Chapter 1

Overall assessment and recommendations

This chapter presents an overall assessment of Finland's innovation system and policy, reflecting key findings of the review. It identifies strengths and weaknesses of the innovation system and key tasks of the innovation policy, and develops specific policy recommendations.

Background

Finland has experienced an extraordinary period of industrialisation and economic and social development since World War II, transitioning from a resource-dependent economy to an industrial and knowledge-based one, retaining – like its peers in Northern Europe and North America – a strong resource base, and has achieved a high standard of living supported by a developed welfare system and culture. This period also saw heavy investment in education and research and development (R&D) and the establishment of a Nordic-style welfare state. During this transformation, Finland successfully aimed to become a leading knowledge-based economy and developed into one of the most research-intensive nations (as measured by investment in R&D), with a strong technology orientation. However, performance has deteriorated in recent years. The global crisis hit Finland severely in 2009. Gross domestic product (GDP) contracted by 8.3% (according to Statistics Finland) and recovery has been difficult ever since. National economic performance as reflected in productivity growth and international competitiveness deteriorated. Moreover, the Finnish economy was subject to shocks associated with Nokia's decline and downsizing in the forestry sector, which brought the issue of Finland's diversification into the limelight.

National confidence in the importance of research and innovation and Finland's widely shared and internationally recognised paradigm of R&D-driven growth and development has come to be contested. The role of national institutions that played an important role in Finland's rise – such as the Science and Technology Policy Council (now the Research and Innovation Council, RIC) and the Finnish Funding Agency for Innovation, Tekes – has diminished. Against this backdrop, and the urgent need to revive the economy and achieve high and sustainable economic growth, research and innovation remain critical for Finland's future success in economic and broader social development. The recent budget cuts for research and innovation have an impact on innovation activity and without corrective action will be felt for years to come in the form of dampened innovation activity and productivity growth.

Overall, the numerous policy reforms undertaken since 2006 in the areas of education, research and innovation seem to have lacked coherence and a unified vision or strategy. Finland needs a new approach for innovation and renewed governance for science, technology and innovation (STI), lifting itself out of the period of uncertainty and lack of confidence that followed the 2009 recession to establish a new national vision for sustainable recovery. This recovery needs to be based on research, innovation, education and training in the framework of the strong international engagement which Finland needs in order to overcome disadvantages due to its small size and geographic location. This effort will entail addressing both short- and medium-term challenges in the economy to boost productivity growth and continuously developing long-term strategies and mechanisms to build new competitive advantages at global scale. Both are fundamental for maintaining the high level of well-being and living standards of the Finnish population in the future which are threatened by persistent economic weaknesses.

Finland can draw on its high level of social capital to build a national consensus on how to mobilise and further strengthen its domestic innovation capacity more effectively to boost productivity growth and social development more broadly. This will involve wide societal consultation and the development of new forms of governance to tackle major transitions through which societies will have to go in the coming years. The vision is that of a knowledge-based Finland with a proactive and innovative government

working in partnership with the business sector and wider society to support and identify opportunities for innovation and sustainable growth.

Achievements and challenges

Finland's long-term development has been impressive. It has enjoyed strong economic progress over the past decades, which is reflected in high living standards and well-being. The country stands out for high subjective well-being, education and skills, environmental quality and personal security. Inequality (as measured by the Gini coefficient of disposable income) is among the lowest in the OECD and has remained fairly constant since the turn of the millennium. Absolute poverty (as measured by material and housing deprivation) is among the lowest in the European Union.

Until the early 1900s, its strengths were the abundant endowments of wood and national resources such as minerals. Like other resource-based economies, Finland tended to import established technologies and to produce commodities containing little value added, and to which further value was then added in supply chains abroad. The subsequent period of industrialisation allowed Finland to develop its own technological competences and increased Finnish capacity in producing capital goods, especially heavy machinery and equipment that could also be sold on international markets and in some of which Finland gained leading positions. Finland built capacities in various kinds of manufacturing-related innovation. For example, paper-making technology and machinery supplemented the strong wood sector and ship-building became important, and is an area where Finland still has strong capabilities in certain high value-added segments.

During the 1970s and 1980s, Finland transitioned from a natural resource-intensive economy into a high-technology exporting country. In the 1970s, it started to expand higher education in engineering sciences, which would become an important element of the country's economic transformation. In the 1980s, Finland began to shift into entirely new areas of knowledge-based innovation and new sectors, such as information and communication technology (ICT), machinery, and chemicals. While the sector shifts were radical, there were also important links with previous developments. Developing a strong paper industry involved moving into pulp and papermaking machinery and developing capabilities in chemistry. A growing ship-building industry created a launch market for heavy marine diesel engines, and so on.

Around the end of the 1980s, Finland invested heavily in human resources. By the mid-1990s, it was investing more in education than any other country (relative to GDP). Important efforts were made to increase the quality and supply of human capital and a number of reforms were introduced along with expanded public investment in education and R&D. Finland was thus able to upgrade its human capital by transforming its education system from less-than-average to one of the best international performers, becoming a modern publicly funded system with a high degree of equity, good quality and wide participation.

In the early 1990s, Finland went through a deep recession caused by a combination of international and domestic factors (the global recession, the collapse of exports to the Soviet Union, and a highly overvalued Finnish mark and over-indebted business sectors, among others). Countercyclical policies compensated for the decline in business R&D expenditure during the crisis. Domestic investment in research and innovation started to expand rapidly in the second half of the 1990s. This was partly a result of policy decisions but even more so due to an expansion of business R&D spending in the wake of

a growth acceleration which entailed a virtuous cycle of productivity gains and improved international competitiveness, as manifested by the rapid expansion of Nokia. Productivity increased due to the growth of electronics and related industries, enhanced investments in machinery and equipment, technology (public and private investments in R&D), education and training. Overall, the economic crisis and the subsequent period of growth resulted in an increased specialisation of production, trade and R&D in the Finnish economy.

Policy that supported the upswing at that time reflected the great importance ascribed to innovation for Finland's long-term success and underlined the necessity of continuous investment in innovation, based on wide societal consensus, rather than short-term policy considerations related to the business cycle. Innovation policy and a long-term approach to building a strong national innovation system were already in place in the 1980s. Economic policy more broadly, deregulation and improvements in tertiary education also contributed to the rise of Finland. The expansion of R&D expenditure during the second half of the 1990s supported Finland's shift towards an increasingly knowledge-based and high-technology economy. Technologies driving the success of the ICT sector, forestry and the metal-mechanical industry were also supported by an ensemble of public research institutions whose quality was recognised internationally. Public investment in education was increased to match the demand for new skills and the structural change towards ICT-related activities. The emerging knowledge-based economy coincided with the opening of the economy. This period saw Nokia rising as a global corporation and becoming a world leader in mobile handsets. The economy developed robustly, underpinned by strong productivity growth and high social and economic performance.

Finland was hit harder than its Nordic neighbours by the crisis in the late 2000s. Its economy went through a deep recession in 2009, followed by a partial recovery in 2010. It became increasingly clear, however, that economic performance was falling significantly behind that of its peers, especially when Finland went into recession again in 2012. Finland found it hard to catch up with the pre-crisis level of GDP in real terms and industrial production has still not recovered to its pre-2008 level, owing mainly to the contraction of the electronics industry but also to the decline in the forestry sector triggered by shifts in demand and the success of lower cost competitors and machinery. The weight of Nokia in the Finnish economy meant that its difficulties contributed significantly to the downturn and weak post-recession economic performance. But Nokia is by no means the only factor. Other important factors include the fall of prices in global markets for electronics, shrinking global demands for durable investment goods and machinery in which Finland is specialised, and disruptive technological change affecting not only ICT but also traditional industries. Shrinking trade with the Russian Federation has also disproportionately touched Finland due to its historically strong trade ties with that country. Finland is finally pulling out of the long, double-dip recession, but output growth still remains weak.

In the aftermath of the "great recession", the need for mobilising new sources of growth has been moving up on the agenda in many countries. Finland's public R&D expenditure continued to increase during the recession in 2009 and in the partial recovery in 2010, but this policy was reversed as the economic difficulties lingered on. Since then both government and business investment in R&D have been declining. There has been a switch from an expansionary ("countercyclical") to a contractionary ("procyclical") policy in funding R&D and innovation. This is in contrast to OECD peer economies (Denmark, Germany) which have responded to the global economic crisis by adopting countercyclical policies. More recently, the Netherlands and Norway have also moved

from a contractionary to an expansionary R&D policy. The level of R&D intensity – gross expenditure for research and development (GERD) as a percentage of GDP – is still relatively high in international comparison. Yet, the trend is steeply decreasing, from 3.35% (of GDP) in 2007 (and 3.73% in 2010) to 2.90% in 2015. According to preliminary estimates by Statistics Finland, R&D intensity reached 2.81% of GDP in 2016. This trend poses a risk to Finland's ability to return to a path of high sustainable growth. While there has been a multitude of changes in innovation policy since 2006, a clear strategy to underpin these adjustments and reforms has been lacking.

Tackling productivity growth, diversification, internationalisation and broader societal needs

Before the crisis of 2008 productivity growth had already weakened in many OECD countries. In some countries, such as Japan, Korea and the United States, total factor productivity (TFP, a measure of efficiency in the use of production factors) continued to increase after the crisis but at a slower pace than before. In others, including Italy, the United Kingdom and all of the Nordic countries, TFP growth declined between 2008 and 2014. In Finland, labour productivity has stalled. The gap vis-à-vis Sweden, to some extent Denmark, and the OECD average has widened and is only slowly recovering. TFP growth contracted substantially over the period 2007-13, in contrast to the rapid expansion in the previous decade. Most of the decline in productivity occurred in manufacturing whereas the business services sector has shown a modest improvement, although at productivity levels lower than those of Norway, Sweden and other European countries. The sharp decline in the high-productivity, high value-added ICT sector meant that more traditional and less productive activities have increased their weight in aggregate economic activity and productivity.

