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FOSTERING INNOVATION IN ICELAND FOR THE DIGITAL ERA

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ABSTRACT / RESUME

Fostering innovation in Iceland for the digital era

Iceland is an innovative country, but has untapped innovation potential. Strengthening innovation, especially in the ICT area, is crucial for strong productivity growth and performance in an increasingly digitalised world, as well as a sustained recovery from the COVID-19 pandemic. Ensuring more effective public support for business R&D is important. The R&D tax incentive scheme is generous by international comparison, but take-up has been low and many smaller firms have not been inclined to innovate. Following increased support, outcomes need to be monitored regularly. Adopting new technologies is also essential for stronger innovation outcomes. Competition-friendly framework conditions are key to sharpening firms' incentives to adopt advanced technologies. The public sector too could become more digitalised. The education system needs to provide relevant skills. Participation of adult workers, especially the less educated, in re-skilling and up-skilling programmes should increase further. At the same time, business and universities need to collaborate more to maximise knowledge flows, with important benefits for innovation and society.

JEL Classification: J24; O3; O32; I23.

Keywords: collaboration, digital, innovation, productivity, R&D, skills, tax incentives, technologies.

This Working Paper relates to the 2021 OECD Economic Survey of Iceland (https://oe.cd/isl).

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Favoriser l'innovation en Islande à l'ère numérique

L'Islande est un pays innovant, mais possède un potentiel d'innovation inexploité. Le renforcement de l'innovation, en particulier dans le domaine des TIC, est crucial pour une forte croissance de la productivité et des performances dans un monde de plus en plus numérisé, ainsi qu'une reprise durable après la pandémie de COVID-19. Il est important de garantir un soutien public plus efficace à la R-D des entreprises. Le régime d'incitation fiscale à la R-D est généreux en comparaison internationale, mais le taux d'adoption a été faible et de nombreuses petites entreprises n'ont pas été enclines à innover. Suite à un soutien accru, les résultats doivent être contrôlés régulièrement. L'adoption de nouvelles technologies est également essentielle pour obtenir de meilleurs résultats en matière d'innovation. Des conditions-cadres favorables à la concurrence sont essentielles pour renforcer les incitations des entreprises à adopter des technologies de pointe. Le secteur public aussi pourrait devenir plus numérisé. Le système éducatif doit fournir des compétences pertinentes. La participation des travailleurs adultes, en particulier les moins instruits, aux programmes de recyclage et de perfectionnement devrait encore augmenter. Dans le même temps, les entreprises et les universités doivent collaborer davantage pour maximiser les flux de connaissances, avec des avantages importants pour l'innovation et la société.

Classification JEL: J24; O3; O32; I23.

Mots clés: collaboration, numérique, innovation, R-D, compétences, incitations fiscaux, les technologies.

Ce Document de travail a trait à l'Étude économique de l'OCDE de l'Islande (https://oe.cd/isl)

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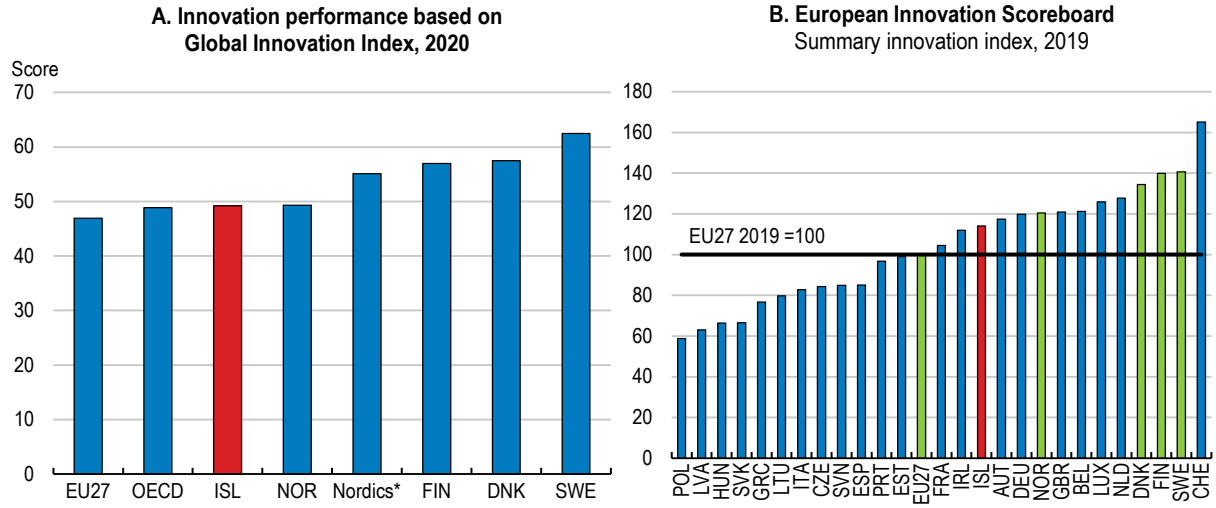
Fostering innovation in Iceland for the digital era

By Vassiliki Koutsogeorgopoulou and Eunha Cho[1]

Iceland has scope to become more innovative and productive

Iceland is an innovative country. Technological innovations are evident in the energy and fishing sectors, including cutting-edge processes for carbon capture and sustainable fish farming, with strides in health technology and towards the development of high-tech solutions in the food industry (Government of Iceland, 2019[1]). In international comparison, Iceland outranks many European countries in terms of overall innovation performance, even though its Nordic peers perform even better (Figure 1). A highly educated workforce and attractive research systems, along with widespread access to, and use, of the Internet provide solid foundations for the digital era (Figure 2, Panel A). Notably, Iceland's density of Internet subscriptions in higher speed tiers, underpinning digital transformation, is well above the OECD average.

