developing sector research and the government R&D institutes
- international co-operation in STI
- other various issues such as exploitation of R&D results, evaluation, etc., as required.

RIC's success has been based not only on its structural characteristics, but also on important cultural features of modern Finland. One of these is a corporatist tradition in which this type of representative council is seen as a normal way of shaping policy (Pelkonen, 2006). Another is the council's place in a rather centralist administrative culture where the people involved are highly networked. This results in co-ordination that is little reflected in formal processes, such as the choice by Tekes and the Academy of Finland to complement R&D areas in the late 1990s, despite the fact that there was no formal consultation (Arnold and Boekholt, 2003). It is also noteworthy that the council became much more influential at the end of the Cold War, when the collapse of about a third of Finland's export markets triggered a recession, and Finland, on the advice of the council, increased national investment in R&D. The sense of being "all in one boat" in a crisis appears to have facilitated the council's change of function from mediation to strategic leadership.

Traditionally the RIC has produced reports and statements about Finnish research and innovation policy, e.g. on issues such as the need to increase the internationalisation of the research and innovation system, as well as periodic reviews of policy and policy guidelines. While historically the Council has set the main research agenda, including the broad budget statement, detailed implementation has been carried out by ministries and agencies. This multi-stakeholder involvement is widely understood to be an important reason for the RIC's effective co-ordination of research and innovation policy (Veugelers, 2009; Schwaag Serger, Wise and Arnold, 2015). In practice, the influence of the RIC has varied and depends substantially upon the amount of interest the Prime Minister gives it. The "six pack" coalition government of 2011-15 is said to have been sceptical of the role of the RIC and of research and innovation policy more generally, leading to an increasing disconnect between the RIC's systemic approach and that of the government.

A 2014 evaluation of the RIC stated that its influence had declined since 2005. While it was supposed to co-ordinate research and innovation policy, the evaluation argued that its binary support structure resulted in separate research and innovation policy "silos". Key conclusions were that the council had an important role bringing together politicians and experts, with significant impact on government programmes, R&D funding and in

placing research and innovation policy on the political agenda. However, it had lost some of its position and effectiveness in the research and innovation system, due to unnecessary segregation between education, research and innovation, and a weak position in horizontal policy, often working reactively.

The last substantive contribution of the old RIC was to publish the "Reformative Finland" review for 2015-20 (Research and Innovation Council, 2015), setting three high-level objectives: 1) increase the quality of research; 2) renew the structures and functions of the public research system; and 3) diversify the economic structure to support regeneration of the enterprise base. In addition, the review proposed a list of approximately 50 actions along 6 themes, which included the radical reform of the higher education system; promoting the exploitation and impact of R&D; strengthening new sources of growth, intellectual capital and entrepreneurship; improving the overall knowledge base and selective support for cutting-edge skills; reforming the public sector and closer cross-administration co-operation; and ensuring the adequacy and targeting of R&D funding.

The review recommended increasing government R&D funding from the 2015 level by 2% annually over the second half of the decade. Of this increase of some EUR 210 million in real terms, EUR 85 million should go to Tekes and EUR 50 million to the Academy of Finland, to be distributed under competition. The RIC stressed the need for greater certainty in research and innovation funding, involving academic-industrial consortia more in policy making, improving the co-ordination between Tekes and the Academy, adjusting the incentives for universities so as to encourage specialisation and more strategic thinking, reversing the downward trend in business expenditure for R&D (BERD), and being more engaged in international R&D activities, notably the Framework Programme.

In its current form, the RIC is chaired by the Prime Minister, while the Ministers for Employment and the Economy and for Education and Culture are vice-chairs. The defence minister is the fourth minister member of the RIC.

The Prime Minister's Office

In addition to the SRC within the Academy of Finland, the Prime Minister's Office (PMO) administers an annual budget item (11 million EUR) supporting research in line with the government's policy priorities. The motivation for centralising research funds at the Prime Minister's Office was to ensure that government-commissioned research would be relevant to society, not only to an individual ministry. The pooling of research resources at the PMO was thus an attempt to generate a common research agenda.

The PMO calls for tenders each year, based on themes and topics outlined in the government programme and plan for analysis, assessment and research. To identify relevant topics, the government set up a "government working group for the co-ordination of research, foresight and assessment activities", which consists of representatives from all ministries. In addition to an annual plan for analysis, foresight, assessment and research, it supports decision making and is also responsible for monitoring and disseminating the generated knowledge. The budgets for individual projects are typically between EUR 100 000 and EUR 600 000.

Key ministries and strategies

Finland has historically assigned considerable importance in research and innovation matters to the Ministry of Employment and the Economy and the Ministry of Education and Culture. Other ministries nonetheless play important roles. Their significance is growing as a result of the development of cross-ministry strategies in areas such as the bio-economy and healthcare, and will need to grow further in the future in order to respond to societal challenges addressed in research and innovation agendas.

Ministry of Employment and the Economy

The Ministry of Employment and the Economy is responsible for the regulation of markets for labour, goods and services, industry, energy and employment policy as well as for regional development. It makes policy in the following areas: industry; energy and climate; innovation and technology; internationalisation; health and safety at work; employment, labour relations and the working environment; regional development; competition; consumer policy; and the integration of immigrants. The ministry's scope is therefore quite broad, bringing together research areas that in other systems are often handled by separate ministries. It maintains significant levels of analytic capacity in order to provide the strategic intelligence needed.

The Ministry of Employment and the Economy's principal agencies are Tekes, Finnvera, the Finnish Industry Investment and the network of regional ELY centres that provide local interfaces between companies and the state. In the Finnish system, as in Norway and Sweden, agencies have high degrees of freedom from their parent ministries. Funding and other instruments are typically designed at the agency level. In the context of a future need for more decentralised, system-changing policies this presents a considerable advantage over more centralised ministry-agency relationships.

Ministry of Education and Culture

The Ministry of Education and Culture is responsible for education, science, cultural activities, sport and youth policies, as well as international co-operation in these fields. It designs policy on daycare, education, training and research; arts, culture, sports and youth; public archives, museums and libraries; the churches and other religious communities in Finland; financial support of students; and copyright. Responsibility for the schools is decentralised at the regional level, though the ministry regulates them. The Academy of Finland operates under the auspices of the Ministry of Education and Culture. Higher education institutions (HEIs) are autonomous and operate mostly in the administrative branch of the MEC that steers their activities and channels government funding to HEIs.

Other ministries are involved in funding research and innovation, several of them via government research institutes (see Chapter 4). The emergence of cross-ministry strategies implies these ministries are starting to find new roles in the development of overall policy for research, innovation and, potentially, for system innovations or transitions. Box 6.2 provides examples of ministerial co-operation carried out along cross-sectorial innovation strategies in national strategic areas (spearhead projects) and new innovation initiatives in cities.

Box 6.2. **National innovation strategies and co-ordination across ministries and agencies in Finland**

The Health Sector Growth Strategy for Research and Innovation Activities

This strategy identifies the parts of the Finnish healthcare system that have potential to enable innovation and growth, in Finland and abroad. It analyses the status of health sector research and innovation policy in Finland and research-based opportunities to close gaps and develop competitive advantage. The Health Sector Growth Strategy was published in 2014. It was developed by the Ministry of Employment and the Economy, the Ministry of Social Affairs and Health, and the Ministry of Education and Culture, together with Tekes, the Academy of Finland, and research funders and organisations in the health sector. They were supported by a wider expert group and several consultations in the field. The emphasis is on developing a health "ecosystem".

The Bio-economy Strategy

The aim of the Finnish Bio-economy Strategy is to generate economic growth and new jobs in bio-economy business and high value-added products and services while protecting ecosystems and ensuring their sustainability. "Bio-economy" involves reduced dependence on fossil resources and shifting the basis of production towards renewable resources such as biomass or organic matter in the forests, soil, lakes and sea combined with greater reuse and recycling in order to be more sustainable. It aims to increase the value of the Finnish bio-economy from EUR 60 million to EUR 100 million per year over a decade, increasing employment from 300 000 to 400 000 in the same period. The strategy was devised in a project set up by the Ministry of Employment and the Economy. Participants included the Prime Minister's Office, the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Education and Culture, the Ministry of Social Affairs and Health, the Ministry of Finance, the administrative branches under these ministries, as well as VTT and Sitra.

The Six City Strategy

The Six City Strategy was set up in 2014 and is a seven-year strategy for sustainable urban development approved by the Ministry of Education and Culture and carried out by the cities of Helsinki, Espoo, Vantaa, Tampere, Turku and Oulu. The idea is to use these large cities as a milieu to develop innovation by improving city services and using the cities themselves as reference sites for future product sales. The combined scale of the six cities is intended to support the scaling up of innovations through pooled procurement.

Some EUR 80 million in European Regional Development Funds (ERDF) have been allocated across the life of the strategy, and the regions themselves must contribute one-third of the funding for projects falling within the strategy. Projects are carried out by networks of organisations, in order to build a basis for subsequent commercial exploitation. Results are then shared and disseminated, not least with other Finnish cities, as a basis for encouraging further take-up and innovation. The strategy is run by a joint management group, comprising the cities' directors in charge of business innovation and/or service development, and managed from the Häme ELY centre.

Agencies

Tekes – the Finnish Funding Agency for Innovation

Tekes was established in 1983, styled on Sweden's National Board for Technological Development (STU, currently VINNOVA). Close-to-market work could be funded via loans – a principle Sweden abandoned as unworkable in the 1980s but which persists in

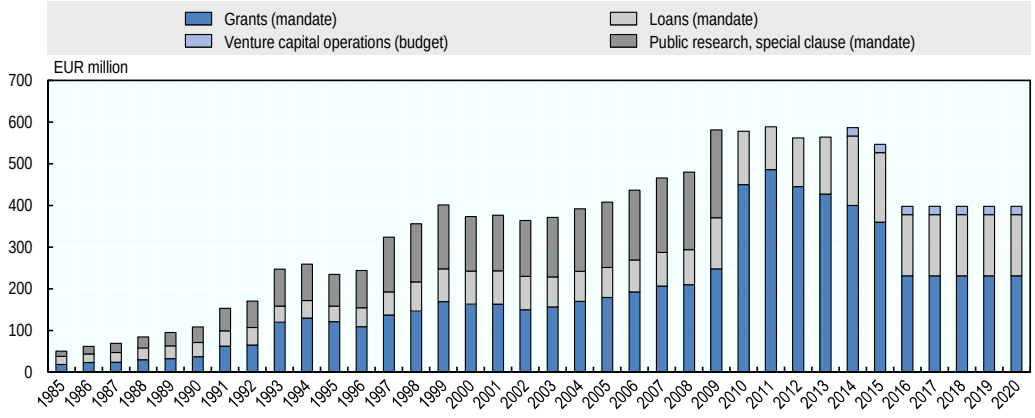
Tekes practice today. Tekes technology programmes have played a significant role in the Finnish industrial development since the 1980s. Some of these programmes have been focused on product and process improvement in existing firms, others have focused on capacity development and yet others on enabling technologies. They have therefore addressed both competitiveness and productivity, both by aiming to improve productivity in existing industries and businesses and by supporting restructuring into new, high-productivity businesses. Most conspicuously, multiple programmes strengthened the capabilities of the IT supply chain, generating a domestic supply community for Nokia and others.

Large firms were often involved as recipients of Tekes funding on the basis that they would then pass the subsidy upstream to the research sector or to smaller companies. While this generated benefits to large companies through the development of technologies and ecosystems of relevance to their business, typically 90% of the subsidy was passed on to SMEs and public research organisations.

A key change in Tekes' role was introduced following the 2008 crisis, when it was required to extend its activities to supporting start-ups and entrepreneurship. Tekes' funding for companies less than six years old more than doubled between 2006 and 2015 and the importance of loans in its portfolio has increased substantially since the crisis. This new role entailed acquiring new skills and setting up new kinds of programmes in addition to its traditional activities. In 2014, Tekes set up Tekes Venture Capital Ltd, which invests in venture capital funds with the aim of encouraging private participation. By 2016, the company had invested in 8 funds, which in turn had collectively invested in 75 companies (Kotiranta and Rouvinen, 2016).

Another key development around the time of the crisis was the setting up of the SHOK programme, which was launched in 2006 at the request of the RIC. The SHOKs were long-term public-private partnerships that received Tekes money to help fund R&D of interest to a group of stakeholders (see below).

Figure 6.4. **Evolution of Tekes' budget**



Note: The continuation of Venture Capital operations funding for 2018-20 has not yet been fixed.

Source: Tekes (2015), "The impact of Tekes and innovation activities 2015", Tekes, Helsinki.

Figure 6.4 shows that the combined effect of Tekes' changed role and the creation of the SHOKs was to reduce substantially national investment in technology programmes. This implied a reduction in "strategic applied research" or key enabling technologies

conducted in and with the university and institute sectors. In effect, a funding gap has been created in this area (Arnold et al., 2013) and there has so far not been any policy move to close it. The cancellation of the SHOK programme meant that Tekes lost the corresponding budget, so there have not been funds to close the gap again.