Finland has also started to encounter difficulties and new challenges in the area of social development. While its level of income is still higher than the OECD average, recent economic performance has been reducing this lead. Unemployment rose to a peak of about 9.5% in 2012, and has started to fall only recently. An ageing population also means that high growth becomes more difficult to achieve – as more people retire from economic activity and demands for healthcare increase. To restore Finland's capacity for productivity growth and international competitiveness and safeguard the high living standards it has achieved over the past decades, it is critical for Finland to:

- Revive value added and enhance economic diversification. Finland needs to tap new sources of growth based on new and sustainable export strengths, as well as by revitalising traditional industries, e.g. the metal-machinery industry, forestry, chemicals and biopharma, fostering their capability to compete globally through new economic competences and value added. 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.
- Enhance firm-level productivity, especially in small and medium-sized enterprises (SMEs) and start-ups, and enable them to grow and compete globally. Raising productivity levels requires making innovation and commercialisation more effective, which entails rethinking the innovation strategy as well as the need for Finnish firms to maximise the benefits of new technologies (e.g. digitalisation). This also requires boosting innovative entrepreneurship – and new firms capable

to grow and compete globally – and new high-technology export sectors. New company formation and growth would be favoured by an ecosystem that is internationally linked, connecting new firms to sufficiently large markets that provide a base for scaling up.

These two objectives are closely intertwined and reinforce each other. Attaining them will require a policy mix that boosts radical innovation while at the same time recognises the need to build on established strengths and companies and diversify to new areas and new knowledge-based firms with high potential to grow. There are opportunities in both directions and policy needs to take account of this.

Finland, along with other countries, also 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. Addressing these challenges – many of which are global – is also an opportunity for business development and global market expansion.

The crisis and industrial decline has highlighted the lack of diversification in the export basket, with a rather narrow range of industries where Finland has comparative advantage. Finnish exports have declined by approximately one-fifth since 2008, which is more than in any other advanced economy. The share of high-technology goods in exports dropped from 23% in 2005 to 6% in early 2016. There is an acute need to build competitive advantages in new areas of business and to diversify Finland's pattern of trade. In this context, the following trend causes some concern: the number of Finnish R&D-intensive "frontier" companies in the EU area has declined from some 70 companies (in the top-1 000 list of the EU Industrial R&D Investment Scoreboard) in the mid-2000s to slightly over 40 in the mid-2010s. Other countries and their companies have overtaken Finland.

There are some industries that have been less affected by Finland's economic downturn and which have potential for future growth. The level of services exports has remained more or less unchanged since 2008. IT services have been a strong pillar in this development, reflecting the massive capability building through the preceding ICT boom period. The creation of large amounts of ICT-capable human capital provides a crucial platform for strengthening existing business, building new firms and diversifying the economy. Harnessing this expertise to develop new competences and addressing new technology challenges (e.g. related to current trends in digitalisation) is an important opportunity for productivity growth and societal development in the coming years. The huge increase in national ICT capabilities and the knowledge base that underpinned Nokia's boom has been the basis of Finnish success in a number of business areas, including gaming apps.

Although some progress has been made, the lack of diversification has not yet been compensated for by developments among new and small firms. There are promising new emerging economic areas such as clean and medical technologies, and new ICT niches (e.g. gaming). While having increased in recent years, start-up rates (new firm creation relative to firm population) still remain comparatively low, and young firms' contribution to job creation and employment is among the lowest in the OECD. In general, firms in this category do little disruptive innovation and are often locked into domestic supply chains and the declining fortunes of important large Finnish enterprises abroad has made it more difficult for small firms to access international markets as subcontractors. At the same time, a lively start-up and early-stage capital scene has been evolving, and social

attitudes to this kind of activity appear to have become much more positive over the past decade or so.

An important challenge for increasing innovation performance opportunities is the low participation of SMEs in R&D. Although aggregate investment by SMEs in R&D has been evolving favourably throughout the decade, the number and share of SMEs in business enterprise expenditure for research and development (BERD) is well below OECD standards, despite the government's efforts. SMEs account for less than a quarter of BERD (21.8% in 2013, far below the OECD average of 35%). In efforts to integrate SMEs, innovation partnerships with large companies and with the universities of applied science (UAS) can play a strategic role in the advancement of industries.

Internationalisation remains a persistent challenge for the entire innovation system, both in the public and the private sector. In addition to relatively high labour costs, language barriers and a peripheral geographic location limit to some extent Finland's capacity to attract talent and foreign investment in knowledge and production activities. As indicated, measures are needed to empower SMEs and new firms and help them grow. This could be part of broader innovation agendas linking such firms with large firms and the public sector and supporting their early integration in global markets. The need to cope with globalisation and the growing importance of new competitors through internationalisation affects much of the Finnish economy and society. In a number of respects, Finland is well prepared. English is commonly spoken and used, just as there has been high capacity in Swedish, Russian and German in the past. However, the level of foreign direct investment (FDI) remains low and – post-Nokia – the extent to which Finland has multinational enterprises (MNEs) performing R&D abroad is rather limited. This tends to make access of Finnish business to international supply chains and to global technological developments and international innovation networks more difficult, and deserves due attention from policy makers. A key challenge for Finland is to transform knowledge (and better utilise knowledge capabilities) and new ideas into new products and innovation in global markets.

Internationalisation is also a challenge for the research and higher education sector, as few foreign researchers come to work in Finland. There is also scope for improvement with regard to the extent to which Finnish researchers co-operate with their peers abroad. As mentioned, language barriers and geography may inhibit the inward flow of foreign talent – but these factors affect all Nordic countries to some degree. Probably the most effective way to make Finland more attractive is to strengthen capabilities in key areas of research and innovation, which means strengthening specialisation and excellence, and better marketing the best local skills and technology assets in global markets. Reducing the fragmentation of the higher education and research sector and further improving governance in important parts of it would be beneficial in this context. While there are strong points, links to industry are in many places poor. Specialisation and scale are keys to improving performance in the higher education sector, and these need to be supported by institutional reforms and by rebalancing state funding with present and likely future societal needs. In addition, Finland could further promote other country-specific endowments, such as the business environment, quality of life, and the country's nature and safe environment, which are also important factors in attracting talent and FDI in both production and research and innovation activities.

Main strengths and weaknesses of the national innovation system

Table 1.1 provides a SWOT analysis of the Finnish innovation system. Finland has built strengths through the process of industrialisation. Over the past decades human capital and skills were reinforced, and the country embraced global market integration. Finland also has important "know-how" and experience in articulating innovation policy and governance mechanisms (e.g. through building broad-based consensus) to tackle structural change and economic transformation. Internationally, Finland has been a pathfinder in establishing good governance of the national innovation system and in building technological capabilities and advantages that sustained development and growth.

Table 1.1. **SWOT analysis of the Finnish innovation system**

Strengths	Opportunities
• Political stability with clear rule of law, high levels of trust and a culture of Nordic-style "flexicurity" • Strong base in resource-based and certain manufacturing industries as well as ICT and related services • Strong, skilled, innovative and experienced ICT and new media communities able to diversify into new businesses and provide digitalisation expertise to existing businesses • High-skilled professionals (ICT, health tech, mechanical engineering) • An education system that is excellent at the school level and good at higher level • Strong culture of co-operation and a willingness to unite behind policy when people are "all in one boat" • Greater willingness and determination to drive and implement change than in other Nordic countries • Most skilled adult population in the OECD (according to the Programme for the International Assessment of Adult Competencies) • Still relatively high levels of both public and private investment in R&D	• Restructure production in new high value-added segments, based on existing strengths in manufacturing, services and digitalisation • Revival of the Research and Innovation Council offers a new option to reinvigorate innovation policy, dialogue and governance • Use the Finnish Innovation Fund's (Sitra)ability to carry out policy experiments "outside the box" of normal procedures • Leverage ICT expertise for digitalisation as a new competence and for boosting productivity in industries • Foster recent cultural change – young talent and professionals embracing entrepreneurship (start-up boom) • Growing attraction of foreign investors (venture capital/business angels) and start-up networks (accelerators, etc.) • University profiling and reforms provide basis for stronger research performance and better links to societal needs • Better integration of demand and tackling societal challenges into government innovation policy • Ambition to improve cohesive, knowledge- and evidence-based policy making
Weaknesses	**Threats**
• Few exporting sectors and firms; a narrow export base; difficulties to diversify the economy • Advanced but small, peripheral market; companies need to export early on to secure growth • Few leading industries and companies; size distribution that is thin on "Mittelstand" • Small and medium-sized enterprises (SMEs) play a very small albeit growing role in R&D and innovation • Low overall rate of entrepreneurship, despite a small and growing start-up scene • Low rate of radical innovation; business innovations mostly focus on minor improvements and operational efficiency; even if "new to the world", little ability to capitalise on it • Talents leaving due to reduced research budgets • More strengths in knowledge than in its deployment	• Declining competitiveness and loss of export markets • Reduced R&D expenditures in both the private and public sectors • Declining knowledge and human capital generation and competitiveness in the longer term as a result of reduced policy priority for research and innovation • Loss of confidence in research as a basis for innovation and growth, as well as with the institutions and policies associated with this • Underutilisation of skilled ICT experts • Weakened consistency in innovation policy making; uncertain business and innovation environment • "Peripheralisation" in industry and research if internationalisation challenges are not adequately tackled • Continuously reduced ability to adjust to globalisation-led changes

Table 1.1. **SWOT analysis of the Finnish innovation system** (*cont.*)

Weaknesses	Threats
• Imbalanced funding pattern, under-emphasising applied research and enabling technologies • Fragmented, under-internationalised university system with decreasing industry links • Lack of university "excellence" in education or research (with some exceptions; e.g. University of Helsinki) • Limited foreign direct investment; domestic business R&D poorly integrated with business R&D internationally • Lack of vision, ambition and holistic approach to develop new forms of public-private partnerships and innovation programmes to tackle societal challenges and driving industrial renewal	• Ageing population, reducing the societal surplus available for investment • Absence of solid/large-scale platforms for strategic (cross-disciplinary) research and innovation

The rise of the ICT sector demonstrated the ability of Finland's innovation policy to nurture new economic competencies with high value added. Finland has thus a well-known track record in pursuing structural change and aligning public policies for national objectives. This legacy provides an important foundation for future development and overcoming recent setbacks and current challenges, but new lessons need to be taken into account.