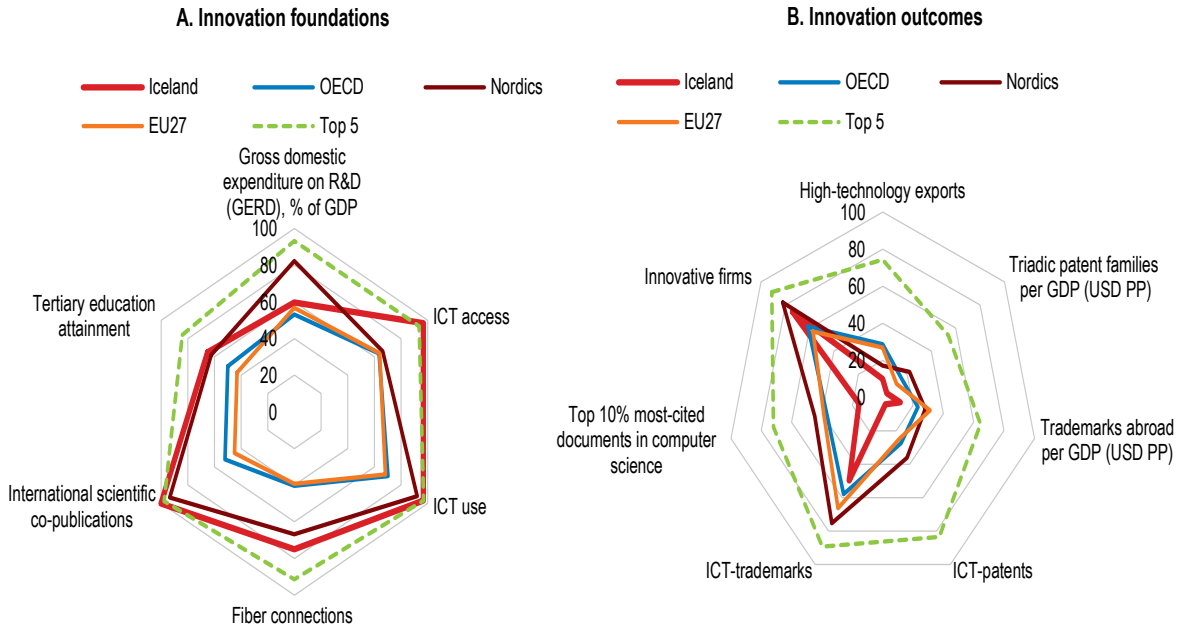
Figure 1. Iceland's overall innovation performance compares well internationally



Note: The country group aggregates represent the unweighted averages for the countries that are available in the database. Nordics refer to Denmark, Finland, Iceland, Norway and Sweden.
Source: European Commission, European Innovation Scoreboard 2020; and Global Innovation Index 2020.

[1] Vassiliki Koutsogeoropoulou is member of the OECD Economics Department. Eunha Cho was a consultant with the Economics Department at the time of writing and is now undertaking Master's studies in Economics at the Ecole Polytechnique – ENSAE. The authors would like to thank Hansjoerg Blöchliger, Vincent Koen, Isabell Koske, Patrick Lenain, Alvaro Pereira, Douglas Sutherland (OECD Economics Department), Silvia Appelt, Dirk Pilat (OECD Directorate for Science, Technology and Innovation), Magdalena Burtscher (OECD Directorate for Employment, Labour and Social Affairs) and Icelandic officials for their valuable comments and feedback on earlier drafts. Special thanks go to Natia Mosiashvili for research assistance, Gemma Martinez and Sisse Nielsen for editorial assistance (OECD Economics Department).

Figure 2. Innovation foundations are solid but some critical outcomes remain weak