Tekes' current strategy focuses on businesses seeking renewable growth from international markets and emphasises business development to create opportunities for global growth. It supports emerging business ecosystems, builds a top-level innovation environment together with partners and offers a path to market via the Team Finland co-operation. Tekes states that it "promotes the development of industry and services by means of technology, innovations and growth funding". Table 6.1 provides an overview of the services delivered by Tekes in 2017.

Table 6.1. **Tekes' services, 2017**

	Start-ups	Small and medium-sized enterprises	Large firms	Research organisations	Public services
Tempo: Testing business concepts, demand, prototypes	X				
Research grants	X	X	X		
Loans for development and piloting	X	X	X		
Young innovative company scale-up funding: Grants and loans	X				
Info: Consultancy for international growth	X				
Innovation vouchers	X				
Team Finland Explorer: Market information from abroad	X	X			
Digiboost: Consulting help for digital renewal in business	X	X	X		
Kiito: Help to develop an internationalisation plan		X	X		
Into: Consulting on foreign market entry	X	X			
Trade fair grants		X			
Energy aid, production funds for film and media industries		X			
Pubic research networked with companies			X	X	
Public research in technology programmes			X	X	
Commercialisation support				X	
Kiito: Leadership and operational models					X
Innovative procurement: New products, pre-commercial procurement and catalyst test/demonstration procurement					X
Market opportunities programmes (Team Finland)	X	X	X		
International network access: Brussels, the People's Republic of China, India, Japan, the Russian Federation, the United States (Team Finland)	X	X	X		

Source: www.tekes.fi (accessed 19 March 2017).

Thematically, Tekes focuses on natural resources and resource efficiency, digitalisation for renewing business and industry, well-being and health, new business ecosystems and market access. Currently, it runs eight technology programmes, a significant reduction compared to before the financial crisis, when a much larger number of technology programmes was active.

Tekes was evaluated in 2012 (van der Veen et al., 2012). The evaluation noted that Tekes had a clear and positive effect on innovation activities, firm-level productivity and business renewal. It supported many of the most successful high-growth and start-up firms and appeared to compensate for the lack of private venture capital available to support early-stage firms. It was administratively efficient. However, co-ordination with other agencies could be improved. The findings on Tekes' impact on productivity and renewal have been confirmed by a more recent analysis (Viljamaa et al., 2014). While the main spearhead activity relevant to Tekes is to fund academic-industry collaboration projects, budget changes in recent years have tended to shift resources away from these activities and towards the third objective of building start-ups and ecosystems.

Finnvera

Finnvera is also an agency of the Ministry of Employment and the Economy. It was created in 1999 through a merger of Kera Corporation, which provided start-up and development loans to companies, and the Finnish Guarantee Board, which offered export credit guarantees. Finnvera has some 28 000 customers and raises capital by issuing bonds and receives an amount of credit loss compensation from the state. This compensation has risen from about EUR 10 million in 2007 to about EUR 80 million in 2015, reflecting Finnvera's growing provision of export guarantees.

The most recent evaluation of Finnvera (Heinonen et al., 2012) found that it is sufficiently capable to effectively compete with other countries' export guarantee arrangements, and largely satisfies the goals laid out by its parent ministry. However, it could take higher risks in cases where potential rewards are big and could play a larger role in company internationalisation.

Finnish Industry Investment (FII)

The FII was set up in 1995 and is an investment company owned by the Ministry of Employment and the Economy. It invests about two-thirds of its resources through private equity funds and the remainder directly. It only takes minority positions, however, with the aim of increasing the amount of capital available for these kinds of investments. Its current portfolio comprises about 670 firms, and in 2015 it invested EUR 93 million.

Following the rearrangement of the division of labour among Tekes, Finnvera and the FII, the FII is expected to focus on later stage venture capital and on growth finance. It should play a stronger role in direct investments, for example in biotechnology, clean technology, digital and health industries, and reduce its role in international funds and investments in order to focus more resources on the Finnish venture capital market.

A recent evaluation (Saarikoski et al., 2014) was positive about the FII's influence on the Finnish private equity market activities in the way it operates but argued that it was not especially proactive in market development. The evaluation suggested that Finland suffered from a poorly functioning late-stage venture capital market and ecosystem in terms of quality and investment volumes. Key bottlenecks were lack of commercialisation know-how, small investment sizes, the large share of the public sector

and a lack of liquidity in the exit market. To remedy these problems would require the FII (or another actor) to go beyond its current role. The evaluators also point out that the process through which the Ministry of Employment and the Economy sets the FII's objectives is complex and suggests that a more "hands-off" governance that leaves the FII's management to decide how to achieve its goals would improve its performance. At the same time, the evaluation argues that the FII's day-to-day operations could be better co-ordinated with those of the Ministry of Employment and the Economy's other agencies.

Finpro

The Finpro Oy is also an agency of the Ministry of Employment and the Economy, which was set up early in 2016 through a merger of the former Finnish Tourist Board and Finpro Ry, which was the agency responsible for supporting both Finnish exporters and foreign direct investment into Finland. Its 2016 budget was EUR 34 million and it operated 36 trade centres in 31 countries. Today it has three main activities: Export Finland, Invest in Finland, Visit Finland.

Finpro currently administers the government's growth programmes on behalf of Team Finland. These have a combined budget of EUR 51.3 million for 2015-17 in the areas of bio-economy, clean-tech, ICT and digitalisation, life sciences and health, foodstuffs, creative industries, teaching and learning, manufacturing, artic competence, tourism, and various cross-cutting themes such as emerging markets and business intelligence.

Team Finland

Linking all of the Ministry of Employment and the Economy's agencies under an umbrella organisation has been discussed since the early 2000s, triggered in part by the realisation that the business and innovation support system was fragmented and an increasing focus on internationalisation in the Finnish industry and innovation policy. Studies reporting to the government in 2012 led to the creation of the Team Finland network. This ultimately reports to the Prime Minister's Office, since it straddles the Ministry of Employment and the Economy, the Ministry of Education and Culture, and the Ministry for Foreign Affairs.

The Team Finland network consists of the three above-mentioned ministries and their agencies (Finpro, Tekes, Finnvera, Finnfund – which funds investment projects in developing countries); *Finnpartnership* (a programme which supports the creation of partnerships with companies in developing countries); Finnish Industry Investment; VTT; the Finnish Patent and Registration Office; the centres for economic development, transport and the environment; Finland's cultural and academic institutes; the Finnish-Russian Chamber of Commerce; the Finnish-Swedish Chamber of Commerce. The network also operates at the regional level, largely through the ELY centres.

A collective evaluation of Team Finland's various growth programmes (Salminen, 2016) found that the programmes are effective in supporting the internationalisation of SMEs. The visible effects are short term but positive and industry is enthusiastic about the programmes, although there have been many complaints about their implementation. Potential key improvements include a revised funding and oversight model, and enhanced co-operation with other programmes and service providers.

There still appear to be co-ordination issues across Team Finland. Operationally, these organisations lack a common customer management system so there is little overview of the individual customers and how they could benefit from the system as a whole. This may partly result from banking privacy regulations. Equally, there do not appear to be working-level routines for co-ordination at the level of customers, so a major form of co-operation appears to be the ability to refer customers towards other organisations better able to meet their needs. However, the government announced its intention to regenerate Team Finland in November 2016, focusing it around six programmes. Immediate measures to be taken included the inclusion of Finpro's 33 growth programmes and Tekes' 11 innovation programmes in Team Finland programmes, under the 6 themes of bio-economy and clean-tech, digitalisation, well-being and health, arctic business, tourism and special themes. In the future, services will be provided for common customers of both Tekes and Finpro, based on these six themes. Another new element will be the adoption of a voucher-based funding service for internationalisation.

It is not clear that Team Finland's activities in capital lending are sufficient. Tekes Venture Capital is a fund of funds, and so does not provide early-stage capital directly to companies. The closure of Finnvera's Vera fund means that Finnvera is no longer a source of such direct investment. The FII co-invests with private equity funds and private investors, focusing on later stage venture capital and growth finance. The state system depends, therefore, on encouraging private investment at the early, most risky phases of venture capital while playing a more direct role (as well as an indirect one) at the later, less risky stages.

The Academy of Finland

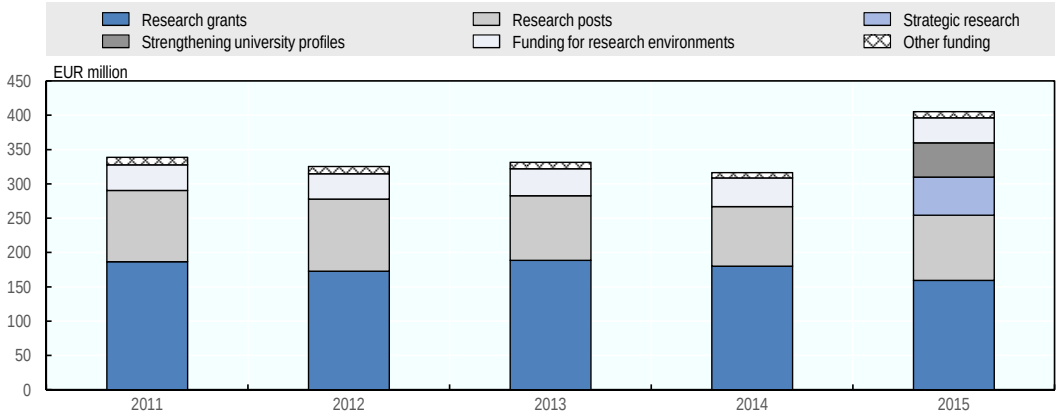
The new Academy of Finland started in 1970 and comprised the Central Board of Research Councils, the Academy's highest decision-making body, six research councils and an administrative office. The number of research councils grew to seven but was reduced to four in the 1995 reorganisation, when the Central Board of Research Councils was replaced by the board of the Academy of Finland, led by the Academy's President.

After its most recent amendment, the Act on the Academy of Finland (2009) states that the Academy's formal objectives are to foster scientific research and its use; promote international scientific co-operation; provide science policy expertise; grant funding for scientific research, researcher training and developing research capacity; and undertaking other science policy expert tasks at government request. The Academy's board comprises seven people appointed by the government, of whom three are currently Finnish academics. Four rather traditional research councils composed of Finnish academics appointed by the government form the main pillars of the Academy: biosciences and the environment, culture and society, natural sciences and engineering, health.

The Academy has a separate committee funding research infrastructure and a new Strategic Research Council that was created in 2015. Figure 6.5 shows how the Academy has allocated its funds in recent years, continuing to spend a large part of its budget on personal fellowships. The research grants funded cover both principal investigator-initiated proposals and a number of small programmes, proposed by the research community, which focus on grand challenges and supporting emergent fields of research. Few grants are less than EUR 200 000, so the Academy has followed the trend among research councils to reduce the importance of small grants and encourage the formation of larger research groups.

Figure 6.5 shows the new expenditure of the Strategic Research Council (SRC) in 2015 and also a second initiative: strengthening university profiles. These are grants to individual universities aiming to strengthen and consolidate areas of expertise. They are intended to be tools for strategic management by the rectors, allowing the universities to specialise, producing a clearer thematic division of labour and supporting strong points in the university system.

Figure 6.5. **Academy of Finland funding decisions and funding type per year**



Source: Academy of Finland (2016).

Since 1996, the Academy of Finland has run centres of excellence (CoE), providing an incentive for defragmenting the academic structure. A major issue is to what extent these CoEs have an impact on knowledge transfer and generating industry or socially relevant research for innovation.

The most recent evaluation of the Academy (Arnold et al., 2013) found that it was well functioning, but constitutes a traditional research council, which needs to modernise in order to deal with the changing context. The Academy did rather little in its role as science policy advisor to the government. Its internal governance was not conducive to change while the Ministry of Education and Culture steered the organisation rather softly. Success rates were declining over time to some 30%. Recently, the success rates have fallen clearly below 20%, close to the rates at equivalent organisations in Norway and Sweden.

In the most recent period, it is clear that the role of the Academy has shifted further away from the old mode of reactively responding to researchers' funding requests towards a more strategic approach, aiming to influence the shape and performance of the system.

The Strategic Research Council

One aim of the recent reform to the funding system and the PRIs is to increase the ability of research and analytical work to inform and support policy making in a systematic way. To this end, the government has established lines and programmes for funding "strategic research". The reform also seeks to strengthen research institutes' co-operation with universities through common research equipment, laboratories, close co-operation in research and education – including shared staff – and the establishment of agreement-based consortia (Kotiranta and Rouvinen, 2016).

At the same time that basic funding to PRIs was cut, a new funding instrument for long-term funding for research to tackle major societal challenges was set up at the Academy of Finland: the Strategic Research Council. The funding, to be allocated in competition, is for strategic, problem-oriented research aimed at finding solutions to societal challenges, with an explicit emphasis on supporting and strengthening policy making. EUR 70 million were to be cut – from Tekes (10 million EUR), the Academy (EUR 7.5 million) and especially the public research institutes (EUR 52.5 million) – for allocation to the SRC. The largest share was to come from VTT (EUR – 16.6 million) (Government's decision-in-principle 2013). Annual funding of SRC is around EUR 55 million. Universities as well as public and private research institutes are eligible to apply for funding.