Scope for improving and further developing innovation policy

It is widely acknowledged that the very success of Nokia combined with the pre-existing structure of industry has entailed a rather narrow base for industrial and economic development and that this constituted a risk. The policy lesson is that efforts to revitalise the economy need to involve a wider range of sectors and technologies that together will allow Finland to build on its advantages and to diversify. It has also been stressed that success in dominating industries was mostly achieved by relentlessly refining core technologies in their respective domains, and introducing them into successful products with the help of supply chains and competitive marketing organisations. It seems that this model based on incremental innovation – where firms tend to improve upon existing technologies and original products – prevails today. For continued success, however, advanced countries' firms in existing industries increasingly have to innovate radically, transforming their products from articles valued for themselves into "platforms" or networks that afford users a wide range of new and evolving possibilities. Sectors should be open to new technology adoption and new industrial applications, widening their market portfolio and even reorienting their business strategy while harnessing or building on existing assets.

Overall, Finland continues to have a range of favourable conditions for innovation-driven growth. Nevertheless, its innovation system has shown some difficulties in ensuring smooth connections between innovation actors, sectors and disciplines and in transforming new ideas and knowledge into globally competitive commercial products and services. This indicates structural weaknesses, weak incentives and downstream competences (such as weaknesses in technology transfer mechanisms, export competences and strategy in business, as well as shortfalls in intellectual property and value-chain management, etc.) complementing Finland's substantial R&D effort in the interactive processes of innovation and diffusion. There is significant scope to improve

linkages between the research sector, innovation intermediaries (e.g. the Technical Research Centre of Finland [VTT] and other technology transfer agents/institutions), industry and government (exerting demand for innovation) in order to better serve existing or create new markets.

The spectacular success of electronics, especially in mobile telephony, and the impressive growth achieved during the latter part of the 1990s and until the early 2000s, might have, paradoxically, rendered innovation efforts targeting new competence development sluggish and might have lessened the pressure to undertake some important reforms (such as university modernisation and regulatory reform affecting innovation). Moving forward also requires continued improvement of framework conditions for innovation and business activity, such as excellent regulatory frameworks enabling fair market competition and entrepreneurship-enabling policy frameworks (e.g. insolvency laws enabling quick firm exit, tax regimes conducive for new firms).

In relation to the innovation system itself, it is critical that policy takes a proactive stance. This means moving from policies that have increasingly become reactive (and unpredictable) towards policies which are set to continuously transform and improve the effectiveness of the entire innovation system. In addition, a better balance between curiosity-driven and applied-oriented research is required to address the needs of diversification and disruption in technology regimes, and focus more scientific and technological effort onto areas of social and economic priority. Public funding for applied R&D and innovation (e.g. the steep decline in Tekes' budget) has been more severely affected than other types of research, contrary to what might be needed to reinvigorate industry in the short and medium term. In addition, cuts at VTT have further exacerbated the gap in funding for technology development and innovation. A better balance is needed between research with a short-term and that with a long-term horizon, which are both important for innovation. With the discontinuation of some of the collaborative programmes (importantly the SHOKs programme funding), the need for more systemic innovation efforts has become more pertinent.

Improving the transfer of knowledge to economic use and all that this process entails (e.g. translational research, technology testing/prototyping, and diffusion/adoption in firms as well as new firm creation) remains a priority and needs to be further opened up to SMEs and new firms. This also means mobilising innovation for a wider set of users in the economy and society, in government, among final users, and abroad. This should be based on a forward-looking strategy and vision which should be promoted by the RIC, but needs the backing of government as a whole.

In a nutshell, innovation policy making should adopt functional mechanisms enabling system transition and adaptability, moving towards:

- A more responsive system with enhanced flexibility and which allows rapid decision making to address disruptions and challenges related to evolving global contexts. This requires having working groups or platforms in priority policy areas with the capacity to mobilise consultation and information from lower levels.
- Stronger interactions and permanent bridges within the innovation ecosystem. Currently, the private and public sectors have to figure out forward developments on their own. Public-private collaboration programmes should be relaunched, but require more diverse stakeholder participation and improved governance mechanisms.

- Addressing societal challenges (e.g. energy efficiency, water constraints, health, environment and green growth, including for example the circular economy) and the needs for more inclusive growth, which entails adaptation to technological change (especially of the least skilled segments of the population), should become a permanent feature of a renewed innovation policy.

The "societal challenges" pose to varying degrees existential threats to mankind. They also provide massive opportunities for knowledge-based innovations and new kinds of business. Their systems-changing nature means that they require a new style of innovation system governance, which is more participatory and more inclusive of a wider set of stakeholders, 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.

Fostering innovation for economic and social development requires the co-ordination of a broad range of public policies (and their mix), including productivity-enhancing and social policies. Public policy has a leading role in fostering innovation, for instance through demand-enhancing regulatory development (e.g. environmental policy and standards, as well as public procurement legislation that specifically supports environmental aspects spurring innovative products and services), other framework conditions (e.g. fostering competition and easing entry of firms), or co-ordination of policies fostering innovation and internationalisation (e.g. by fostering international trade and FDI).

It is important for Finland to move towards a more integrated and systemic approach to STI policy. This entails conceiving new policy mechanisms to support innovation ecosystems (and communities), challenging traditional roles for both businesses and the higher education sector (and scientific communities). New interactions and more open modes of innovation are needed, which include a broad range of communities of knowledge and practice.

Key issues and recommendations

Some key issues have been identified based on the foregoing analysis. These are summarised below, together with recommendations on how they could be addressed.

Develop a new national vision for STI and reinvent governance to generate a whole-of-government policy for innovation-enabling system transitions

Finding ways to meet the economic and societal challenges will provide a way to reunite and reinvigorate key actors in research and innovation in Finland. Two lines of action are needed. First, with the authority of government, the Research and Innovation Council should lead the generation and co-ordination of the new national vision for research, innovation and economic renewal that addresses the need for boosting productivity growth and diversification as well as societal challenges. It should also decide which are priorities for Finland. It should then establish itself as the central co-ordination mechanism for implementing the vision and linking this implementation to broader research and innovation policy. This will require gathering and aligning relevant innovation stakeholders (not only research actors) around shared economic and societal challenges and innovation agendas. Hence, second, this vision should be supported by creating new instruments for establishing networks and programmes able to lead and manage the transitions in individual socio-technical systems that will be needed to address the selected challenges. Since the practices needed are still evolving, there will be

a need for policy experimentation. Implementing the vision will also depend on using more established research and innovation policies in parallel while carefully co-ordinating them so that there is consistency at the systemic level.

Develop a new national vision for research and innovation policy, driven by societal and economic needs

In view of recent developments, there is a strong need for a unifying national vision that establishes a consensus about how to reinvigorate the economy and enhance societal development by harnessing research and innovation. This should counteract the lack of co-ordinated action across different parts of government, business and the wider society. Tackling productivity and societal challenges requires going beyond more traditional models of research and technological development to more broader and inclusive partnerships. A higher-level strategy is needed that determines which challenges Finland should prioritise and invest in based on the available opportunities and the assets that it brings to the table.

For this reason, a high-visibility, national effort is needed to create and generate support for a new vision and all-of-government strategy for using knowledge to drive economic performance by tackling the societal challenges. This would involve mobilising knowledge and experiences from recent years on how to manage "transitions" or "system innovations". Key elements of such a strategy would be:

- Define a vision for Finland's future development through a wide-ranging consultative process. Advanced foresight, should be reinforced in many areas and extend to road mapping, in order to establish a consensus about implementation and reduce the perceived risk of innovation.
- In addition to technology experts, industry and sector representatives, such foresight exercises should include a wide range of stakeholders and experts – such as various categories of consumer, regulators, "users" such as healthcare and transport providers, social scientists, philosophers, artists, students, immigrants, regions and cities – 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 expectations.
- Establish a co-ordination mechanism that can oversee the implementation of the vision, but that spans both the vision and more established research and innovation policy. It will be important to maintain a systemic perspective on the whole innovation system and its associated policies, in order to ensure coherence.

Over the years, the RIC has functioned as an "arena" in which alternative policies and priorities are debated and a strategic consensus formed. This function has been closely coupled with monitoring the health of the innovation system as a whole. The need for such functions has not disappeared. However, addressing the prioritised challenges is inherently a decentralised process. Economic and societal challenges are too big to all be addressed by one central body; they must involve numerous stakeholders. Each will require its own arena or co-ordinating mechanism to be effective. Given the number of stakeholders involved, each challenge will have its own decentralised "arena". The revival of the RIC should be used as an opportunity to redefine its role to encompass the wider mission of defining and co-ordinating the implementation of the national vision. In

addition to its traditional function, the RIC would become an "arena of arenas" to co-ordinate the implementation effort and keep the vision up to date.

The revival of the RIC in 2016 has entailed a number of changes. It is now smaller; its independent secretariat was abolished and preparatory work is now carried out by a group consisting of civil servants from the Ministry of Education and Culture, the Ministry of Economic Affairs and Employment, the Prime Minister's Office, Tekes, and the Academy of Finland. It is envisaged that the group will involve stakeholders in the preparations. The RIC's membership could usefully be extended to include one or two foreign members, in order to expose it to more international ideas.

The RIC still appears to be best placed to lead these processes because it encompasses the highest level of government and is in principle capable of reaching across multiple ministries, agencies, and sectors of society and stakeholder groups. But generating and co-ordinating the needed vision is a very demanding task because it extends far beyond research and innovation policy. It would require sufficient budgetary resources to support analysis and monitoring as well as the various supportive mechanisms (consultative processes, foresight exercises, etc.) for developing and launching the new vision.

