2 Rebooting the innovation ecosystems

Naomitsu Yashiro

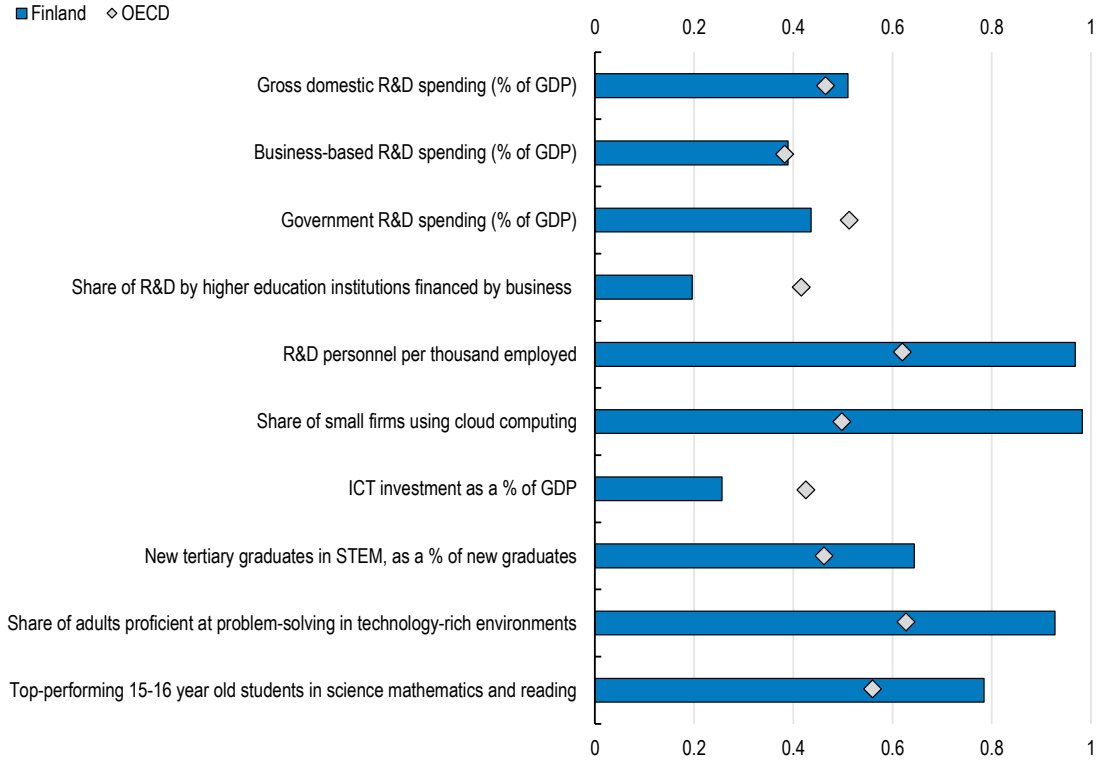
Finland is stepping up its efforts to reboot its innovation ecosystems, which weakened during the long economic stagnation that followed Nokia's withdrawal from the mobile handset business. The government aims to increase Finland's R&D spending to 4% of GDP by 2030 and will introduce legislation that commits to large and stable government R&D spending. However, rebooting Finland's innovation system requires far more than revamping innovation support. Finland needs a clear mission-oriented innovation policy that directs applied research and innovation activities toward solving the most pressing socio-economic challenges. It will also need to strengthen innovation collaboration between the public and private sectors. In particular, concerted efforts toward a more diversified innovation ecosystem that is resilient to firm- and sector specific shocks are essential. To allow for more intensive innovation, the government must increase higher education study places and attract foreign skilled workers to meet the ever-growing demand for skilled workers. It should also help more Finnish firms capture foreign markets, enabling them to reap larger returns from their innovation.

Introduction

Finland is an innovative economy and outperforms many OECD countries on several dimensions of innovation activities and framework conditions (Figure 2.1). At 2.9% of GDP, its gross spending on research and development (R&D) exceeds the OECD average. The number of R&D personnel per thousand employees is among the highest in the OECD. The use of digital technologies is also widespread. For instance, 71% of Finnish firms with 10 to 49 employees use cloud computing services, as opposed to 38% in Germany or 26% in France. Finland boasts a highly skilled workforce, with high shares of adults with excellent problem-solving skills and tertiary education graduates in the fields of natural science and engineering. There are, however, areas where Finland is lagging, such as government R&D spending, innovation collaboration between businesses and higher education institutes, and investment in ICT capital.

Figure 2.1. Finland is an innovative economy

Finland's innovation performance compared to OECD countries, 2021 or latest



Note: Indicators normalised to 0-1, 1 = top OECD country and 0 = bottom OECD country.
Source: OECD Going Digital Toolkit, https://goingdigital.oecd.org/.

StatLink https://stat.link/24bifl

An innovation ecosystem is a network of actors from the private sector, the government and research institutions who work together to develop new technologies, products or services that address shared specific goals (Box 2.1). Finland's innovation ecosystems flourished in the 1990s and 2000s, on the back of strong public support for innovation, vigorous investment in tertiary education, and the development of export industries like electronics, forestry and metal (OECD, 2017[1]). However, they weakened during the long period of economic stagnation following the global financial crisis, as innovation support was withdrawn owing to fiscal consolidation needs and the competitiveness of the export sector, notably that of Nokia's mobile handset business, waned.

Box 2.1. What is an innovation ecosystem?

An innovation ecosystem is a complex network of innovation actors contributing their human and financial resources and expertise to collaboration in research, development and commercialisation of new technologies that address shared priorities such as industrial competitiveness or climate change mitigation. These actors include business firms, higher education and research institutions, government agencies and innovation support organisations, as well as investors.

Innovation ecosystems can be geographically concentrated as clusters of interconnected firms and institutions in specific industries or research domains providing a related group of products or services. The key component of innovation ecosystems is innovation collaborations (Granstrand and Holgersson, 2020[2]), which are often coordinated and funded by government agencies. This contrasts with business ecosystems or (global) value chains, which foster innovation mainly through competition and are governed by the dominant firms that seek to appropriate the value of innovation by the participants (Jacobides, Knudsen and Augier, 2006[3]). The large externalities generated by innovation collaboration justify public support for innovation ecosystems.

The innovation ecosystems in Finland

Finland's innovation ecosystems are often driven by large R&D-intensive firms like Nokia, Neste and Sandvik as well as the multitude of innovative start-ups, highly innovative universities like Aalto university, research institutes for applied research like the Technical Research Centre of Finland (VTT), public innovation funding agencies namely the Academy of Finland and Business Finland (Box 2.7), venture capital investors that include public investment funds like Tesi and Sitra, and Slush, the platform connecting start-ups and tech firms with investors (Chapter 1).

Policymakers in Finland have acknowledged the need for steady funding for innovation to deliver stronger productivity growth, which, in turn, is needed to sustain economic growth and the welfare state. The government has an objective to boost Finland's gross domestic R&D spending to 4% of GDP by 2030. To meet this target, it recently reached a political agreement to increase overall public R&D spending to 1.33% of GDP (one-third of the 4% target) by 2030 and will introduce legislation that commits to increasing government R&D spending to 1.2% of GDP (90% of the overall public R&D spending). The government will also introduce a new R&D tax incentive, which is expected to broaden the scope of firms engaging in business-based R&D. However, boosting R&D and investment in complementary intangible capital such as data or organisational changes requires good access to highly qualified personnel. Policy reforms to reboot Finland's innovation ecosystems thus need to go beyond revamping public innovation support. They need to alleviate Finland's severe skills shortage, which is acting as an important bottleneck for more intensive innovation. They also should help Finnish firms reap higher returns on innovation so that more firms will invest in R&D despite the large upfront costs and high uncertainties. Against this background, this chapter highlights the following reform priorities:

- Revamping innovation support in a way that maximises value for public money and helps Finland's innovation ecosystems become more diverse and resilient;
- Addressing the structural shortage of skilled workers through tertiary education and migration reforms;
- Encouraging more Finnish firms to internationalise through exports or foreign direct investment.

Finland boasts favourable framework conditions for innovation, namely high technological capabilities and educational attainment, as well as business friendly regulatory settings and good access to credit (Chapter 1). Enhancing the innovation ecosystems by addressing bottlenecks is therefore crucial to boost Finland's innovation performance and productivity growth.

The next section describes some important features of Finland's innovation ecosystems and stresses the need for a more diversified one that is resilient to firm- or sector-specific shocks. Section 2.3 reviews the latest policy efforts to reboot Finland's innovation ecosystems including the government's R&D spending target and highlights policy reforms to enhance the effectiveness of revamped innovation support. Section 2.4 discusses the latest reforms in tertiary education and migration and their implications for the severe skill shortages. Section 2.5 explores the link between the internationalisation of Finnish firms and their propensity to innovate, showing that there is room to improve the current export and foreign direct investment promotion policies. Section 2.6 concludes.

Finland needs more diversified, resilient innovation ecosystems

Finland's R&D spending declined in the 2010s

Finland's R&D spending increased rapidly in the second half of the 1990s and throughout the 2000s, reaching 3.7% of GDP in 2009 (Figure 2.2, Panel A). Vigorous business-based R&D spending improved the productivity and export competitiveness of Finnish firms, which in turn boosted the demand for innovation (OECD, 2017[1]). This positive feedback loop was largely driven by the ICT sector, in particular Nokia, which represented 37% of Finland's gross domestic R&D spending in 2008 (Ali-Yrkkö, 2010[4]). The extremely large role played by Nokia exposed Finland's innovation ecosystems to firm- and sector specific risks, which materialised with the downfall of Nokia's mobile phone business (Box 2.2). Finland's R&D spending plunged to 2.6% of GDP by 2016, driven by an almost 30% fall in business-based R&D from its 2009 peak (Figure 2.2, Panel B). The large fall in business-based R&D contrasted with the increases among Finland's competitors. However, the large decline of R&D spending in the electronics sector masked the increases in R&D spending in some knowledge-intensive sectors like pharmaceuticals (where R&D grew by 31% between 2009 and 2016) or information and communication (where R&D grew by 54%). Government R&D spending also declined from 2011 until 2016 (Figure 2.2, Panel C). In particular, public funding for innovation collaboration between firms, universities and research institutes was withdrawn quickly, weakening Finland's innovation ecosystems (Section 2.3). While Finland's R&D spending started to rise anew in 2016, business-based and government R&D spending remain at about 20% and 28%, respectively, below the 2009 levels (Figure 2.2, Panels B and C).

The main lesson from the 2000s is that Finland's innovation ecosystems need to be driven by a more diverse set of firms, industries and technologies (Box 2.2). Diversification of the innovation base and portfolio is key to the resilience of Finland's innovation ecosystems and can help Finland expand its comparative advantage beyond its traditional exporting industries.

Box 2.2. Nokia's role in Finland's innovation

Nokia was a dominant player in Finland's innovation both quantitatively and qualitatively. At its peak in the mid-2000s, Nokia accounted for nearly half of Finland's business-based R&D spending and 43% of patent applications filed to the European Patent Office (EPO). Nokia also employed a large share of Finland's R&D workforce and led large networks of domestic suppliers comprising about 300 Tier 1 supplier firms. As the result of its rapid global expansion, Nokia eventually shifted a large part of its R&D activities abroad and offshored the production to large Asian electronics manufacturing services providers.

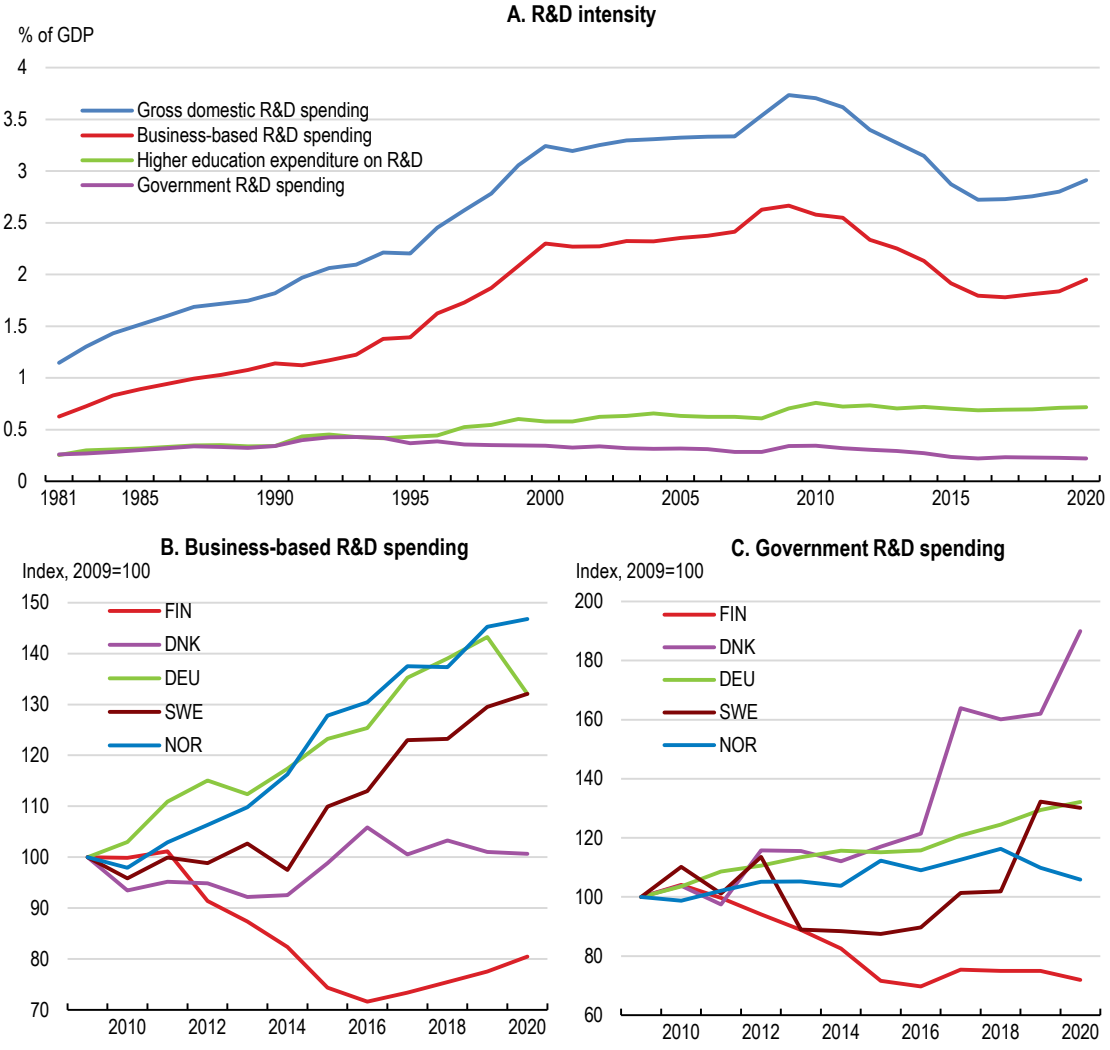
Nokia played an important role in technology diffusion from the global frontier to Finnish firms. It engaged in active R&D collaboration with universities and suppliers co-funded by Tekes (the National Agency for Technology and Innovation) on the latest technologies. Nokia also lobbied for an increase in university study places in the fields of electronics, telecommunications, and information technology.

This contributed to the high share of STEM graduates seen today. Nokia recruited a large number of STEM graduates, offered them experience and later supported their spin-offs.

There are other examples of a handful of large firms playing a more than proportionate role in a country's innovation. For instance, Philips accounted for a bit over 40% of the Netherlands' patent applications to the EPO during 2000-06. However, Finland's innovation was highly dependent on a single firm specialised in telecommunication, exposing it to large firm- and sector specific risks. Nokia's weight in business-based R&D shrank to 17% after the takeover of its mobile handset activities by Microsoft in 2013. The downfall of Nokia's mobile handset business led to knock-on effects that weakened Finland's entire innovation. For instance, major software providers cut back on R&D spending and large telecommunications firms like Telia Sonera withdrew product development activities from Finland. Business funding for research collaboration between universities and research institutes like VTT (Technical Research Centre of Finland) shrank considerably. Nevertheless, many of Nokia's former employees have founded new companies or joined them. Nokia's Bridge Programme in 2011-14, the comprehensive plan for supporting the job transition of its employees, led to the creation of some 400 companies in Finland

Source: Ali-Yrkkö and Hermans (2002[5]), Ali-Yrkkö (2010[4]), OECD (2017[11]).

Figure 2.2. Finland's R&D spending has begun to increase but remains below earlier peaks



Source: OECD, Main Science and Technology Indicators (database).

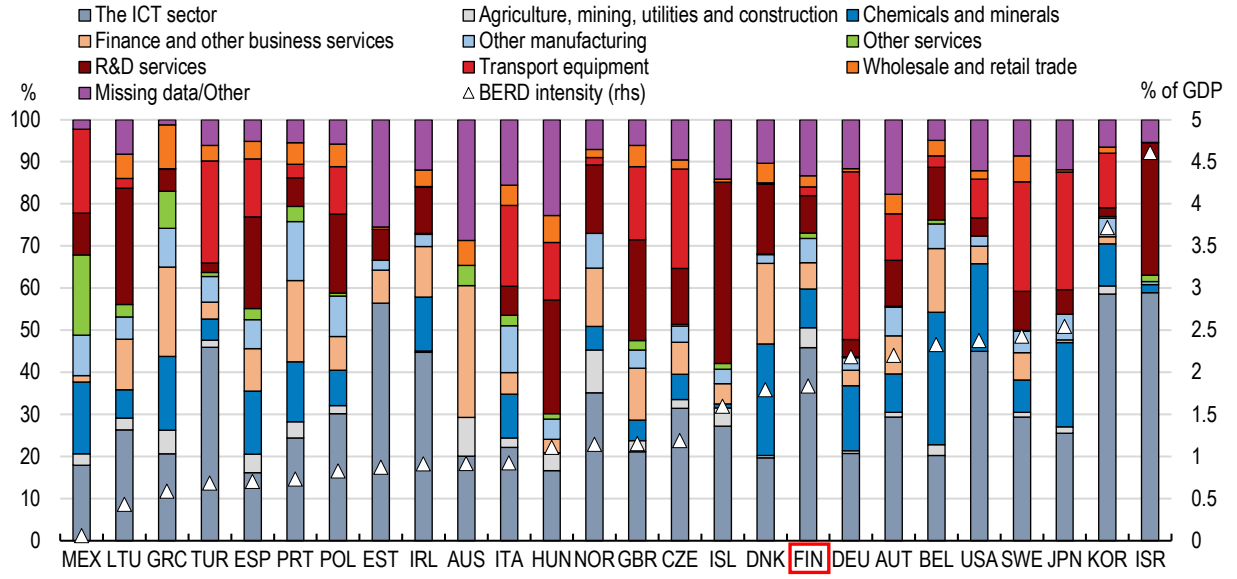
StatLink https://stat.link/i6y2j9

There is room to diversify the base of business-based R&D

Finland's business-based R&D is dominated by high-technology industries, namely the ICT sector (Figure 2.3). In 2019, ICT equipment manufacturing and information and communication services accounted for 40% of business-based R&D spending. The weights of other service industries, for instance wholesale and retail or transportation, are smaller than in other OECD countries. Higher R&D in those industries could unlock large productivity gains, especially if resources are reallocated toward innovative firms. The retail sector in the United States experienced fast productivity growth in the 1990s mainly due to the entry of more productive establishments that capitalised on the latest technologies like e-commerce and advanced inventory management and the exit of less productive establishments (Foster, Haltiwanger and Krizan, 2002[6]).

Figure 2.3. Business-based R&D is concentrated in the ICT sector

Industry composition of Business-based R&D (BERD) spending



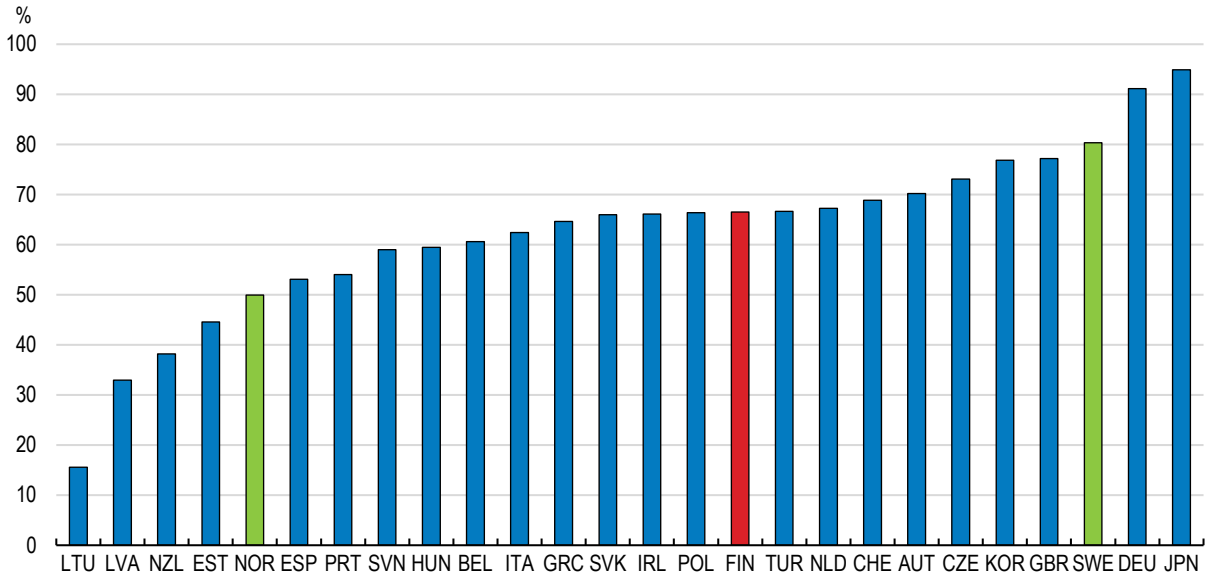
Note: The ICT sector refers to ICT equipment, electrical equipment and machinery, and information and communication services.
Source: OECD Research and Development Statistics (database).