The members of the Strategic Research Council currently comprise two persons working in the senior management of government research institutes (VTT and Finnish Environment Institute), four university professors (two of whom hold the title of Academician), two senior executives of a private company and one retired senior civil servant (also professor of practice). The largest grant so far has amounted to EUR 4.77. Once a year the SRC prepares a proposal on strategic research themes based on a consultation process which it then presents to the government for approval. The government decides the final themes based on which the SRC then designs research programmes and funding calls. The SRC's current priorities are shown in Table 6.2.

Table 6.2. **The Strategic Research Council's key priorities, 2015-18**

Year	Key themes
2015	Utilisation of disruptive technologies and changing institutions A climate-neutral and resource-scarce society Equality and its promotion
2016	Knowledge, know-how and the changing working life Health and the changing of lifestyle Overall security in a global environment Dynamics of urbanisation
2017	Changing citizenship - society in a state of global flux
2018	Reform or wither – resources and solutions

Note: In 2016, the government also decided that a common priority area would be to take into consideration the effects of migration on Finnish society. In 2017, the government also decided that a common priority area for both 2017 and 2018 themes would be harnessing scientific knowledge in decision-making and achieving sustainable growth.

Source: Academy of Finland.

Public research institutes participate in the majority of projects funded by the SRC so far. However, relatively few projects are led by institutes. In 2015, 4 out of 16 projects funded by the SRC were led by PRIs, while in 2016 in 2 out of 14 projects the consortium leader was from a PRI (based on funding decisions listed on the SRC's homepage). Thus, the vast majority of the bottom-up projects currently funded by the SRC are led by university researchers. Some 75% of the 2015 SRC funding went to university projects and the remaining 25% to institutes, representing a reallocation of just under EUR 40 million from the institute to the university sector that year.

Sitra

Sitra is an independent foundation reporting directly to the Finnish parliament, which is capable of making policy interventions without a government mandate. It was established in 1967 as an organisation of the Bank of Finland. Its mission was to promote balanced economic growth and international development. In 1991 Sitra was externalised, becoming an independent foundation using the revenues from its fund to finance its activities. At the end of 2015, the fund stood at EUR 771 million and Sitra had spent about EUR 38 million on its activities that year.

Sitra's independence has enabled it to play a variety of roles over time, focusing on ways to trigger change. It has fairly consistently maintained a rolling programme of change-orientated projects, training and events such as workshops. In the past, it has run foresight projects (and still runs foresight networks), reorganised the state's regional provision of venture capital and invested in start-up companies. In 2012, Sitra adopted a project-based form of organisation, based on three themes:

1. empowering society, currently described as "capacity for renewal"
2. resource-wise and carbon-neutral economy
3. new working life and sustainable economy.

Projects involve research, policy experimentation and piloting; workshops and other events; funding policy-relevant research; networking; foresight; strategy development; calls for ideas and challenge competitions. This range of project types is increasingly needed as Sitra addresses aspects of transitions in socio-technical systems. This tends not to mean head-on attempts to change existing systems, but rather experimenting with and piloting partial solutions that can run parallel to them.

Sitra was last evaluated in 2012 (Ramböll, 2012). The evaluation endorsed the quality of Sitra staff and the effectiveness of its work in triggering and encouraging change. Sitra often achieves impact by temporarily entering areas where there are no other effective actors and experimenting with social innovations such as health kiosks and municipal service centres. It has a good reputation and influences public opinion (for example, in the area of green energy) as well as policy making.

In a time of new policy requirements, Sitra's potential for experimentation and as a change agency are important assets for Finland, which could be exploited in the search for new ways to define and implement policy. The Director General of Sitra is a member of the "6DG" group, together with heads of key agencies, so there is an established channel for co-ordination between its independent actions and those of the state.

The regions

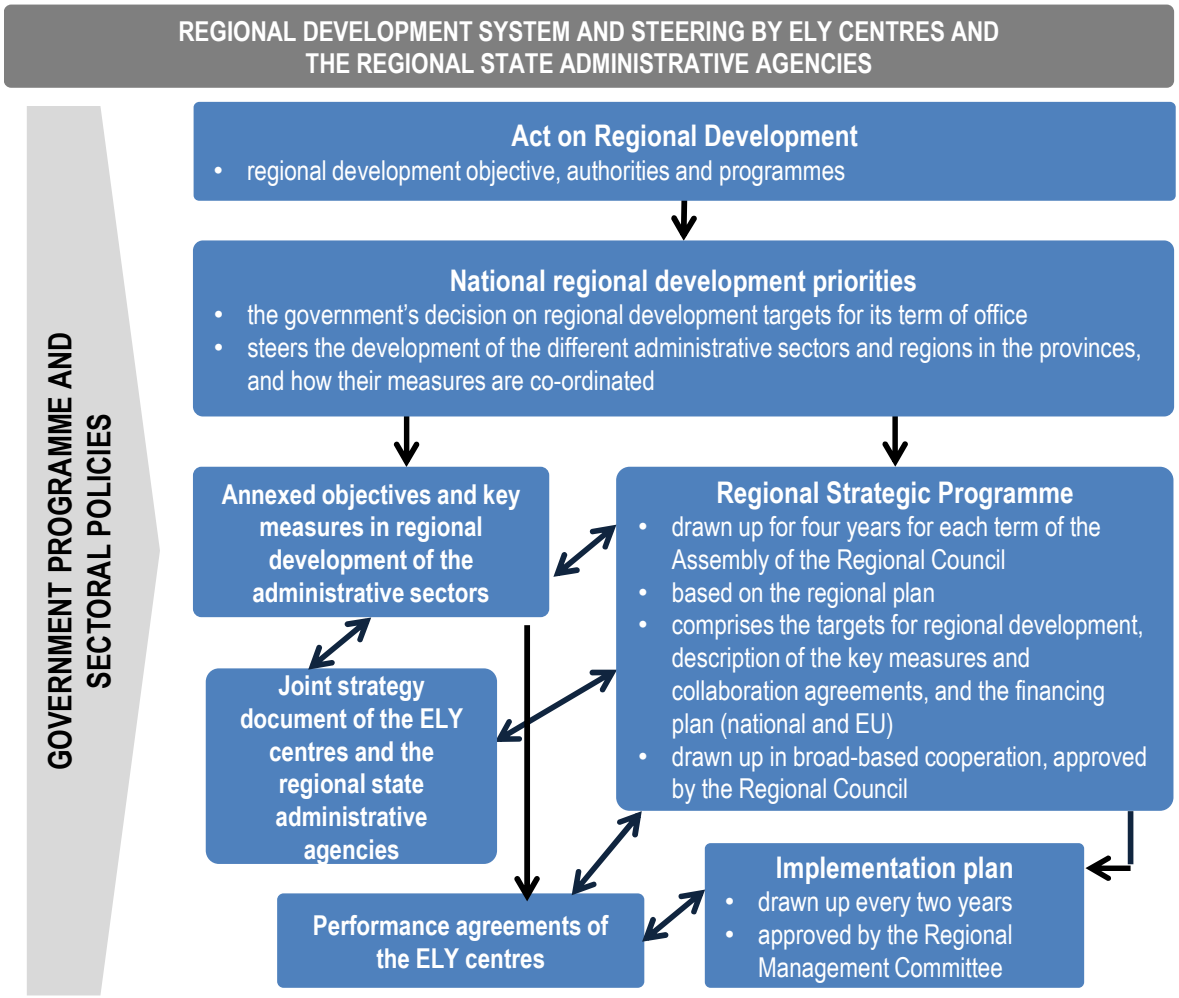
Finland is a relatively centralised state, where the regions play less of a role in policy development and implementation than their larger counterparts in more regionalised countries like France, Germany or Spain.

Between 1634 and 2009, Finland was divided into a number of provinces, from which government managed the regions based on Swedish administrative practice where the lowest level comprised self-governing municipalities. At the time of their abolition in 2009, there were six provinces. Today, the municipalities have responsibility for healthcare and social services, schools, infrastructure and land use, economic development, and aspects of law enforcement not handled by the police. In the early

1940s there were a little over 600 municipalities, falling to some 450 by about 1990. In 2016, there were 20 regional associations (including the autonomous region of Åland) made up of 313 municipalities of varying sizes. Given the small size of many municipalities, it is hard for them to fulfil their responsibilities – a problem which many solve by outsourcing services.

Since the early 2010s, both the government and the Association of Finnish Local and Regional Authorities (Kuntaliitto) have been pushing for more municipal mergers, aiming to create a threshold population for a municipality of 20 000-30 000 people. From 2012, Kuntaliitto has been running a development programme to improve the capacities of the municipalities and inspire development, with limited success. The current government has revamped local and regional reform, aiming to merge municipalities and certain central government authorities into 18 counties with directly elected councils, replacing the existing regional associations. These will be responsible for healthcare and more widely for about 60% of the local and regional government budget. To what extent these 18 counties will take on responsibilities for formulating innovation policies remains to be seen, while national-level organisations should ensure their co-ordinating role to avoid any risks of fragmentation of the research and innovation system.

Figure 6.6. **Current regional development framework in Finland**



Source: Ministry of Economic Affairs and Employment.

The regional associations have been the focus of regional planning and in recent years have been the level at which regional development subsidies from the European Social Fund and ERDF have been planned. Every region developed an innovation and development plan some years ago, so the tradition for such planning is well embedded at this level. Previously, the provincial level was a useful one at which EU support could operate, since the number of provinces was small enough and the size of each province large enough to be handled by EU programmes, notably the Regional Innovation Strategy programme, currently known as "Smart Specialisation" or RIS3. The loss of the provincial level has entailed a more fragmented dialogue between the regional and EU levels.

There is a strong interplay between the regions and the national level, based on the government's national regional development priorities. Figure 6.6 provides an overview of the current regional development framework of Finland. The government's "spearhead projects" frequently have a regional dimension and the government has started to sign development contracts with major cities, having abandoned a more fragmented approach to regional innovation via the Centres of Expertise programme in 2013. Central government has maintained different generations of representative offices at the level of the regions. Known as TE-Keskus in the 1990s and more recently as ELY centres, they provide regional outposts for the work of a (slightly shifting) constellation of national ministries spanning work, industry and development issues. The ELY centres not only deliver state services, but serve as a key interface for regional development planning between the regions and the central state.

The Ministry of Education and Culture's policy of encouraging universities to focus their thematic research "profile" also has potential synergy with the regions. For example, it has allowed the University of Vaasa to expand its research activities in partnership with the local industrial clusters, centred on Wärtsilä and ABB Group (ASEA Brown Boveri), with expected effects not only on the university's ability to support industrial R&D but also on education at all levels, therefore improving the local availability of skilled and educated people who are otherwise difficult to attract and retain in the more peripheral regions.

Overall, despite the fragmentation of the municipalities, the regional development system combines the ability to act locally with a degree of central government steering and opportunities to use central government initiatives and programmes in support of regional innovation and development. There is a trend in government policy towards handling regional development in larger blocks, encouraging defragmentation and the emergence of strong, city-centred regions rather than attempting to empower every municipality or even region. Given the context of global competition and the fact that Finland's population is comparable to that of German Bundesland or a French département, this aim to operate in larger entities is reasonable, as is (within reason) the city-centric approach. It is well documented that urban regions tend to produce higher rates of innovation than other regions.

Governance: Agenda setting, co-ordination and evaluation

Research and innovation governance in Finland

The RIC has for decades been the cornerstone of the system, forming an "arena" where central actors from government, agencies, academia and industry can hammer out a policy consensus that has the authority of government based on a system-wide

overview. In relation to research and innovation policy, all the needed voices have therefore been heard.

The RIC's policy statements were traditionally evidence-based, but brief. They set directions but do not go into the details of implementation, leaving those to the expertise of the ministries in the case of reforms and regulation, the agencies in relation to policy instruments and their use, and to the industrial and research communities. The Academy of Finland and Tekes involve their stakeholders on their boards, so that they are in close touch with their constituencies. The analytic and operational capabilities of the ministries and agencies mean that the state's part of the research and innovation system has considerable "distributed strategic intelligence" (Kuhlmann et al., 1999) which is needed to be effective at both strategic and operational levels. However, there are concerns that there is a serious shortage of free, untied financial resources for policy analysis and development in the ministries.

Despite the imperfections detected in its recent evaluation (Pelkonen, Nieminen & Lehenkari 2014), the RIC has provided Finland with a uniquely powerful way to understand the national research and innovation system, to develop the main lines of policy for it, and to co-ordinate the implementation of policy. It has been able to tackle systemic issues such as the balance between research council-style bottom-up funding on the one hand and applied and thematic funding in support of innovation on the other. It has identified the constraints that fragmentation within and among higher education institutions impose on research quality, relevance, critical mass, the reputation and international attractiveness of Finnish universities and proposed measures ranging from setting up SHOKs and centres of excellence through to "profile" funding, institutional reorganisations and mergers to address these issues. It has highlighted the need for internationalisation of both public and private sector R&D as well as higher education and triggered measures to address the problem.