There is also a need for co-ordination at the government level, to ensure that the ministries are aligned and involved with the policy and to get 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). Due to its membership, the RIC is best placed to engage with government policy.

Create new networks and partnerships to co-ordinate individual system transitions

Implementing the vision entails using new instruments to link a wide range of actors (knowledge producers, users, intermediaries and others) for addressing industrial innovation and societal challenges. A new model for public-private partnerships (PPPs) will be needed.

Finland already has some activities in place that foreshadow the proposed new approach to addressing economic and societal challenges, notably in the form of the cross-ministry Health Sector Growth Strategy and the Bioeconomy Strategy. Each involves a number of ministries as well as research, industry and users, among other stakeholders. The transition literature implies that even wider coalitions may be necessary. The fact that Finland is already working in this direction implies that it is at the forefront in developing these kinds of policies and instruments. Finland should exploit this advantage, which should also make it easier to take the next step towards more holistic strategies with yet wider stakeholder participation as it already has experience moving in this direction. Another advantage that Finland enjoys is a strong national tradition of foresight activity, although it has not been so widely in the recent past. This means that skills needed for the visioning process are already available locally. The Strategic Research Council (SRC) provides a further opportunity to support such a new approach. Its activities could be more explicitly integrated into wider social policy, and research and innovation more generally.

Other countries are also beginning to use public-to-public (P2P) partnerships and PPPs to cope with broad industry-wide (or economy-wide issues such as skills or infrastructure) and societal challenges. These typically involve the creation of a platform for relevant stakeholders, which generates a strategic research agenda approved by the

government or one of its agencies. The partnership is then left to manage certain aspects of implementation. 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 instances this can involve the partnership 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 socio-technical system that they require.

The Swedish Strategic Innovation Projects (SIP) programme provides an interesting example of such partnerships and their governance. The cross-ministry "21" strategies in Norway provide another. Like the Finnish Health Sector Growth Strategy and the Bioeconomy Strategy, these represent a step towards the kind of P2Ps and PPPs (stronger industry-government collaboration in innovation) needed but so far under-emphasise the non-R&D related aspects of networking, road mapping and policy development.

In deploying these efforts, there is need for policy experimentation and innovation in order to find models that correspond as much as possible to Finnish specificities. An important element of new programmes and initiatives are facilities for policy experimentation and learning. It should be acknowledged that learning by doing and rigorous testing will define in the end what the best modalities are for Finland, hence flexibility and recognition of the need for continuous improvement and adjustment will be needed. In order for experimentation to have an impact, it needs to be matched by a willingness to implement and scale up successful solutions and to tackle regulatory or other obstacles.

In rethinking governance, it is also necessary to examine the key public innovation actors (such as Tekes) to see whether their current missions, organisations, operations and competencies are appropriate for ensuring the kind of reflexive governance, new instruments and collaborations and experimentation that will be required to tackle societal challenges and turn them into opportunities, and to contribute to strengthening Finland's long-term resilience and innovative strength.

Recommendations

- Develop a new vision for STI and reinvent governance to generate whole-of-government policy for innovation enabling system transitions. To succeed in this effort the RIC needs to take on a key role.
  - Work at the highest level of government to initiate the creation of a new unifying national vision about how to reinvigorate the economy and society by harnessing research, innovation and education. This vision needs to be broadly accepted across government and in and beyond industry, including the research and higher education sector, in particular by encompassing national action on societal challenges.
  - Adopt a forward-looking strategy making use of various types of foresight (technology, global markets/demand, socio-economic prospects) to nourish strategic planning and the definition of innovation roadmaps to address industry-specific and cross-cutting (e.g. digitalisation, green growth) and societal challenges.

  - Extend the role of the RIC beyond its current mission of co-ordinating research and innovation policy to become an "arena of arenas" to co-ordinate the implementation of the vision across the necessary decentralised networks and to keep the vision up to date. In doing so, provide the RIC with the capacity and financial means to fulfil its commitments based on a clear mandate and agenda.

- Improve the steering and impact of research and innovation policy by supporting stakeholder co-ordination to address societal and economic challenges.
  - Use new instruments to link a wide range of actors (knowledge producers, users, intermediaries and others) in addressing innovation and societal challenges.
  - Launch a programme for PPPs for societal challenges that will enable co-ordination not only for research and innovation via jointly agreed strategic research and innovation agendas but also for involving the other stakeholders whose engagement is needed in order to achieve systems transitions.
  - Ensure that PPPs not only tackle research but also pursue broader innovation goals by including downstream areas – translational research, product testing, and technology diffusion and commercialisation of innovation – and a wider set of national- and regional-level stakeholders, such as innovation users and regulatory agencies.
- Strengthen policy learning and design through experimentation.
  - Embed policy experimentation into the mainstream of implementation of the vision so that it becomes a routine way to evolve policy and instruments towards better performance.
  - As an option, foster experimentation by encouraging Sitra to experiment with network-based governance models for socio-technical transitions.

Foster productivity and innovation in the business sector

Part of the policy response to Finland's protracted economic difficulties has been a reduction of public funding of business R&D and innovation. Tekes, the main funding agency for applied R&D and business sector innovation, has seen its R&D budget shrinking steadily since 2010. Over the period 2011-17, its budget has been cut by 51% (in real terms). Furthermore, research institutes – in particular VTT, which could play an important role in more long-term and strategic R&D for the business sector – have been hit particularly hard by the combination of cuts in basic funding for public research institutes (PRIs), a hard reduction in funding from Nokia (which added to the cuts in funding to Tekes, which has lowered both the direct funding the institutes receive from Tekes and revenue from large companies who often used Tekes funding to procure projects).

Business R&D intensity (BERD relative to GDP) is still well above the OECD median and at a level similar to that of Sweden. However, there has been a rapid contraction in the wake of the ongoing industrial restructuring, from 2.3% in 2013 to 2.12% in 2015. At the same time, Finland shows one of the lowest shares of government funding of BERD in the OECD. Finland's BERD is primarily performed by the high-technology manufacturing sector and strongly concentrated in large firms. Nokia

alone performed about half of BERD in 2010. In 2015, the firm represented 20% of BERD whereas Microsoft Mobile accounted for 10%. Nokia's reduction of investment in R&D is the main cause of the decline of Finnish BERD in recent years. In the aggregate, the remainder of the firms – including in the services sector – have shown a more stable pattern of development and their BERD (in real terms) has actually slightly increased since 2010.

A three-pronged approach is needed to foster productivity and innovation in businesses:

- Investment in research and innovation should be increased but with a new approach that is aimed more at the development and adoption of radical innovation and new technological solutions for building new competitive advantages in both existing and new industries. This should also include the pursuit of technologies and business models that enable companies to upgrade business and shift from existing activities to new, related ones.
- Closely related to the previous objective, larger scale initiatives for research and innovation needs in industries should be launched, allowing for greater involvement of innovation actors and facilitating a more ambitious medium- to long-term innovation agenda co-ordinated within networks. The purpose is to revitalise industries through radical innovation and wider strategic (economic challenge-driven) innovation agendas. A new type of strategic (challenge-driven) PPPs should be established based on new models of governance and operation.
- Encourage new and existing SMEs to innovate and enter markets. This includes embedding them into innovation ecosystems, improving access to business services that facilitate the development of management skills necessary for the internationalisation of SMEs and better integrating them into global value chains (GVCs). All three elements need to be combined to make both new and existing industries more dynamic. Finally, efforts should be geared towards providing better growth opportunities for firms through value creation networks and internationalisation.

There is a clear role for government to foster renewal through education, research and innovation and to help businesses manage risks and invest in strategic areas of research and innovation. Finland has done this successfully before and should consider doing it again, based on new evidence. In particular, it should identify strategic areas in need of public investment, rather than indiscriminately cutting public funding across the board.

Boost radical innovation for diversification and new competitive advantages

Diversification is critical for future economic performance. Finland's opportunity for restructuring existing industries towards high value-added and high-productivity activities can take the form of strengthening capabilities in existing areas of business strengths and extending from those areas into related ones that provide innovation opportunities. Yet, as international experience shows, the adoption of new and radically new technologies (which may be developed by third parties, e.g. PRIs or new technology-based firms) can revolutionise existing industries and enable them move to new industrial applications and higher value-added products. Certainly, general purpose technologies such as biotechnology and clean technologies are of high relevance to Finnish traditional industries.

However, while Finland has a high share of industry-funded R&D, survey evidence shows that Finnish businesses invest little in radical innovation, with the likely implication that they become overly locked into existing products and markets and that they then fail to replace them with new ones in sufficient number. As individual product cycles mature, there is an increasing need for firms to break out into successor cycles. Finnish companies are less likely to do so than those in countries more committed to radical innovation. Incentives for "radical" innovation development and adoption should be strengthened, not only through public funding programmes but also through stronger and more systemic (and inclusive) cross-sectoral collaboration and better aligned industry-science co-operation for research and innovation.

Enhance research and innovation partnerships – the need for large-scale collaborative initiatives

Firm collaboration in innovation is also an area that deserves attention. In principle, aggregate figures place Finnish firms among the best performing of OECD countries in terms of co-operation (co-operating with others in innovation, all types of partners combined). A closer look shows that co-operation activity by SMEs seems to have suffered dramatically since the crisis and has not recovered to its 2008 levels. In terms of innovation outputs, Finnish firms mostly generate product improvements rather than "new-to-the-world" innovation. They seem to have encountered some difficulties in generating intellectual property rights (patents, trademarks, etc.) which can be partly related to under-performance in reaching global markets, in particular by SMEs, as previously discussed.