StatLink https://stat.link/6yieb8

As in many OECD countries, SMEs are under-represented in innovation, especially in applied research. Business-based R&D in Finland is concentrated in large firms, although not as much as in Sweden or other technologically advanced economies (Figure 2.4). The large fixed costs and considerable uncertainties associated with R&D often deter firms with small production scales or small internal funds from investing. In 2020, more than 60% of business-based R&D spending in Finland was undertaken by firms with 250 or more employees, most of them being very large firms with more than 500 employees (Figure 2.5). The weights of large firms are particularly pronounced in applied research, a crucial phase in successful innovation that bridges basic research and experimental development toward the commercialisation of innovation. Broadening the base of business-based R&D spending by increasing the weight of SMEs would strengthen the resilience of Finland's innovation ecosystems. Participation in applied research involves intensive collaboration with higher education and research institutions, which would enable SMEs to strengthen technological capabilities and acquire new knowledge in their relevant sectors.

Figure 2.4. Business-based R&D is driven by large firms as in many other OECD countries

The share of firms with more than 250 employees in business-based R&D, 2019

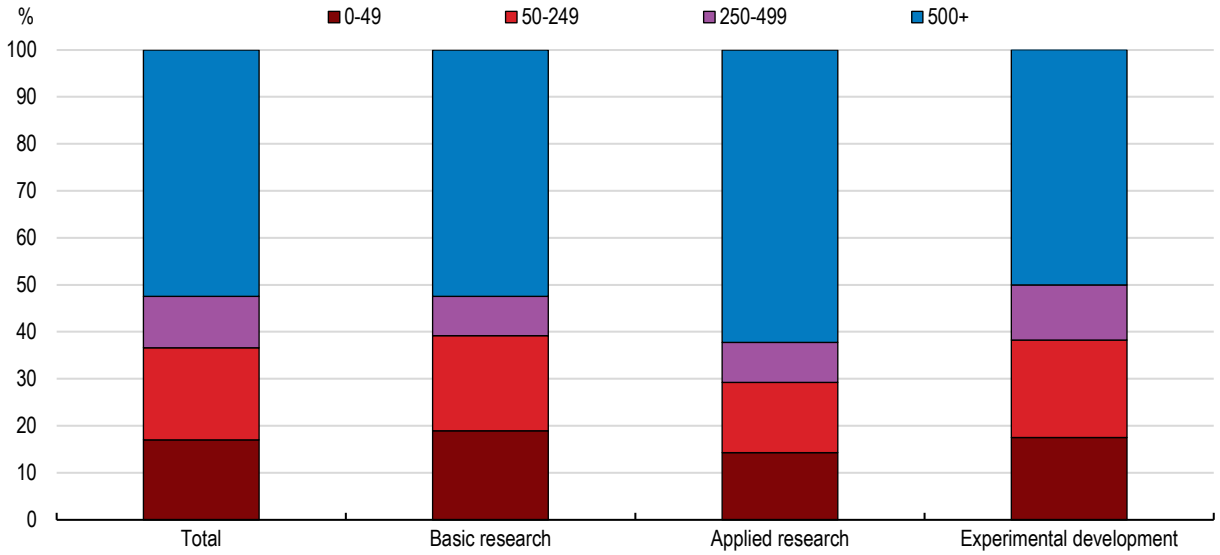


Source: OECD Research and Development Statistics (database).

StatLink https://stat.link/bhmqcy

Figure 2.5. The weight of SMEs in business-based R&D is small, particularly in applied research

The composition of Finland's business-based R&D spending by firms' size (number of employees), 2020



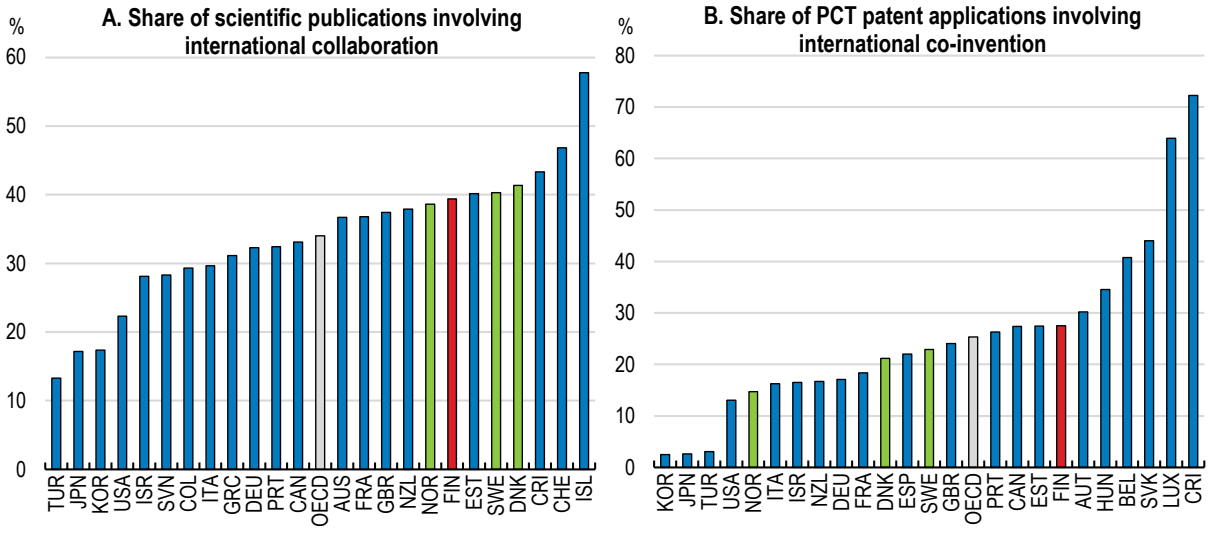
Note: Basic research is defined by Statistics Finland to be experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Applied research is an original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.
Source: Statistics Finland.

StatLink https://stat.link/18hfvi

Innovation collaboration is common but can be strengthened further

Innovation collaboration is an important channel through which advanced technologies and knowledge are transferred from research institutions or frontier firms to less technologically advanced firms. In particular, international collaboration provides opportunities for Finnish researchers and firms to absorb the latest technologies and scientific knowledge from the global frontier. Innovation collaboration seems rather common in Finland. For instance, Finland has a higher share of scientific publications involving international collaboration than many other OECD countries, albeit slightly lower than Sweden or Denmark (Figure 2.6, Panel A). The share of patents application involving international co-invention is also high, even compared to Scandinavian peers (Figure 2.6, Panel B). According to the European Commission's Community Innovation Survey, 47% of surveyed Finnish firms undertaking some kinds of innovation collaborated with other firms, research institutions or foreign partners in 2018, a share that is higher than in most EU economies. However, Finland lags behind many other OECD countries in university-industry collaboration (Figure 2.7), which is an integral part of applied research. Indeed, the share of higher education R&D financed by business is highest among the economies with very strong innovation performance such as Korea, Germany and Switzerland.

Figure 2.6. Finland engages intensively in international innovation collaboration

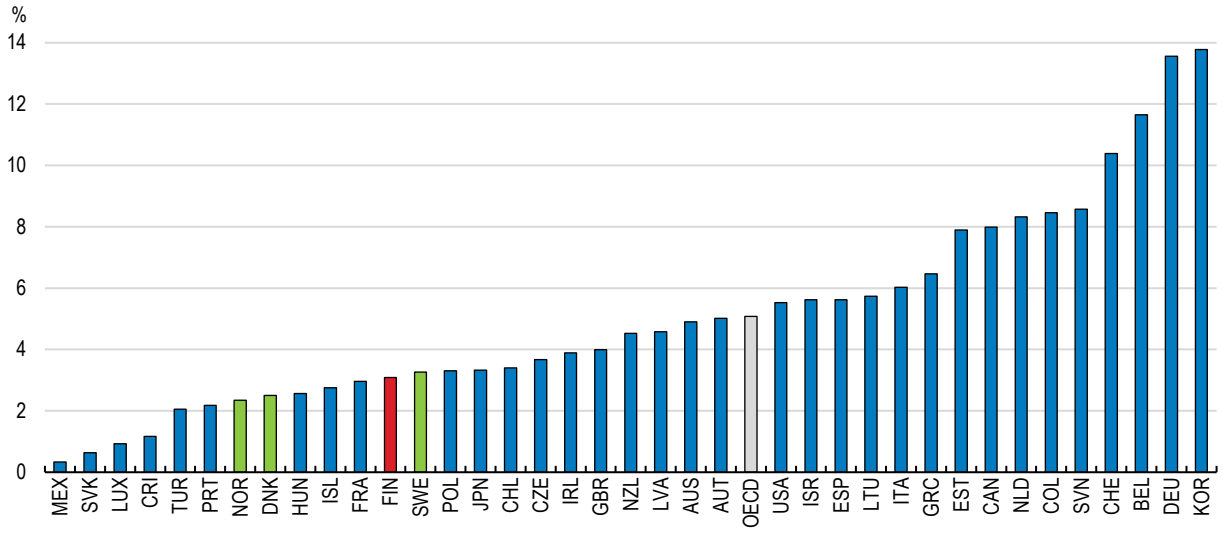


Source: OECD Science Technology and Industry Outlook (database).

StatLink https://stat.link/9j4hef

Figure 2.7. University-Industry R&D collaboration is low

Percentage of higher education expenditure on R&D financed by the business sector, 2020 or latest



Source: OECD, Main Science and Technology Indicators (database).

StatLink https://stat.link/qgw9ni

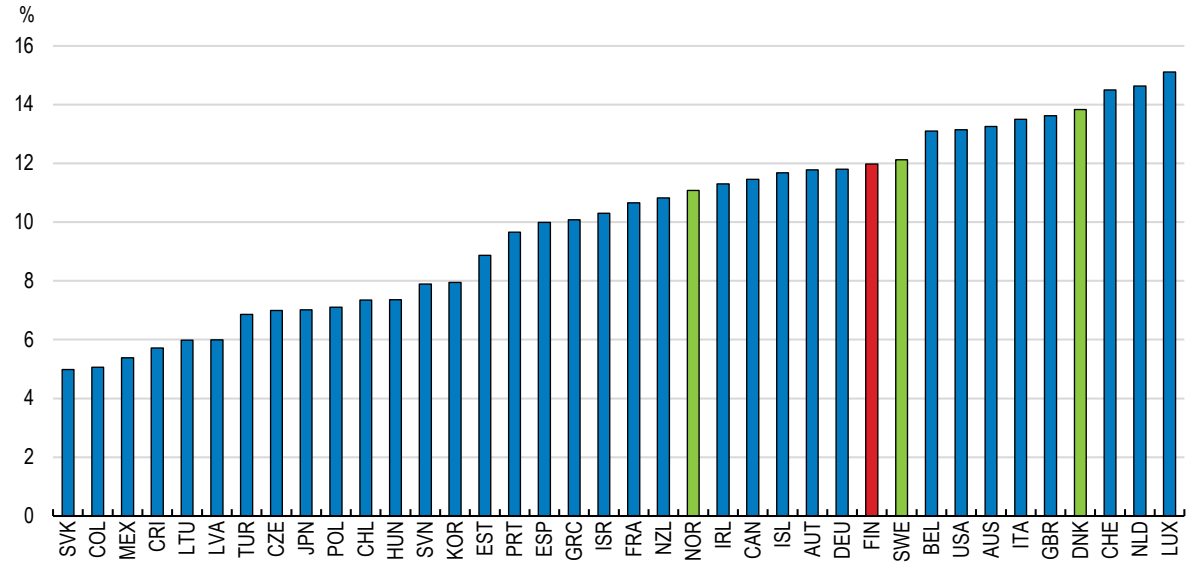
Research quality is high

The high quality of research in Finland can be seen for instance in its relatively high share of scientific publications belonging to the world's top 10% of most cited publications (Figure 2.8). The quality of research can be improved further by addressing the fragmented research base in higher education institutions. For instance, the need for small universities to provide a full set of degree programmes prevented them from building larger, more specialised internationally competitive research groups (OECD, 2017[1]). Steps were taken to strengthen research quality, for instance through consolidation. For example, three universities leading in the areas of Science and Technology, Art and Design, Business and Economics were merged into Aalto University in 2010, which ranks high internationally in research and innovation collaboration. The government also facilitated collaboration among groups of researchers, for instance through centres of excellence run by the Academy of Finland.

Business-based R&D in Finland has been resulting in patent applications with international significance, attesting to the high quality of Finland's industrial innovation. The number of patent applications under the Patent Cooperation Treaty (PCT) relative to business-based R&D spending is among the highest across OECD countries (Figure 2.9). Nevertheless, innovation in Finland's main industries has been more incremental in nature, where continuous refining of existing core technologies is reflected in new products (OECD, 2017[1]). According to Statistics Finland's Innovation Survey, some 48% of surveyed Finnish firms introduced new products that improved upon the existing products in 2020, while 36% introduced products that were new to their markets (Statistics Finland, 2022[7]). Finland's innovation ecosystems should better support radical innovation by promoting multidisciplinary innovation collaboration. Radical innovation can deliver strong productivity gains by opening up the possibilities of new technology adoption and new industrial applications.

Figure 2.8. The quality of scientific research is relatively high

The share of scientific publications belonging to the world's top 10% of most cited publications, 2020

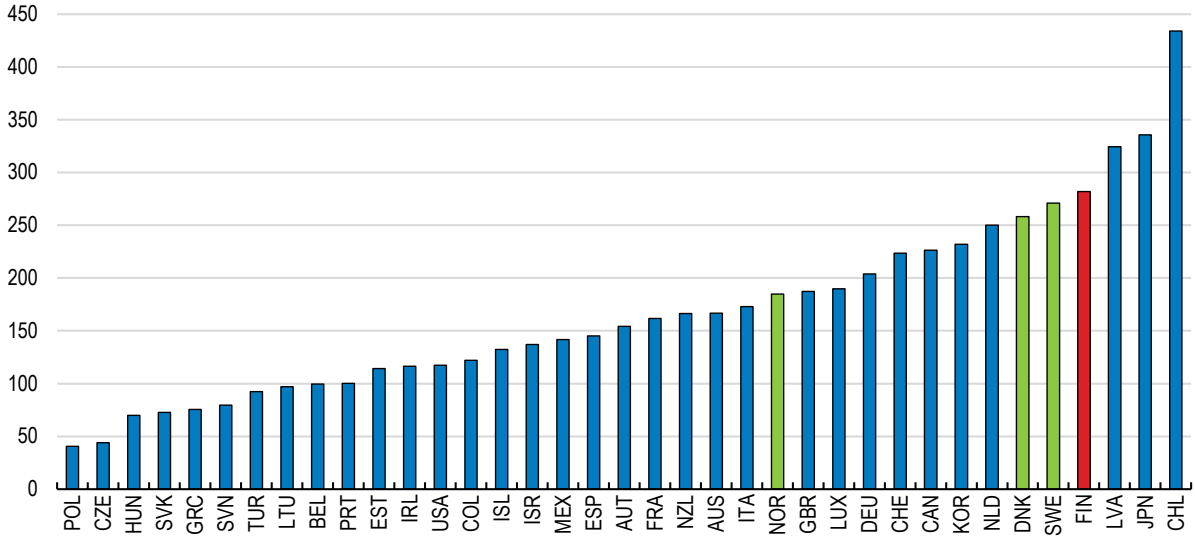


Note: OECD calculations based on Scopus Custom Data, Elsevier, Version 5.2021, September 2021; and Scimago Journal Rankings.
Source: OECD Science, Technology and Innovation Scoreboard.

StatLink https://stat.link/fuvrna

Figure 2.9. Business R&D is resulting in a high number of patent applications

Number of patent applications under the Patent Cooperation Treaty per USD one billion of business-based R&D spending, 2019



Note: Business-based R&D spending is converted to USD using PPPs and is in 2015 prices.
Source: OECD computation based on the OECD Main Science and Technology Indicators.

StatLink https://stat.link/norskt

Finland needs more investment in intangible capital

Innovation and productivity growth are increasingly driven by intangible capital, which includes not only R&D but also data and software, design and copyrights, as well as organisational structure and firm-specific skills (Box 2.3). Intangible capital plays a central role in successful commercialisation of new technologies, thereby translating innovation into productivity growth (Corrado and Hulten, 2010[8]). In many OECD countries, investment in intangible capital has increased faster than investment in physical capital and it significantly exceeds physical capital investment in some countries (Corrado et al., 2021[9]). Finland's investment in intangible capital as a share of value added is relatively high compared with other OECD countries, albeit with some room to catch up to Scandinavian peers (Figure 2.10). However, it has been decreasing gradually since the early 2000s (Figure 2.11) and remained consistently lower than investment in physical capital.

Box 2.3. Intangible capital as a driver of innovation and productivity growth

Corrado and Hulten (2010[8]) classified intangible capital as the following expenditure on knowledge-based activities:

- **Computerised information**: software and databases
- **Innovative property**: R&D, patents, copyrights, designs, trademarks, etc.
- **Economic competencies**: brand equity, firm-specific human capital, and organisational capital that generates competitive advantage and increases efficiency

Although these expenditures are usually treated as intermediate inputs in the System of National Accounts (except R&D, which has been capitalised in the 2008 System of National Accounts), they often contribute to production for more than a fiscal year, thereby meeting the accounting-convention definition of capital investment (OECD, 2013[10]).

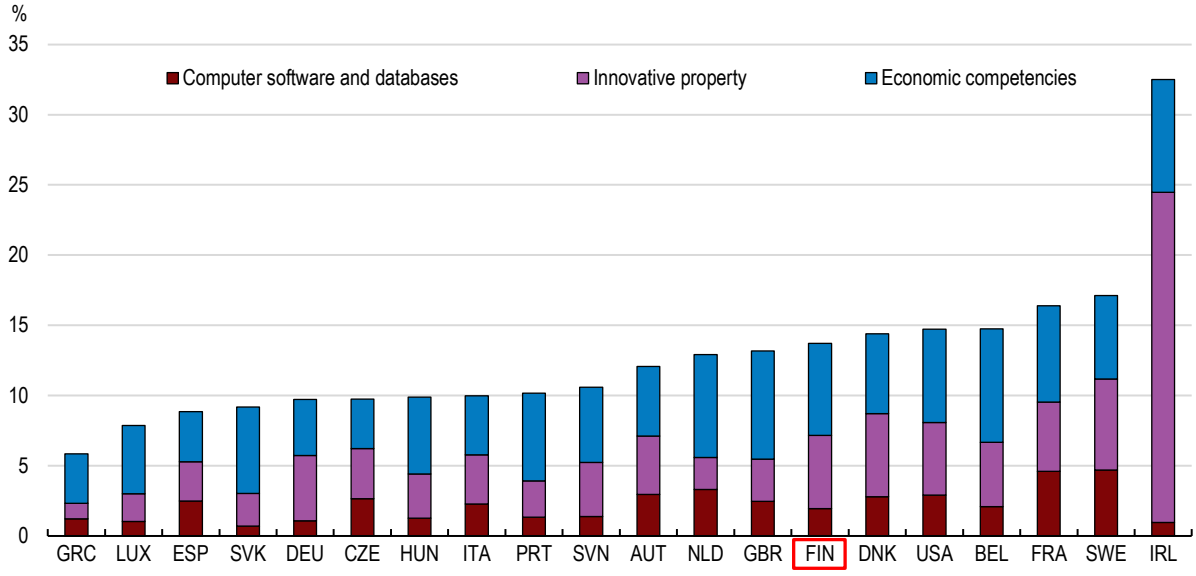
Intangible capital plays an essential role in innovation. For instance, the automotive industry spends an increasingly large share of the cost of developing new vehicles on software, with high-end vehicles relying on millions of lines of computer code. Intangible capital is also an important source of productivity growth partly because several types of intangible capital can be duplicated at very low cost, generating large economies of scale. Corrado et al. (2016[11]) estimated that business investment in intangible capital accounted for 34% of annual average labour productivity growth in the United States and 20% in 14 advanced European economies during 2000-13. In Finland, it accounted for 25% of average labour productivity growth during the same period. Intangible capital continued to contribute positively to Finland's labour productivity growth in the aftermath of the global financial crisis, even as overall productivity growth turned negative.

Stronger investment in intangible capital is essential for Finland's strong innovation to result in significant productivity growth. It also helps Finland reap larger benefits from its vigorous adoption of digital technologies (see below). The extent of productivity gains firms enjoy from adopting digital tools is defined by their stock of intangible capital, such as valuable (big) data or sophisticated work organisation that is more conducive to the digitalisation of workflows (Brynjolfsson, Rock and Syverson, 2021[12]). However, Finland may not be making the most effective use of digital technologies due to insufficient investment in intangible capital that complements digital technologies. Indeed, there is room for more investment in software and datasets, which weights in Finland's intangible investment are lower than in Sweden or Denmark (Figure 2.12). It has also been observed that diffusion of new technologies is held back by a shortfall in organisational capital like managerial skills, which holds back Finnish firms from translating their innovation into competitive new products (OECD, 2017[1]). Smaller firms, in general, lack the capabilities to reorganise work to reap the efficiency gains digital tools offer. The digitalisation of economic activities can then widen the productivity dispersion among Finnish firms, as only a handful of firms with a large

stock of complementary intangible capital would enjoy large productivity gains (Corrado et al., 2021[9]). Therefore, Finland's innovation ecosystems should foster stronger investment in intangible capital that helps more Finnish firms to capitalise on digital technologies.