The PMO has in the past played small role in research and innovation policy. However, as part of the package of reforms that created the Strategic Research Council and restructured the government research institutes, a new budget item was created under the PMO for funding studies) to support government decision making, with a proportion of the money being used to study aspects of the research and innovation system. The central position of the PMO means that it is a potentially powerful place from which to tackle the increasingly difficult and complex task of co-ordinating policy.

The new government of May 2015 did not appoint members of the RIC until a year later, so the government programme was launched without the benefit of work by the RIC. However, with the exception of RIC recommendations on the PPP instruments and education and R&D funding, the government programme did not deviate considerably from the lines proposed by the previous RIC in its final policy review "Reformative Finland" (Research and Innovation Council, 2015). Hence, neither the systemic and integrative focus of Reformative Finland nor the attached recommendation to increase government R&D spending by 2% per year is reflected in the new government's policy. The decision by the new government to defund the SHOKs and dismantling INKA without replacing them with other instruments fails to acknowledge the systemic role the RIC foresaw for them. The new government's 6 strategic objectives, to be reached through cross-ministry co-operation and 26 "spearhead projects" (10 of which involve research and innovation measures) constitute a challenging, and in many ways forward-looking, programme. However, the absence of the RIC during the period when these objectives were formulated means that they are not connected to a coherent overall

research and innovation policy. A new government decree on the RIC was issued in March 2016 and a re-structured Council finally met in September 2016. The thrust of its activities is not yet clear but the revival would suggest it to launch a new policy agenda, to generate the restructuring and growth needed in the economy.

Governance, economic and societal challenges and transitions

There is growing international recognition of the need to adapt the way countries govern research and innovation policy in order to meet the societal and increasingly complex economic challenges that globalised economies encounter today. As discussed in previous chapters, Finland needs to develop new and sustainable export strengths, and revitalise traditional industries, fostering their capability to compete globally through new economic competences. This transformation will require Finland to engage more in "radical innovation" and become more effective in utilising its valuable knowledge capabilities and transforming them into globally competitive innovation. Raising productivity levels also requires making innovation and commercialisation more effective, which entails rethinking the innovation strategy and ensuring the benefits of new technological paradigms (e.g. digitalisation).

Finland, along with other countries, faces the challenge of ensuring the future quality of life and well-being and addressing societal challenges such as energy efficiency, healthcare for an ageing population and climate change, and developing new solutions in innovative ways and based on innovation. The system-changing nature of these challenges means that they require a new style of innovation system governance, which is more participatory and more inclusive of a wider set of stakeholder groups – in the economy and society, in government, among final users, and abroad – and which is more open to societal input to the process of innovation. These elements are also pertinent for addressing economic challenges in more effective ways through innovation policy than in the past. The "societal challenges" also provide massive opportunities for knowledge-based innovations and new kinds of business, including for global markets. Addressing them should be based on a forward-looking strategy and vision promoted at the highest level of policy decision making.

The necessary new style of governance needs to coexist alongside earlier styles that remain relevant in many parts of the system and are adapted to other important purposes. As it requires a system-wide approach, it has encouraged experimentation, but there is no established "best practice". Finnish experience with innovation system governance positions the country well to take a lead. The RIC would play a central role in this endeavour. Implementing this new form of governance implies developing new policy instruments, an area in which Finland has also gathered considerable experience. But these will only function well in a system that invests strongly in research and innovation, and uses and further develops more traditional instruments where these are appropriate.

An emerging literature describes tackling the societal challenges in terms of "transitions" between socio-technical systems or systems innovation (Geels, 2010; Kuhlmann and Rip, 2014; OECD, 2016a). The commonly used exemplar of a transition is the one needed in the energy system in order to combat global warming, but a similar logic applies in areas such as ageing and healthcare, where system-wide changes in production, consumption, markets, regulation and social attitudes will be needed to cope with change (see Box 6.3 for some OECD examples). At the core of the transition is a shift in governance structures that not only allows change to occur, but also directs and orchestrates some of the changes. The "smart city" and "circular economy" initiatives that

mobilise technological and social innovations to make the production and consumption of a city's goods and services more sustainable illustrate this point.

One implication is that transitions need to be managed on a more decentralised basis and with bigger networks than in traditional research and innovation policy. The scope of these networks will be specific to each system innovation: the shape and composition of the needed networks will be different among climate change, ageing, HIV/AIDS and so forth. There will be considerable limits to the ability of a single co-ordinator to manage these in detail. Significant power and initiative will have to be devolved to the level of the networks tackling the individual challenges. At the same time, a degree of national prioritisation and co-ordination will be needed if overall national strategy and policy are to be coherent.

Taking these opportunities requires more coherent and thought-through cross-cutting national strategies and more integrated funding and governance that will allow researchers to play their part. The need for scientific excellence and industrial relevance do not disappear but policy and research need to be better co-ordinated and connected to grand challenges. Inevitably, small countries like Finland need selectively to choose the areas where they will grow or strengthen the capabilities needed for specific grand challenges. A key dimension will be to balance research potential with innovation potential, based to a great extent on the availability of strong domestic industrial partners.

Box 6.3. **System innovation transition programmes in OECD countries**

The concept of system innovation can be characterised as a horizontal approach to innovation policy directed at problems that are systemic in nature, such as transitioning towards low carbon energy systems or low carbon transport systems. It is one that involves engaging a range of private and public sector actors and takes a longer term view in policy (OECD, 2016a). The rationales for a system innovation go well beyond traditional motivations for innovation policy such as market failures; other failures such as demand articulation failures (i.e. hidden or weak demand) and transitions failures are considered reasons for public action. Furthermore, system innovation theories argue that destruction – or at least disassembly of existing infrastructures, regulations, norms or standards – may be needed for new solutions to emerge and scale (ibid).

Implementation of system innovation as a framework for policy making is a recent development spurred by forward-looking governments, innovation agencies and regions in countries such as Belgium, Finland, the Netherlands, Sweden and the United Kingdom but also Korea and Japan, which are experimenting with a systems approach and use the systemic policy instruments such as longer term (five to ten years) innovation funding programmes; road mapping; new cluster policy; smart regulation and demonstrators. Many OECD countries are also mainstreaming system-based approaches to innovation policy in the context of a dedicated green economy agenda or as part of energy and industrial regeneration strategies. Examples of recent policy initiatives are discussed below.

Austria: National Platforms for Industry 4.0 are an example of a national initiative that is mainly policy driven that has been set up in a top-down mode. The platform explicitly addresses the complex challenges of the transition of small and medium-sized enterprises towards Industry 4.0. Although initiated top-down, platforms encourage the participation of all stakeholders.

Belgium: Flanders has been a pioneer in using system innovation as a policy approach. Transition management tools were first adopted in 2004 to tackle the systemic challenge of sustainable living and housing by starting a transition arena called DuWoBo.

Box 6.3. **System innovation transition programmes in OECD countries** (*cont.*)

Korea: A full-scale discussion on autonomous vehicles in Korea began with the announcement of "Autonomous Vehicle Service Commercialisation Support Measures" in the 3rd Regulatory Reform Ministerial Meeting held in May 2015 under the chairmanship of the President. Legislative and regulatory initiatives have been implemented to facilitate system transformation as well as raising public acceptance.

Sweden: The Re:Source initiative, one of Sweden's 16 strategic innovation programmes, provides long-term support for system transformation by supporting innovative business and governance models for the transition to a circular economy. The first phase was initiated in 2016 and will last three years but from the beginning, consortia actors have planned for a 12-year duration.

Japan: The Ministry of Economy, Trade and Industry reviewed four large-scale smart city demonstration projects in different areas of Japan which were called "next-generation energy and social systems demonstration areas" and launched the Virtual Power Plant Demonstration project in 2016 to demonstrate business models in smart cities. Policy and institutional measures for facilitating communication and engagement with end-users have been particularly important in the development of innovation for smart cities.

Source: OECD (2016a), "System innovation", in: *OECD Science, Technology and Innovation Outlook 2016*, http://dx.doi.org/10.1787/sti_in_outlook-2016-9-en.

New approaches to innovation policy through public-private partnerships

Increasingly OECD countries are beginning to use public-to-public (P2P) partnerships and public-private partnerships (PPPs) to cope with broad industry- or economy-wide issues such as skills or infrastructure as well as societal challenges. These typically involve the creation of a platform for relevant stakeholders, which generates a strategic research agenda. The strategic research agenda is approved by the government or one of its agencies and the partnership is then left to manage certain aspects of implementation. Each partnership forms an "arena", in the terminology of the previous section.

Policy instruments can then be matched and utilised by the consortiums to address their innovation needs. In some cases, new instruments are launched to support implementation. In some cases, this can involve the partnership in issuing calls for proposals, evaluating and funding research using money provided by the state. The power of wide partnerships is their ability to move beyond the confines of research and innovation policy to deal with the broader, systemic issues involved in addressing the societal challenges and the transitions among the socio-technical system that they require. Finland could benefit from a renewed approach to PPPs to address sectoral (and cross-sectoral) challenges by promoting stakeholder innovation co-ordination (supporting self-organisation) via jointly agreed strategic research innovation agendas and implementation of resulting innovation programmes. While there are some networks or clusters (remaining SHOKs), (cross-)sectoral innovation strategies and road mapping are currently lacking. Innovation road mapping consists of the identification of both technology and non-technology bottlenecks (e.g. regulation; skills) and innovation priorities and value-chain development needs.

The Swedish Strategic Innovation programme (SIO) provides an interesting example of such partnerships and their governance (Box 6.4). This programme seeks to reinforce the foundations for new, long-term and in-depth collaboration (across a wide set of innovation actors) based on a bottom-up approach where innovation needs and priority areas are defined by actors themselves with the government facilitating the process and

establishing a framework of selection criteria reflecting societal challenges, high scientific quality, collaboration, cross-disciplinarity and co-financing (OECD, 2016d). A number of strategic innovation programmes in different areas have been launched, among them the Strategic Innovation Programme Aeronautics (INNOVAIR) or the Strategic Innovation Programme for the Swedish mining and metal-producing industry, STRIM, based on their innovation agendas. The cross-ministry "21" strategies in Norway provide another example. Like the Finnish Health Sector Growth Strategy and the Bio-economy Strategy, these represent steps towards the kind of P2Ps and PPPs needed, but so far under-emphasise the non-R&D-related aspects of networking, road mapping and policy development.

Box 6.4. **The Swedish SIO programme: A renewed approach to public-private partnerships**

The SIO programme was formally created in 2012 in response to a formal task assigned to VINNOVA, the Swedish Energy Agency, and the Swedish Research Council for Sustainable Development (Formas) by the Swedish government to identify and jointly support strategic innovation areas (SIO) in Swedish areas of strength. The purpose of investing in strategic innovation areas is to lay the foundations for sustainable solutions to global social challenges, economic renewal and international competitiveness by means of new, long-term and in-depth national collaboration between universities, research institutes, the business sector, the public sector, civil society as well as international collaboration. Specific goals are to renew Sweden's innovative strength in a number of strategic areas, develop new value chains and strengthen cross-sectoral competence, knowledge, technology and service development (Palmberg and Schwaag Serger, 2017; OECD, 2016d). The programme includes two types of efforts:

- Strategic research and innovation agendas, which aim to stimulate a strategic dialogue between actors so as to, through a joint research and innovation agenda, highlight areas for improvement and the needs and possibilities available.
- SIO programmes, which aim to support the implementation of the research and innovation agendas that are most important for Sweden, as well as those that have the greatest potential to create conditions for international competitiveness and to find sustainable solutions to global challenges for societies.

Funding for implementation is initially provided for three years, "with the possibility of renewal for a maximum of nine further years based on a triennial review process. Thus, a further key characteristic is the long-term horizon of the programme. An SIO programme must have an organisation in order to ensure that the goals can be met, and in order to be able to adapt activities and initiatives to external changes. Its management should be proactive and have the trust of actors in the field. The organisation should at the very least consist of a board of directors and have an active programme management that sees to the operations of the SIO programme.

As of December 2016, there were a total of 16 SIO programmes in Sweden, including lightweight materials; metallic materials; mining and metal extraction; production 2030; process industrial information technology and automation; aeronautics; graphene; ICT electronic components and systems; Internet of Things; bio-innovation, among others. Between 2013 and 2016, the total public budget for the SIO initiative amounted to around SEK 1.1 billion (roughly EUR 120 million). Between 2017 and 2024, around SEK 600 million (approximately EUR 62 million) annually have been budgeted for the initiative. Many of the large Swedish-based companies are involved in one or several of the SIO programmes.

Sources: VINNOVA (2013); VINNOVA (2017), VINNOVA website, www.vinnova.se/en; OECD (2016d), *OECD Reviews of Innovation Policy: Sweden 2016, OECD Publishing, Paris,* http://dx.doi.org/10.1787/9789264250000-en.