Cuts in Tekes' budget have entailed a reduction in funding for collaborative research and innovation. Earmarked Tekes funding for strategic centres for science, technology and innovation (SHOKs) – PPPs for collaborative research led by industry clusters – was discontinued in 2016, although the SHOKs, as private limited liability companies, are still operating independently under business law. SHOK companies are still eligible for normal Tekes funding and may apply for other types of funding. The aim of the SHOKs was to reinforce global market relevance of publicly funded R&D and innovation by enhancing the joint involvement of industry (or public R&D institutions).

According to an evaluation and certain experts, the SHOKs showed mixed performance and weak governance mechanisms, in addition to difficulties in aligning academia and the business sector in the setting of common research interests. They were considered as being used mostly by large firms (incumbents) with limited participation by other firms (SMEs and new firms), and functioning under a rather closed regime and with a bias towards existing technologies and products. There are, however, interesting cases of practice still under operation (such as DIMECC Ltd and CLIC Innovation Ltd), whose features and evolution should be examined and better understood. Active and promising innovation networks could be further mobilised and better utilised to address innovation challenges in high-priority areas such as bioeconomy/cleantech, the circular economy and digitalisation. PRIs need to work and interact closely with business enterprises in order to deliver commercial success of high significance.

The INKA Innovative Cities programme, involving PPPs using a bottom-up approach, will be suspended in 2017. Hence, incentives for public-private collaboration for research and innovation are currently limited, which restricts the business sector's possibilities for innovation and productivity recovery. While new forms of policy are needed, it will be crucial to restore the level of resources and effort previously devoted to

these policies in order to enable recovery and growth. The government does recognise the importance of cities and regions as drivers and test beds for innovation. Effective use of them requires focused effort and a formal framework so that interventions happen at a scale that can be effective. More interaction and closer co-operation will be needed to link national strategies and policies to regional and local strengths and development effort. Open co-operation platforms involving local actors, national and international networks can be mobilised to leverage the dynamism and strength of innovation ecosystems in the regions.

Like many other countries, Finland needs to move forward, draw lessons from the SHOK experience and engage in a new generation of PPPs for research and innovation. These PPPs should be more open, flexible, allow for a wider set of stakeholders to co-operate and could also extend to broader innovation agendas, not only research but also complementary resource development (e.g. training and human capital formation) and downstream stages of innovation (e.g. commercialisation). They should be based on enhanced governance and a clear definition of common goals agreed through a joint research or innovation agenda (for the medium to long term), based on road-mapping and joint stakeholder engagement.

The renewed PPPs could mobilise complementary support mechanisms for innovation competence development and commercialisation and better link to new innovative firms and value chains. Hence, a better mix of top-down and bottom-up approaches is key to launching a new revitalised model of PPPs. Finland currently lacks programme-based national-level mechanisms to support industry-science collaboration to address urgent industry needs for innovation and productivity growth. The only available policy tool for cross-sectoral collaboration is the SRC project funding, but this addresses policy concerns in priority societal challenges.

Increase innovation opportunities for SMEs through networks and internationalisation

The share of SMEs in BERD in Finland is below the OECD average and less than in Norway and Denmark. SMEs account for less than a quarter of BERD (21.8% in 2013), well below the OECD average (35%). Norway and the Netherlands display shares of 50% and 41%, respectively. According to Statistics Finland's last R&D survey, large firms with more than 500 employees represented about 76% of BERD in 2014. Finnish policy has provided comparatively little economic support to in-company innovation in SMEs in an OECD comparison. This means that the state mitigates the risks of innovation to a lesser extent than in other countries, making it more difficult for companies to undertake more radical or risky forms of innovation.

One way to strengthen the participation of SMEs in innovation is through the promotion of innovation linkages between large firms and SMEs. Tekes already goes some way to promote such linkages. One funding criterion for large companies is research co-operation with other innovation actors: SMEs, research organisations and universities. Almost 90% of Tekes funding to large companies is channelled through subcontracting to SMEs or research service purchases to higher education institutions (HEIs) and research organisations.

Looking to innovation beyond R&D, several indicators suggest that Finnish firms invest less in non-R&D innovation activities (relative to total sales) and intangibles (e.g. ICT investment and intellectual property) than some of their European peers and less than the European business average. Moreover, between 2008 and 2012, Finnish firms'

non-R&D innovation expenditures fell from 0.57% to 0.37% of GDP while EU firms overall devoted as much as 0.69% of turnover to such activities in 2012. This suggests a low rate of non-technical innovation and may well indicate difficulties in valorising the R&D already performed. This could result from companies' difficulties in national and international markets and may also suggest that the mix of types of R&D – especially that funded by the state – is not well adapted to industrial structure and needs.

ICT investment (relative to GDP or value added) is an area where Finland clearly lags compared to comparator countries. For instance, computer software investment represented about 1.1% of GDP in 2013 whereas this share was twice as high in Sweden and Denmark (2.25% and 2.2%, respectively). Finnish firms could also improve their use of ICT, and digital technologies more generally.

The propensity to export among Finnish SMEs is generally low. While there is scope for improvement across the board, the barriers facing smaller firms are especially severe. Efforts should be made to increase growth opportunities for firms through value creation networks and internationalisation. The former means facilitating technology and production markets through platforms and inter-linked procurement, innovation and commercialisation systems. The latter entails enhancing innovation support mechanisms for rapidly reaching export markets and GVC integration and upgrading. Finally, complementary and synergistic to all these priorities is the need to address the development of non-R&D competences in Finnish firms (e.g. ICT investment, technology licensing/adoption, training related to innovation, and marketing/new organisational models, etc.) and non-technological innovation in SMEs and new firms. These two aspects are fundamental for all sectors for productivity catch-up and competitiveness, especially in the services sector.

Recommendations

- Strengthen public support to business R&D and innovation to address the current needs for economic renewal and productivity growth.
  - Prioritise more radical innovation projects which have the potential to lead to new high value-added products and services and increased export potential. This entails addressing gaps in the innovation cycle, including knowledge transfer, technology testing and commercialisation.
  - Strengthen the participation of SMEs in innovation activities and consider improved measures to help new firms enter R&D and innovation activities. Examples of programmes include the Engage Grants programme in Canada, KMU-innovativ in Germany and InnovationAgent in Denmark.
  - Promote R&D and 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 houses a number of SMEs in a common innovation space and gives them access to their research facilities and experts).
  - Enable SME innovation by supporting test sites and demonstration facilities (in areas of new technologies and applications) that are accessible to SMEs; examine ways of making research infrastructure (e.g. laboratories) more

accessible to companies (e.g. the ongoing efforts in Sweden to maximise companies' access to the MAXIV – one of the brightest X-ray sources in the world).

- Address sectoral and cross-sectoral challenges by promoting co-operation and stakeholder co-ordination via jointly agreed strategic research and innovation agendas and their implementation.
  - Support co-ordination for innovation and strategy setting (innovation road mapping and innovation agendas). While there are some networks or clusters (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.
  - Launch a new PPP model for research and innovation. In doing so, move towards a new, more open and inclusive programme, with reinforced governance and stronger participation of the state in governance, and based on an innovation agenda with broader scope, including different stages of the innovation process (according to the network needs), including start-up participation, demonstration and commercialisation stages. Examples are the Strategic Innovation Programmes in Sweden, Strategic Platforms for Innovation and Research in Denmark, and Leading Edge Clusters in Germany.
  - Encourage and facilitate new cross-sectoral collaboration involving 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.
- Expand growth opportunities through innovation networks around public markets and demand-side programmes.
  - Enhance support for and co-ordination between innovation and internationalisation programmes (export, GVC integration, and FDI and business linkages with foreign firms) and assist firms in identifying which innovation and commercialisation capabilities are needed for successful exporting and globalisation of Finnish firms.
  - Consider launching an innovation support programme for international value-chain integration and exporting.
  - Enhance public procurement of innovation and work towards a more integral innovation model that is scaled up across government agencies and regions. This will entail expanding current initiatives for matched funding schemes for innovative businesses (start-ups and SMEs) participating in procurement processes. The adequacy of procurement laws should be ensured to prevent the implementation of new initiatives from being blocked or constrained.
  - Consider introducing a programme to support small companies in commercialising knowledge from the government laboratories. This could be modelled on the SBIR scheme pioneered in the United States, which requires

government labs to reserve a small part of their budget for innovation contracts with SMEs.

- Continue and strengthen efforts to involve the regional level, especially cities, in innovative procurement, acting as test beds and linking up with international activities – for example, in Smart Cities – that will help keep Finnish initiatives up to date and allow this work on the Finnish demand side to be leveraged in international markets. All this requires intense interaction between national- and regional-level organisations and their joint action in implementing policy measures and pooling resources for jointly selected priorities.

Research policy and the gap in "strategic technology" development

The need for public investment in key enabling technologies and applied research

In recent years, the development of public research funding in Finland has, in relative terms, moved away from the earlier pattern of focusing on applied research and technology through Tekes towards more basic research which is mostly conducted at universities. This has different causes.

First, between 2011 and 2017 institutional university research funding slightly decreased in real terms while the total funding of the Academy of Finland increased by 16%, due to the introduction of the SRC and the transfer of funding from the budget line for universities to the academy for supporting university "profiling". Second, Tekes has been instructed by successive governments to focus increasingly on start-ups and entrepreneurship, responding to the correct perception that these need to be fostered in Finland. However, the result has been a significant reduction in Tekes' spending on technology programmes and innovation. Third, the government announced the withdrawal of the SHOK programme in 2015. The overall effect is that the level of applied industrial research funding is dropping below that of the academy's bottom-up research funding. The SHOK programme, launched in 2008 and providing up to EUR 100 million per year to enable science-industry consortia in R&D for business innovation needs, certainly had shortcomings. While the intention was – like in similar "competence centre" programmes abroad – both to induce industry to engage with more fundamental research so as to enable more radical innovation and to encourage academia to carry out research and PhD education in industrially relevant areas. However, the governance of the SHOKs was dominated by the companies in a way that there was little voice for the interests of more fundamental research. As a result, the work funded through the SHOKs was of a highly applied, short-term nature, and the desired convergence between industry and academia did not take place.