Figure 2.10. Finland's investment in intangible capital is relatively high

Investment in intangible capital as the share of gross value added, %, 2017

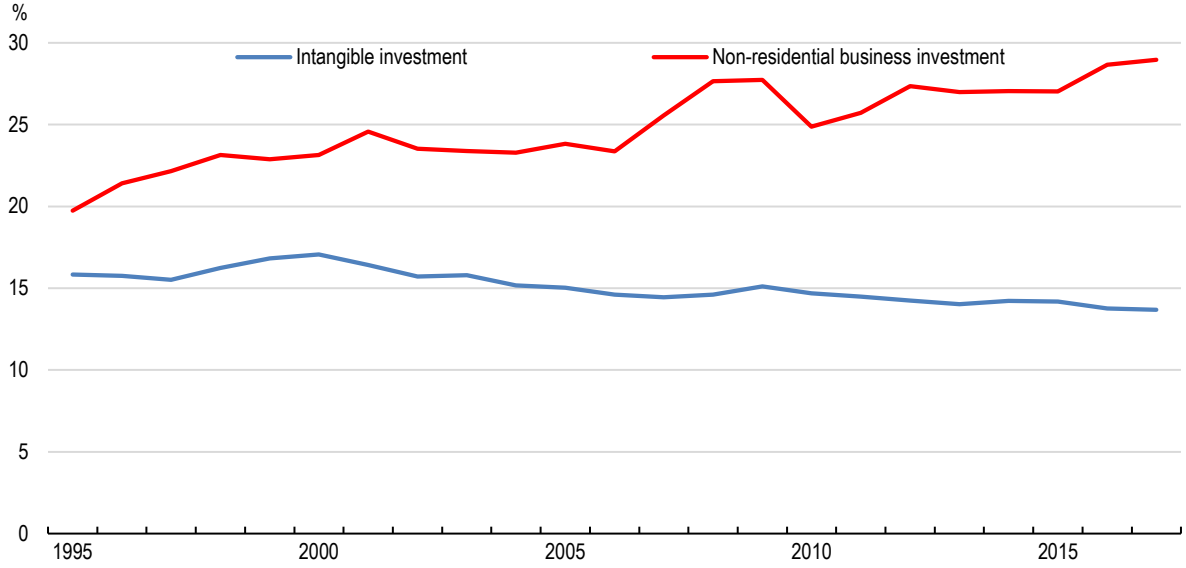


Note: 2016 data for USA.
Source: OECD computation based on INTAN-invest data, April 2020.

StatLink https://stat.link/ezak45

Figure 2.11. Finland's investment in intangible capital has been declining

Investment in intangible capital as a share of gross industrial value added, %

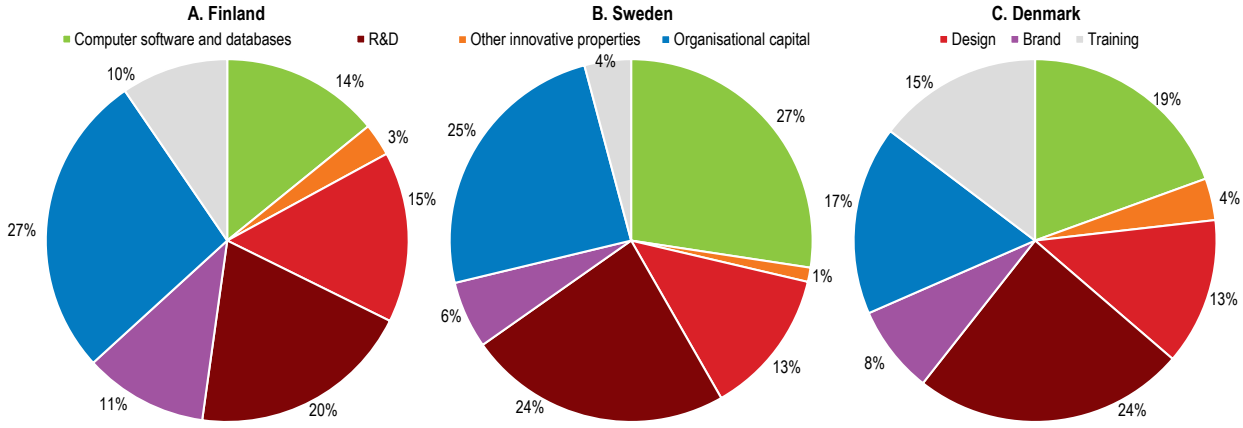


Source: OECD computation based on INTAN-invest data, April 2020.

StatLink https://stat.link/r0uvo4

Figure 2.12. Finland invested less in software and data than its peers

Composition of intangible capital investment, 2017



Source: OECD computation based on INTAN-invest data, April 2020.

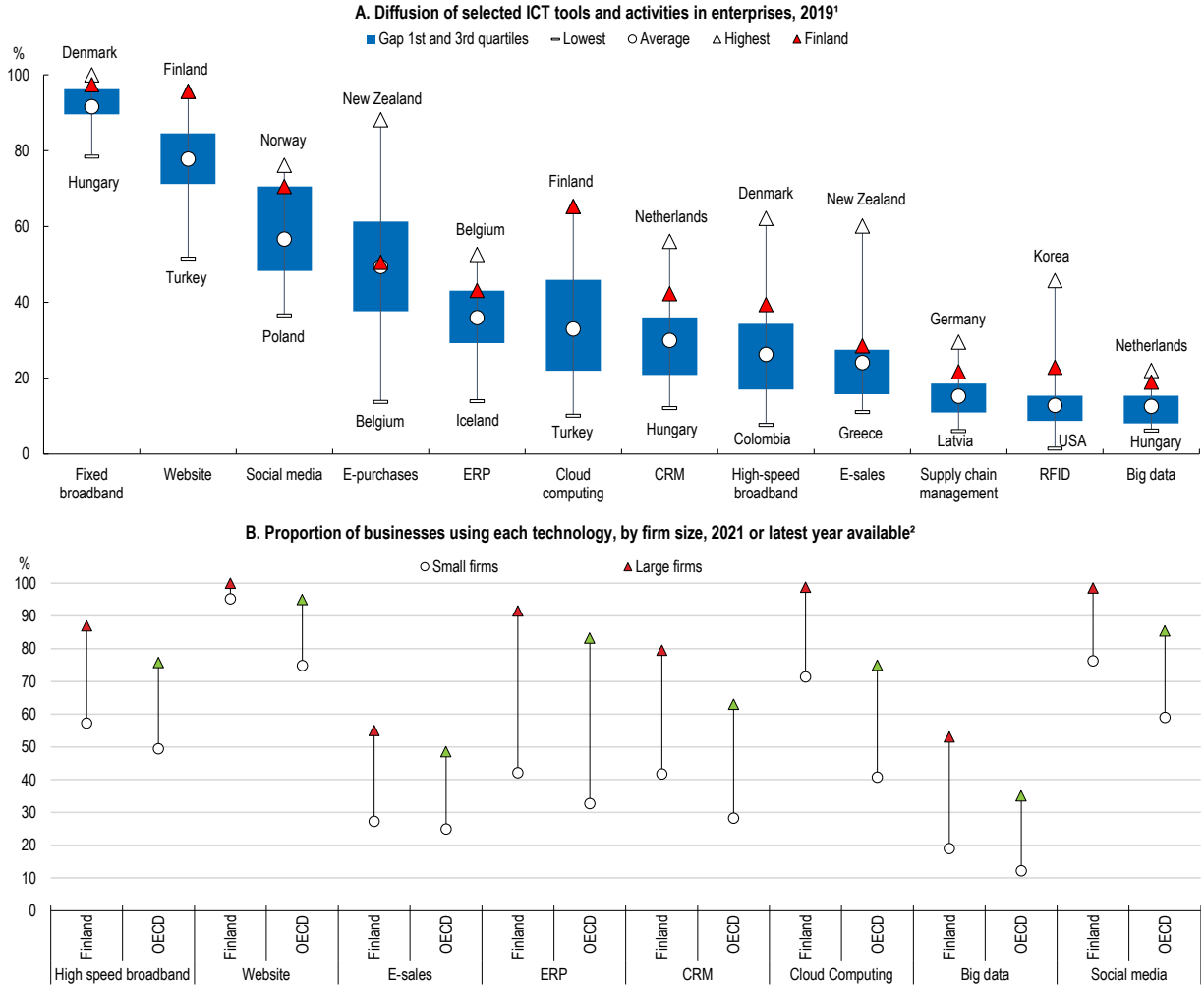
StatLink https://stat.link/pisgzh

Low ICT investment holds back the gains from advanced digital adoption

Investment in information and communication technologies (ICT) is crucial for seizing the opportunities for higher productivity growth presented by digital technologies (OECD, 2020[13]). Finland is considered the front runner in the adoption of digital technologies among EU countries (European Commission, 2022[14]). Indeed, a higher share of firms have adopted advanced digital technologies like Cloud Computing or Big Data Analysis in Finland than in many other OECD countries (Figure 2.13, Panel A). As in other OECD countries, the adoption of digital technologies is slower among smaller firms, but Finland outperforms the OECD average in the share of small firms adopting digital technologies (Figure 2.13, Panel B).

Despite the vigorous digital adoption, the average contribution from ICT capital deepening to labour productivity growth has been smaller in Finland than in many other OECD countries, particularly Sweden and Denmark (Figure 2.14). This owes to Finland's slower deepening of ICT capital compared to many OECD countries (Figure 2.1), and the smaller weight of ICT capital in production for instance than in Sweden. There is thus substantial room for Finland to boost productivity through higher ICT investment and more intensive use of ICT capital in production.

Figure 2.13. Finland's uptake of digital technologies is high even among small firms

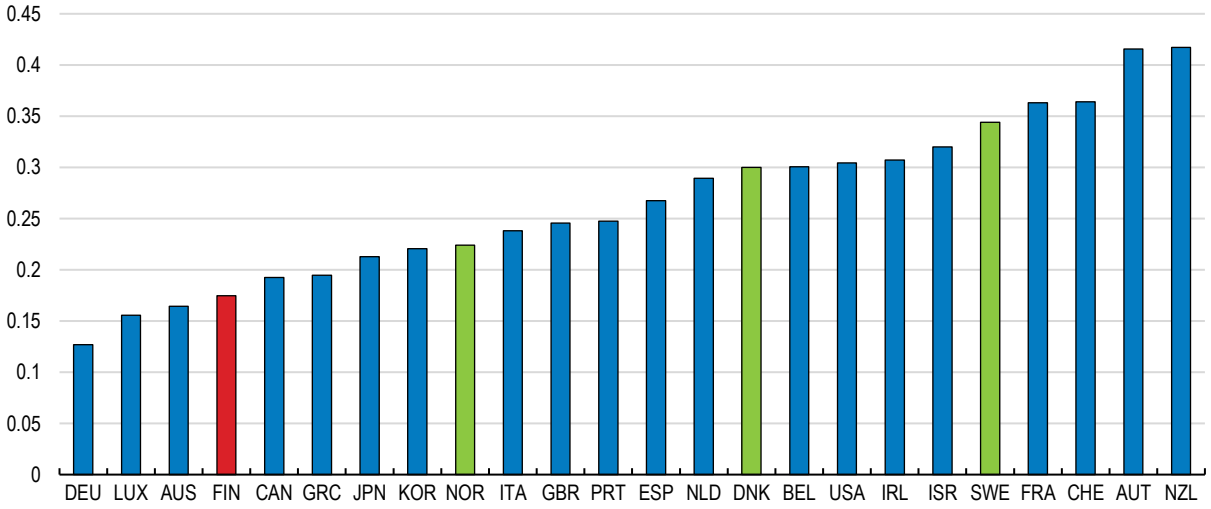


1. CRM stands for customer relationship management. Enterprise resource planning (ERP) systems are software-based tools that can integrate the management of internal and external information flows, from material and human resources to finance, accounting and customer relations. Here, only sharing of information within the firm is considered. Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity, etc. Supply chain management refers to the use of automated data exchange applications. Big data analysis refers to the use of techniques, technologies and software tools for analysing big data. This, in turn, relates to the huge amount of data generated from activities that are carried out electronically and from machine-to-machine communications. Social media refer to applications based on Internet technology or communication platforms for connecting, creating and exchanging content online with customers, suppliers or partners, or within the enterprise. Radio frequency identification (RFID) is a technology that enables contactless transmission of information via radio waves.
2. Small firms are defined as firms with 10 to 49 employees, whereas large firms are defined as those with more than 250 employees.
Source: Eurostat (2019), Digital Economy and Society Statistics (database) and OECD (2022), ICT Access and Usage by Businesses (database).

StatLink https://stat.link/iwj8ef

Figure 2.14. The contribution of ICT capital to labour productivity growth has been small

Average annual contribution of ICT capital deepening to labour productivity growth, 2010-2020, percentage points



Note: Data for Greece, Israel, Norway and Spain refer to the average over 2010-2019.
Source: The OECD Productivity Database.

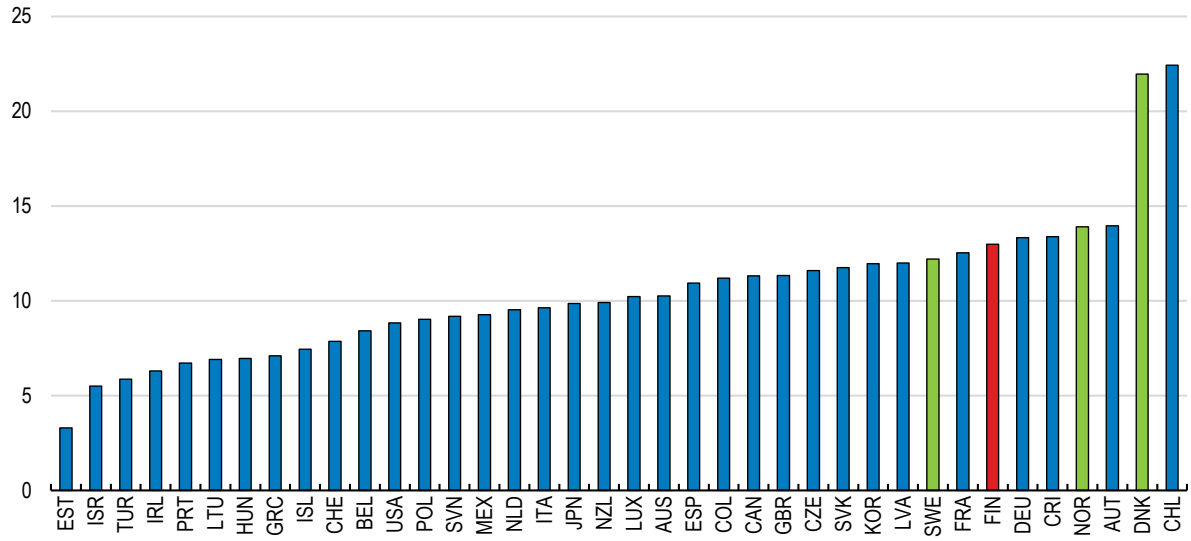
StatLink https://stat.link/13nih0

Finland has a competitive edge in green innovation

Finnish firms have invested heavily in climate change mitigation and other environmental management technologies. For instance, 13% of patent applications concern environment-related technologies, a share that is higher than in many other OECD countries (Figure 2.15). In particular, Finland is leading in circular economy and bioeconomy innovation. Green innovation in Finland has been driven mainly by the business sector, motivated by environmental regulations and growing demand by customers for environment-friendly products. Finland has been a pioneer in implementing the EU environmental policies, which gave Finnish firms a first-mover advantage in the development of cleantech products (OECD, 2021[15]). As a result, Finland's share in the global cleantech market, at over 1%, is twice as large as its contribution to global GDP. About 70% of firms in the cleantech industry are microenterprises and SMEs, illustrating the importance of entrepreneurship in this sector. Yet, their insufficient managerial skills are constraining the growth of these innovative firms and thereby the diffusion of novel technologies (European Commission, 2019[16]).

Figure 2.15. Finland is among the leading countries in green innovation

Patent applications on environment technologies, % of all patent applications, 2019



Source: OECD Environment Statistics.

StatLink https://stat.link/0z4sga

Making the most of the revamped innovation support

Innovation support was withdrawn quickly in the aftermath of the global financial crisis

Finland's innovation ecosystems enjoyed broad-based policy support until 2010, underpinned by the government's initiatives and a policy consensus that continuous investment in innovation was key to Finland's long-run prosperity. Innovation collaboration between enterprises, universities and public research institutes was promoted through various funding schemes by Tekes (the National Technology Agency, currently Business Finland), which successfully strengthened the technological capabilities of Finnish firms and boosted business-based R&D spending (OECD, 2017[1]).

Public support for innovation waned during the long economic stagnation of the 2010s (see above) and underwent significant restructuring. Public funding for applied research was cut back, as the government reduced its R&D funding for Tekes by 24% in 2016. The government also consolidated the 20 public research institutes into 12 and cut their research funding by 37% during 2013-16. The Strategic Centres for Science, Technology and Innovation, aimed at establishing new types of public-private innovation partnerships similar to the Competence Centres in other OECD countries, were terminated abruptly in 2015 after issues of effectiveness and governance were raised (OECD, 2017[1]). The rapid withdrawal of public funding for applied research and innovation collaboration weakened Finland's innovation ecosystems, especially by making it difficult for firms and universities to share the risks associated with the commercialisation of radical innovation.

The government's stance towards innovation policy took a welcome turn in 2017 when it stressed the need to redress the decline in R&D spending to secure long-run innovation-based growth. Business Finland, a new organisation merging Tekes and the export promotion agency Finpro, was set up in 2018 to disburse innovation funding and promote trade, tourism and investment. The Research and Innovation Council (RIC), an effective platform that formed national strategic consensus and monitored Finland's innovation ecosystems in the 1990s and 2000s (see below), was reconvened. It formulated at the time a vision that aims to turn Finland into the world's most attractive and competent environment for experimentation and innovation by 2030 (Research and Innovation Council, 2017[17]). The government followed up in April 2020 with a National Roadmap for Research, Development and Innovation, which laid out policy priorities for

achieving the government's target on R&D spending (see below) as well as boosting business-based R&D and strengthening the innovation ecosystems (Box 2.4). On the back of renewed innovation support and the economy exiting the long stagnation, Finland's business and government R&D spending grew in nominal terms by 19% and 9%, respectively, between 2016 and 2020 but their shares of GDP have not increased notably.

Box 2.4. Finland's National Roadmap for Research, Development and Innovation

The National Roadmap for Research, Development and Innovation was put forth in April 2020 and updated in December 2021. It presents the strategy for attaining the R&D target and stresses the need to achieve a more diverse economic structure and stronger productivity growth. It highlights the need for more extensive innovation activities involving a wider range of industries and smaller firms and new models of public-private innovation partnership. The roadmap classifies policy measures across the following three pillars:

Competence

To increase the supply of qualified experts and R&D personnel, the government aims to lift the share of the 25-34 age group with tertiary educational attainment to 50% by 2030. It would also increase the number of foreign students threefold to 15 000 by 2030 and raise the share of foreign students graduated from Finnish universities who are employed in Finland to 75%. Adult education will be more aligned with industries' need for research and innovation competence.

Public-private partnership

Responsible ministries and funding agencies, namely the Academy of Finland and Business Finland, and other stakeholders will develop a flexible public-private partnership for long-term research, development and innovation cooperation and its funding instruments. The use of EU funding and other international funding will be enhanced through better coordination within the government and new approaches developed jointly among universities, research institutes and firms.

Innovative public sector

The government will foster demand for innovation and leverage the latest technologies and innovation. It will increase innovative public procurement, make regulation more conducive to the commercialisation of innovation, and share public resources like data for innovation.

Source: Ministry of Economic Affairs and Employment; Ministry of Education and Culture (2020[18]; 2021[19]).

The government established an ambitious goal to boost R&D spending

The government has a target to increase gross domestic R&D spending to 4% of GDP by 2030. Finland has been setting national targets for R&D intensity since the 1970s and long had a good track record in achieving them (Deschryvere, Husso and Suominen, 2021[20]). The 4% target was first set in 2005 when Finland's actual R&D spending reached 3.7% of GDP, buoyed by innovation in the ICT sector spearheaded by Nokia. However, this target was never reached and eventually dropped out of the government's programme. It was reinstated in 2019 and promoted by the current government. R&D intensity targets are commonly found across OECD countries and some innovation-oriented non-OECD economies like China (OECD, 2021[21]). Finland's target level of 4% is relatively high, a level shared only by Japan, Sweden and Iceland. Only Israel and Korea exceed this level of R&D spending. It will be challenging to achieve this target since it requires sustaining very large increases in R&D spending (Box 2.5). Moreover, such rapid expansion in R&D will not be feasible without addressing existing bottlenecks, notably severe skill shortages (see Section 2.4).

Box 2.5. How much of an increase in R&D spending is needed to meet the government's 4% target?

This box provides a simple estimate of the growth rate in R&D spending needed to achieve the government's R&D spending target. The main assumption is that Finland's real GDP and inflation will follow the projection by the General Government Fiscal Plan for 2023-2026 (Ministry of Finance, 2022[22]) until 2026, and then the Bank of Finland's central scenario between 2027 and 2030. This would bring nominal GDP to EUR 345 billion in 2030.

Gross domestic R&D spending equivalent to 4% of GDP would be EUR 13.8 billion. Given that the level of R&D spending was EUR 6.9 billion in 2020, it would require 7% annual growth in gross R&D spending to reach the target.

Similar computations imply that achieving the target for government R&D spending (1.2% of GDP by 2030) requires government R&D spending to grow by 6.4% (or around EUR 191 million) annually from 2020, on average. Government R&D spending decreased slightly in 2021 but increased by EUR 272 million in 2022. It is expected to decline by EUR 100 million in 2023. However, the government envisages an annual increase in its R&D spending by EUR 260 million between 2024 and 2026. Overall, these budget measures until 2026 roughly meet the cumulative increases needed to keep public R&D spending on track to achieve the 1.2% target.

In addition to these increases in public R&D spending, the government expects the introduction of the new R&D tax incentive (see below) to reduce fiscal revenue by about EUR 100 million every year from 2023.

Source: OECD computation based on the Ministry of Finance (2022[22]) and Bank of Finland (2021[23]).