Whilst there is no one-size-fits-all model for PPPs, several factors recurrently appear as fundamental in the design and implementation of successful PPP schemes. In particular, good governance and public leadership are key factors ensuring the success of PPPs. These include setting clear objectives and well-defined activities/responsibilities for each participant, operational rules and implementing regular monitoring and evaluation, transparency, the establishment of dispute settlement and exit strategies (OECD, 2015). Among the most important principles of good practice in setting challenge focused PPPs are:

- Define clear challenges/necessities through innovation agendas addressing sectorial/industries' challenges.[2] Such agendas will tackle R&D needs and technology diffusion needs and more broadly innovation strategies for the medium/long run. When necessary they should involve end-users, regulators and other actors whose actions are necessary for success.
- Ensure that governance standards are in line with good practices in PPPs (road mapping, accountability, clear commitments, ex ante governance criteria, intellectual property rights, etc.), planning and periodical evaluation. This will also require a stronger involvement of the government; the government should be an active member of the PPP. The PPP should take the form of a legally binding contract agreement.
- The PPP should integrate the participation of SMEs, including start-ups, and foster (and facilitate) linkages between start-ups and large firms.
- Maintain close monitoring and evaluation of the partnerships. Ensure that project selection within the programme is done under competition and is quality assured by an external agency, in order to ensure that the best possible work is done and to avoid capture by the stakeholder group.
- Encourage and facilitate new cross-sectoral collaborations with the involvement of users, including the public sector. One example is the Challenge-Driven Innovation Programme carried out by VINNOVA in Sweden which has resulted in new, strategic, collaborations – e.g. between the mining industry and ICT companies.

Box 6.5. **The Finnish digital cluster: A successful public-private partnership development and ecosystem**

DIMECC (Digital, Internet, Materials and Engineering Co-Creation Ltd.) is a non-profit company previously part of the strategic centres for science, technology and innovation (SHOKs) financed by Tekes and one of the public-private partnerships (PPPs) with successful performance and growth. DIMECC is a leading breakthrough-oriented co-creation ecosystem that speeds up time to market and is the Finnish industry's answer and response to the digital revolution. It is an innovation ecosystem combining the industry's relevance and needs with research competence. The network consists of 2 000 R&D&I professionals, 400 organisations, 69 shareholders and 10 co-creation facilitators. DIMECC was built by combining two of the most efficient innovation platforms in Europe. These are the manufacturing industry's FIMECC Ltd. and the digital industry's DIGILE Ltd. Its administrative costs have been only 3.5%; this is a European record. The results calculated by the industrial companies themselves show that EUR 1 invested in FIMECC Ltd. innovation programmes has returned an average of EUR 20.

Box 6.5. **The Finnish digital cluster: A successful public-private partnership development and ecosystem** (*cont.*)

DIMECC's vision is to be the leading co-creation platform for digital transformations. This is achieved through PPP-based co-creation activities in the following thematic areas: enabling technologies, technology cross-utilisation and business on emerging technologies. DIMECC accelerates R&D&I activities through three types of services: 1) programmes and projects; 2) co-creation; 3) network as phases of "innovation funnel". DIMECC programmes and projects are built and implemented openly together with companies, universities and research institutions in order to accelerate R&D&I. They follow the principles of open innovation, co-creation and agile development. Co-creation services offer a partnership for strategic research, development and innovation activities through the construction of ecosystems to create competitiveness for the future, and boost new business creation and new market entries.

DIMECC's organisation and operating model are based on lean operations through which network-based co-creation activities can be effectively steered and managed. The activities to accelerate the research work of the programmes include, for example: Demobooster (rapid commercialisation), PoDoCo (strategic renewal and technology transfer), Innovation Camp (idea crowdsourcing), industry-driven doctoral schools, and effective utilisation of partnership networks. According to its 2016 annual report, the company achieved a EUR 50 million research portfolio, had more than 400 customers and 40 significant international partners and stakeholder organisations. Also, more than 3 000 people were involved in DIMECC activities, there were 13 full-time employees, 3 part-time employees and 10 programme managers. In terms of its activities, it had 4 DIMECC factories (in Espoo, Tampere, Turku and Oulu), 42 PoDoCo scholarships by private foundations, 2 doctoral schools (breakthrough materials and CEESIMP), 4 demo days, 34 Demobooster customers, 150 student participants and 6 companies at Innovation Camp, 7 FiDiPro professors and 5 Academy of Finland projects linked to DIMECC.

Sources: DIMECC (2017), DIMECC website, www.dimecc.com; DIMECC (2016), *2016 Annual Report*, http://dimecc.com/wp-content/uploads/2017/03/AR-2016-final.pdf.

Future role of the Research and Innovation Council and the ministries

Translating changed governance needs into practice requires: a process of prioritisation; obtaining consensus about the resulting priorities; establishing a national co-ordination mechanism; and innovating instruments that enable implementation. The revival of the RIC under the current government provides an opportunity to redefine its role towards the wider mission of defining and co-ordinating the implementation of a national vision for addressing both economic and societal challenges.

First, a high-visibility, national exercise is needed to create and generate support for a new vision and all-of-government strategy for using knowledge to tackle the societal challenges and drive economic performance. The strategy needs to identify areas where aspects of societal challenges can be coupled with actual or potential Finnish comparative advantages, so that innovations within networks that also reflect needs and the demand side can be focused on areas where they will generate competitiveness, productivity and growth. This should involve wide-ranging consultation. Advanced joint foresight activities would be required but needs to extend to road mapping in order to establish a consensus about implementation, reduce the perceived risk of innovation and identify lead markets.

In addition to the technology experts, industry and sector representatives, such foresight exercises should involve a wide range of stakeholders and experts – such as various categories of consumers, regulators, "users" such as healthcare and transport

providers, social scientists, philosophers, artists, students and immigrants – to ensure a broad, ambitious and socially relevant perspective. This effort should not only seek to define a set of priorities but also be deliberately public and inclusive, in order to establish a social consensus and boost morale.

Box 6.6. **Enhancing innovation governance: Japan's Cross-ministerial Strategic Innovation Promotion Programme**

In 2014, the Japanese government established the Cross-ministerial Strategic Innovation Promotion Programme (SIP). This is a national project for science, technology and innovation, spearheaded by the Council for Science, Technology and Innovation in its role to lead science, technology and innovation beyond the framework of government ministries and traditional disciplines. Its creation is based on the directives of the 2013 Japan Revitalization Strategy and the Cabinet's comprehensive strategy on science, technology and innovation.

The SIP has identified ten themes that will address the most important social problems facing Japan, as well as contribute to the resurgence of the Japanese economy. These programmes include: energy (innovative combustion technology, next-generation power electronics and energy carriers), structural materials for innovation, new technologies for the exploration of ocean resources, automated driving systems, infrastructure (e.g. cyber-security for critical infrastructure), technologies for next-generation agriculture, forestry and fisheries; and innovative design and manufacturing technologies. The SIP Program promotes focused, end-to-end research and development, from basic research to practical application and commercialisation.

Each project is led by an experienced and talented programme director who is responsible for end-to-end focused research and development, facilitating co-ordination among government, industry and academic entities. These directors have been charged with guiding their project from basic research to practical application and commercialisation, and ultimately to a clear exit strategy. The programmes utilise and mobilise developments in regulations, systems, special wards and government procurement, among other public policies for innovation.

Source: Government of Japan (2015), "Cross-ministerial Strategic Innovation Promotion Program", http://www8.cao.go.jp/cstp/panhu/sip_english/5-8.pdf.

There is a need for better co-ordination across the government to ensure that the ministries are aligned and involved with the policy and to take an overview that identifies synergies and opportunities, for example to boost the generation of knowledge and skills to support (selected) transitions (e.g. regarding digitalisation or the bio-economy). The RIC appears nonetheless to be well placed to lead these processes because it encompasses the highest level of government and is, in principle, capable of reaching across multiple ministries, agencies, sectors of society and stakeholder groups.

The RIC needs to become an "arena of arenas" to co-ordinate the implementation effort and keep the vision up-to-date. Economic and societal challenges are too big to be addressed by one central body and must involve so many stakeholders (participating in various arenas). Rather, each will require its own arena or co-ordinating mechanism to be effective. The role of the arena of arenas should be to provide a place where these mechanisms can meet and where it is possible to link the needs of the various arenas to overall research and innovation policy – while recognising that each arena must maintain its own links with other policy areas.

The priority challenges should improve the steering and impact of research and innovation policy by supporting stakeholder co-ordination and innovation agenda setting as well as the implementation of their resulting strategic research and innovation agendas. This entails using new instruments for linking the relevant actors. These are most likely to be in the form of PPPs, and are explored in the next section. Extending governance and developing new policy instruments means that it will also be necessary to examine the mission, organisation, operations and skills of the key public innovation actors. For example, Tekes has a long and successful experience of creating and moderating stakeholder networks in support of its technology programmes. This provides a strong basis for taking a broader role in supporting, monitoring and managing the individual "arenas" needed for implementing system innovations and transitions.

Strategic intelligence and evaluation

In deploying these efforts, there is a need for policy experimentation and innovation in order to find models that will work in Finland. Learning by doing and experimentation – both in mainstream policy formulation and potentially by Sitra – will establish what the most effective implementation mechanisms are for Finland. Finland has an important potential advantage in that it is accumulating experience in how to tackle change policies that go beyond traditional research and innovation. Key examples are: the Six City Strategy, the Health Sector Growth Strategy and the Bio-economy Strategy (see Box 6.1).

Finland has established a strong evaluation culture in research and innovation over the past quarter century. Tekes was an early leader, establishing a practice as early as in the beginning of the 1990s of evaluating all its programmes, and more recently introducing ex ante impact assessment. The Academy of Finland has a long tradition of peer review-based field evaluations and has for many years published reports on the state of scientific research in Finland, largely based on international comparisons of bibliometric indicators.

Evaluation activities have intensified since 2008. Since the evaluation of the national innovation and research system (Veugelers, 2009), VTT, Tekes, the Academy of Finland, Finnvera, the FII, the SHOKs and even the Research and Innovation Council have been evaluated. Evaluations are systematically followed up and many of their recommendations are implemented (Halme, Saarnivaara and Mitchell, 2016). Some use is also made of foresight and national capability in this area has been marshalled under the National Foresight Co-operation and the Government Foresight Group in the Prime Minister's Office. The research and innovation system and those who govern it are therefore well served with evidence in support of policy. Creating a Strategic Research Council and a budget in the Prime Minister's Office explicitly to fund research for policy created the opportunity for policy making to benefit from a massively increased volume of strategic intelligence.

Supporting business R&D and innovation

Support to industrial R&D and emerging technologies

Tekes was originally established to provide support to industrial R&D and technological development and has done this through a combination of predominantly loan-based subsidies to individual companies that perform industrial innovation activities and technology programmes, linking groups of private stakeholders (mostly companies)

with public research. Tekes has applied a variation of the Nordic technology support approach that has also been practised in Norway and Sweden. In consultation with relevant stakeholders, this approach identifies areas of opportunity, designs a research agenda and facilitates their implementation through calls for proposals addressing the various parts of the research agenda.

The need for thematic technology programmes is also apparent in the appearance of technology clusters based on similar bottom-up proposals. Programmes are overseen by stakeholder committees, but funding decisions are exclusively taken by Tekes to prevent capture by its beneficiaries. By nature, such programmes tend to address established companies and industry sectors, but would benefit from being complemented by separate measures that address longer term scientific and technological opportunities (Academy of Finland), but also supporting start-up businesses in new technology fields that eventually could drive the formation of entirely new industries.

Tekes' technology programmes have facilitated both incremental innovation as well as the generation of more radical change, such as the development of new enabling technologies. These technologies have been important in the development of the electronics cluster, supporting not only Nokia but the development of the large-scale capabilities in industrial ICT, as well as in other branches of industry, increasingly involving "soft" innovation in the services sector. Since 2010, however, the proportion of Tekes' budget allocated to these programmes has decreased significantly, and is being replaced by instruments supporting start-ups and internationalisation.

A key development of the past decade was the implementation of the SHOKs programme, which was launched in 2006 at the request of the RIC. The SHOKs were long-term public-private partnerships that received money from Tekes to help fund R&D of interest to a group of stakeholders (see below). This money came from the part of Tekes' budget normally used for technology programmes. Unlike equivalent "competence centre" programmes in other countries that use state subsidies to encourage industry into longer term co-operation with academia that addresses more basic research than is typically handled in technology programmes and therefore typically handling enabling technologies, the SHOKs used it to conduct activities closer-to-market than those normally supported by such programmes (Lähteenmäki-Smith et al., 2013).

National expenditure in public applied research and technological development has fallen significantly, effectively creating a funding gap in areas that have been and remain crucial for innovation and ultimately economic growth. Tekes now has a rump of 11 technology programmes clustered in a small number of research areas – compared with about 40 such programmes at the end of the 1990s – and that have to address the needs of a wide range of industries.

In terms of scale, scope and the degree to which fundamental research questions are addressed, generating innovation, technology programmes requiring substantial deployment of R&D often go beyond what firms are able to fund themselves. Therefore, reducing the degree of government support for business R&D bares the risk of reducing innovation opportunities for the Finnish industry, and in return can be expected to exacerbate the decline in BERD that may amplify the stagnation in productivity growth from which the Finnish industry is currently suffering.