The reductions in Tekes funding for technology means that less effort is being made towards developing and absorbing new and enabling technologies. This trend has affected research and societal impact of more applied R&D, conducted in various institutions, including in the universities of applied sciences. While the Academy of Finland continues to play a rather traditional research council role, funding investigator-initiated research and research infrastructure, it has broadened its activities to providing "profile" funding to encourage restructuring in the higher education sector and provided a home for the SRC, which funds research to address policy and the societal challenges. Nonetheless, a gap has opened in the funding of industrially strategic, "key" and "enabling" technologies. This is the opposite of what is needed to support innovation in existing

industries, diversification into related areas and tackling the societal challenges – the three elements identified above as necessary to combat Finland's recent decline in competitiveness, exports and productivity and to set Finland back on a sustainable growth trajectory.

Strategic research funding – implications and trade-offs

Another recent reform involved the reallocation of core funding from the government to new strategic tools. According to the Government Resolution of September 2013, during 2014-17, a total of EUR 65 million was to be transferred from the government R&D institutes to the SRC (EUR 52.5 million) and the government's analysis, assessment and research activities, the so-called TEAS projects (EUR 12.5 million). Almost one-third of the total sum (nearly EUR 21 million) was transferred from VTT. An additional EUR 10 million were moved from Tekes, EUR 7.5 million from the Academy of Finland and the remainder from other research institutions.

This reallocation may represent a loss of ability to pursue enabling, strategic research and technology in the PRI sector and appears unlikely to address the "strategic research" gap identified above. Furthermore, VTT's capacity in facilitating technology transfer towards industry is also weakened, which is also likely to constrain innovation opportunities for industry. Quite distinct in its purposes and goals from other public labs, VTT has traditionally played a major role in supporting innovation in the business sector. As a research and technology organisation, its role is to equip itself with technological capabilities that are in advance of those in industry and then work with companies to transfer and exploit those capabilities in innovation. This often means that VTT works with "key", "enabling" of "strategic" technologies that correspond to the strategic research gap identified here. Reducing VTT's core funding undermines this logic and is likely to make VTT's capacity building less ambitious and reduce its ability to help industry take significant steps in new technology development and adoption. The reforms of the government institute sector are very recent, so little can be said about their effects.

With the SRC, Finland has launched an ambitious attempt to strengthen research on real-world problems and, in particular, on societal challenges. The SRC was originally intended to address "strategic" research in the sense of "strategic basic" or "enabling" research to address real-world problems, in particular major societal challenges. SRC – and the Prime Minister's Analysis Unit, currently rather represent ambitious efforts to strengthen knowledge-based decision making particularly on complex policy issues such as societal challenges. They do so by promoting policy-relevant, cross-cutting and multidisciplinary research and analysis on themes selected and prioritised by the government. They also put a strong emphasis on continuous interaction with potential users and beneficiaries of the knowledge produced as an integral part of the projects, particularly the SRC.

The SRC is a very ambitious instrument for generating primarily evidence-based policy recommendations, since research or analytical work related to identifying regulatory, institutional or other bottlenecks that might hamper the upscaling or development of solutions is of a different nature (and time horizon) than engaging in breakthrough research for developing new solutions to address societal challenges. However, the SRC appears to focus more on policy than on promoting the development of technical aspects of concrete, scalable solutions and innovations for societal challenges that could also become business opportunities. Implementing its work will require links to significant scientific and technological programmes investing in research and innovation.

In contrast, with Vinnova's Challenge-driven Innovation and Strategic Innovation programmes, Sweden has put in place innovation programmes aimed at addressing societal challenges and driving system renewal for future competitiveness that are stronger in the applied, problem-solving dimension of developing concrete, scalable solutions for societal challenges. However, these initiatives have not yet been matched by concrete changes, such as the SRC in Finland or the Prime Minister's Analysis Unit, to strengthen knowledge-based policy making and a systemic "whole-of-government" approach to addressing societal challenges (e.g. identifying regulatory, institutional or other bottlenecks that might hamper the upscaling of solutions that address societal challenges). It seems that both Finland and Sweden could learn from each other and each country's policy effectiveness could be strengthened by combining the two approaches.

These efforts to strengthen research on complex policy issues should now be complemented with changes in education as well as efforts to strengthen the ability to translate research and knowledge into concrete and scalable products and services that can address societal challenges as well as create business opportunities. The latter requires collaboration between industry, academia and institutes, but also experimentation and demonstration. The current efforts seem quite research-heavy but light on the innovation end. So far, about three-quarters of the funding awarded – which is allocated competitively – has gone to the university sector. Furthermore, the international dimension should be strengthened, since many issues can only be addressed in international co-operation and the market opportunities for successful solutions are global.

Recommendations

- Enhance funding for applied research and "enabling technologies" (e.g. biotech, nanotech, advanced materials, advanced manufacturing), aimed at supporting innovation capacity to address both industrial and societal challenges, e.g. the United Kingdom's Emerging and Enabling Technologies programme (E&E).
  - This will involve a combination of traditional Tekes-style technology programmes and wider programmes linked to the agendas for resolving the societal challenges. Some of these may be run by PPPs, provided due care is taken in designing their governance and in keeping them accountable to the government and society. Special care must be taken to close the "strategic research" gap.
- Enhance funding for VTT and other relevant PRIs to maintain their quality and industrial impact, and address the "strategic research" needs of industry and intermediary stages of the innovation process.
- Consider adjusting the funding and operational model of the SRC programme ("societal challenges") to encourage better co-ordination with instruments and policies for the participation of innovation actors, including business enterprises, and more downstream innovation development. More attention should be given to how research on societal challenges can be turned into concrete, viable and scalable solutions. Research or analysis related to identifying regulatory, institutional or other bottlenecks that might hamper the upscaling or development of solutions is of a different nature and time horizon than engaging in new breakthrough research for developing new solutions that could address societal challenges.

Complete the modernisation of the research and higher education sector

The performance of the higher education sector is constrained by governance shortcomings, which call for continued reform. The national performance-based research funding system cannot compensate for this institutional deficiency and involves such a high degree of contestability in institutional funding that it risks causing unfavourable side effects. While reformed universities would have greater freedom to reallocate internal resources and reduce the fragmentation of the Finnish research system, the profiling funding provided by the Academy of Finland is welcome but may not be sufficient to encourage specialisation and the creation of larger research groups where needed.

A second major issue hindering the contribution of universities and the public research sector to innovation is the high fragmentation of research and education that prevails. Progress has been made in terms of education or departmental consolidation at HEIs. Strengthening the quality of research remains an important challenge. Some progress notwithstanding, e.g. in the number of international staff, the science and education systems still need to become more international and better connected to international networks of research and education. The Ministry of Education and Culture is preparing a new international policy for higher education and research which aims at addressing these issues.

Facilitating the contribution of universities and PRIs to innovation and improving the quality of research has also been addressed through the Open Science and Research Initiative (ATT). This initiative attempts to improve the visibility of open and collaborative science to relevant innovation system actors and has already had some success in engaging stakeholders in the open science strategy, although it still needs to strengthen its impact on the operational level. Further development of the ATT in 2017 is expected to improve the initiative's reach.

Complete governance reforms and optimise the structure of the research and higher education sector

The Universities Bill of 2009 provided universities with autonomy, giving them legal entity status and control over recruitment and finance. It mandated that a minimum of 40% of the governing board comprise people external to the university. Rectors were already appointed by the university boards rather than being elected, but leaving a majority of internal members on the boards (Finnish universities differ in this regard) imposes some of the constraints that apply to elected rectors, especially the need not to "rock the boat" within the university. This may explain the slow pace at which Finnish universities are reacting to the need for consolidation and specialisation and for making changes in course content. Other factors, like regional policy and political decision making, may also play a role.

HEIs' contribution to innovation could be enhanced in different ways. In general, the technology transfer function within Finnish universities is not strong and the broader links to industry are weaker than those in many other countries. Degree programmes are specialised and university rules could make it easier to move from one programme to another. The type of broader programme or degree sought by employers may help to lower the high rate of graduate unemployment.

In addition, moving course credits from one system to the other should be facilitated, enhancing the kind of institutional and social mobility this engenders. An evaluation of the reforms indicated that they had strengthened university management, but in combination with the recent cuts in university funding led to some reduction in the level of enthusiasm among faculty members.

There is room for improvement in terms of skills both at the higher education and post-graduate levels. There are indications that the skill sets which are being produced, especially in doctoral education, are not sufficiently aligned with those required by society, and this might be one of the reasons why the Finnish industry has not been employing doctoral degree holders as widely as some other countries.

Overall, the process of optimisation through mergers has been rather slow. While the Academy of Finland provides "profile" funding to help universities define clearer strategies and patterns of specialisation, the number of institutions is declining slowly from a very high level. There were 48 institutions defined either as universities or polytechnics (UAS) in 2009 and 37 in 2017. This will still leave Finland with about twice as many institutions per student as in other countries, so there continues to be significant scope for rationalising the system. It is now possible for universities and UAS to form consortia, which may help reduce the fragmentation.

Not only the number of institutions needs to be reduced but, more fundamentally, the number of small branches (ca. 120) of these institutions and a large number of comparatively small departments (in the same field of education/research) scattered across the country. Overall, it appears that the process of university reform in Finland is a work in progress. Many of the measures needed to affect the reform have been put in place but a significant amount continues to depend on the ability and mandate of university management to manage the reforms effectively. The balance of power probably needs to shift more towards the management if universities are to consolidate, focus and modernise in the way intended by policy.