In December 2021, Finland reached a political agreement to boost public sector's R&D spending to 1.33% of GDP by 2030, which corresponds to a third of the overall R&D spending target of 4% of GDP. This agreement is motivated by the fact that historically public R&D has comprised one-third of Finland's domestic gross R&D spending (for example, it was around 1% of GDP in 2020 while overall R&D amounted to 2.9%). Each additional euro in public R&D spending will need to be matched by two additional euros of business-based R&D. The government needs to commit to stable innovation support to induce such R&D spending by the business sector, given its history of swift and abrupt withdrawal of innovation support. Legislation (the R&D Finance Act) mandating the government to boost its R&D spending to 1.2% of GDP by 2030 is foreseen to enter into force in January 2023. The 1.2% target for government R&D spending is motivated by the fact that government R&D spending historically comprised 90% of the public sector R&D spending. The government will also introduce a long-term R&D funding plan that specifies the orientations of R&D policy and provides guidelines for the allocation of government R&D spending.

Two elements would define the effectiveness of the new framework for public R&D spending. First, the government should work closely with the private sector in achieving the R&D spending target. The government should not only monitor the development of business-based R&D but also work together with the private sector on designing policy measures to boost R&D spending by private enterprises, especially SMEs. This includes reflecting private-sector needs in the long-term orientation of government R&D funding. The R&D Finance Act foresees a monitoring role by the State Council, but it is unclear to what extent the private sector will be involved in its monitoring exercise. Second, while innovation support needs to be stable to provide a clear prospect of lasting innovation collaboration, it should not be rigid. The legislation should allow for some flexibility in annual government R&D spending, enabling future governments to accommodate fiscal revenue shocks or finance exceptionally large expenditures. This would make it easier for future governments to abide by the Act. The unused budget for R&D spending should be allowed to be carried over to avoid having to disburse all innovation support within a fiscal year, which risks compromising the quality of research projects and lowering the value for public money.

Innovation support must balance between basic research, which is driven by excellence and underpins Finland's competitiveness as the innovation hub, and applied research, which is more targeted and oriented toward specific missions. While ensuring ample funding for basic research, Finland's long-term R&D funding plan needs to set clear objectives and directions for research and innovation support to ensure that the large increase in government R&D spending strengthens Finland's innovation ecosystems in the most cost-effective way. Finland's innovation support is thinly spread across regions, measures and agencies, often lacking sufficient scale to reach a critical mass (OECD, 2017[1]). The government also does not target specific sectors or technologies in their efforts to reach the R&D intensity target. However, the limited size of policy resources and of the domestic market implies that Finland needs a more strategic innovation policy, like ones adopted by many OECD countries that orient public R&D spending toward specific missions to solve the most pressing societal challenges (Box 2.6). Such innovation policies involve picking the "problem" as opposed to picking the "winners", while allowing innovation actors to propose the best technology solutions to address it (Larrue, 2021[24]). This trend in public R&D policy is likely to strengthen after the COVID-19 pandemic (Paunov and Planes-Satorra, 2021[25]).

Finland's updated National Roadmap for Research, Development and Innovation mentions "a new challenge- and mission-based approach to implementing and funding research and innovation", but the envisaged innovation strategy is unclear (Ministry of Economic Affairs and Employment; Ministry of Education and Culture, 2021[19]). There are also existing schemes like the Flagship Programmes by the Academy of Finland and the Growth Engines platforms by Business Finland, which are powerful policy instruments to mobilise a wide set of actors towards commonly developed strategic agendas. Although these initiatives do not fulfil all the design principles of the mission-oriented innovation policy, they have supported significant learning and cultural change in terms of governance and policy framework, upon which a fully-fledged and wider scope mission-oriented innovation policy could build. While the large coordination costs is a common drawback of mission-oriented policy (Box 2.6), OECD countries addressed this issue by enhancing the efficiency of the project governance through building trusts among the participants and adapting the governance system through learning.

Finland also needs stronger high-level coordination on innovation policy, given that its budget for innovation support is distributed across several ministries. It has had a highly effective coordination body that ensured systemically coherent research and innovation policies. The Research and Innovation Council (RIC) created in 1987 acted as an arena for debating innovation policy priorities from a holistic perspective and forming a national strategic consensus. While The RIC was an advisory body, it monitored the state of Finland's innovation system and supported strong coordination and high-level decisions (Deschryvere, Husso and Suominen, 2021[20]; Arnold et al., 2022[26]). Unfortunately, the RIC was significantly downsized in 2016, and stripped of its secretariat and information gathering function. Although it has launched key innovation policy initiatives like the National Roadmap for Research, Development and Innovation, its functions are not as broad or independent as they used to be (Deschryvere, Husso and Suominen, 2021[20]). There is a case for restoring the RIC's original capabilities, especially the strong coordination power. The rejuvenated RIC can be a suitable body for overall planning, implementing and monitoring mission-oriented innovation policies, given that mission-oriented innovation support should be subject to rigorous impact assessments and resulting reallocation of policy resources. The RIC can also help ensure that private sector needs are adequately taken into account in government R&D funding and support measures (see above).

Box 2.6. Mission-oriented innovation policies in OECD countries

What are mission-oriented innovation policies?

Mission-oriented innovation policies (MOIPs) are a coordinated package of policy and regulatory measures aimed at mobilising actors in science, technology and innovation to address well-defined societal challenges such as ageing or climate change within a defined timeframe. They emerged as governments across OECD economies needed to overcome limitations in traditional innovation policies, such as weak directionality, lack of holistic coordination and fragmentation of policy measures. MOIPs often involve a newly established coordination body at the level of each mission that determines and implements the direction of innovation activities toward the collectively developed objectives and a tailor-made bundle of instruments to meet these objectives. Public R&D spending plays a large role in MOIPs, as well as mission-oriented government procurement, such as green procurement that incorporates environmental requirements into their tenders or procurement of solutions to specific societal challenges.

Examples of mission-oriented innovation policies

Germany's High Tech Strategy (HTS) 2025

The HTS 2025 adopted in 2018 is a comprehensive, inter-ministerial strategy that aims to raise Germany's gross domestic R&D spending to 3.5% of GDP in 2025. It has set 12 mission areas to guide joint efforts of science, industry, and policy makers across ministries, which include healthcare, plastic pollution, reduction of greenhouse gas (GHG) emissions and artificial intelligence. For example, the GHG reduction mission aims to use research and innovation funding for new technologies that enable industry to contribute to the long-term carbon neutrality goal while securing Germany's competitiveness as an industrial location. Challenges associated with the HTS include high coordination costs and the lack of common R&D funding resulting in fragmented funding across government agencies.

The Netherlands' Top Sector Policy

The Top Sector Policy started in 2011 as an industrial policy for boosting the competitiveness of the Netherlands' key sectors, such as agriculture, logistics, high-tech systems and materials, referred to as Top Sectors. Since 2018, it aims to achieve 25 missions in four societal challenges including energy transition, agriculture and healthcare. For each of these societal challenges, the public sector (led by the Ministry of Economic Affairs and involving authorities across various policy areas) and Top Sector partners (namely corporate enterprises) jointly draft and implement the Integral Knowledge and Innovation Agenda (IKIA), which specifies mission targets and the timeframe for achieving them. The IKIA is revised every four years. Challenges associated with the Top Sector Policy scheme include a large number of missions, an overly hierarchical governance system (currently being reformed) and the over-representation of incumbent actors experienced in collaborating with the government.

Source: Larrue (2021[24]), OECD (2020[27]).

The R&D intensity target is effective in signalling the political commitment to boosting innovation given that it is based on a straightforward indicator that is internationally comparable. Nevertheless, it fails to capture several important aspects of innovation, in particular investment in intangible capital, the quality of research, and the extent of knowledge spillovers. Furthermore, the R&D target does not capture R&D spending by innovative start-ups and other small firms with less than 10 employees. This is because these firms are not covered in Finland's innovation survey nor in the innovation surveys of other EU countries, following the common sampling instruction by the European Commission (Deschryvere, Husso and Suominen, 2021[20]). The government should thus complement this target with other targets, for instance on research outcomes like the number of patent applications or the share of top scientific publications.

This would allow more comprehensive monitoring of the progress toward the competitive innovation ecosystems envisaged in the Research and Innovation roadmap. Indeed, the National Roadmap for Research, Development and Innovation specifies eight indicators aside from R&D intensity to be monitored in the assessment of progress toward its policy goal, even though it does not assign any target levels for those indicators. The government should also consider collecting basic information on R&D expenditures by start-ups and micro enterprises, for instance by including the R&D spending in the list of information to be collected for its structural business and financial statement statistics, which surveys turnover and spending on inputs of all Finnish firms.

The new R&D tax credit should balance wide accessibility and efficiency

In addition to the large increase in government R&D spending that will revamp direct funding of business-based R&D, the government will also introduce a new R&D tax incentive. Both measures stimulate business-based R&D by subsidising the costs of R&D activities but differ importantly in their abilities to target some types of innovation and the scope of firms they can reach out to. For instance, the government can tailor direct support measures like R&D grants to guide innovation to specific societal challenges. However, only a limited number of firms with sufficient capacity to participate in these government-funded programmes would benefit from those grants. In contrast, R&D tax credits can be claimed by all eligible firms, but it is administratively difficult to target them to specific research themes. This trade-off between the extent to which the government can target the R&D support and the scope of firms it can reach out to implies that the government needs to deploy both direct support and tax credits to promote more diversified and competitive innovation ecosystems.

The government envisages introducing a tax allowance on 50% of the labour costs and expenditure on services purchased dedicated to R&D activities. Until recently, Finland was one of the few OECD economies that does not offer R&D tax incentives (Figure 2.16). While a temporary tax allowance introduced in 2013 allowed firms to deduct the wage expense of their R&D activities, it was removed at the end of 2014 following very low take-up (Kuusi et al., 2016[28]). In 2021, the government started offering a 50% deduction for the costs of R&D conducted jointly with higher education institutions or research institutes as a temporary measure until 2027. The deduction rate was boosted to 150% in 2022. Nevertheless, only firms with capacity to collaborate with higher education or research institutions benefit from this provision. The new tax incentive will cover more general R&D spending in line with the tax incentives offered by other OECD economies. It is expected to help broaden Finland's R&D base by encouraging a larger mass of Finnish firms from a broader range of industries to innovate.

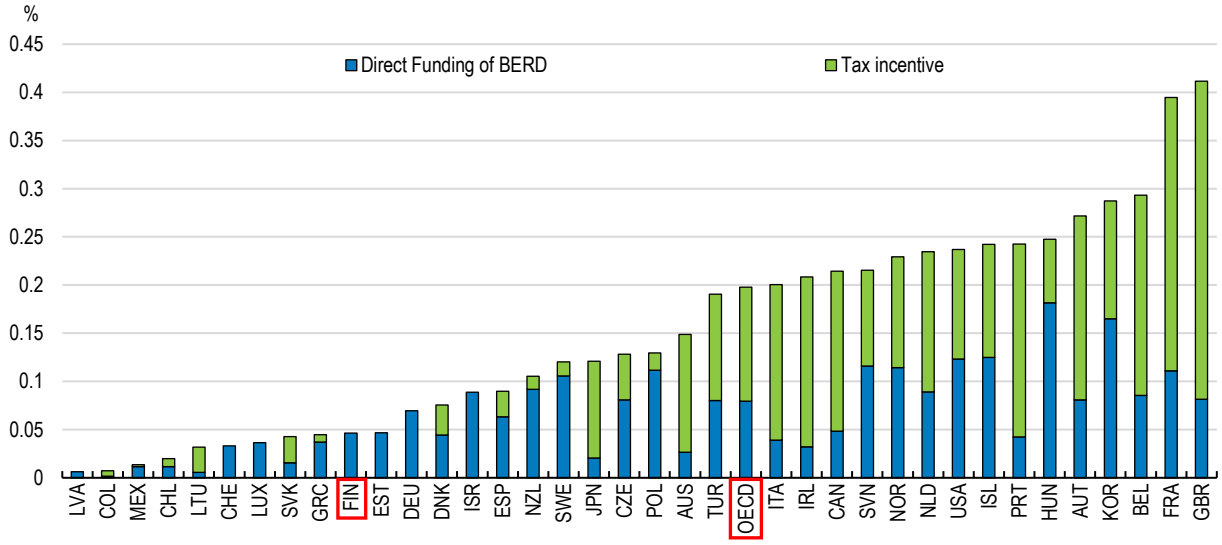
The new R&D tax incentive should be easily accessible to start-ups and other Finnish firms that would respond most to the scheme. A tax incentive in its purest form only covers firms that are profitable and pay taxes, thereby excluding firms that have not generated taxable profits. However, in many OECD countries, unused tax incentives can be carried forward. The period over which tax incentive claims can be carried forward varies widely across the OECD, ranging from three years in the Czech Republic to 20 years in the United States (OECD, 2021[29]). The government envisages allowing the new R&D tax incentive to be carried forward in line with corporate operational losses, which can be carried over for 10 consecutive years.

It is also common across OECD countries that R&D tax incentives are made refundable, transferring the excess credit that cannot be used to reduce tax liability in the form of a cash payment to the firms. Alternatively, the excess credit can be deducted from other corporate taxes or employer's social security contributions. These features turning R&D tax incentives into de facto subsidies are particularly effective in providing cash flow to innovative firms in their early stage when they need to finance investment or product development. The R&D tax incentive can be also made "incremental," covering the R&D spending exceeding a pre-defined baseline amount. Such baseline amount can for instance be 50% of the firm's average R&D spending over the past three years, as in the United States. Some countries like Korea,

Spain or Portugal offer hybrids of a volume-based R&D tax incentive topped by an incremental one. Koski and Fornaro (2022[30]) find that business-based R&D spending is larger in countries implementing either an incremental R&D tax incentive or a hybrid scheme. The government indeed envisages offering an incremental tax allowance on top of the 50% allowance mentioned above.

Figure 2.16. Finland was until recently one of the few OECD countries not offering R&D tax incentives

Direct government funding and tax support for business-based R&D, % of GDP, 2019



Source: OECD R&D Tax Incentives (database).

StatLink https://stat.link/s3go5z

Across OECD countries, R&D tax incentives often target some firms and activities to induce larger R&D investment for a given tax expenditure (OECD, 2021[29]). For instance, the R&D tax incentives can target SMEs, given that the R&D investment by large firms is less responsive to tax incentives. An OECD empirical study based on firm-level data on R&D found that across 20 OECD countries, one euro of R&D tax credit induces 1.4 euros of R&D by firms with less than 50 employees whereas it induces only about 0.4 euros of R&D by firms with 250 or more employees (Appelt et al., 2020[31]). Instead of limiting the tax credits to smaller firms, many OECD countries set an upper bound on the amount of R&D spending that qualifies for R&D tax incentives. However, this was observed to result in pure income transfer to firms with R&D spending exceeding the upper bound. For instance, Finland's temporary tax allowance in 2013-14 did not induce any additional R&D by firms with R&D spending larger than the upper bound of EUR 400 000 but allowed these firms to deduct EUR 400 000 from their corporate tax base (Takalo and Toivanen, 2017[32]).

The types of spending or activities eligible for the R&D tax incentives should be sufficiently broad for them to be relevant for many firms but need to be specified so they do not risk financing generic activities. In many OECD countries, R&D tax incentives often cover the labour costs of R&D personnel but the acquisition of capital assets to be used for R&D activities is less typically supported, as assets may be subsequently disposed of or used for other purposes (OECD, 2021[29]). Providing a clear definition of eligible activities would reduce uncertainties for firms embarking on innovation projects, especially those involving software development or other service-based activities that are on the boundaries between R&D and investment in intangible capital (OECD, 2021[33]). For instance, the United Kingdom offers detailed guidelines on the conditions under which software development qualify for the R&D tax allowance (HMRC, 2018[34]).

Direct R&D support should foster a strong public private partnership in innovation

As the government revamps direct R&D support, it should aim to build a strong public private partnership that links basic research with applied research and commercialisation of new technologies. This partnership should be driven by stronger interactions between research institutions and SMEs. The Academy of Finland and Business Finland promote industry-research collaboration through their support measures (Box 2.7). The two organisations should endeavour to attract innovative small firms into their innovation collaboration programmes. Innovation collaboration with universities and research institutions can be particularly beneficial for Midcap and small firms in developing novel environment-related technologies and commercialising them (OECD, 2021[15]). Small firms need a clear prospect of innovation outcomes to justify committing their time and scarce resources to these programmes. A fair governance system that reflects the concerns of SMEs as well as transparent communication of the project contents and burden sharing are key. It is also important to ensure that participation in those programmes does not penalise SMEs financially, for instance by preventing them from using the R&D tax incentive. For instance, the temporary tax allowance in 2013-14 (see above) was unavailable for firms receiving direct R&D support (OECD, 2017[1]).

The government should ensure the stability of support measures to encourage firms and research institutions to invest substantial resources in applied research and innovation collaboration. At the same time, both the Academy of Finland and Business Finland should streamline or consolidate support measures so that revamped innovation support will not be spread thinly across numerous potentially duplicative support measures. Furthermore, there has not been a notable synergy between their schemes. Deeper collaboration between the two organisations, such as launching co-funded projects is warranted, as this would bring grant recipients closer, facilitating the diffusion of knowledge and innovative ideas. At the same time, severe resource constraint has prevented the Academy of Finland from conducting rigorous impact assessments and reforms of its support measures (Arnold et al., 2022[26]). The government should ensure that sufficient resources are allocated to the Academy of Finland and Business Finland so that they can fulfil their essential functions.

While direct R&D support has been effective in inducing R&D investment in Finland, its contribution to the productivity of Finnish firms is less clear. For instance, Fornaro et al. (2020[35]) estimated that R&D support by Tekes (current Business Finland) boosted Finnish firms' R&D spending per euro of sales by 30%. However, Koski and Parajanen (2015[36]) found that direct R&D support by Tekes has not resulted in significant labour productivity improvement of recipient firms, neither in the short run nor in the long run. These findings suggest some room for better targeting the R&D support like R&D grants or loans to firms with higher innovation capabilities and growth potential. Einiö et al. (2022[37]) show through a simulation that R&D support is most effective in boosting productivity when it can target firms with high innovation capabilities. In this case, R&D support promotes the reallocation of scarce resources (such as skilled workers) toward more innovative firms as it strengthens their competitiveness, displacing less innovative firms. Conversely, R&D support is less effective when it cannot exclude unproductive firms as it would delay their exit, hampering resource reallocation (Fornaro et al., 2020[35]).

Box 2.7. Direct R&D support in Finland

Most direct R&D support in Finland is disbursed by the Academy of Finland, which allocates grants to basic research, and Business Finland (formerly Tekes), which provides grants and subsidised loans to applied research.

The Academy of Finland

Over the period 2011-20, the Academy of Finland allocated on average about half of its budget to bottom-up research support, which includes research grants to projects proposed by academic researchers and various fellowship programmes. The other half of the budget was allocated to thematic funding, including the Strategic Research Council programmes aimed at establishing extensive multidisciplinary research consortia around four themes (Urban, Health, Work and Security), and the funding for Centres of Excellences and research infrastructure.

The Academy of Finland's budget decreased in the early 2010s as public spending on innovation was cut back but increased after 2014, as funds for public research institutes like VTT were reallocated to the Academy of Finland to fulfil new responsibilities, such as the Strategic Research Council programmes. Nevertheless, the Academy of Finland is subject to significant resource constraints, which is contributing to low success rates in its bottom-up research grants. For instance, far less than 20% of applications for research grants and fellowship positions have been met with funding during 2011-20, which is very low by international comparison (Arnold et al., 2022[26]).

Business Finland

Business Finland offers loans for firms' product development and piloting projects, covering 50 to 70% of project costs at a fixed interest rate (currently 1%) without collateral. Should a project fail to produce commercial revenue, a fraction of the loan will not be collected. Business Finland also offers grants to R&D projects covering up to 80% of costs. In 2021, it allocated 59% of its R&D support to grants, 21% to subsidised loans and 20% to its specific research programmes. The grants and loans are available to both large firms and SMEs. Roughly 70% of innovation support was directed to SMEs until 2020. SMEs also enjoy a 10% higher coverage of their project costs by R&D grants than midcap and large firms. Large firms are required to outsource at least 15% of project costs to SMEs or research institutions to receive subsidised loans. The weight of large firms in the R&D support increased to nearly half in 2020, as Business Finland launched the Challenge Competitions scheme (below).

Challenge Competitions scheme

In 2020 and 2021, Business Finland launched Challenge Competitions, which granted about EUR 180 million of R&D support to large leading firms (such as Nokia, Neste and Sandvik) to address major future challenges and increase their innovation investment in Finland. The scheme is expected to strengthen the innovation ecosystem, as 67% of this R&D support to leading firms was used to subcontract SMEs and research institutions (Business Finland, 2022[38]). In return for the R&D support, the leading firms have committed to boosting their R&D and other innovation investments by EUR 870 million, contributing to the government's 4% R&D target.

Business Finland also funds other co-innovation efforts by groups of firms and research institutions collaborating on creating new international businesses or increasing the export competitiveness of Finnish firms.

Source: Academy of Finland homepage; Arnold et al. (2022[26]); Business Finland homepage.

Supporting investment in intangible capital

Intangible capital plays an integral role in translating innovation into productivity growth (see above). Yet, like R&D, investment in intangible capital is costly and time-consuming, as well as risky and requiring trial-and-error, which likely results in an under-investment (OECD, 2013[10]). Policies to reboot Finland's innovation ecosystems should thus go beyond R&D to stimulate investment in a wide range of intangible capital. However, while public support to R&D is based primarily on the presumption that R&D generates large positive externalities that cannot be fully appropriated by the investor, this may not necessarily apply to intangible capital. For instance, some types of intangible capital like design or software are protected by intellectual property rights. Other types of intangible capital, like organisational structures, are highly firm-specific and cannot be replicated easily by competitors. Many forms of intangible capital are also often closely related to the commercialisation of innovation (Corrado and Hulten, 2010[8]), which brings investors more tangible financial returns than basic or applied research. These characteristics of intangible capital investment indicate that conventional policy support for R&D like tax credits may not be an appropriate tool for fostering intangible investment.