The decision to defund the SHOKs has aggravated this problem. The SHOKs were designed to provide a Finnish presence in the emerging landscape of international "competence centres". These PPPs are organised as academic-industry consortia to

collaborate in long-term R&D programmes, providing better access to more fundamental research for industry, and clearly signal to the research community what areas of research are important to industry. Key requirements for successful centres are a balanced governance between academia and industry, combined with steering and monitoring through the state to prevent capture (Stern et al., 2013; Luukkonen, Arnold and Martínez Riera, 2016). In Finland the implementation of this idea failed to a large degree due to a faulty governance design (Lähteenmäki-Smith et al., 2013). The potential to defragment university research through competence centres and improve industry-academic co-operation to secure the socio-economic impact of research calls for a new attempt to create such centres in Finland. Despite the absence of such centres current budget reductions are damaging to Finland's prospects for innovation and growth. Urgent attention is needed to address this industrial need.

Support to business development, innovation and internationalisation

Tekes provides access to the largest number of business support instruments. These include:

- services and consultancy to test start-up business ideas and help companies internationalise
- research grants and loans for product development and piloting
- support funding for scaling up SMEs
- direct assistance to companies with information, contacts and presence in foreign markets
- consulting help with digitalisation (Digiboost)
- innovation vouchers
- participation in research networks between companies and public research organisations
- participation in research in larger scale technology programmes
- participation in innovative procurement programmes.

Tekes also runs a number of specialised programmes such as on energy and production support for the audiovisual industry, short-term funding – e.g. for drone and computer game development – or healthcare business opportunities in India. The range of instruments is fairly complete, and is comparable to those in other European agencies that support business innovation. Recent evaluations have found the availability and impact of these instruments to be satisfactory, however, networking and cluster instruments are largely absent, with the exception of public sector research. Apart from public business support, Finland has a well-developed system of science parks and incubators, some owned by universities and others operating in the private sector. Entrepreneurship education and business support services are available, however, these are largely concentrated in the Capital region.

A major issue in business innovation is the weak participation of SMEs in BERD, which remains below the OECD average (see Chapter 5). According to Statistics Finland's last R&D survey, large firms with more than 500 employees represented about 76% of BERD in 2014. In fostering SMEs' participation in innovation, it is important to pay attention to the entry of new firms into policy programmes and innovation activities,

including R&D. Examples of programmes that encourage first time entry of SMEs into innovation programmes include the Engage Grants programme in Canada, KMU-innovativ in Germany and InnovationAgent in Denmark (Box 6.7).

One way to strengthen the participation of SMEs in innovation is through the promotion of innovation linkages between large firms and SMEs. Tekes promotes such linkages. One funding criterion for large companies is research co-operation with other innovation actors: SMEs, research organisations and universities. In doing so, it is important to promote innovation linkages between SMEs and large firms through capacity-building projects and encourage joint research and co-development, e.g. by creating common spaces that give SMEs access to large firms' research infrastructure and expertise (an example is Synerleap in Västerås Sweden, where ABB Group houses a number of SMEs in a common innovation space and gives them access to their research facilities and experts).

Box 6.7. **Innovation in small and medium-sized enterprises: Denmark's Innovation Agent Programme**

The Innovation Agent Programme, financed by the Danish Agency for Science and Higher Education, is operated by a network of 35 competent innovation agents from 8 independent research and technology organisations in Denmark. The innovation agents offer knowledge and guidance to small and medium-sized enterprises (SMEs) in the field of technological innovation and business development, with referrals to knowledge experts and partners best suited to help the company move its innovation endeavors forward.

The focus of the programme is to uncover potential areas of technological innovation and development in less innovation active SMEs. Through an "innovation check-up", the innovation agent, together with decision makers in the company, examines the company's processes, products, market approach, organisational setup and strategy in order to identify opportunities for technology-driven innovation. An innovation check-up nudges the SME to review and renew its commercial basis and to improve its innovation capacity and activity levels. This is likely to strengthen competitiveness and the productivity of firms and may lead to growth opportunities for participating SMEs. Overall, the programme benefits both the individual company and society as a whole.

Over 3 000 companies from many different industries have already taken advantage of the offer of a free innovation check-up. More than half of the companies have been launching concrete innovation with a focus on new value-added solutions. The programme found that new customers increased revenue, improved competitiveness, got new products, processes and services, and access to the latest high-tech knowledge. The Innovation Agent Programme has been successfully exported to New Zealand and has trained 24 innovation agents in Austria. Algeria, Jordan, and Trinidad and Tobago are on the way with similar programmes. More countries, like Ghana, have also shown interest in the programme.

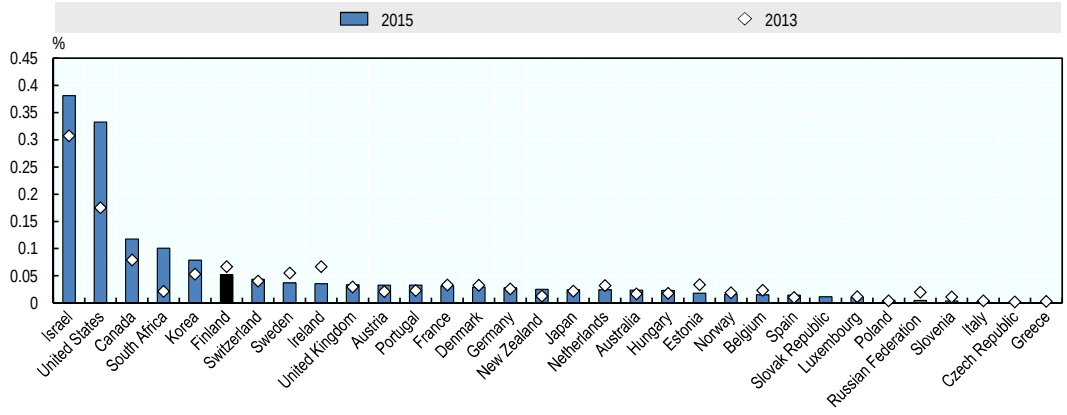
Sources: Danish Technological Institute website, www.dti.dk/specialists/innovation-agent-program/31424; Innovation Agent Program website, http://innovationstjek.dk (in Danish).

Venture capital, private equity and entrepreneurship environments

Private venture capital and support is well organised through the Finnish Venture Capital Association and the Finnish Business Angels Network, and the amount of funding available remains high relative to the size of Finland's GDP. Though the share of venture investments as a proportion of GDP in 2015 has slightly declined vis-à-vis 2013, but

remains above the respective shares of its Nordic neighbours (Figure 6.7). Taking private and public activities together, Finland has a well-developed system of venture capital and development banking that also handles the need for loan and export credit guarantees. The state played a key role through the financial crisis in maintaining the availability of capital and this is now being supplemented via growth in the availability of private money. However, the private sector is not taking over the state's contribution in areas such as business concept testing, services supporting internationalisation and support to scaling-up. In the Finnish context, scaling-up and internationalisation often have to be pursued hand in hand, yet the market is especially poor at delivering venture capital for this purpose, especially growth-stage venture capital.

Figure 6.7. **Venture investments as a proportion of GDP**



Note: Data provided for Canada correspond to 2011; Japan to 2012 and 2014; Israel to 2014; New Zealand to 2012; the Russian Federation to 2014; South Africa to 2012 and 2014.

Source: OECD (2016c), *Entrepreneurship at a Glance 2016*, http://dx.doi.org/10.1787/entrepreneur_aag-2016-en; OECD (2014), *Entrepreneurship at a Glance 2014*, OECD Publishing, http://dx.doi.org/10.1787/entrepreneur_aag-2014-en.

The Finnish government has devoted considerable efforts to supporting start-up entrepreneurship. Among the different government-launched funding mechanisms for start-ups with high growth potential are: the Finnish Industry Investment, running EUR 133 million in 2014; Veraventura and a direct investment instrument, the Start Fund Vera Ltd. with EUR 126 million in investment volume in December 2014, and Tekes, which has funding programmes for young innovative firms ("Young Innovative Growth Companies"), and the Vigo Accelerator Programme – a government lead accelerator programme established in 2009The EUR 230 million of government investment allocated for 2013-17 is expected to raise more than EUR 1 billion in venture capital investment in total. Firms' growth is also promoted through a programme of 10 accelerators comprising about 100 portfolio firms. Tekes has also a small early-stage fund of funds investments (established in 2014). In 2015, a third of Tekes' funding went to young small firms (EUR 140 million; of which, EUR 27 million were for young innovative firms). The role of the private sector is expected to increase jointly with foreign venture capital and the state will be able to reduce its activities over time. However, this expectation should be seen in the context of the increased difficulty in recent years of finding private investors who will invest in the early stages of company growth, especially in smaller economies.

Given the limited size of the Finnish market, small companies need to internationalise rapidly. This weakness cannot successfully be tackled with money alone. First, company formation and growth needs to take place within ecosystems that are international in nature, connecting new firms to sufficiently big markets to provide a base for scaling up. Further, these entrepreneurial ecosystems also need to be well anchored in the Finnish economy and have enough participants to enable the development of supply chains and complementarities, to build "critical mass" and reach over time. With a respective business environment in place, scaling-up investment becomes less risky and funding sources can become more international, increasing the likelihood that young Finnish firms can establish themselves internationally, which in return will be receptive to further market penetration and growth. The conditions are also likely to create new ecosystems where there is a substantial number of stakeholders involved and where activities are explicitly linked to addressing societal challenges that have both a Finnish and an international dimension. The total volume of new venture investment in 2015 was about EUR 113 million, an average investment of about EUR 375 000 per firm.

Finland boasts a considerable number of start-up environments such as the Otaniemi Science Park and corresponding parks at other universities as well as the Helsinki Business Hub. Well-developed start-up services such as the Aalto Start-up Sauna course at Otaniemi are available and there is a small community of investors and entrepreneurs providing informal advisory services. The Finnish Business Angels Network has about 500 investing members. Helsinki regularly hosts the Slush conference for young, innovative companies, which attracted some 2 000 participants from abroad in 2016. Tekes was a substantial early-stage investor, accounting for 33% of early-stage funding. However, this is a significant decline compared to 2011, when Tekes provided 55% of early-stage investment.

Fiscal incentives

While currently, Finland does not offer R&D tax incentives, the government introduced a temporary R&D tax credit scheme in 2013 in an attempt to counteract firms' tendency to respond to the economic climate by reducing R&D expenditure. This allowed SMEs to set off 100% of their R&D-related personnel costs against their corporate tax, providing they were pursuing basic or applied research or experimental development. Since the tax credit worked against corporate tax, it was only effective for profitable companies and was therefore of little use to many start-ups. Firms had to perform more than a minimum amount of R&D in order to qualify for tax benefits, while the tax incentive was subject to a cap. Those firms already receiving other forms of support, such as grants through Tekes, were ineligible to the tax benefit programme.

Data from the Finnish the tax administration show that in 2013, 550 companies applied for a total of EUR 63.6 million in tax relief, compared to the tax administration's expectation that it would have to forgo EUR 155 million in tax. The tax incentive scheme was to run for three years. However, the reduction of the corporate tax to 20% in 2014 reduced the attractiveness of the incentive and increased pressure on the government budget. It was therefore decided to terminate the scheme after its second year. ETLA's evaluation shows that take-up was low (Kuusi et al., 2016). In the end, companies only claimed 8% of the taxes the government had expected to forgo. It was not clearly possible to identify a target group of companies to which the credit would provide a unique incentive or to demonstrate that it had had much impact on company behaviour.

Human capital from the universities

With the university research system being directly linked to higher education, including the production of PhDs, the way university research is designed also has importance in supporting Finland-based industry. Universities' research specialisation has an immediate effect on the specialisation of PhD graduates. Hence, the thematically focused research funding (for example, through technology programmes and especially via longer term competence centres, where PhD education is explicitly built into the strategic research agenda) feeds back to the production of industry-relevant PhDs. Competence centres are particularly interesting in this context, as their co-operation with industry supports the graduation of PhDs that bring skills relevant to the Finnish industry, and scientific research also feeds back to both Masters and Bachelors education. Graduates are normally much more likely than faculty members to start new businesses; hence, in terms of supply of relevant human capital for start-ups as well as established firms, it is important that Finland maintains a strong funding portfolio for applied and industry-relevant research – much stronger than is the case today.

Demand-side innovation policies

While there has been growing interest in demand-side innovation policies internationally, Finland has done little in this area so far, with the exception of innovation procurement. Tekes runs a programme that provides help to organisations trying to undertake innovative procurement, but little of this activity is actually visible. Similarly, the use of cluster and supply chain development policies is limited and the idea of using US-style "challenge funding" to encourage the attainment of specific social and technological goals (Hicks, 2016) is not applied. Finally, there appears to be little use of regulations or norms as ways to stimulate innovation. Adopting the third-generation "societal challenge" approach discussed previously would necessitate the use of some of these demand-side instruments in the context of a common programme affecting demand as well as supply. Leaving that possibility aside, however, there is clearly space to explore innovation policy opportunities on the demand side in order to complement the weight of existing activity on the supply side.