The UAS suffer from many of the same rigidities as the universities but they are also confronted with other types of challenges given their different orientation and stronger connection to regions and localities. UAS are strongly engaged in research, innovation and entrepreneurship-related activities and one of their strengths is close interaction with the SME sector in regions as well as developing entrepreneurial competence as part of higher education curricula. According to the Polytechnics Act of 2003 (amended in 2009), a key mission of UAS is to carry out mainly applied research, development and innovation activities as well as artistic activities that serve UAS education, promote industry and commerce and regional development and regenerate the industrial structure of the region. Given the UAS' emphasis on applied R&D, an important challenge for their R&D funding is that there are few national tools and instruments for applied research and innovation. The Universities of Applied Science Act of 2015 promoted the role of research and innovation and for the first time takes it into account in the funding model.

Reconsider the balance between performance-based and block allocation of research funding to the higher education sector

The "levers" through which government can influence the quality of university research include:

- external, competitively allocated project funding

- the ratio between institutional and externally awarded funding
- using a performance-based research funding system (PRFS) to govern some of the institutional funding
- internationalisation, exposing domestic researchers to world-class quality norms
- the governance of the universities, including their ability to strategize and develop a quality culture
- overall investment in higher education research.

The policy choice in Finland has been primarily to focus on performance-based institutional funding, although there is also a significant effort in considering internationalisation among funding criteria.

The university reforms included changes to the funding model, which have made not only external but also institutional funding for research performance-based and dependent upon results.[1] However, major changes were made after the reform was introduced. In the current (2017) model, 39% of university core funding is allocated based on education metrics, 33% based on research performance and PhD education, and 28% on a mix of the university's strategic development intentions, its activities in specific fields and its performance of various national duties, such as professional education needed by the state.

While the universities and UAS receive the performance-based income as a lump sum and are in principle free to allocate it internally as they see fit, in practice it is hard to use these resources in a strategic way. This is partly because of the governance limitations in the university system that undermine rectors' ability to reallocate internal resources and partly because a performance-based incentive system empowers the good performers who have high value in the academic labour market and can easily move if they are not satisfied with the way their university treats them.

Depending on how much of the strategic funding can be treated as disposable resources by the universities, most or almost all institutional funding for research is conditional on performance, leaving little scope for strategic use of resources to invest in change. On average, half of the university research funding from the state is project-based, although this varies greatly across universities, so the level of contestability of university research funding is very high indeed. Finland and the United Kingdom are outliers in this sense: other countries tend to provide both a bigger proportion of research funding as institutional funding and where they use a PRFS to base a smaller proportion of it on past performance.

Convincing statistical evidence about the effects of performance-based funding systems on university performance is scarce. Most countries that have introduced such systems have done so in a context where performance (measured in bibliometric terms) was already improving, so the net effect of the PRFS is hard to determine. The behavioural effects of performance-based funding on university management, however, are easy to observe. There is a uniform picture in which university managers manage recruitment and careers to maximise faculty performance along whatever lines are encouraged by the national performance funding framework. Some frameworks (such as the Norwegian one) affect very little but nonetheless change behaviour significantly, so there is no evidence to suggest that awarding a very high proportion of institutional funding based on performance is better than awarding a somewhat lower one.

International experience suggests therefore that while there is probably a minimum amount of performance-based funding that is helpful to change behaviour and raise quality, allocating a very high proportion of institutional funding for research based on performance does harm in the longer term. Doing so, moreover, minimises universities' room for autonomous manoeuvre and is likely to lock relative university performance to existing levels. There are also indications that some performance criteria may lead to perverse effects on the research itself. These vary somewhat according to detailed aspects of PRFS design but may include making research more short term, avoiding high-risk or transformative research, discouraging interdisciplinarity, reducing career prospects for women and impeding inter-sectoral mobility.

A particularity of the Finnish PRFS is that the funding system does not give credit for "third mission" activities, thereby discouraging knowledge exchange and the generation of social and economic impacts from research. These negative effects are well documented in the case of the United Kingdom, illustrating the need for the Finnish research sector to better consider the societal relevance of research in funding decisions.

The cut in Tekes' funding and the decline of funding channelled through Nokia to universities are likely to have further affected universities' propensity to interact with surrounding society and engage in third-mission activities, by reducing the availability of funding for industry-academia collaboration and for industry-relevant research.

Use funding instruments to encourage defragmentation and strengthening of the research base, using centre-of-excellence or competence-centre arrangements in academia-initiated and industrially oriented research

Finnish HEIs are also internally fragmented. There are exceptions, but many institutions run in the old "one professor per specialisation" way and so fail to build larger, more sustainable research groups. Consolidation within the sector would ease this problem, which is partly driven by the need for small institutions to provide the full set of specialists needed to teach a degree, leaving little room to build bigger groups in selected specialisations. The funding system helps to tackle this problem, but in too limited a way. The Academy of Finland has increasingly started to use larger project awards that imply research should be done by groups rather than individuals, but continues to provide a large number of personal fellowships, which have the opposite effect. The declining role of Tekes in university funding has reduced the supply of large projects.

Since 1996, the Academy of Finland has run centres of excellence (CoE) programmes. This provides an incentive for defragmenting the academic structure. However, a precondition for the success of such centres is that the universities are willing and able to form larger research groups, often crossing departmental and disciplinary lines. This in turn depends on having a strategic management able to implement changes in university practice and culture. Today, there are 29 CoEs and some of these are of limited size. A critical issue – that should be subject to evaluation – is to what extent these CoEs are having an impact on knowledge transfer and generating industry or socially relevant research for innovation.

Strengthening the quality of research remains an important challenge. While significant resources are allocated to the science base, Finnish scientific performance measured by bibliometric and citation impact indicators has remained flat since 2000. Continuing to strengthen the quality of Finnish science is critical, as research is vital to world-class innovation activity. It is also a precondition for internationalisation of the university sector, and improvement of industry-science links and the relevance of

research for innovation. As discussed above, several measures have been taken to strengthen research excellence, including the reform of funding models and evaluations, and fostering conditions for improving research organisation and collaboration (e.g. CoEs).

Recommendations

- Complete governance reforms and consolidation in both the research and education sector to ensure critical mass and an efficient specialisation:
  - Use funding instruments to encourage defragmentation and strengthening of the research base, using CoEs (and other collaborative) arrangements in both academia-initiated and industrially oriented research (and collaborative schemes).
- Ensure skills are aligned with demand. Identify education needs for a changing world (skills, update programmes, allow transferability between programmes and universities).
- Encourage HEIs to develop their strategies to engage in knowledge transfer activities and contribute to economic and societal development.
- Improve the strategic use of resources at HEIs by considering reducing the proportion under performance-based criteria in institutional funding and minimise the unintended negative effects of performance-based funding.
  - Consider adding an "impact" dimension to the assessment, especially if the level of influence of the PRFS on funding is to remain high.
  - Better recognise "third-mission"/"societal interaction" activities (such as technology commercialisation) and advance a specific impact assessment and measurement agenda in this context.

Other measures rather concern the operational level of universities. For example, assessing the need to further professionalise university management and increase its internal power relative to the staff as a whole. A key measure would be to increase the proportion of external and international members on university boards to more than half, and putting the rector's authority beyond the reach of the collegiate. Secondly, review the content and structure of first degrees, with a view to broadening their scope and making them better adapted to the needs of the labour market. In doing so, also consider measures to increase the mobility of students across degree programmes and between institutions.

Pursue foreign direct investment and further internationalisation of R&D in both the research and business sectors

Integrate the business sector with global knowledge development and GVCs through FDI and innovation networks involving foreign companies

Finland has not been very successful in attracting FDI compared to its neighbours, especially Sweden and Denmark, and MNEs' participation in BERD is only a little more than half the share reported in Sweden, according to 2013 data. The ratio of FDI to GDP in Finland is lower than that in Denmark and Sweden. For many reasons (e.g. early industrialisation, a larger manufacturing base and a more favourable geographical location, etc.), Sweden has been more successful in attracting FDI, in recent decades

involving a wave of mergers and acquisitions starting in the mid-1990s. Finland's weak multinational activity not only limits the opportunities of domestic firms' integration in GVCs and global innovation networks but also the associated knowledge spill-overs. Finnish businesses also need to use the full range of opportunities to benefit from linking up to foreign-owned MNEs in and outside the country.

FDI can provide a link between Finland-based technological capabilities and the R&D performed by Finland-based MNEs outside the country. Experience elsewhere also suggests that inward investment by MNEs creates a kind of "training school" from which nationals often graduate to set up their own companies or to successfully manage existing domestic ones. Finland offers investors important advantages in terms of the capabilities of the labour force, but is less attractive because it is a small, geographically and linguistically peripheral market.

The need for measures to increase internationalisation is widely recognised in Finnish industry and policy circles. Measures are in place, but there is a need to make them more effective.

Further internationalise Finnish research through both inwards and outwards mobility and international collaboration

International mobility is an important driver and determinant of the globalisation of science, technology and innovation. Finland has a relatively small share of international students for a country with a relatively small population which, in addition, prior to the autumn of 2016, did not charge tuition fees for students from outside the European Economic Area ("third-country" students). From autumn 2017, these fees will be mandatory. Judging from the recent Swedish experience, the introduction of tuition fees for third-country students is likely to lead to a significant drop in the number of these students, perhaps close to the 80% decline in non-EEA students Sweden experienced after it introduced tuition fees. In 2014, only 19% of all doctoral students were international students, which is lower than in all the other Nordic countries (excluding Iceland for which data are not available) and 8 percentage points lower than the OECD average. The provision of English-language higher education programmes has been identified as a key enabler of internationalisation in higher education. Therefore universities and UAS should further increase the range of English-language degree programmes they offer.

Finnish researchers co-publish with international co-authors only a little less than their counterparts in the other Nordic countries. At the level of publications, the Finnish community appears to be as well integrated into global research as others. However, the small number of foreign-born researchers working in Finnish institutions suggests that these links may be shallow. In fact, much of co-publication activity has a regional bias (collaboration remains mostly within the Nordic area).

Researchers who move to another country take their networks with them, creating the basis for deeper relationships over time. Greater international mobility of students and researchers could contribute significantly to strengthening the linkages of Finnish firms to emerging and strategic markets and innovation hubs. Currently, however, given the limited degree of internationalisation of Finnish HEIs, this avenue is sorely underexplored.