The experiences from OECD countries suggest that the schemes in line with the Centres of Excellence or Competence Centres are effective in supporting intangible investment. For example, Germany has 26 *Mittelstand* 4.0 Centres of Excellence that offer a wide range of services helping SMEs develop organisational changes to leverage digital technologies effectively. These services include demonstration factories and managerial consultations that help SMEs develop their own solutions to exploit digital technologies. The government could consider setting up a platform similar to the Strategic Centres for Science, Technology and Innovation (SHOKs) while addressing the shortcomings identified in the past evaluation exercise (see above).

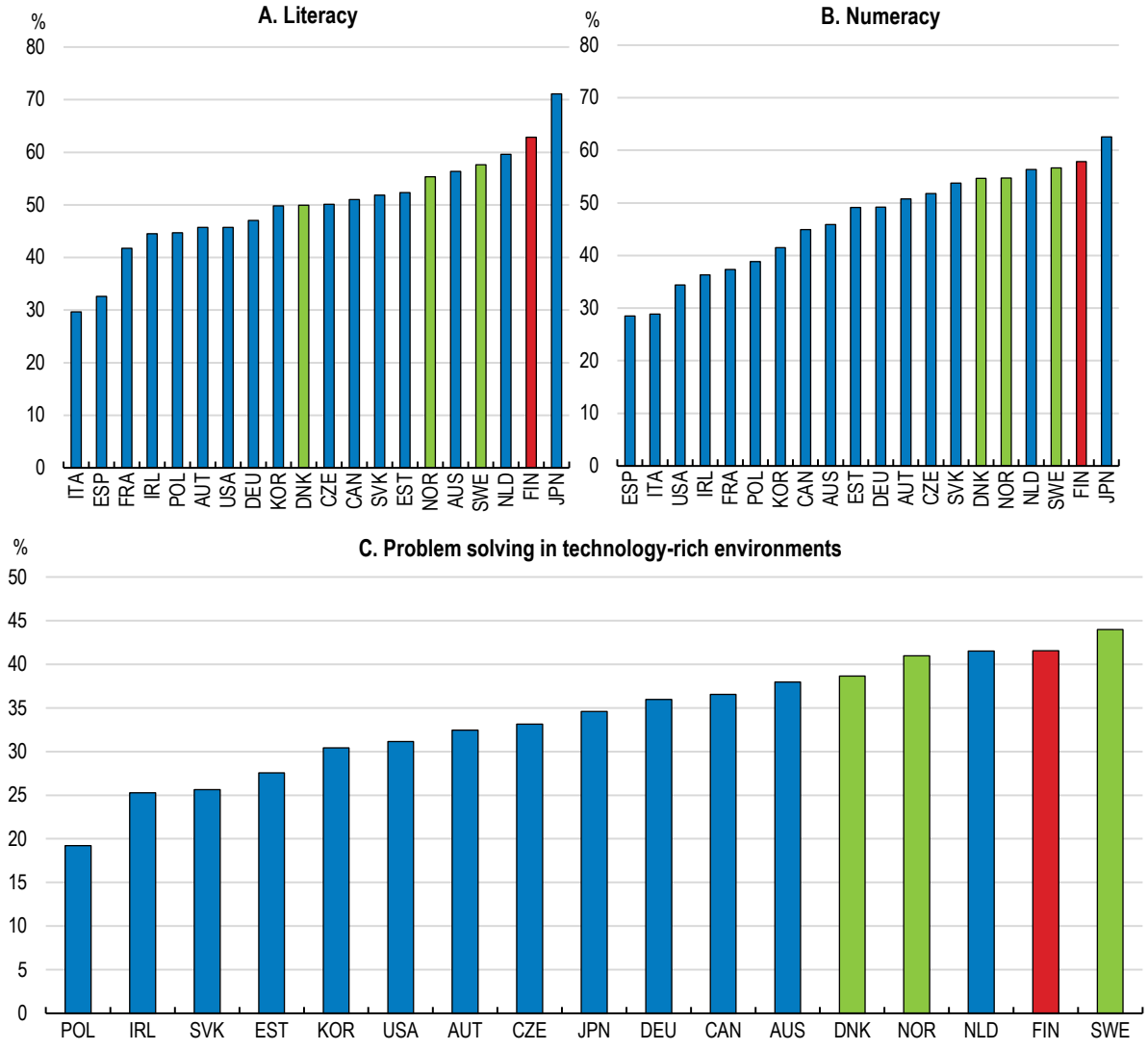
Removing the skills bottleneck to unleash innovation

Skills shortages are more serious in Finland than elsewhere

Finland boasts one of the most skilled workforces in the OECD economies. For instance, the shares of working-age adults excelling in literacy, numeracy and problem solving in technology-rich environments are all among the highest in the OECD countries (Figure 2.17). A relatively high share of graduates from tertiary education hold degrees in natural science, mathematics, ICT and engineering fields (Figure 2.18). Yet, Finland is suffering severe skills shortages. On the one hand, the fast pace of innovation and digitalisation is generating high demand for skilled workers (Hirvonen, Stenhammar and Tuhkuri, 2022[39]). For instance, the Finnish Federation of Technology Industries (Technology Finland) estimated that Finland's high-tech industries will need to hire 130 000 experts over the next ten years, a 41% increase over their current employment (Technology Finland, 2021[40]). Finland's public employment service also foresees persistent shortages of skilled workers required to exploit new technologies in various sectors including Medicare (in occupations like Medical Practitioners and various laboratory and equipment technicians as well as Nursing Professionals), ICT (Software and Application Developers, Application Programmers) and Construction (Civil Engineers). On the other hand, Finland's skills supply is constrained by low tertiary educational attainment among young adults and a small inflow of skilled immigrants (see below). A massive increase in skills supply is needed just to prevent population ageing from reducing Finland's skilled workforce and inevitably its growth potential: half of the required increases in experts foreseen by Technology Finland is due to the retirement of older skilled workers.

Figure 2.17. Finland's workforce boasts high skills

Percentage of surveyed adults with high proficiency levels, 2012



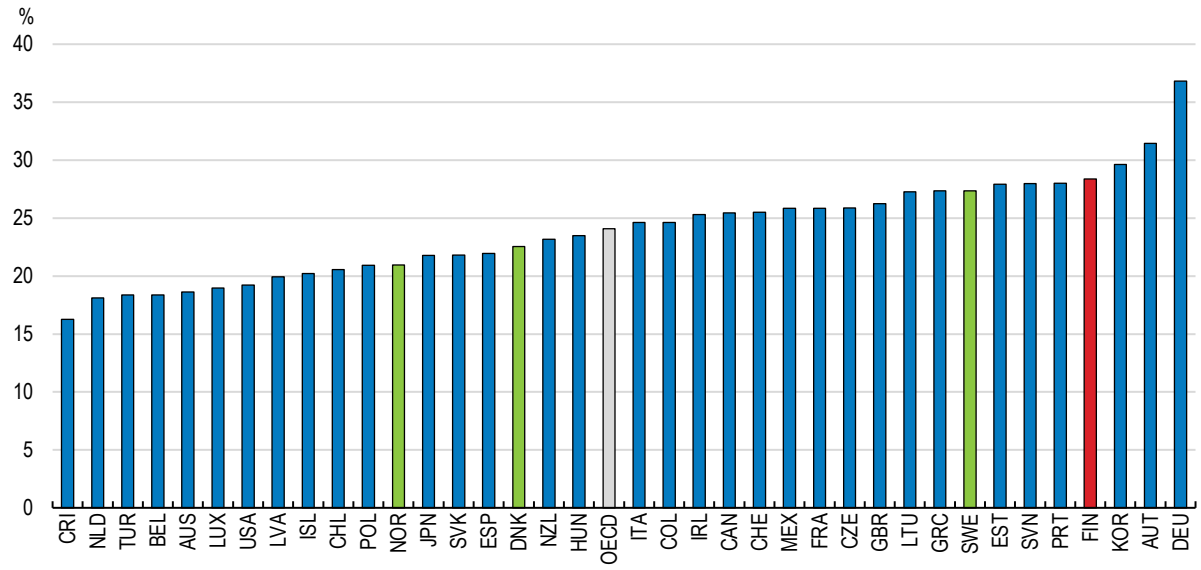
Note: For literacy and numeracy, high proficiency corresponds to Level 3 and above. For problem solving in technology-rich environments, high proficiency corresponds to Level 2 and above. See the OECD Survey of Adult Skills for details.
Source: OECD Survey of Adult Skills.

StatLink https://stat.link/i6glce

Skills shortages are a more significant bottleneck for innovation in Finland than in other OECD economies for two reasons. First, the shortages of highly skilled workers in Finland are severe compared with many other OECD countries. For instance, more than nine out of ten jobs experiencing labour shortages in Finland were in high-skill occupations, such as managerial or professional occupations, which is the highest share across OECD countries where on average five out of ten jobs in shortage were in high-skill occupations (OECD, 2018[41]). Second, Finland's good framework conditions for innovation including the business-friendly regulatory settings and good access to capital (see Chapter 1) make the skills shortages the most important bottleneck. The shortage of qualified personnel holds back innovative firms from expanding R&D and collaborating with research institutions. It also makes it difficult for innovative firms to scale up for instance through exports, thereby limiting the return to innovation (see Section 2.5).

Figure 2.18. Finland's share of STEM graduates is high

The share of tertiary education graduates in fields of natural science, mathematics, ICT and engineering, 2019



Note: The share of tertiary education graduates in the following fields: Natural Science, Mathematics and Statistics; Information and Communication Technologies; and Engineering, Manufacturing and Construction.
Source: OECD, Education at a Glance database.

StatLink https://stat.link/gyouh4

Low tertiary educational attainment among youth has been a long-standing issue

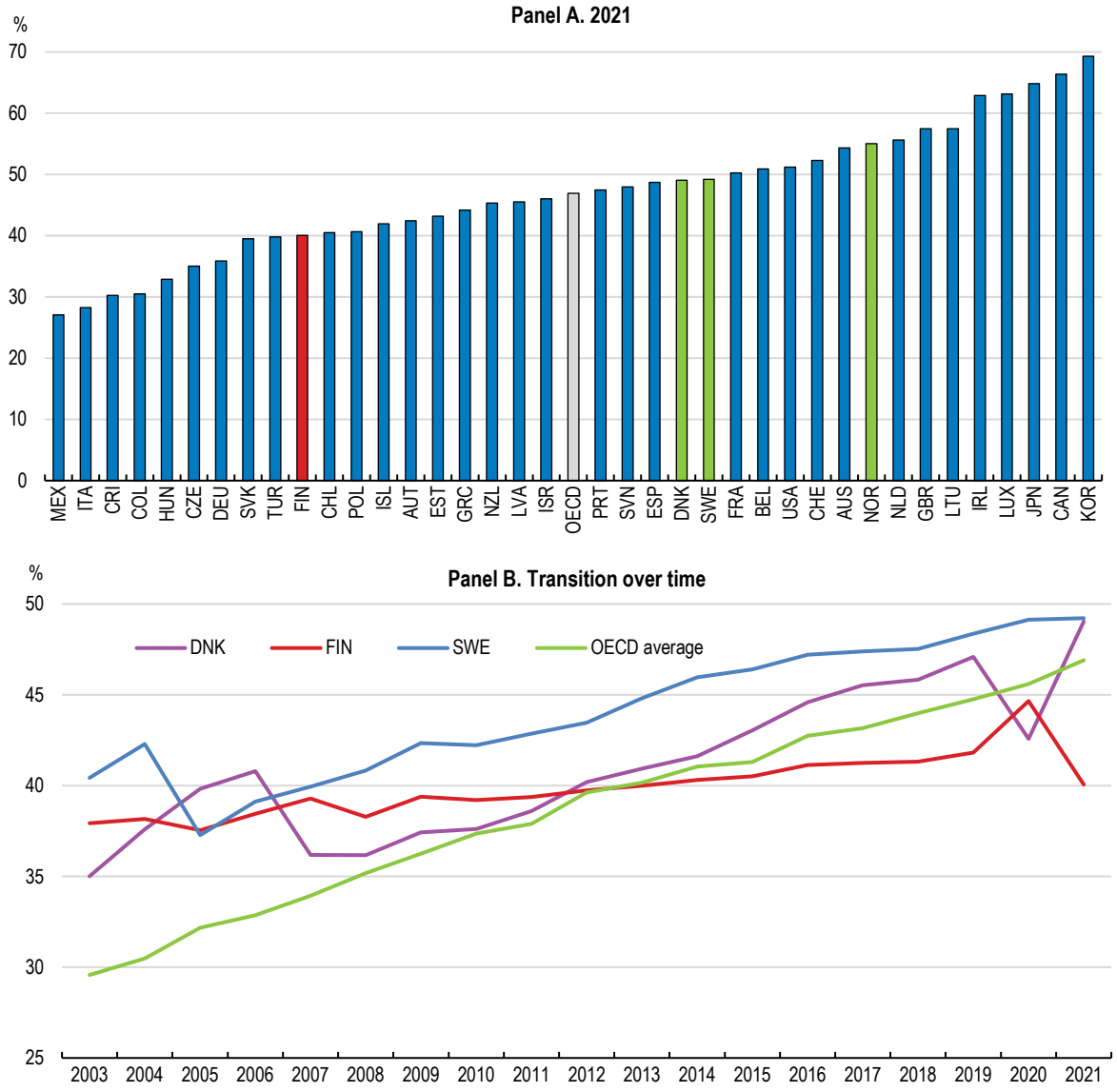
Young adults' tertiary educational attainment is low in Finland compared with many other advanced OECD economies including Scandinavian peers (Figure 2.19, Panel A). The attainment rate improved little since the early 2000s, in contrast to many OECD countries including Sweden and Denmark (Figure 2.19, Panel B). This owes to severe shortages of study places in universities relative to demand, which results in high application rejection rates. During 2015-20, universities in Finland accepted only 30% of applicants while universities of applied sciences (UAS) accepted 33%, the lowest rates among the 14 OECD countries reporting admission rates (OECD, 2021[42]). The long study time at universities also contributes to low tertiary educational attainment among youth: university students most commonly take six years to complete their degrees while UAS students take five years (OECD, 2021[42]). The challenging transition from upper secondary education to tertiary education and long study time result in individuals graduating from tertiary education for the first time on the average age of 27.3, about two years older than the OECD average (25.4). Only 77.2% of the first-time graduates with bachelor's degree are younger than 30, the share that is among the lowest in the 29 OECD countries with comparable statistics, constraining the supply of young, qualified workers.

The government has been tackling the shortfall in study places for many years. The Vision for Higher Education and Research in 2030, published in 2017, included a commitment to increase the share of higher education graduates to at least 50% of the 25-34 years-olds by 2030 (it was 44% in 2020). This would require increasing the number of graduates in that age group by 34 500 from 2019 to 2030 (OECD, 2021[42]). The current government's policy priorities for higher education include ensuring that the number of available student places at universities and UAS meets the needs of society, taking into account regional employment needs (The government of Finland, 2019[43]). The government funded an additional 4 248 study places in 2020 and has committed to funding 5 954 additional study places during 2021-22. Nevertheless, these increases fall short of the pace needed to generate additional graduates needed to

attain the 50% target (OECD, 2021[42]). The government has not yet provided a clear long-term plan laying out the number of study places to be increased and a commitment to greater funding to meet the target. A clear budgetary commitment is essential since the increases in study places will have to be funded mostly by the government, given that Finland does not charge tuition fees for tertiary education except for foreign students from outside the European Union.

Figure 2.19. Tertiary educational attainment among young adults is relatively low and has improved little

Percentage of 25-34 year-olds having completed tertiary education



Note: Panel A data refer to 2020 for Chile. The OECD average in panel B is calculated based on countries which data are available.
Source: OECD (2022), Education at a Glance 2022.

StatLink https://stat.link/ifm4wo

Allocation of study places should become more flexible and responsive to labour market demand

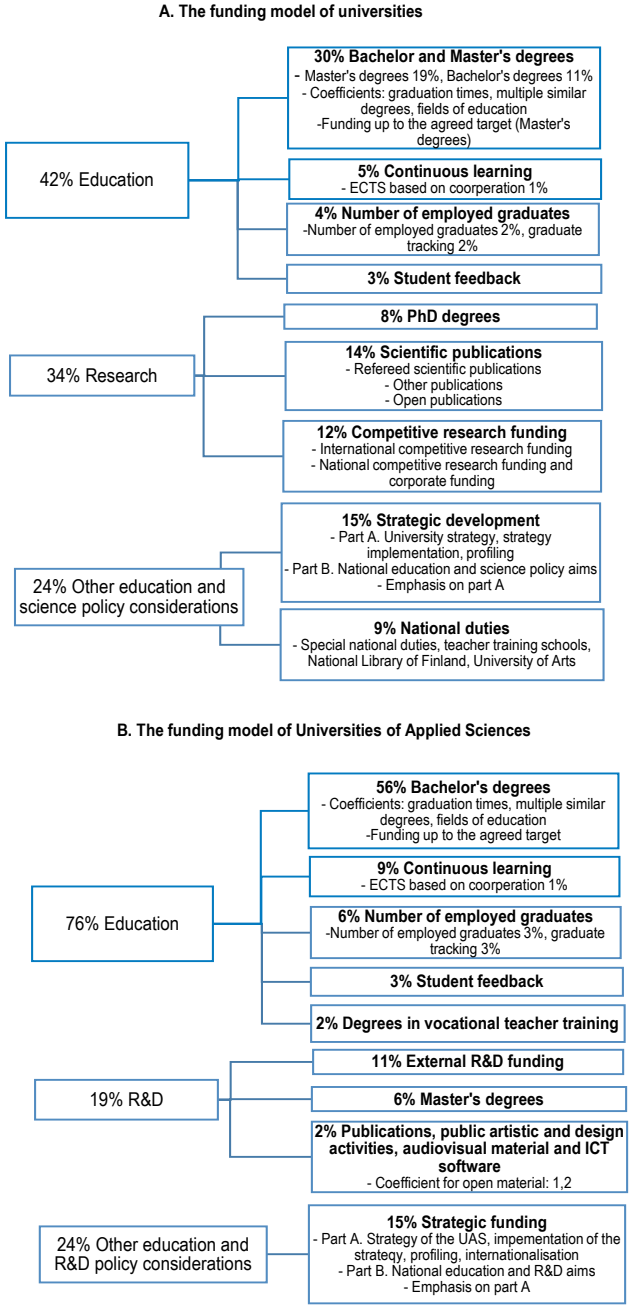
The government's financial efforts to increase study places need to be matched by reforms to increase flexibility in the allocation of study places across study fields. In Finland, study places in UAS and universities are allocated by study field, as the result of consultation between the Ministry of Education and Culture and higher education institutions, informed by forecasts on labour market demand. In practice, additional study places are allocated across higher education institutions based on each institution's willingness and capacity to accommodate additional students (OECD, 2021[42]). The allocation of study places is therefore highly rigid and may not reflect labour market demand well in the end. The highly supply-side driven allocation of study places contrasts with other countries charging tuition fees for tertiary education, where the allocation of study places is primarily driven by students' demand.

The funding models of universities and UAS, together with the strong autonomy of these institutions in managing their financial resources, limit the capacity of the government to direct higher education institutions to increase the enrolment of students in fields of study with strong labour market demand (OECD, 2021[42]). For instance, the weight of the provision of bachelor's degree programmes in the funding for universities is only 11%, lower than the weight of scientific publications (14%) or competitive research funding (12%) (Figure 2.20, Panel A). This weight may be reduced, as universities will be receiving larger research funds as the government expands its R&D spending to meet the 4% R&D target (see above). Similar tend would apply to UAS, which weight of bachelor's programmes is nevertheless much larger than that of universities (56%) (Figure 2.20, Panel B).

It is important to tighten the government's control over higher education institutions' bachelor's degree programmes. The Ministry and higher education institutions agree on graduation numbers in each field of study during the budgetary cycle. However, these numbers are base assumptions for computing the budget disbursed to each higher education institution and is not statutory targets the institution is required to meet. The only statutory targets the government imposes to higher education institutions are the caps on the numbers of enrolment into study fields with weak labour market demand (OECD, 2021[42]), which do not involve significant financial penalties when institutions do not respect them. The government should introduce statutory targets on the minimum number of enrolment and graduates to be attained by each higher education institutions.

An increase in the number of study places should be flanked by additional academic and/or pastoral support for students to maintain the high quality of education and the levels of graduation rates. In 2019, 42% of students aged under 30 graduated from the tertiary education for the first time, a share that is about the OECD average. As many university students in Finland work part time during the long study period (see above), some of them may choose to leave universities without completing degrees to work full time, especially if faced with strong financial needs. In the academic year 2019/20, 6.2% of UAS students and 4.8% of university students discontinued their education, which would have led to a qualification. Without a formal degree, these individuals can face difficulties in upgrading their skills later in their careers and may have to return to universities as adult learners. Measures to prevent non-completion should be put in place and target students from disadvantaged socio-economic backgrounds, who face higher opportunity costs from spending five to six years of their prime working ages in tertiary study.

Figure 2.20. Undergraduate study has only a small weight in universities' funding model



Source: Ministry of Education and Culture.

Further reforms in admission processes complement the study places reform

The government has complemented its efforts to increase the number of study places with reforms of admission processes in higher education institutions. For instance, UAS have adopted a common standardised test for assessing applicants' aptitude in most study fields in 2019. However, universities have preferred to select applicants through 180 distinct entrance examinations each highly specific to the subject of study, adding significant burdens to applicants (OECD, 2021[42]). From 2020, admissions to just over a half of study places in higher education institutions have shifted to certificate-based admission, which is based on the grades of the matriculation examination at upper secondary schools and initial vocational qualifications from vocational institutes.