As regards procurement, it has been argued that the process of adoption across the government has been slow as new types of skills, working methods and attitudes in general in the public sector are required. Innovation procurement means higher risk (financial, technological, political and societal) and there is currently a lack of skills and tools to manage that risk (OECD, 2017). Finland is currently working on these areas. Improving skills for procurement at public agencies, risk-sharing tools and practical support to public contracting authorities are provided through a number of initiatives, including the Tekes Smart Procurement services for strategic areas and cities, the Forerunner Cities programme and the government central purchasing body. The adoption of monitoring, measurement and evaluation procedures of procurement activities remains underdeveloped.

The government continues to improve the regulatory framework and strengthened promotion and knowledge support at the different levels to increase expertise and innovation procurement. New public procurement legislation was adopted in 2016 to better consider innovation and environment aspects in public procurement agendas. This revision is based on the EU Public Procurement Directives. The government also initiated national training for innovative public procurement for the 15 largest cities in 2015 and all 20 health districts in 2016. The government recently passed a resolution that

encourages public actors to adopt sustainable procurement, particularly in the areas of energy, construction and housing, transport, food services, and energy services. Further, the government programme 2015-19 includes for the first time a numerical target of 5% for innovative public procurement. This target is a strong encouragement to conduct innovation procurement.

Box 6.8. **Innovation procurement in Finland**

According to the OECD Public Governance Review of Finland (2016b), there is no stand-alone innovation procurement action plan in Finland; however, the country has an overall national strategic framework with objectives. Innovation procurement takes part of the government's strategic projects (bio-economy, clean-technologies, digitalisation, health) and embeds them into several national sector strategies and programmes (e.g. ICT 2015, Innovative Cities, intelligent transport, clean-tech strategy, etc.). The government aims to link sectorial policy objectives with procurement and the development of markets and technologies in more strategic ways. The scope for innovation procurement policy is wide; it encompasses both public procurement of innovation and pre-commercial procurement.

The first policy steps in the promotion of public procurement of innovation dates from 2008 as emphasised in the national innovation strategy; this was followed by a new financing programme by Tekes in 2009. The importance of the issue was further stressed in the "Demand and User Driven Innovation Policy" (2010-13) and in a government decision to encourage innovation in sustainable procurement (2013).

Tekes' Smart Procurement Programme is a programme for public procurement of innovation and pre-commercial procurement. The goal of the programme is to support the development of new innovations with smart, innovation-friendly public procurements. The programme encourages public buyers to use procurement to solve societal problems, renew public services, and improve market access for new products and services. Over the period 2009-16, funding covered a total of EUR 11 million for 73 ended projects. The main areas that received funding are environment/building (36%) and social and health (26%). The programme currently covers horizontal themes such as digitalisation, energy efficiency and the environment. Apart from providing financing, the programme also promotes awareness raising, networking, training, and supports sharing best practices among the government.

Strengthening industry-science collaboration

This section considers technology programmes, SHOKs and Tekes' commercialisation measures as instruments for promoting industry-science collaboration. New kinds of PPPs can also improve industry-science links. Finally, it is important that policy instruments adopted across the innovation system are mutually consistent. In this respect, there is a need to adjust the performance-based funding system used at universities in a way that does not discourage industry-science collaboration.

Technology programmes

Tekes' technology programmes have over time provided strong support to both emerging and existing industries, building capacity, pursuing applied research and developing enabling technologies. These programmes have been Finland's biggest arena for industry-science collaboration. Budget cuts and the refocusing of much of Tekes' start-ups and entrepreneurship support have resulted in the disappearance of most of this effort.

The decline in technology programmes has greatly reduced opportunities for industry-science collaboration, despite Finnish organisations participating in the EU Framework Programme, in which several priorities overlap with those of Tekes. While it is important for Finland to participate in a wide range of technology areas, it is striking that among Tekes' technology programmes, "Arctic Seas" is the only one to focus distinctly on needs and opportunities specific to Finland. With a gap in funding technology programmes and the importance to continue and to strengthen industry-science links, policy should emphasise either a growth in the number and scope of technology programmes, or identify additional instruments that can fulfil this purpose.

An important issue is the signalling effect of technology programmes to the research community. Industrial problems, needs and opportunities affecting research agendas, and eventually higher education requirements, need to be communicated to develop capacities respective to the technologies found important to the growth of the Finnish industry. This in return affects the supply of human capital to industry.

The strategic centres for science, technology and innovation

The design of the SHOKs was originally inspired by the "competence centres" set up in other countries. These models are all PPPs involving an academic-industrial consortium pursuing collaborative research, typically over seven to ten years. The level of subsidy is typically high in order to encourage fundamental research, involving PhD education that strengthens the role of the collaboration in human capital formation. Evidence from international evaluations about these programmes are strongly positive, but also point to the importance of a balanced governance power between the academic and industrial stakeholders to guarantee successful outcomes.

At their peak in 2012 six SHOKs existed, absorbing about EUR 100 million in subsidy from Tekes:

- Cleen Ltd (environment and energy) – now part of CLIC Oy
- Finnish Bio-economy Cluster (FIBIC Oy) – now part of CLIC Oy
- FIMECC Ltd (metals and engineering)
- SalWe Oy (health and well-being)
- Digile Oy (previously TIVIT Oy, Internet economy)
- RYM Ltd (built environment sector).

Like other competence centres, the SHOKs developed strategic research agendas. Overall, about 60% of the research was funded by Tekes and the remainder by participating companies. The Academy of Finland contributed indirectly by funding strategic research in the areas of interest to the SHOKs. In the period 2008-15, Tekes provided EUR 544 million, the participating companies EUR 441 million and other public sources EUR 118 million.

The evaluation of the SHOKs pointed to significant challenges in their operational model, multiple and often conflicting objectives, weak governance, and a failure to achieve a cross-disciplinary perspective or wider scientific engagement. The open PRI model used appeared to ensure that potentially disruptive research was conducted outside the SHOKs. Adjustments were made to the way the SHOKs were operating, but the programme was discontinued from 2015 and is being phased out.

Variations of the "competence centre" funding instrument are of increasing importance internationally because of the effectiveness of the academic-industry links involved, their long-term impact on innovation and innovation capacity, their production of valuable "industry-ready" human capital (especially but not only PhDs), and their effects on defragmenting university research capacity by providing incentives to direct that capacity towards societally important problems. Further, it exacerbates the lack of "strategic technology" research investment in Finland. Consequently, the closure of the SHOK programme leaves a significant gap in Finland's research and innovation policy.

Significant overhaul is therefore needed of the Finnish centres of excellence policy. The profusion of small basic research centres over the past two decades appears to have had little effect on generating quality peaks and there is no centres of excellence instrument working around innovation. Bigger basic research centres and a revived competence centres programme appear to be necessities for tackling the quality "peaks".

Commercialisation

Larger Finnish universities have technology transfer offices, making public engagement to encourage such a development redundant. For the most part, universities are not in a position to fund the early-stage commercialisation of research results, a capacity gap that is filled through Tekes' commercialisation programme "New business from research ideas".

There does not appear to be a Finnish equivalent to the United States' Small Business Innovation Research programme. This sets aside a very small fraction of the budget of government laboratories or institutes to transfer research results to the business sector via joint R&D projects with small companies. The programme is widely imitated (for example in the Netherlands, Sweden and the United Kingdom) and like its imitators abroad is evaluated positively. Given the policy focus on streamlining government laboratories and ensuring that they are societally relevant, Finland should consider setting up such a programme.

Box 6.9. **The United Kingdom's Small Business Research Initiative**

The United Kingdom's main vehicle for taking forward innovation procurement is the Small Business Research Initiative (SBRI). The programme contains a well-established process to connect public sector challenges with innovative ideas from industry. The SBRI is a competition-based innovation programme managed by Innovate UK, which provides 100% R&D funding to support companies to develop solutions. The intellectual property rights remain with the company, which is then able to market the product commercially more widely.

The SBRI was established in 2009 and closely modelled on the United States' Small Business Innovation Research programme. The SBRI is run under EU rules for pre-commercial procurement. It works by setting up a competition when a government department or public body wants to procure an innovative product or service to solve a particular problem. The most promising applications are awarded development contracts. Companies can be granted up to GBP 1 million to develop their ideas into innovative solutions for the public sector; 100% of the development and prototyping or demonstration cost of developing a new product or service are funded.

Box 6.9. **The United Kingdom's Small Business Research Initiative** (*cont.*)

The SBRI has been growing steadily since 2009, with the value of contracts awarded through the programme increasing from GBP 13 million in 2010/11 to GBP 83 million in 2014/15. Overall, the SBRI has provided businesses with over GBP 270 million of contracts since 2009. There are now over 70 departments and agencies that have used the programme. Examples of successful projects include the development of long-endurance marine unmanned surface vehicles, intelligent fabrics, solutions to combatting online fraud, novel light bulbs and many more (ERAC, 2015). Recently, Innovate UK has established an SBRI Practitioners Community of Practice which provides a forum to share best practices across government departments. There is no central funding, and departments need to fund their own SBRI competitions.

Sources: OECD (2016b), "OECD Public Governance Reviews: Public procurement for innovation: Good practices and strategies", www.oecd.org/gov/ethics/procurement-innovation-practices-strategies.pdf; ERAC (2015), "ERAC opinion on innovation procurement", http://data.consilium.europa.eu/doc/document/ST-1209-2015-INIT/en/pdf.

Open science and research infrastructure

With the objective to have open access to all scientific publications by 2020 (Ministry of Education and Culture, 2017), open science is paramount to current science policies in Finland. In 2014, the Ministry of Education and Culture launched the Open Science and Research Initiative (ATT) with the aim of creating a national open access and open science policy and building the infrastructure necessary to reach this goal. The ATT aims to make open and collaborative science more visible to innovation system actors, and to promote not only open access to research data and publications, but also transparent, collaborative research and the skills, knowledge and support services necessary to achieve these goals. In the framework of the ATT, the ministry plans to organise an annual "Open Science and Research Forum" to gather all relevant stakeholders and promote fruitful discussion about the ATT and its implementation. In addition, the Academy of Finland currently requires open access publishing as well as open access data whenever possible (in the limits of juridical framework and available infrastructure), while training sessions will be launched in higher education institutions to train researchers and students in data management and data ownership.

Evaluation on the impact of the Finnish Open Science and Research Initiative, both nationally and internationally, was conducted externally under the request of the Ministry of Education and Culture. The evaluation finds the Finnish initiative able to raise interest in open science among its target groups (Tuomi, 2016). According to the evaluation, although the impact on politics and strategies has been medium strong, on the operational level, impact has been weak. However, many instructions and services are still in the development phase. Thus, the impact is expected to increase during the final period of the initiative (Tuomi, 2016). The initiative's target groups generated a set of ideas that fed back directly in its final year, 2017. These ideas cover the active participation in international forums, the collection of best practices, special attention to open innovation, and specific actions to engage researchers and staff members.

The Finnish Research Infrastructure Committee (FIRI Committee), a body appointed by the Academy of Finland, was responsible for updating the national roadmap for research infrastructure in 2013. The FIRI assesses the urgency and priority level of research infrastructure projects included in the roadmap. In addition, the committee drafts

proposals on the funding of PRI projects for the state budget, as well as for other funding sources where necessary. Decisions on funding for research infrastructures are taken by a subcommittee appointed by the Board of the Academy of Finland. The Academy of Finland provides funding for the acquisition, establishment or upgrading of nationally significant research infrastructures that promote scientific research.

The updated National Research Infrastructure Roadmap (2014-20) also considers enhancing open science mechanisms and supports the activities of a broad-based co-operation initiative (2014-17) between ministries, universities, research institutions and research funders such as the Academy of Finland and Tekes, the Finnish Social Data Archive (FSD), the National Library of Finland, the Federation of Finnish Learned Societies, FinnOA (the Finnish Open Access Working Group), CSC – IT Center for Science Ltd. As an example of higher education institutions, the University of Helsinki plays a key role in open access in Finland.

The National Research Infrastructure Roadmap is a plan for key research infrastructures in Finland that are either under development or that will be newly required over the next 10-15 years. Research infrastructures form a reserve of research facilities, equipment, materials and services. As such, they are essential instruments for research (OECD, 2015). The state of national research infrastructures, the progress of the 19 infrastructure projects and the 13 developing research infrastructures listed in the 2009 report had to be brought up to date. The field of national research infrastructures has, in many respects, become clearer since the drafting of the previous roadmap in 2009.

Fostering public research excellence and impact

Applying high-quality science matters for several reasons:

- An internationally competitive research community attracts international partnerships and foreign direct investment (FDI).
- It helps ensure a supply of high-quality human capital from research and higher education sectors.
- It provides significant and accessible knowledge resources to national industry, both in the form of knowledge for production and in terms of policy advice.
- It helps ensure that industrial, social and policy development are based on reliable forms of knowledge.

Viewed through the lens of citation analysis, the average quality of Finnish science has been climbing, from below the world average in the mid-1980s up to a point where it is clearly above that average, about the same level as Norway and Sweden, but still well behind Denmark. However, measuring the Finnish presence in the most highly cited 10% of research publications indicates that Finland is not well represented, and that it has fallen behind the leading countries over time. The challenge, therefore, is that while the average quality of Finnish research is good, there is only relatively little world-class research performance. Therefore, policy should address the "peak quality" problem rather than focusing on average quality.