The government has tried to promote internationalisation by including four internationalisation indicators in the budget formula according to which it allocates basic funding to universities. More widely, internationalisation was identified as a priority by

the predecessor to the RIC at about the turn of the millennium and again in 2004 and 2009 when separate internationalisation strategies were adopted, and project funding has become receptive to international participation. The Finland Distinguished Professor Programme (FiDiPro) aims to attract both international and expatriate researchers to work and team up with the "best of the best" in Finnish academic research. This programme was implemented in 2006 but discontinued in 2014. It would be helpful to identify lessons from this programme in the design of a new head-hunting strategy and policy programme to attract talents and globally competitive researchers to Finland. Funding agencies have made efforts to address the internationalisation challenge. The Academy of Finland has channelled a considerable amount of funding to international activities through the standard funding instruments. For example, all bottom-up instruments contain funding considerations for international collaboration. And there are ongoing programmes for international researchers and mobility.

More information may be needed on the reasons for the low level of internationalisation. A more ambitious and co-ordinated strategy for internationalisation of research and innovation might be needed. More capacity is needed to absorb and make the best use of EU funding. It is likely that, beyond language and geography and perhaps a lack of international schools and employment opportunities for spouses, the limited number of research groups recognised as internationally excellent is a factor. In addition, foreign researchers may also interpret the lack of established foreign-born academics as an indicator that there is a "glass ceiling" for foreigners.

Finland could benefit from strengthening the use of EU Framework Programmes for strategic networking as well as for excellence- and market-driven innovation activities. They provide a functional platform for more intense internationalisation and leveraging the impact of national R&D funding and innovation activities. Analysing the impact for different type of participants and of different kind of activities is important for developing adequate support and steering mechanisms.

Recommendations

- Enhance efforts to accelerate the integration of the Finnish innovation actors (both in business and public research) with global knowledge networks:
  - Attract foreign R&D activities and joint initiatives with foreign firms through the creation of joint CoEs in key areas for future competitiveness and/or societal challenges (e.g. digitalisation, big data, clean-tech and health-tech, etc.).
  - Foster inward and outward mobility, and strengthen incentives for talent attraction:
  - Establish a fund or some other specific instrument to head-hunt leading international researchers. This will involve competitive conditions to attract talent from abroad (both Finnish and foreign). Such a strategy could be part of the organisation of CoEs, thereby facilitating the placement of highly qualified scientists from abroad and their rapid integration in efforts to increase research excellence and critical mass in key areas of research and innovation.

- Ensure that immigration laws are conductive to attract talent, including timely and reasonable working permit conditions for foreign researchers and their spouses.
- Increase the proportion of higher education conducted in English. This will not only encourage foreigners to come to Finland, but also improve the linguistic capabilities of Finnish students.
- Further open faculty recruitment to global competition, based on scientific excellence.

Maintain and improve framework conditions supportive of innovation and entrepreneurship

General framework conditions are critical for a country's performance with regard to innovation and entrepreneurship. Finland's framework conditions are strong overall. Reforms have been implemented since 2015 to promote employment, entrepreneurship and economic growth. Structural reforms and government measures aim at reducing regulation and red tape to improve operating conditions for businesses. The government's tax policy aims to boost growth, entrepreneurship, work and employment. The total tax rate is not set to rise during the government term and labour taxes will be eased.

Despite a sluggish economic environment, credit remains relatively easy to obtain in Finland, although it has become more difficult for small firms in the very recent past. Although credit standards for SMEs have been tightened somewhat, access to finance has remained easy compared to most other European countries since the 2008 financial crisis. Finland ranks high on many key financial indicators compared to Europe, e.g. the percentage of firms with credit lines and loan application grant rates, and private equity investment (as a share of GDP) is one of the highest in Europe. Companies do not name access to finance as a significant problem, according to different business surveys. There is also econometric evidence that confirms that, on average, Finnish firms do not face financial constraints.

As regards early-stage financing, Finland's venture capital market ranks high among European countries in terms of size. Venture capital investment represented 0.05% of GDP in 2015, which is higher than in the other Nordic countries and well above the OECD average. Public funding for entrepreneurship, including venture capital, has been expanding in recent years. While early-stage funding seems more accessible to firms than in the past, young expanding companies still encounter difficulties to obtain growth financing. Funding of growth capital has not returned to 2010 levels when it reached EUR 253 million. The total venture capital flow has averaged less than EUR 130 million annually since. In 2014, venture capital came close to the level reached in 2007 in absolute terms. In addition, restrictions related to workforce availability (including highly skilled ICT personnel and managerial skills) and indirect labour costs have not eased significantly, despite the prolonged recession and comparatively high level of unemployment.

Finland's general business framework scores high in several indicators. In terms of the World Bank's aggregate Ease of Doing Business 2017 index, Finland ranks among the highest, at 13th position, just behind Sweden (9th) and Norway (6th), while Denmark comes out as the 3rd best country. Finland, however, has room to improve regulations regarding the protection of minority investors, contract enforcement and getting credit. Regulations remain cumbersome in some areas, notably in retail trade, network

industries, construction and land-use planning. Streamlining regulations is a key objective of the new government, which also plans to promote competition in the construction industry and public services.

Finland scores relatively well in terms of trade and FDI regulations. Finland's Service Trade Restrictiveness Index (STRI) scores are above the OECD average and scores of other Nordic countries in several sectors. A comparison with the OECD's best performers on these indicators suggests that there is room for lowering barriers further in a number of sectors, including transport and construction, consistent with the product market regulations indicators. Finland's product market regulations are less restrictive overall than the OECD average. Only the Netherlands and the United Kingdom have significantly leaner regulations. The 2011 Competition Act brought regulation in line with recommendations from the European Commission. It reinforced merger control and enhanced damage compensation as well as "whistle-blowing" instruments. It also expanded the investigation powers of the Finnish Competition Authority, whose resources have been increased. Competition is, however, limited by low population density in large parts of the country.

Recommendations

- Foster innovation through more competition-friendly business policies and product market regulation. Revisit the regulatory framework to encourage vigorous product competition, firm entry and ease cumbersome regulations in retail trade, rail network industries, construction and land-use planning, which helps increase the number of suppliers.
- Enhance flexibility in labour markets in various ways, including through employment protection legislation and labour market regulations.
- Continue improving business and regulatory conditions for business creation and growth and foster the entrepreneurship ecosystem through global linkages and investors.

Note

1. Although the model is mostly performance-based in principle, all of the funding is allocated to universities as a lump sum and they are free to decide internally how it is allocated. All metrics are calculated by using three-year averages to eliminate fluctuation in the institutional funding.

Annex 1.A1

The role of research and development in fostering macroeconomic performance

There is widespread agreement that research and development (R&D) for technological change and innovation is an important driver of growth, especially in the long run. However, the conceptual and empirical links between innovation and growth are complex. Innovation is not a simple linear process, with a chain of one-directional links between investments in R&D to economic or social outcomes. Moreover, metrics for certain aspects of innovation suffer from limitations, which have made it difficult to establish the role that innovation policies can play in shaping or strengthening innovation performance (OECD, 2015), in order to stimulate competitiveness, productivity and economic growth through entrepreneurial activities. Consequently, there has been an extensive discussion among academics and policy makers on the rationale for innovation policies. Neo-classical perspectives recognise only a limited set of market failures, such as externalities and information asymmetries, while other schools of thought point to a much wider range of factors and constraints that affect innovation and that provide a rationale for policy. These factors will vary from country to country and also depend on the particular area of innovation that is being considered, such as specific industrial sectors of the economy.

A significant body of econometric research on the impact of R&D on economic growth has been collected since the early work in the late 1950s, and generally confirmed the positive impact of R&D on productivity and economic growth. Most studies find that the social rates of return in R&D externalities exceed private rates by an order of magnitude greater than 50% (Mohnen, 2017). One important lesson to be drawn from the macro-econometric literature is that to positively impact economic growth, innovation requires not only investment in technology and R&D, but needs to be complemented and combined with other assets and embedded within a sound policy framework. As new knowledge-based assets, such as computerised information, intellectual property and economic competencies and business models grow in importance, so do the framework conditions facilitating their creation. The capacity to translate R&D investments into commercially viable product innovation is an important determinant of the efficiency of R&D inputs, and can be linked to the framework that motivates firms to innovate. Mohnen (2017) stresses a wide range of framework elements that affect the efficiency of R&D inputs in generating innovation. These include, among others, a high-quality education for the formation of human capital, pro-competitive market regulations, flexible and well-functioning labour markets, incentives to entrepreneurship, openness to trade and FDI that increase the diffusion of knowledge and new technologies, the accessibility of venture capital, pro-active government procurement that can support

scaling-up successful innovation, ease of starting new ventures, and industry-government collaborations in areas that present a comparative advantage to meet emerging demand. Tax incentives can also stimulate additional R&D, particularly if used simultaneously with direct support for R&D (Mohnen, 2017).

Finland is among the leading knowledge-based economies in the world, particularly due to its strength in education, technological readiness, financial market development and institutional capacity (Mohnen, 2017). Many of the framework elements underpinning the efficiency of R&D investments are thus well developed. Continued investments into R&D and Finland's innovation framework combined with an expansion of international collaboration in research and innovation and internationalising research and economic activity more broadly) are powerful tools to keep Finland in the proximity of the world technology frontier and at the forefront of technological progress, and which could generate additional returns from international R&D spill-overs (Mohnen, 2017).

Sources: Mohnen, P. (2017), "The role of Research and Development in fostering economic performance. A survey of the macro-level literature and policy implications for Finland", Survey prepared for the OECD and commissioned by the Finnish Ministry of Economic Affairs and Employment, (forthcoming); OECD (2015), *The Innovation Imperative: Contributing to Productivity, Growth and Well-Being*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264239814-en.