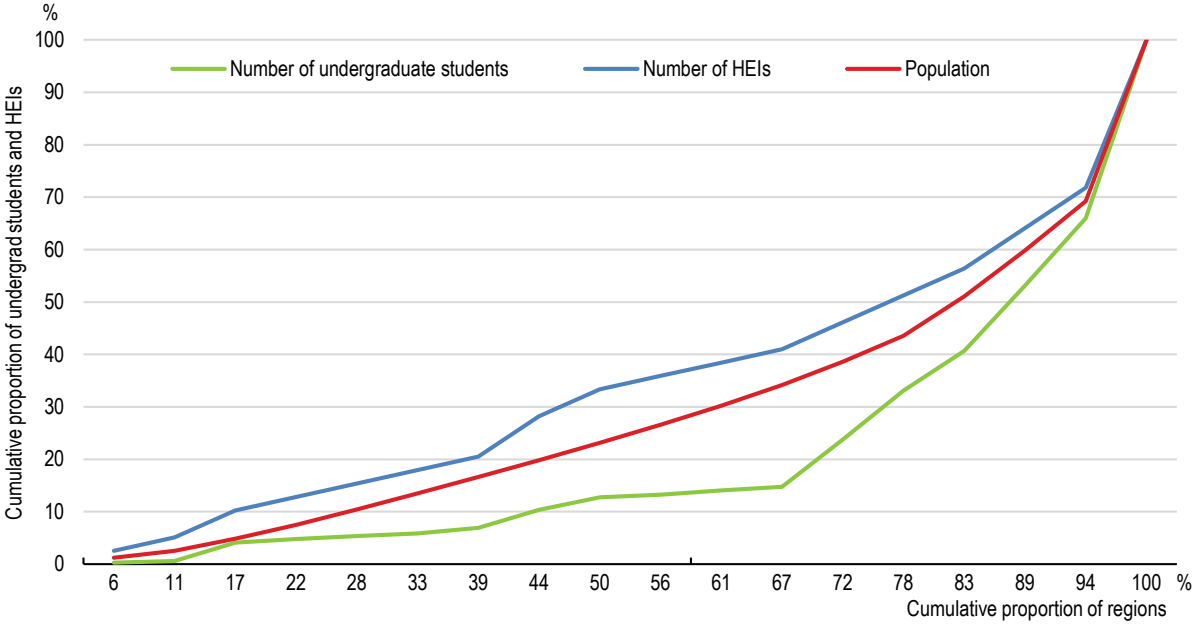
Applicants whose grades did not reach the required levels of certificate-based admissions still have to take entrance examinations to compete for the rest of the study places. However, the matriculation examination grades only become available shortly before mid-May, when the first entrance examinations for universities start. It is essential to secure more time between certificate-based admissions and entrance examinations to allow applicants sufficient preparation, even though universities are required after 2018 to ensure that their entrance examinations do not require lengthy preparation. Due to an overall increase in the number of study places, the number of places based on entrance examinations will increase even though its share in total study places will decline. This underscores the importance of a reasonable admission process to ensure a smooth transition from upper secondary schools to higher education institutions.

The regional allocation of additional study places should reflect real demand

Finland has promoted good access to higher education in each of its counties as a part of its longstanding policy commitment to support sparsely populated rural communities. At the same time, the university system has been consolidated to pursue efficiency in public spending and to create higher education institutions with sufficient scale to compete globally. Policy makers have boosted the provision of UAS, as well as university networks of satellite campuses and centres in rural areas to ensure good access to higher education. As the result, the distribution of number of higher education institutions across regions is not aligned with the distribution of the population, and even less with the distribution of the number of undergraduates (Figure 2.21). This indicates some room to enhance the efficiency in tertiary education by reallocating the resources toward regions with stronger demand for higher education while ensuring access to higher education in rural areas for instance through a variety of online courses.

Figure 2.21. Higher education institutions are evenly distributed across regions

Cumulative distribution of the number of higher education institutions and undergraduate students



Note: This chart describes the cumulative distribution of the number of undergraduate students and higher education institutions (HEIs) against the cumulative distribution of population of the NUTS 3 level regions in Finland.
Source: OECD (2021[42]).

StatLink https://stat.link/np4ce1

The mismatch in the allocation of study places across regions remains large, with more populated regions facing severe shortages. For example, while 25% of university study places are allocated to the capital region of Uusimaa, it houses 35% of university applicants (European Commission, 2020[44]). Youth in the Uusimaa region often leave Finland for their tertiary studies instead of applying to higher education institutions in rural areas where competition for study places is less fierce. Around 60% of Finnish students starting their higher education abroad are from the Uusimaa region (European Commission, 2020[44]). The regional allocation of additional study places to achieve the 50% target in the tertiary educational attainment among young adults should primarily reflect demand for study places, which is underpinned by the size of the youth population and employment opportunities.

New arrangements for adult learning are needed

The shortage of study places is exacerbated by the enrolments by adults already holding a tertiary degree in regular bachelor's or master's degree programmes seeking to acquire additional learning free of charge or for very low fees. In particular, UAS, with their strong work orientation, consider adult learners as an important target group. In 2020, some 29% of applicants to university study places (22% of applicants to UAS) already held post-secondary, tertiary or higher degrees. There are legitimate needs for adults to acquire new qualifications. For instance, some workers whose tasks are prone to automation risks have to acquire qualifications for new tasks that complement new technologies. However, pursuing a new degree for up to five years is not an efficient way to keep up with changing skill needs. There is a need to develop alternative adult learning arrangements that do not crowd out initial tertiary learning opportunities and are more effective in updating skills alongside work and family obligations.

Steps were taken to increase modularised courses for adult learners at universities and UAS. For instance, universities and UAS offer Open Studies, modularised online courses with a flexible schedule that includes evenings and weekends. While Open Studies do not lead to formal qualifications, their courses are based on the same curricula as regular degree programmes, and individuals that acquired required amount of credits (typically 60 credits for UAS) under Open Studies can apply for regular degree programmes. Open Studies are a promising avenue for adult learners to complement their prior degrees and acquire new competencies at low costs (the tuition is at most EUR 15 per course). However, financial support for adult education has been more readily available for those enrolled in regular degree programmes (OECD, 2020[45]). For instance, the Adult Education Allowance, income support to adults with an employment history of at least eight years taking up educational leave, was only fully accessible for those pursuing full-time education. The allowance was reformed in August 2020 to allow recipients to work alongside their study, facilitating access by adults pursuing part-time learning or non-formal learning. To further alter the balance of incentives, the government should introduce tuition in regular degree programmes for adult learners already holding a tertiary degree. Moreover, it is important to boost employers' recognitions on these modularised courses and other adult learning and training opportunities that do not result in formal qualifications.

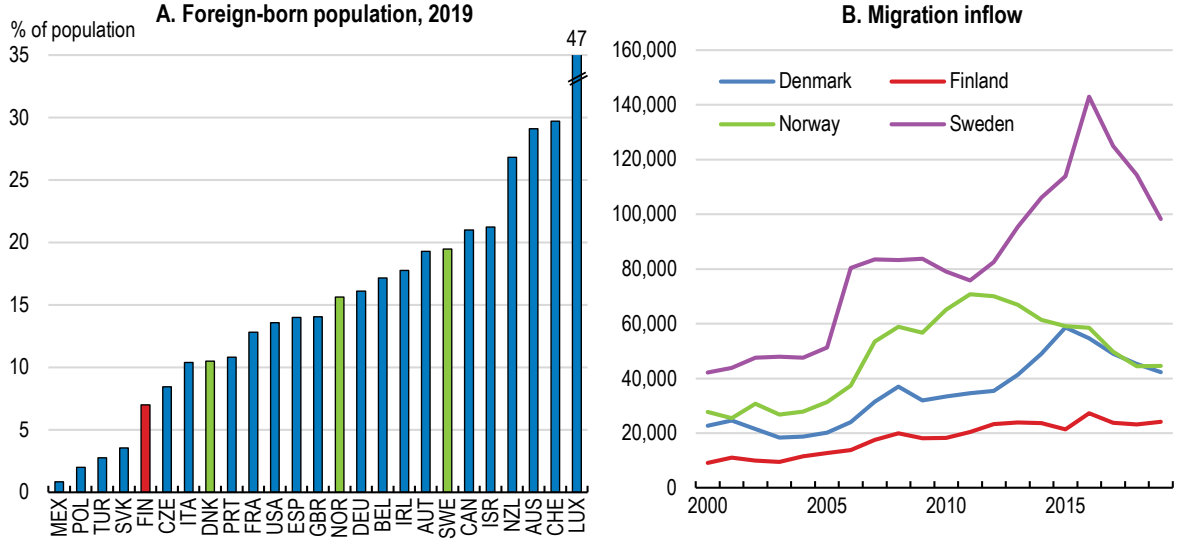
Non-formal adult learning is underdeveloped in Finland, mainly due to the free or low-cost provision of formal learning, which makes it difficult for the providers of non-formal learning to earn sufficient profits. Nevertheless, there are training needs that are not met by courses offered by universities or UAS. Indeed, some non-formal learning opportunities have been developed in cooperation with employers for working adults with higher education degrees. For example, the Specialisation Studies scheme provides learning opportunities on very sector-specific topics not taught in higher educational institutions. More should be done to provide adult learners with labour market relevant non-formal training opportunities as an alternative to regular degree programmes. Strong involvement of employers and employees is essential to ensure these non-formal learning schemes are well designed and funded, as well as quality controlled and resulting in skills recognition. As emphasised in the 2020 *Economic Survey of Finland*, Finland has some room to enhance the role of employers in adult education and should take forward-looking measures to update workers' competencies throughout their working lives (OECD, 2020[46]).

Attracting and retaining foreign talent

Finland is benefiting little from foreign talent

Attracting highly skilled foreign workers, investors and inventors is crucial for strengthening the global linkages and competitiveness of Finland's innovation system (OECD, 2017). Larger inflows of highly skilled foreign workers not only alleviate the skills shortages but also channel the diffusion of advanced technologies and knowledge embodied in these workers. Foreign students who have graduated from Finland's higher educational institutions are a promising pool of skilled employees for Finnish firms. Yet, until recently, Finland has not been actively promoting immigration to address its labour shortages. The weight of immigrants in Finland's population is considerably lower than in Scandinavian countries (Figure 2.22, Panel A), and migrant inflows remain relatively low despite a steady increase since the early 2000s (Figure 2.22, Panel B).

Figure 2.22. Immigration to Finland has been low



Note: 2017 data for Canada and 2018 data for New Zealand and Türkiye.
Source: OECD, International Migration (database).

StatLink https://stat.link/918gxe

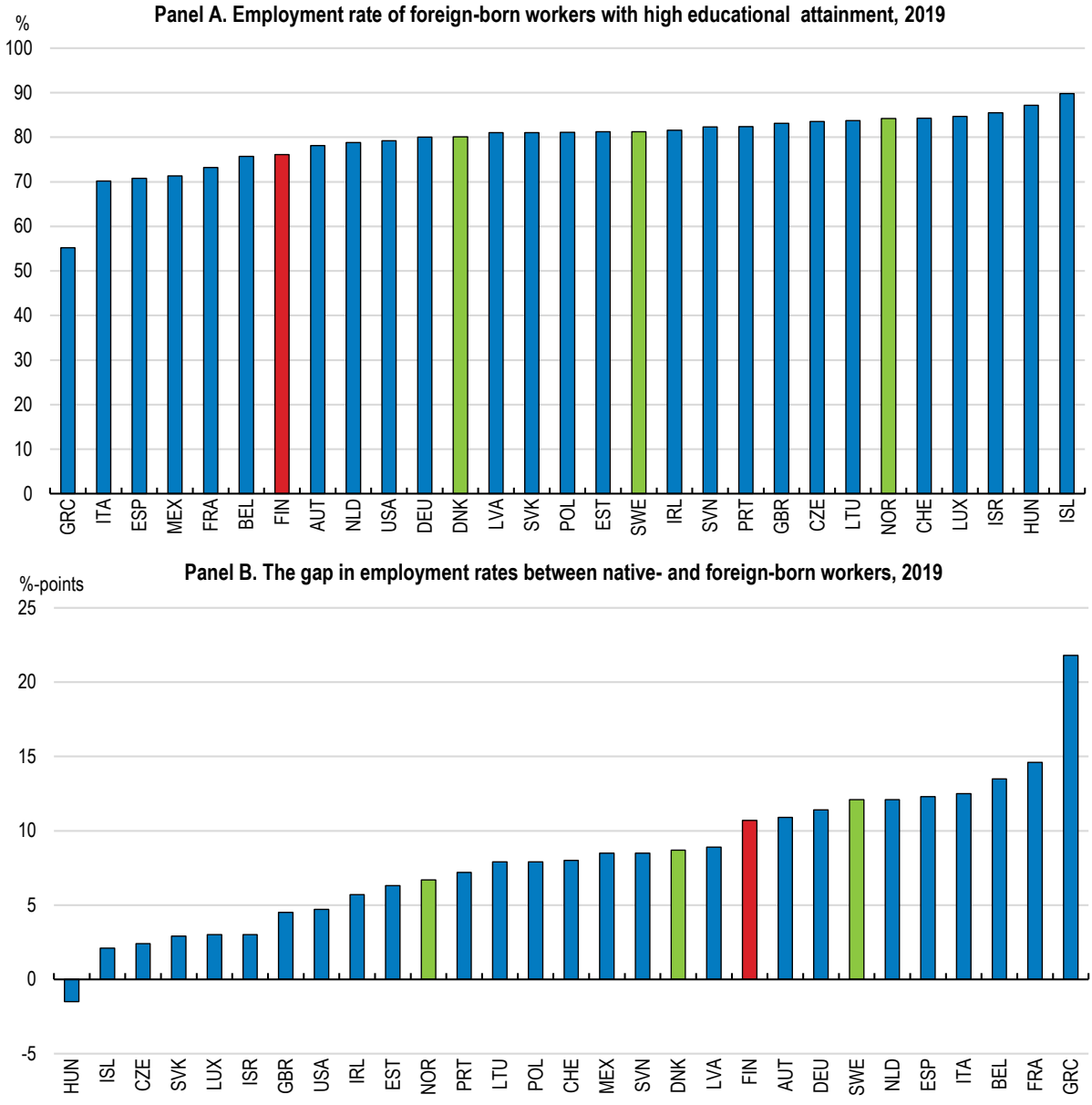
Migration policy took a turn in 2017 when the government launched the Talent Boost programme to attract international talent. This initiated the introduction of policy measures facilitating the immigration of foreign highly skilled workers like the special residence permit for start-ups introduced in 2018. The second phase of the Talent Boost programme was launched in 2020 and its key initiatives included streamlining the residence permit processes for workers and students and promoting the employment of international students and researchers in Finland. The current government aims to increase annual work-based immigration by at least 50 000, to a level that is at least twice the current size, by 2030 and to increase it further by at least 10 000 after 2030.

A notable challenge for Finland is the low employment rate of migrants with high educational attainment relative to many other OECD countries (Figure 2.23, Panel A). The gap in the employment rate between the native- and foreign-born workers is relatively large, albeit smaller than in some major European economies (Figure 2.23, Panel B). Overall, Finland is not making the most of foreign talent, possibly due to various barriers to their employment (see below). Indeed, the OECD Indicators of Talent Attractiveness

rank Finland around the mid-range of the OECD countries in terms of the capacity to attract foreign highly skilled workers, far behind Scandinavian countries (OECD, 2019[47]). This also contrasts with Finland's high attractiveness as a destination for university students and entrepreneurs. The main factor dragging down Finland's attractiveness for foreign highly skilled workers is poor labour market opportunities, which reflects the high unemployment and incidence of over-qualification at jobs by highly skilled foreign workers (Tuccio, 2019[48]). Achieving the government's target on work-based immigration requires improving significantly the career prospects of foreign highly skilled workers in Finland.

Figure 2.23. Finland is not making the best of skilled migrants

Employment rates of foreign- and native-born workers with high educational attainment, 2019



Source: OECD, International Migration (database).

StatLink https://stat.link/fkdauy

Attracting and integrating foreign highly skilled workers into the labour market

The government recently bolstered its efforts to facilitate the immigration of skilled workers. In June 2022, it shortened the time for issuing its decision on residence permit applications by experts, entrepreneurs with global expansion plans, as well as their family members to 14 days. Aside from this fast-track decision for skilled workers, the government is aiming to shorten the average processing time for all work-based and education-based residence permits to 30 days. The government also introduced the D Visa, which allows these skilled workers and their family to enter Finland as soon as they receive a positive response to their residence permit applications, without waiting for the issuance of residence permit cards. The D Visa is to be extended to foreign researchers and students from April 2023. These measures are a notable improvement over the previous residence permit procedure that took longer than in Finland's peer economies, holding back the inflow of highly skilled workers as well as foreign direct investment (OECD, 2021[49]).

Various measures to promote the employment of foreign workers are in place, including advocacy events promoting the benefits of diverse workplaces and websites matching Finnish employers with foreign jobseekers. Business Finland's Talent Explorer scheme subsidises Finnish firms for hiring foreign experts by covering half of their hiring costs up to 40 thousand euros. Business Finland's direct R&D grants can be used to hire foreign researchers. Nevertheless, no measure has been taken so far to help employers develop capabilities to exploit foreign talents effectively for their business strategy and innovation activities. Measures to diffuse advanced practices in managing foreign talents among employers can facilitate the hiring of highly skilled foreign workers and improve career opportunities for them.

Further efforts are needed to promote the recognition of qualifications held by foreign workers and provide necessary training to fill gaps with the skills required at their workplace. In Finland, the recognition procedure for foreign qualifications is fragmented across regulated professions. The Finnish National Agency for Education decides the recognition for 20 out of the 81 regulated professions as well as the eligibility for positions requiring a higher education degree. Fourteen other authorities evaluate foreign qualifications in their area of competence, such as Valvira, the largest organisation responsible for recognising qualifications in healthcare professions (OECD, 2018[50]). Little assistance is provided to foreign workers in finding the right recognition body and navigating through the complex process. In its roadmap for education and work-based migration (Ministry of Education and Culture, 2021[51]), the government envisages establishing a faster and more effective recognition framework. This framework should include a systematic referral of foreign workers to the corresponding recognition authority and a one-stop shop offering information and services related to the assessment and recognition of foreign qualifications.

Vocational training for immigrants is offered mostly in Finnish and its pre-requisite level is often prohibitive. Therefore, many migrants fail to transition from the integration training on language skills to vocational training, compromising their employment prospects (OECD, 2018[50]). The government should increase the provision of vocational education and training offered in foreign languages while strengthening language training beyond the initial integration phase. Finnish employers often require native-level language proficiency from foreign workers. While this is understandable for jobs requiring intensive interactions with end consumers, the government should encourage firms to adopt more measured language requirements in others job categories. Language training for immigrants in Finland has been biased toward formal education curricula, with little relation to actual language needs in workplaces (OECD, 2018[50]). The government plans to increase opportunities for foreign workers to learn Finnish/Swedish in workplaces and to encourage employers to offer language training.

Reforms to accelerate the recognition of foreign qualifications and enhance the effectiveness of vocational training for foreign workers should be high on the government's agenda, for they would contribute to the swift employment of Ukrainian refugees with skills corresponding to the sectors with high labour shortages like healthcare.

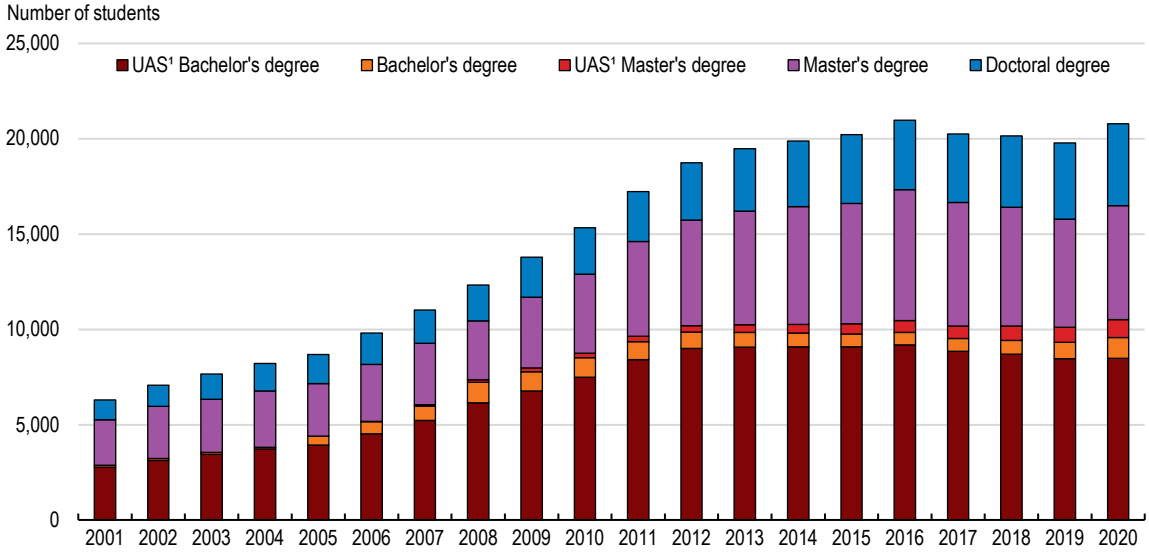
Attracting foreign students and promoting their employment in Finland

The government has set a goal of tripling the number of foreign students enrolling in Finland's tertiary education from around 5 000 in 2020 to 15 000 by 2030. It also committed EUR 46.2 million in 2021-24 to promote the internationalisation of higher education institutions and education-based immigration. Furthermore, it aims to raise the share of foreign students being employed in Finland upon graduation to 75% by 2030. The number of foreign students increased rapidly in the latter half of the 2000s and in the early 2010s but seems to have plateaued after 2016 after the introduction of tuition fees for non-European foreign students (Figure 2.24). The increase has been driven mainly by foreign students enrolling in the University of Applied Science bachelor's degree and university graduate programmes (Master's and PhD), while the contribution of university bachelor's degree programmes has been limited due to the shortages of study places that results in high rejection rates. The government's goal on increasing foreign students is unlikely to be met without successful reforms in boosting study places (see above).