The main "levers" available to policy makers for improving the quality of university research can be summarised as follows:

- providing competitive, quality assured external funding to supplement institutional funding

- adjusting the ratio between institutional and external funding
- making some of the institutional funding for research that universities receive dependent upon past performance
- internationalisation, not least international collaboration
- influencing university governance, which determines their ability to develop and manage research strategies and portfolios, so as to allocate resources towards promising and high-performing groups and research fields.

Finnish universities already have a high ratio of external to institutional funding. Many countries, including Finland, have adopted the idea of funding centres of excellence, with the intention of building critical mass and creating competitive environments in which quality is driven to higher levels than can be obtained in fragmented systems. Centres of excellence are instruments that can be used to drive the needed "peaks" of quality in the Finish research system.

Other funding instruments can also be brought into play. Like other research councils, the Academy of Finland has long been addressing the well-known challenge of funding interdisciplinary research under a peer review system. Such research is seen as important both because of the view that new disciplines and opportunities often occur at the boundaries of existing ones and because it is needed in order to tackle real-world problems. It should therefore be quality-enhancing over time. The Academy has studied the matter (Bruun et al., 2005), but in the end resorted to "mainstreaming" interdisciplinary research in existing panels, which is not very effective (Arnold et al., 2013). It has also tried to address the need for high-risk, potentially "transformative" research (Häyrynen, 2007), and very recently has introduced a small funding programme. These efforts are important, but their overall effectiveness would be enhanced if a more explicit mechanism could be devised to address interdisciplinary questions and the efforts in transformative research were also reproduced in the funding of research for innovation.

Part of universities' institutional funding for research has been based on performance and the formula was revised in 2015 and again in 2017. The performance-based component is an unusually large fraction of total institutional funding for research. With the exception of the United Kingdom, other countries steer only a small part of institutional funding in this way, in order to combine a degree of stability with incentives for performance improvement. There is limited evaluation evidence internationally about the effectiveness of performance-based research funding system (PRFS), in part because most of the systems introduced this century appeared in a context where performance was already improving. Hence it is hard to identify the net effect of the PRFS on changing performance. There is evidence that the PRFS tend to increase the volume of published research outputs – sometimes without affecting the quality of research – and it is clear that the main pathways to impact for the PRFS go through researchers' careers, as they encourage university managers to recruit and promote people whose performance is likely to maximise the university's returns from the PRFS.

A PRFS tends to increase the power of the researchers who perform well against its criteria, so universities are encouraged to direct the rewards to those who "earn" them – a behaviour that promotes lock-in and undermines the university's ability to make strategic investments in new groups and areas (Arnold et al., 2017). Since the positive effects of the PRFS appear to be available even when the proportion of funding they govern is low, it might be better for Finland to reduce the amount of institutional funding it governs,

retaining its positive effects but leaving the universities in some other way the strategic headroom provided by non-competitive institutional funding.

Governance changes take a long time to have an effect on quality, but are nonetheless important. Both the university and the polytechnic systems have been under reform since 2010. The universities have become independent legal entities separate from the state. The universities of applied science became independent legal entities in 2015. Mergers have been encouraged in both sectors. However, Finland still has roughly twice as many higher education institutions per head of population as its Nordic neighbours. The two sectors have been encouraged to form closer links and even mergers, in the context of recent, very significant cuts in funding for higher education and research.

The universities have long suffered from duplication and internal fragmentation. As a result, departments are often small and have few professors, making it difficult to follow the international pattern of increasing the size of research groups in order to increase their quality and (especially) sustainability. The current development plan for higher education relaxes this pressure and the Academy of Finland has been given money to help universities "profile" their research activities more sharply. Continued efforts at "profiling" combined with the modernisation of academic governance are pre-requisites not only for a more efficient higher education and research system, but also for a higher quality one.

Supporting international knowledge linkages

The limited extent of internationalisation of Finland's research and innovation system has long been recognised, and was one of the driving factors for Finnish participation in the EU Framework Programme ahead of EU accession. This was singled out as a problem by the Science and Technology Policy Council (now the RIC) in 2003 (Science and Technology Policy Council, 2003). The council stressed that this was not only a problem for the research community but an issue for industry as well. In order to encourage internationalisation, Tekes introduced an internationalisation dimension into its project funding assessment criteria fairly immediately. Limited degrees of internationalisation nonetheless remain an acute problem.

Industry

There are five main internationalisation issues in industry: international co-operation on R&D; the small size and peripheral nature of the Finnish market and the need for growing companies to internationalise at an early stage; limited FDI into Finland, restricting the access of the Finnish R&D community to world developments, limited FDI from Finland, with the same effect and constraints for Finland-based companies to access international R&D workers.

The EU Framework Programme is the largest and most accessible way for Finnish companies and research institutions to participate in international R&D collaboration. Finland received EUR 32 per capita from the 7th Framework Programme (FP7). This placed it fifth after Cyprus,[3] the Netherlands, Denmark and Sweden, and compares very favourably to the average of EUR 14 across the EU15 (Fresco, 2015). While the Framework Programme by no means addresses all thematic interests relevant to the Finnish industry, there is a strong overlap between its foci and those of Tekes, which links relevant EU national contact points to its programmes. As in other Nordic countries, however, industrial participations comprise a modest 10% of the total (Table 6.3). In

contrast, 24% of total funding for the Seventh Framework Programme went to companies (Fresco, 2015). Grants are available from Tekes to support proposal-writing and there is a strong network of national contact points which can be accessed nationally or through regional ELY centres. Finnish industrial participation is nonetheless disappointing, and there is significant scope to further increase it.

Table 6.3. **Distribution of participation of different types of organisation in the Seventh Framework Programme, Nordic countries**

Type of organisation	Denmark	Finland	Iceland	Norway	Sweden
Higher education institutions	51%	36%	27%	27%	54%
Research organisations	12%	31%	18%	34%	13%
Small and medium-sized enterprises	17%	14%	14%	20%	14%
Industry	10%	10%	17%	10%	13%
Public bodies	8%	6%	23%	8%	6%
Non-profit bodies	1%	2%	0%	1%	1%
TOTAL	100%	100%	100%	100%	100%

Source: VINNOVA et al. (2013), *FP7 and Horizon 2020: A Comparative Study of the Support Services in Nordic Countries*, http://www2.vinnova.se/upload/EPiStorePDF/va_13_16.pdf.

The need for young firms to internationalise from an early stage of their development has long been appreciated in Finnish policy. There is a rich variety of support mechanisms available from Team Finland members, while the main obstacle of available venture capital for scaling up and internationalisation persists.

While Finland is not a "headquarters economy", it relies significantly on inward FDI to generate interaction with global industrial developments. Team Finland provides supportive measures to increase international links, whose effectiveness would be considerably strengthened if Finland could boast more internationally attractive research excellence, preferably linked with domestic industry.

Finnish start-up companies indicate that they experience difficulties in hiring non-EU nationals, owing to visa restrictions, even in areas of skill shortage, such as coding. Documentation required to start a company can only be provided in Finnish. Recruitment of foreign students upon graduation is also challenging, impeding the internationalisation of companies, and legal hurdles to remain in Finland are high. For people coming from outside the Schengen area, permission to start a firm can take up to one year, indicating room for improvement to streamline entrepreneurship opportunities for immigrants.

The research community

In the research community, there are three main internationalisation issues: international co-operation and co-publication; attracting foreign talent to the Finnish research community and funding conditions and regulations limiting Finland's ability to attract foreign students.

The evidence presented in Chapter 4 indicates that the proportion of Finnish scientific publications produced with one or more international co-authors is over 55%, which is high in international comparison and similar to other Nordic countries. These co-publications tend to be more highly cited than national publications, indicating that the average quality of Finnish research as measured in terms of citations is improving.

Universities and government research organisations account for two-thirds of Finnish participation in the Framework Programme (Table 6.3). In terms of research co-operation, the Finnish research sector appears to be well integrated into the global community.

However, while leading research nations such as the Netherlands, Switzerland, the United Kingdom and the United States rely heavily on tapping a large talent pool by importing researchers from other countries, the proportion of foreign researchers in the Finnish system is low. One cause of this is an inability to attract large numbers of foreign-born PhD students, who become important to research elsewhere. The PRFS rewards both the number of foreign-born PhD students graduated and the share of foreign-born researchers in the total faculty. However, the combination of language barriers, climate and pay do not make Finnish academia particularly attractive. In order to import research talent, more flexible and attractive pay and research facilities would be helpful, as would increasing the amount of English-language teaching that will have positive effects on the attractiveness of both Finnish education and research.

The Academy of Finland and Tekes did run the Finland Distinguished Professor Programme (FiDiPro) in 2006–2015. The Academy funded about eight professors (or other senior researchers) per year to spend two to five years working part time at Finnish universities and funding small research teams for them in Finland. Tekes also provided a similar number of FiDiPro grants, so that roughly equal numbers of people with a basic and an applied orientation were involved. An evaluation shows that the scheme was well received and had substantial effects both on the universities and on the companies involved, improving their international research networks, transferring capabilities and methods, increasing international co-publication, and creating commercial opportunities (Wennberg, Oosi and Toivanen, 2014). In general terms, the Academy of Finland currently supports internationalisation of research through all its funding instruments. Roughly one quarter of the project and researcher funding goes to funding international researchers or to funding researcher mobility. This is complemented by Finland's access to the EU Marie Sklodowska-Curie mobility programme.

More radical approaches are possible. One adopted with apparent success is Chile's International Centres of Excellence Programme, which invites and subsidises selected foreign research organisations to establish centres of research excellence within the country, contributing knowledge but also establishing networks within which local researchers can participate. Selective use of such an instrument could help establish better links with researchers abroad, especially companies operating in Finnish areas of specialisation.

Box 6.10. **The Chilean International Centres of Excellence Programme**

Research centres of excellence have been under development in Chile since the late 1990s, originally through the World Bank's Millennium Science Initiative and subsequently funded by the Chilean government. In 2009, InnovaChile, the innovation agency, opened the first call for the installation of international centres of excellence. The programme "Attraction of International R&D Centers of Excellence (ICEs)," in its first call selected four large-scale and prestigious ICEs from among dozens of large R&D centres from all over the world. Fraunhofer-Gesellschaft (Germany), CSIRO (Australia), INRIA (France) and Wageningen UR (the Netherlands) were the first entities selected by the Chilean government, setting up an "ICE-Chile" branch to promote R&D and technology transfer by generating links and formal networks with key local industries and universities.

Box 6.10. **The Chilean International Centres of Excellence Programme** (*cont.*)

In the wake of the success of the first ICE application round, the Economic Development Agency established a second call for applications to be made in the second semester of 2012. In this call, the proposal emphasised high-impact projects for the Chilean economy or with the potential to create new industries. Two kinds of centres were foreseen: 1) institutional ICE, with a non-profit orientation, and a maximum grant of USD 12.8 million (matching contributions in cash and in kind required) over a term of eight years. Applicants could be universities, non-profit R&D centres or government entities. 2) Corporate ICE, for-profit orientation, with a maximum grant of USD 8 million (matching contributions in cash required) over a term of four years. Applicants could be large companies with significant R&D efforts.

Applicants to the ICE programmes, whether institutional or corporate, had to fulfill several requirements, including "critical masses" of personnel (scientists and technologists); R&D activities in accordance with measurable global standards in terms of scientific production and technological innovation; focus of activities in areas at the cutting edge of R&D; high levels of visibility and international scientific and industry connections; applied research and technology development capabilities; specialised capabilities in technology transfer and commercialisation processes for R&D results through the sale of technology licenses or other relevant modalities. As of 2014 the Economic Development Agency had supported 12 ICEs.

Sources: Ministry of the Economy, Development and Tourism (2016), MSI website, www.iniciativamilenio.cl; CORFO (2016), "ICE Program", www.corfo.cl/programas-y-concursos/programas/atraccion-de-centros-de-excelencia-internacional-en-id; World Bank (2013), "Research centers of excellence in Chile", https://innovationpolicyplatform.org/sites/default/files/rdf_imported_documents/researchcentersofexcellenceinchile_0.pdf.

More broadly, the type of societal challenge networks and PPPs discussed above would need to involve foreign as well as national partners, in order to ensure that they include relatively complete supply chains. This would provide a mechanism to involve and eventually anchor more foreign research-performing companies and institutions in the Finnish innovation system.

Notes

1. The evaluation (Veugelers, 2009) argued that despite the existence of the RIC, co-ordination across different ministries'" sector interests and the innovation system as a whole was poor. Having reached the "technology frontier" and built up a large industry, Finland needed to innovate in new ways by "pioneering" innovation, increasingly in smaller companies. The evaluators recommended reorganising the Finnish "sector" research and transferring the basic research done by the government labs to the universities.

2. Such agendas will tackle R&D but also subsequent stages in the innovation process and technology diffusion needs and, where necessary, involve end-users, regulators and other actors whose actions are necessary for success.

3. Note by Turkey:

   The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

   Note by all the European Union Member States of the OECD and the European Union:

   The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

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