To achieve its targets, the government needs to capitalise on strong demand for Finland's tertiary education by non-European students. In 2021, the acceptance rate for study places for foreign students from EU/EEA countries was 29%, slightly lower than that of Finnish students (31%), whereas that of other foreign students was only 22% (OECD, 2021[42]). At the same time, there were 20 736 applicants from non-EU/EEA countries, four times more than the number of applicants from EU/EEA countries. In 2019, around half of non-EU/EEA foreign students were employed in Finland one year after their graduation, whereas a little less than 40% of students from EU/ EEA countries were (OECD, 2021[42]). The large number of applications by non-EU/EEA students and their higher propensity to remain in Finland indicate that there is further room to boost the number of foreign students and their employment by enrolling more non-EU/EEA students. Since these students already comprise two-thirds of foreign students in Finland, this would inevitably reduce the share of EU/EEA students. Nevertheless, it would be difficult to triple the number of foreign students as the government aims to do without capturing the large education demand by non-EU/EEA students.

Figure 2.24. The number of foreign students increased rapidly but has plateaued in recent years

The number of foreign students enrolled in Finland's higher education institutions in 2001–2020



1. University of applied sciences.
Source: Vipunen - Education Statistics Finland.

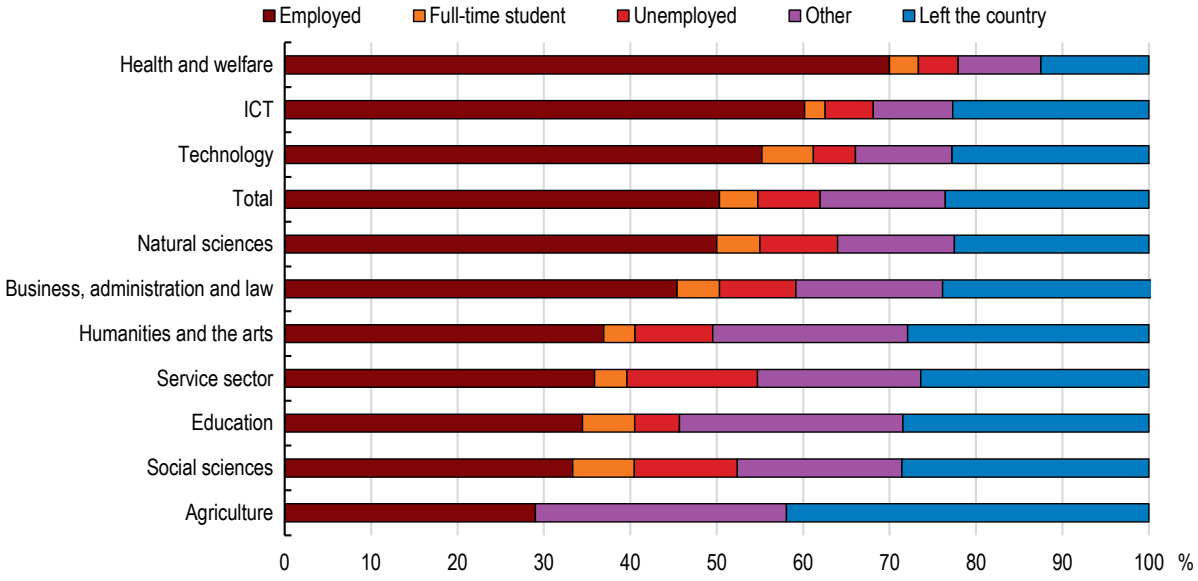
StatLink https://stat.link/6kjny1

Foreign students' most popular fields of study are economics, technology and ICT (Ministry of Education and Culture, 2021[51]). Half of the foreign students who graduated from a higher education institution found a job in Finland one year later (Figure 2.25), whereas nearly one quarter of all graduates left Finland. Foreign students in some study fields need more time to find a job following completion of their degree. While 70% of foreign graduates in health and welfare were employed after a year, only one third of the graduates in social sciences and humanities were.

The government substantially alleviated the administrative burdens faced by foreign students seeking to work in Finland after their graduation. Previously, foreign students were subject to a relatively lengthy process for acquiring a residence permit for studying in Finland and often had to renew the permit during their study. Upon their graduation, they were allowed to stay only for a year to look for jobs under the so-called jobseeker's permit. As the result, many of them left Finland despite the desire to stay. A new law entered into force in April 2022 granting residential permits to foreign students for the entire duration of their studies and extending the jobseeker's permit to two years. Nevertheless, those who find a job must undergo a lengthy process to obtain a work-based residence permit. The government should consider granting a post-graduation work permit as is done in Canada (Box 2.8). In the short run, it should apply the fast track processing of work-based residence permits for highly skilled foreign workers (see above) to foreign graduates who find a job.

Figure 2.25. The chance of swift employment varies by field of study

Foreign students' labour market outcome one year after their graduation, 2020



Source: Vipunen - Education Statistics Finland.

StatLink https://stat.link/6el5ux

Box 2.8. The post-graduation work permit in Canada

Canada grants a temporary post-graduation work permit (PGWP) to foreign students who studied full time and graduated with a degree from a designated learning institution (DLI), which are post-secondary education institutions including universities authorised by a provincial or territorial government to host international students.

Foreign students can apply for PGWP within 180 days following graduation. The PGWP is valid for up to three years depending on the length of the programme completed at a DLI, which cannot be shorter than eight months. Students should have a valid study permit to apply for a PGWP but even those with an expired study permit can still apply within 90 days of the expiration by paying an extra charge. The PGWP cannot be renewed.

Source: Government of Canada Post-Graduation Work Permit Program homepage.

Encouraging the return of highly skilled Finnish workers

Increasing circular and return migration of highly skilled Finnish workers is also high on the government's agenda (Ministry of Education and Culture, 2021[51]). Finnish students, especially those from the capital region where the shortages of study places are most severe, often leave Finland for their tertiary study (see above). This adds to skills shortages in Finland as these students often remain abroad to work due to higher earnings there than in Finland, where the wage distribution is compressed. In addition, foreign degrees are not well recognised by Finnish employers, which is a significant barrier to the employment of returning students. The government should follow the example of Australia, Germany and Denmark by providing employers with access to comprehensive databases about international education systems and courses to help employers understand the value of foreign qualifications (OECD, 2018[50]), which would also facilitate the employment of foreign skilled workers. Preferential income tax treatment is an important measures for attracting foreign talents in many OECD countries (OECD, 2011[52]). Foreign experts starting to work in Finland enjoy a 32% flat income tax rate for at most two years. However, this treatment does not apply to Finnish nationals returning from abroad. The government could consider extending this treatment to returning Finnish highly skilled workers, as is done in France.

Reaping higher returns to innovation through internationalisation

More Finnish firms should export

As in many small open economies, Finland's business-based R&D and innovation activities have been driven importantly by the export performance of Finnish firms (Deschryvere, Husso and Suominen, 2021[20]). Exporting stimulates innovation, because it allows firms to reach a production scale at which R&D and other investment in innovation pay off (Box 2.9). Exports have also been an important channel for Finnish firms to learn about advanced technologies from foreign buyers and feed such knowledge into innovation (Ali-Yrkkö, 2010[4]). Furthermore, participation in global value chains has strengthened the innovation capabilities of Finnish firms in part by making use of sophisticated imported intermediate inputs.

Box 2.9. Why do exporting firms innovate more?

Across OECD countries, exporting firms are found to innovate more than non-exporting firms (for instance, Baldwin and Gu (2004[53]) for Canada; Damijan, Kostevc and Polanec (2008[54]) for Slovenia; Sin et al. (2014[55]) for New Zealand; and Peters, Roberts and Vuong (2020[56]) for Germany).

R&D and other innovation activities are often associated with large fixed costs that cannot be recovered. Firms therefore engage in innovation activities only if they expect a considerable returns covering these large sunk costs. Firms that export can capture the returns to innovation, such as larger sales in both domestic and foreign markets. Therefore, they have a stronger incentive to innovate than non-exporting firms, especially in countries with small domestic markets (Bustos, 2011[57]; Lileeva and Trefler, 2010[58]). Exporting firms also have a better chance to succeed in innovation because exporting provides a chance to absorb the diffusion of technology and knowledge from the global frontier (Peters, Roberts and Vuong, 2020[56]). As innovation translates into higher productivity and thus stronger export competitiveness, there is a positive feedback loop between exporting and innovation (Damijan, Kostevc and Polanec, 2008[54]).

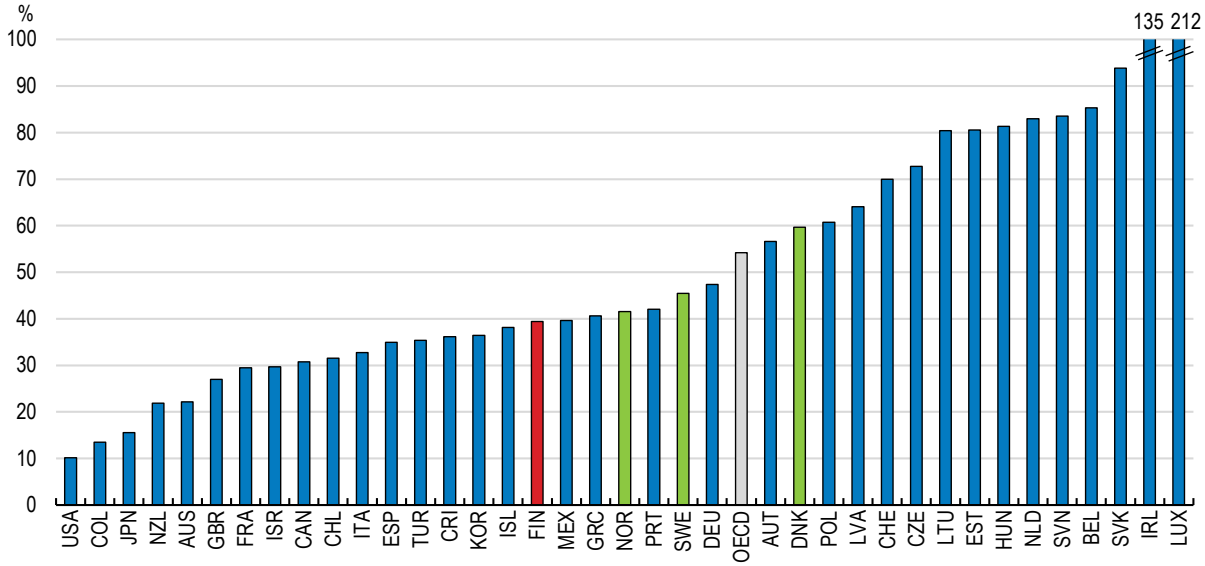
In some cases, decisions to innovate and export are made in tandem. For instance, firms that are not sufficiently competitive in foreign markets have an incentive to innovate and boost their competitiveness so that they can penetrate foreign markets (Lileeva and Trefler, 2010[58]).

Finland has ample room to enhance export participation among a wider range of Finnish firms. Finland's export intensity is low compared to other small open economies, including Scandinavian ones (Figure 2.26). A little less than 10% of Finnish firms export, a share that is smaller than in Denmark and some other small open economies (Figure 2.27). At the same time, 74% of large Finnish firms export, indicating that the low share of exporting firms reflects a large mass of midcap firms and SMEs that do not export. Finland's exports are also highly concentrated in a handful of large firms: in 2019, its largest 100 exporters comprised close to 60% of Finland's exports, a share that is higher than for Scandinavian peers (Figure 2.28). In contrast, the weight of SMEs in exports and participation in global value chains in Finland is low compared to the OECD average (OECD, 2021[59]). It is desirable that a larger mass of firms participate in Finland's exports, not least because the high concentration of exports to among a handful of firms exposes Finland's exports to firm- and sector specific shocks. Diversification of the export base and comparative advantage would not only improve the resilience of Finland's export performance to these shocks but also of its innovation ecosystems, considering the experience in the 2000s when innovation performance deteriorated rapidly driven by the downfall of the key export industry (Box 2.2). Finland needs to strengthen its export competitiveness in a broad range of sectors by promoting the positive feedback loop between exporting and innovation (Box 2.9), especially among smaller firms.

Finland's SMEs and midcap firms often struggle to enter and survive in export markets, which limits the returns they can reap from innovation (Box 2.9). The common issues include lack of managerial capabilities and know-how in formulating competitive export strategies, as well as insufficient investment in marketing and development of new products tailored to foreign customers' tastes (Koski et al., 2020[60]).

Figure 2.26. Export intensity is lower than for many other small open economies

Exports as % of GDP, 2021 or latest

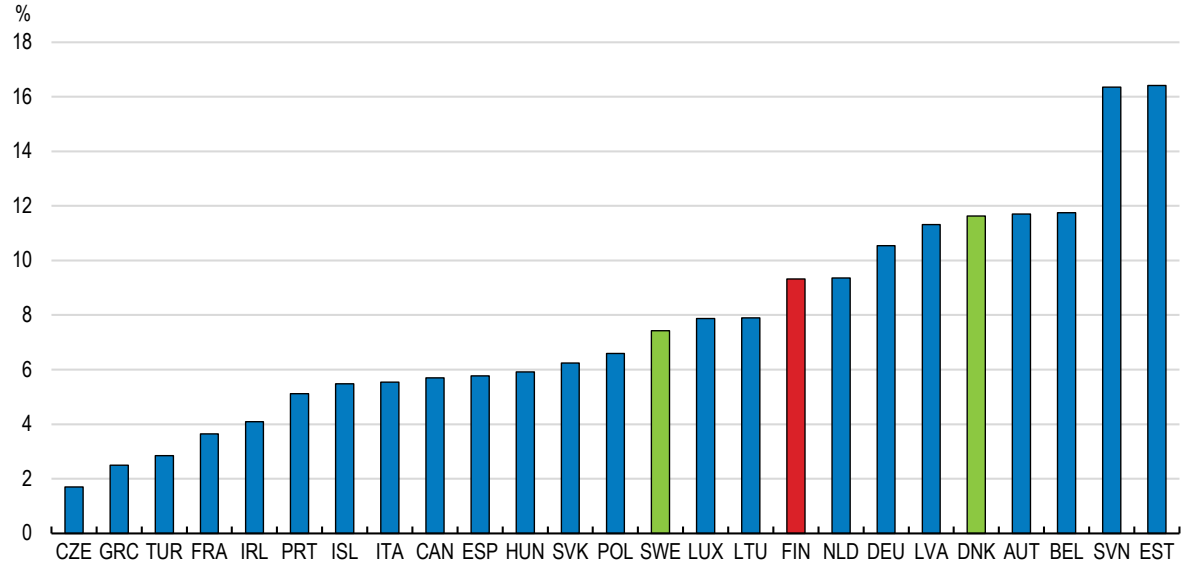


Source: OECD (2022), Trade in goods and services (indicator).

StatLink https://stat.link/nvzhy8

Figure 2.27. The share of exporting firms is low compared to other small open economies

The share of exporting firms in the total number of firms, 2019

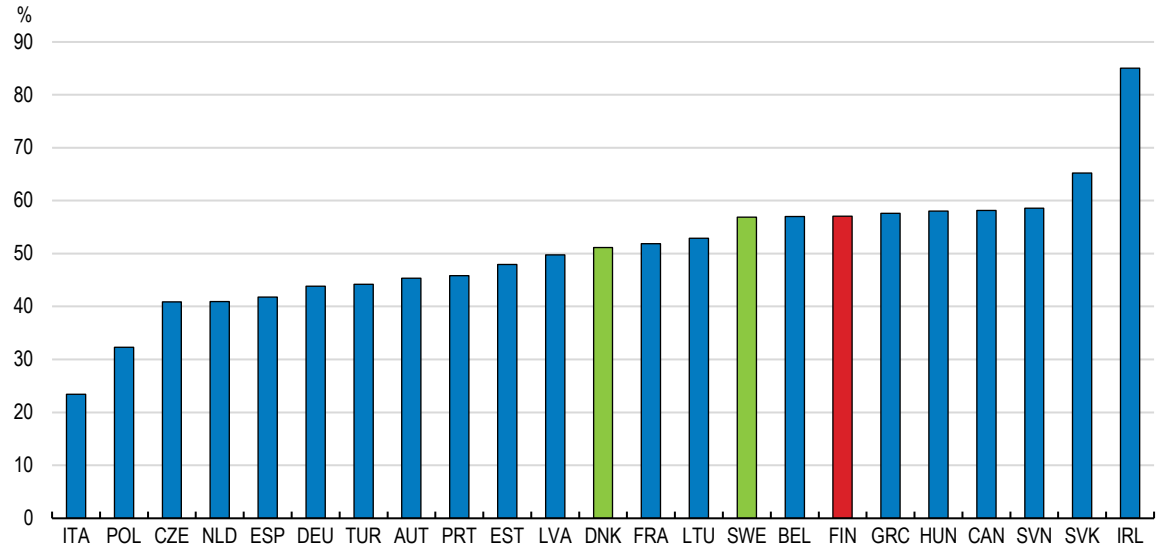


Source: OECD, Structural and Demographic Business Statistics.

StatLink https://stat.link/s9h6mx

Figure 2.28. Finland's exports are relatively concentrated in the largest exporters

The share of the largest 100 exporting firms in total exports, %, 2019



Source: OECD, Trade by Enterprise Characteristics (database).

StatLink https://stat.link/9srlwq

Export promotion and innovation support should be integrated further

Business Finland offers extensive services to Finnish firms seeking to export, including the provision of market information and consulting services, matching with foreign buyers and investors, and partial finance of firms' efforts to strengthen their capacity to export. For instance, its Tempo funding covers 75% of the costs firms incur to prepare export strategies, up to EUR 50 000. It funds activities like the piloting of new products, marketing, and managerial and organisational reforms. A fund is also available for hiring external experts for conducting a market survey assessing export opportunities or participation in a trade fair in foreign countries. Furthermore, Business Finland targets its R&D support (Box 2.7) to SMEs and midcap firms seeking significant growth in export markets through innovation. However, an empirical evaluation (Koski et al., 2020[60]) found that these export promotion and R&D support measures have not resulted in a significant increase in exports by recipient firms. Nevertheless, these measures increased their sales, suggesting that they helped firms boost competitiveness.

The effectiveness of export promotion services can be enhanced further. The consulting services for firms seeking to export were made free of charge in 2014. This induced many firms with very low export capabilities to apply for the services, overburdening the capacity of Business Finland and its overseas offices (Koski et al., 2020[60]). Introducing a small fee for the consulting and matching services can ensure that only firms with readiness to export use those services. Export promotion services can focus more on promoting export entry of midcap firms and SMEs with high technological capabilities but insufficient knowledge of foreign business. Capitalising on these low hanging fruit while offering more introductory services to a broader range of firms online would enhance the efficiency of public spending on export promotion. The resources for export promotion services were revamped in 2020, bringing the number of experts in the overseas offices to 150. Yet, each overseas office consists of only a few experts and cannot follow up on diverse industries. Stronger collaboration with the export promotion offices of other European countries, especially Nordic countries, is thus essential to boost their capacity. A successful example of such collaboration is the Nordic Innovation House, funded by the Nordic government agencies and Nordic Innovation (an organisation under the Nordic Council of Ministers), which helps firms to grow their export business by providing co-working places and networking opportunities, mentorship, and innovation programmes in five innovation hubs around the world. A similar collaboration scheme can be explored more widely, for instance to facilitate the penetration of midcap firms and SMEs into the markets of large emerging economies.

There are several ways to exploit a stronger synergy between innovation support and export promotion, which was the rationale for the merger of Tekes and Finpro into Business Finland. Stakeholders in Finland's innovation ecosystem have voiced mixed views on the extent of such synergy, some expressing a concern that the merger biased the innovation support toward the later stages of innovation, where new technologies can be more easily commercialised and exported (Deschryvere, Husso and Suominen, 2021[20]). While ensuring balanced support at each stage of innovation, the innovation support by Business Finland could bring in export promotion considerations earlier on in the process. For instance, this involves identifying unmet needs in the global market at a very early stage and formulating export strategies at the commercialisation stage of innovation. Business Finland could also extend its innovation support toward non-R&D innovation activities aimed at capturing export markets, such as new product development targeting foreign customers or organisational changes that strengthen cost competitiveness and increase capabilities to handle global business operations.

Benefiting more from foreign direct investment

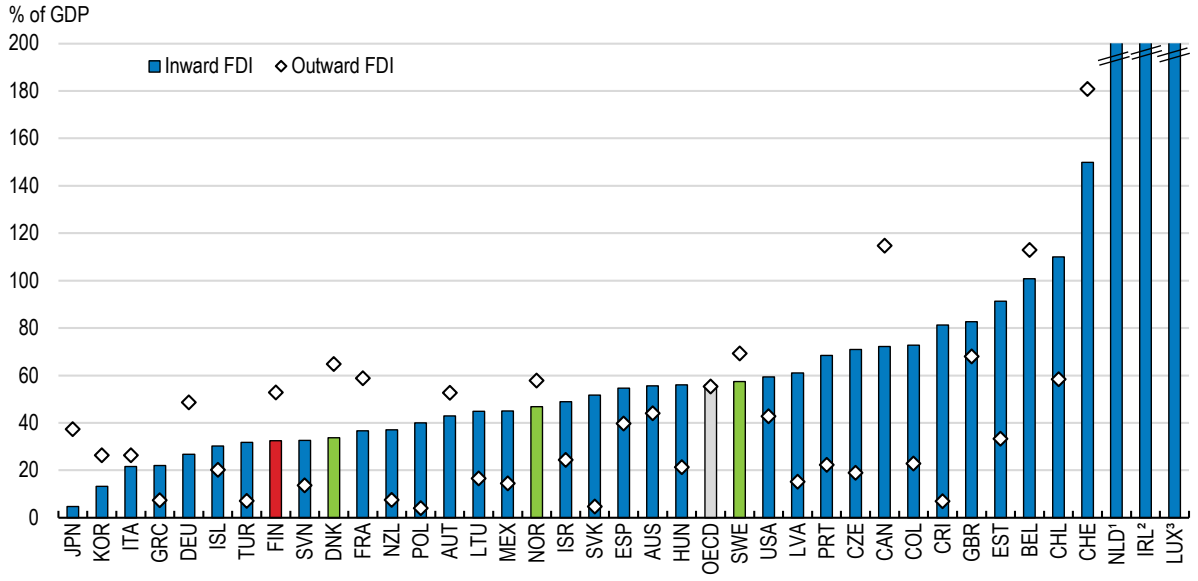
Finland should leverage more inward foreign direct investment (FDI) as a driver of innovation and an opportunity for the internationalisation of innovative Finnish firms. Finland has received smaller FDI relative to GDP than many other OECD countries, especially other Nordic or small open economies (Figure 2.29), in contrast to its relatively large outward FDI. FDI generates knowledge spillovers to local firms as they observe the advanced products and management practices of multinational enterprises (MNEs). Such demonstration effects can indeed stimulate innovation by local firms competing in the same industry (Ito et al., 2012[61]). However, these firms can also lose their market shares against the technologically advanced MNEs, making the net benefits of FDI ambiguous. Clearer benefits of FDI are observed among local firms in upstream or downstream industries, which benefit from the use of advanced intermediate goods supplied by MNEs or technology transfer from MNEs associated with a buyer-supplier relationship (Javorcik, 2004[62]).

Local firms that receive FDI (foreign affiliates) often display higher productivity, better innovation performance and managerial practices than domestic firms, partly because they enjoy technology and knowledge transfer from their parent MNEs (Bloom, Sadun and Van Reenen, 2012[63]). At the same time, such an advantage may be driven mainly by the fact that MNEs target exceptional local firms that are more innovative and productive to begin with (Arnold and Javorcik, 2009[64]). Indeed, the primary reason for foreign investors to invest in Finnish firms is to access their technology and skills (OECD, 2021[49]). It is also common for innovative Finnish firms to be acquired by foreign firms. The benefits of receiving FDI thus depend on the investing MNEs being more technologically advanced than the receiving Finnish firms (Berghäll, 2017[65]). FDI also provides opportunities for the receiving firms to penetrate the home market of the parent MNEs or participate in the global value chains they operate. Indeed, foreign affiliates account for about 40% of Finland's exports (OECD, 2021[49])

While Finland's regulatory barriers to FDI is low, the scope of sectors and activities that might fall under the scope of the screening mechanisms is not clearly defined (OECD, 2021[49]). While this legal uncertainty is addressed to some extent by preliminary discussions often held between authorities and foreign investors, more could be done to increase the predictability of FDI screening processes, for instance by publishing guidelines for the screening process that foreign investors can refer to. Invest in Finland, the sub-organisation of Business Finland, has been providing an array of measures to attract and facilitate FDI. It has recently introduced innovative measures including a customized, company-specific "virtual visit" to Finland as response to the travel constraints imposed by the pandemic and aftercare services for foreign investors to facilitate the business expansion by foreign affiliates in Finland. Such supporting measures can include promotion of R&D investment by foreign affiliates and their participation in Finland's innovation ecosystems.

Figure 2.29. Inward FDI is relatively low

Stock of inward FDI as % of GDP, 2020



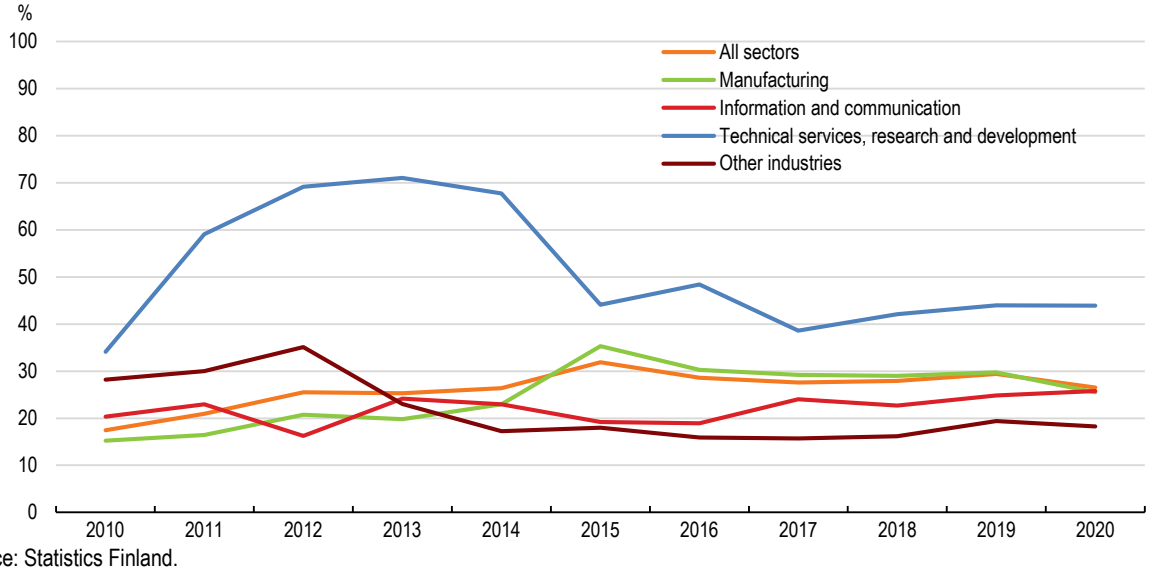
Note: The observations for the Netherlands, Ireland, and Luxembourg are the following: 1. The Netherlands: outward FDI: 254, inward FDI: 330. 2. Ireland: outward FDI: 276, inward FDI: 291. 3. Luxembourg: outward FDI: 1169, inward FDI: 1468.
Source: OECD, FDI statistics (database).

StatLink https://stat.link/6m3jsp

Participation of foreign firms in Finland's innovation ecosystems can facilitate the transfer of cutting-edge technologies invented elsewhere and strengthen the international linkages of Finland's innovation ecosystems. The weight of foreign enterprises in Finland's business-based R&D spending increased during the early half of the 2010s, most notably in technology services, but has moderated since (Figure 2.30). In 2020, foreign enterprises accounted for 26.5% of Finland's business-based R&D. While this share cannot be easily compared to those in other OECD countries due to limited data availability, the 2017 estimate by the OECD (2017[66]) suggests that it is relatively low, especially compared with Sweden (42%) and Norway (32%).

Figure 2.30. The weight of foreign affiliates in business-based R&D has not increased

The share of foreign affiliates in Finland's business-based R&D spending



Source: Statistics Finland.

StatLink https://stat.link/kczspw

Innovation support should be made readily accessible to foreign affiliates to induce more intensive innovation activities by these firms in Finland. The innovation support measures provided by Business Finland are already accessible to foreign affiliates. Foreign affiliates that pay tax in Finland should also be allowed to claim the forthcoming R&D tax allowance for their R&D conducted in Finland. Efforts to attract foreign affiliates in the innovation ecosystems support programmes funded by the Academy of Finland and Business Finland (Section 2.3) are warranted, provided that they are willing to build an innovation ecosystem engaging Finnish firms. An example of an innovation ecosystem created by a foreign affiliate is Silicon Vallila in the Helsinki region established by GE Healthcare in 2014, which hosts start-ups to promote partnership in research and product development.

The government should promote partnerships between MNEs and innovative Finnish firms geared toward exports, for instance through buyer-supplier linkages. Business Finland offers extensive services to foreign investors, notably providing data and information to assist their decision to invest in Finland, matching them with Finnish firms to form a business partnership and supporting their administrative work for setting up a business. However, it does not provide significant support to Finnish firms seeking to tap into foreign demand through a partnership with MNEs. Business Finland's internationalisation support for Finnish firms is oriented more toward exporting than establishing domestic transactions with MNEs or foreign affiliates. It could for instance advise Finnish SMEs seeking to supply MNEs and provide them with financial support for their efforts in building a capacity to meet the product quality or specifications required by MNEs. It is important that these support measures also enable SMEs to diversify their partners so that they are not locked into a monopsonistic relationship with specific MNEs.

Main findings	Recommendations (key recommendations in bold)
Revamping innovation support in more effectively	
The government reached a political agreement to boost public sector R&D spending to 1.33% of GDP by 2030 (one third of the 4% R&D target by 2030) and will introduce legislation mandating a long-term R&D funding plan providing guidelines on the allocation of government R&D spending.	While ensuring ample support to basic research, set clear mission-oriented objectives and directions for support measures for applied research that respond to the most pressing societal challenges in the long-term R&D funding plan. Work closely with the private sector in determining the orientation of long-term R&D funding and designing innovation support schemes. Complement the R&D spending target with targets for other indicators that enable more comprehensive monitoring of progress toward better innovation ecosystems. Collect information on R&D spending by innovative start-ups and micro-enterprises.
The government will introduce an R&D tax incentive with an upper limit, making it insignificant for large companies.	**When sufficient data are available, evaluate the effects of this tax incentive and adjust it accordingly.** Provide guidelines specifying the scope of activities covered by the tax incentive.
Business-based R&D spending is concentrated among large firms and the weight of SMEs is particularly small in applied research. The contribution of foreign affiliates to business-based R&D is low compared with Sweden or Norway. Direct R&D support has been effective in boosting R&D spending by Finnish firms but not their productivity.	Promote stronger collaboration between the Academy of Finland and Business Finland in their innovation ecosystems support. Attract small firms into innovation collaboration programmes. Ensure that innovation support is readily accessible to foreign affiliates. Better target R&D grants and loans at firms with high innovation capabilities.
Removing the skills bottleneck to unleash innovation	
Chronic shortages of study places in higher education institutions are resulting in high rejection rates and low tertiary educational attainment among young adults. These in turn contribute importantly to the severe skills shortage that constrains innovation.	**Commit to a credible plan to increase study places in universities and universities of applied sciences and funding for additional study places while enhancing flexibility in the allocation of study places across study fields.** Allocate additional study places across regions and fields of study with a primary purpose of alleviating the skills shortage and meeting labour market demand.
The funding models for universities and universities of applied science (UAS) do not provide sufficient incentives to increase enrolment of students in the fields of study with strong labour market demand.	Increase the weight of bachelor's degrees in universities' funding model. Introduce targets for the number of enrolments and graduates in fields of study with severe foreseen skills shortages. Include in the funding models financial penalties that apply when these targets are unmet.

The employment rate of migrants with high educational attainment is low. The employment and career prospects of foreign highly skilled workers in Finland are worse than in many other OECD countries.	**Promote the recognition of qualifications held by foreign skilled workers and provide effective training to fill the gap between their qualifications and the skills required at their workplace.**
Foreign students graduating from Finnish universities must undergo a lengthy process to obtain a work-based residence permit if they want to work in Finland.	Consider granting foreign graduates a post-graduation work permit. In the short run, apply the fast track to their work-based residence permit applications.
Reaping higher return to innovation through internationalisation	
The export promotion measures have not increased the exports of Finnish firms significantly. The synergy between export promotion and innovation support is limited.	Focus export promotion services on export entry by midcap firms and SMEs with high technological capabilities. Enhance cooperation with overseas offices of export promotion agencies in other Nordic countries. Integrate export promotion at earlier stages of innovation support.
FDI penetration is relatively low and foreign affiliates play a relatively small role in innovation activities. Support for Finnish firms trying to establish domestic transactions with multinational enterprises or foreign affiliates is thin.	Enhance predictability in the FDI screening process. Strengthen the FDI promotion including facilitating the business expansion and innovation activities by foreign affiliates. Provide consulting services to SMEs seeking to collaborate with MNEs. Offer financial support to their efforts in developing the capacity to meet MNEs' product quality standards or product specifications.

References

Ali-Yrkkö, J. (ed.) (2010), *The role of Nokia in the Finnish economy*, Taloustieto Oy, Helsinki. [4]

Ali-Yrkkö, J. and R. Hermans (2002), "Nokia in the Finnish innovation system", *Discussion Paper No. 811*. [5]

Appelt, S. et al. (2020), "The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBeRD project, 2016-19", *OECD Science, Technology and Industry Policy Papers* 92. [31]

Arnold, E. et al. (2022), "Evaluation of the Academy of Finland", *Publications of the Ministry of Education and Culture, Finland* 2022:7. [26]

Arnold, J. and B. Javorcik (2009), "Gifted kids or pushy parents? Foreign direct investment and plant productivity in Indonesia", *Journal of International Economics*, Vol. 79/1, pp. 42-53. [64]

Baldwin, J. and W. Gu (2004), "Trade Liberalization: Export Market Participation, Productivity Growth, and Innovation", *Oxford Review of Economic Policy*, Vol. 20/3, pp. 372-392, https://doi.org/10.1093/oxrep/giti022. [53]

Bank of Finland (2021), "Finland's new long-term forecast suggests GDP growth will be more subdued", *Bank of Finland Bulletin* 5/2021. [23]

Berghäll, E. (2017), "Knowledge Spillovers, the Technology Frontier and High-Tech FDI-Evidence from Finland", *Finnish Economic Papers*, Vol. 28/1, pp. 34-49. [65]

Bloom, N., R. Sadun and J. Van Reenen (2012), "Americans Do IT Better: US Multinationals and the Productivity Miracle", *The American Economic Review*, Vol. 102/1, pp. 167-201. [63]

Brynjolfsson, E., D. Rock and C. Syverson (2021), "The Productivity J-Curve: How Intangibles Complement General Purpose Technologies", *American Economic Journal: Macroeconomics*, Vol. 13/1, pp. 333-372. [12]

Business Finland (2022), *Results and Impacts 2021*. [38]

Bustos, P. (2011), "Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on argentinian firms", *American Economic Review*, Vol. 101/1, pp. 304-340, https://doi.org/10.1257/aer.101.1.304. [57]

Corrado, C. et al. (2021), "New evidence on intangibles, diffusion and productivity", *OECD Science, Technology and Industry Working Papers*, No. 2021/10, OECD Publishing, Paris. [9]

Corrado, C. et al. (2016), "Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth", *EIB Working Papers 2016/08*, Vol. 2016/08. [11]

Corrado, C. and C. Hulten (2010), "How Do You Measure a "Technological Revolution"?", *American Economic Review: Papers & Proceedings*, Vol. 100, pp. 99-104. [8]

Damijan, J., Č. Kostevc and S. Polanec (2008), "From innovation to exporting or vice versa? Causal link between innovation activity and exporting in Slovenian microdata", *LICOS Discussion Paper Series*, No. 204/2008, LICOS Centre for Institutions and Economic Performance, Katholieke Universiteit Leuven, http://www.econ.kuleuven.be/licos (accessed on 27 September 2021). [54]

Deschryvere, M., K. Husso and A. Suominen (2021), "Targeting R&D intensity in Finnish innovation policy", *OECD Science, Technology and Industry Working Papers* 2021/08. [20]

Einiö, E. et al. (2022), "Innovation, reallocation, and growth in the 21st century", *Publications of the Government's analysis, assessment and research activities*, Vol. 2022:1. [37]

European Commission (2022), *Digital Economy and Society Index (DESI) 2022: Finland*. [14]

European Commission (2020), *Country Report Finland 2020*. [44]

European Commission (2019), *The Environmental Implementation Review 2019 Country Report FInland*. [16]

Fornaro, P. et al. (2020), *Evaluation of Tekes R&D Funding for the European Commission*. [35]

Foster, L., J. Haltiwanger and C. Krizan (2002), "The link between aggregate and micro productivity growth: evidence from retail trade", *NBER Working Paper*, Vol. 9120. [6]

Granstrand, O. and M. Holgersson (2020), "Innovation ecosystems: A conceptual review and a new definition", *Technovation*, Vol. 90-91/102098. [2]

Hirvonen, J., A. Stenhammar and J. Tuhkuri (2022), "New Evidence on the Effect of Technology on Employment and Skill Demand", *ETLA Working Paper* 93. [39]

HMRC (2018), *R&D tax relief: conditions to be satisfied: BIS Guidelines (formerly DTI Guidelines) (2004): application to software*. [34]

Ito, B. et al. (2012), "How do Chinese industries benefit from FDI spillovers?", *China Economic Review*, Vol. 23/2, pp. 342-256. [61]

Jacobides, M., T. Knudsen and M. Augier (2006), "Benefiting from innovation: Value creation, value appropriation and the role of industry architectures", *Research Policy*, Vol. 35, pp. 1200-1221. [3]

Javorcik, B. (2004), "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages", *American Economic Review*, Vol. 94/3, pp. 605-627. [62]

Koski, H. and P. Fornaro (2022), "The Design of R&D Tax Incentive Schemes and Firm Innovation", *ETLA Report* 123. [30]

Koski, H. and M. Pajarinen (2015), "Subsidies, the Shadow of Death and Labor Productivity", *Journal of Industry Competition and Trade*, Vol. 15, pp. 189–204. [36]

Koski, H. et al. (2020), "Global Growth for Companies-Impact Study", *Report* 4/2020. [60]

Kuusi, T. et al. (2016), "A Study on the Finnish R&D Tax Credit of the Years 2013–2014", *ETLA Reports* 51. [28]

Larrue, P. (2021), "The design and implementation of mission-oriented innovation policies: A new systematic approach to address societal challenges", *OECD Science, Technology and Industry Policy Paper* 100. [24]

Lileeva, A. and D. Trefler (2010), "Improved access to foreign markets raises plant-level productivity. . .for some plants", *Quarterly Journal of Economics*, Vol. 125/3, pp. 1051-1099, https://doi.org/10.1162/qjec.2010.125.3.1051. [58]

Ministry of Economic Affairs and Employment; Ministry of Education and Culture (2021), *Updated National Roadmap for Research, Development and Innovation*. [19]

Ministry of Economic Affairs and Employment; Ministry of Education and Culture (2020), *Objectives and targets of the National Roadmap for Research, Development and Innovation: A new beginning for RDI cooperation between companies and research organisations*. [18]

Ministry of Education and Culture (2021), "Roadmap for education-based and work-based immigration 2035", *Publications of the Finnish Government* 2021:86. [51]

Ministry of Finance (2022), "General government fiscal plan for 2023–2026", *Publications of the Ministry of Finance*, Vol. 2022:29. [22]

OECD (2021), "Expanding and steering capacity in Finnish higher education – Thematic policy brief", *OECD Education Policy Perspectives* 50. [42]

OECD (2021), *OECD Environmental Performance Reviews: Finland 2021*, OECD Publishing, Paris. [15]

OECD (2021), *OECD Science, Technology and Innovation Outlook 2021*, OECD Publishing, Paris. [33]

OECD (2021), *OECD SME and Entrepreneurship Outlook 2021*, OECD Publishing, Paris. [59]

OECD (2021), *R&D intensity as a policy target: main takeaways from 11 international case studies*. [21]

OECD (2021), *Report on OECD R&D tax incentives database, 2021 edition*. [29]

OECD (2021), *The Impact of Regulation on International Investment in Finland*, OECD Publishing, Paris. [49]

OECD (2020), *Continuous Learning in Working Life in Finland, Getting Skills Right*, OECD Publishing, Paris. [45]

OECD (2020), *OECD Digital Economy Outlook 2020*, OECD Publishing, Paris, https://doi.org/10.1787/bb167041-en. [13]

OECD (2020), *OECD Economic Surveys: Finland 2020*, OECD Publishing, Paris. [46]

OECD (2020), *OECD Mission-Oriented Innovation policies online toolkit*, https://stip.oecd.org/moip/. [27]

OECD (2019), *OECD Indicator of Talent Attractiveness*, https://www.oecd.org/migration/talent-attractiveness/. [47]

OECD (2018), *Skills for Jobs: Insights*, https://www.oecdskillsforjobsdatabase.org. [41]

OECD (2018), *Working Together: Skills and Labour Market Integration of Immigrants and their*, OECD Publishing, Paris. [50]

OECD (2017), *OECD Reviews of Innovation Policy : Finland 2017*, OECD Publishing, Paris. [1]

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The digital transformation*, OECD Publishing, Paris, https://doi.org/10.1787/9789264268821-en. [66]

OECD (2013), *Supporting Investment in Knowledge Capital, Growth and Innovation*, OECD Publishing, Paris, https://doi.org/10.1787/9789264193307-en. [10]

OECD (2011), *The Taxation of Mobile High Skilled Workers*, OECD Publishing, Paris. [52]

Paunov, C. and S. Planes-Satorra (2021), "What future for science, technology and innovation after COVID-19?", *OECD Science, Technology and Industry Policy Papers*, Vol. 107. [25]

Peters, B., M. Roberts and V. Vuong (2020), "Firm R&D Investment and Export Market Exposure"*, NBER Working Paper*, No. 02138, National Bureau of Economic Research, Cambridge. [56]

Research and Innovation Council (2017), *Vision and road map of the Research and Innovation Council Finland*, https://valtioneuvosto.fi/en/research-and-innovation-council/meetings. [17]

Sin, I. et al. (2014), "Exporting, Innovation and the Role of Immigrants"*, Motu Working Paper*, No. 14-15, Motu Economic and Public Policy Research, Wellington, https://doi.org/10.2139/ssrn.2537149. [55]

Statistics Finland (2022), *Statistical data/Innovation*, https://www.stat.fi/en/statistics/inn. [7]

Takalo, T. and O. Toivanen (2017), "Estimating the Potential and Pitfalls of an Innovation Policy Re-form: A Counterfactual Analysis of the Finnish R&D Tax Credit Scheme", *mimeo*. [32]

Technology Finland (2021), *Study: Finland's technology industries will need 130,000 new experts within 10 years – The skills shortage in ageing Finland threatens to devastate digi-green economic growth*, https://teknologiateollisuus.fi/en/ajankohtaista/press-release/study-finlands-technology-industries-will-need-130000-new-experts. [40]

The government of Finland (2019), *Inclusive and competent Finland – a socially, economically and ecologically sustainable society: Programme of Prime Minister Sanna Marin's Government 2019*, https://valtioneuvosto.fi/en/marin/government-programme. [43]

Tuccio, M. (2019), "Measuring and assessing talent attractiveness in OECD countries", *OECD Social, Employment and Migration Working Papers* 229. [48]