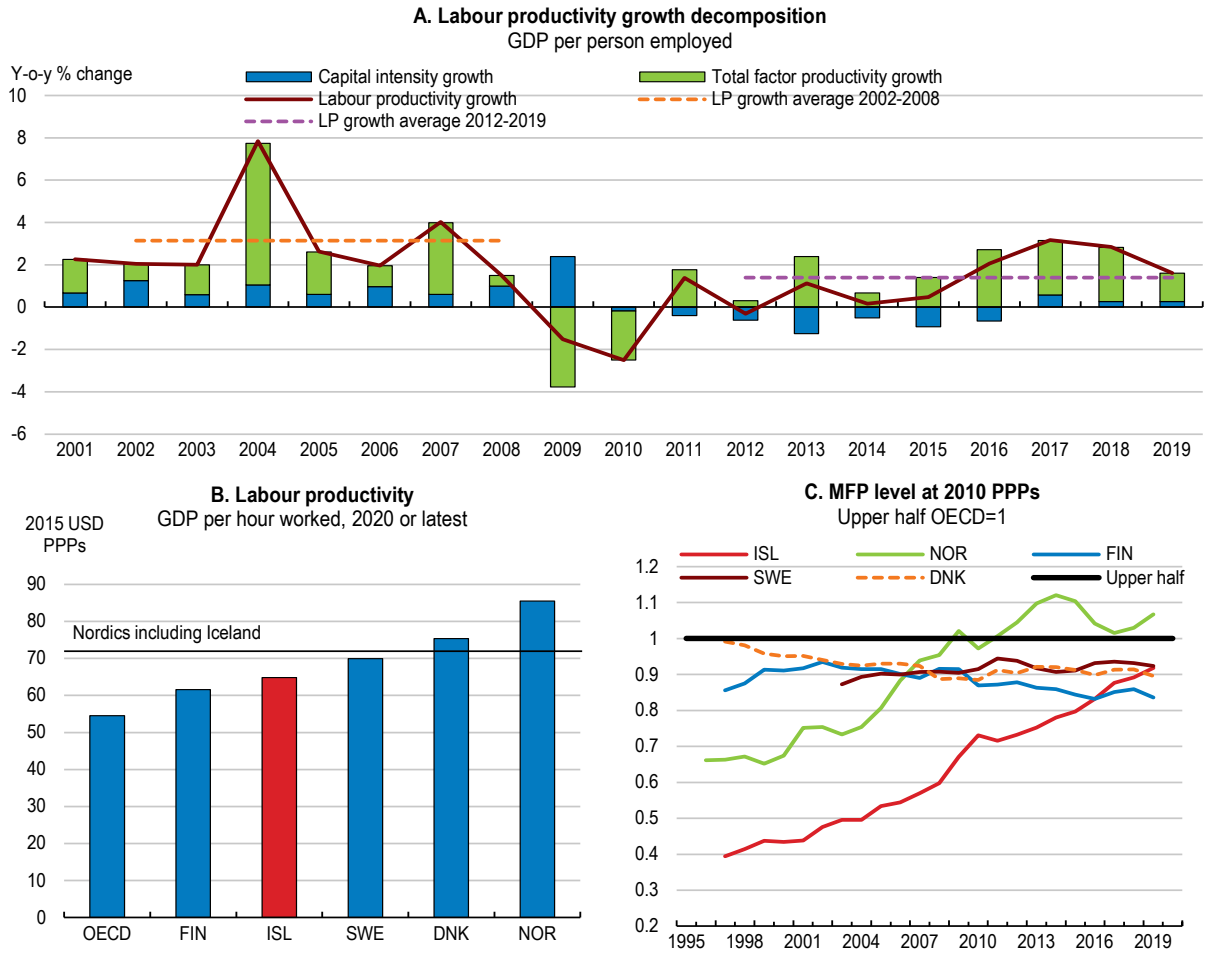


Note: Numbers have been normalised using (value – min)/(max – min)*100. Max refers to the top OECD performer and min to the bottom OECD performer in each category for which the data are available for a given indicator. Top 5 stands for the average of the five best performers. Data for country aggregates represent weighted averages when possible. Nordics includes Denmark, Finland, Iceland, Norway and Sweden. Nordics always refers to an unweighted average.
Source: OECD, Main Science and Technology Indicators database; Global Innovation Index 2020; OECD Information and Communication Technology database; European Commission, European Innovation Scoreboard 2020; OECD, Education at a Glance database; World bank, World Development Indicators; OECD, Science Technology and Patents database; World Innovation Property Organisation; OECD 2019 measuring digital innovation https://doi.org/10.1787/9789264311992-en; and Eurostat, the Community Innovation Survey 2018.

Iceland's innovation potential can be strengthened further. Patents and trademarks, including those relating to information and communications technology (ICT), and exports of technology companies lag behind Nordic standards (Figure 2, Panel B). This may partly reflect the large weight of tourism in the Icelandic economy, a sector that has comparatively low technological intensity, and the prevalence of SMEs, which are less likely to innovate than their larger peers. The relative small size of the country may be another factor.

Strengthening innovation, especially in ICT-enabled innovation (digital innovation), can do much to boost productivity and create new sources of growth, paving the way for a diversified economy and solid performance in an increasingly digitalised world. Innovation can also contribute to a stronger recovery from the COVID-19 crisis, given that labour productivity has increased since the global financial crisis but remains below the average of the Nordic countries (Figure 3). Moreover, productivity growth appears to have slowed recently, reflecting mainly a weakening in multi-factor productivity (MFP). Strong innovation can also help pursue environmental goals (OECD, 2021[2]).

Figure 3. There is scope to boost productivity



Source: OECD National Accounts database; OECD Economic Outlook, No. 109 database; and OECD Productivity database.

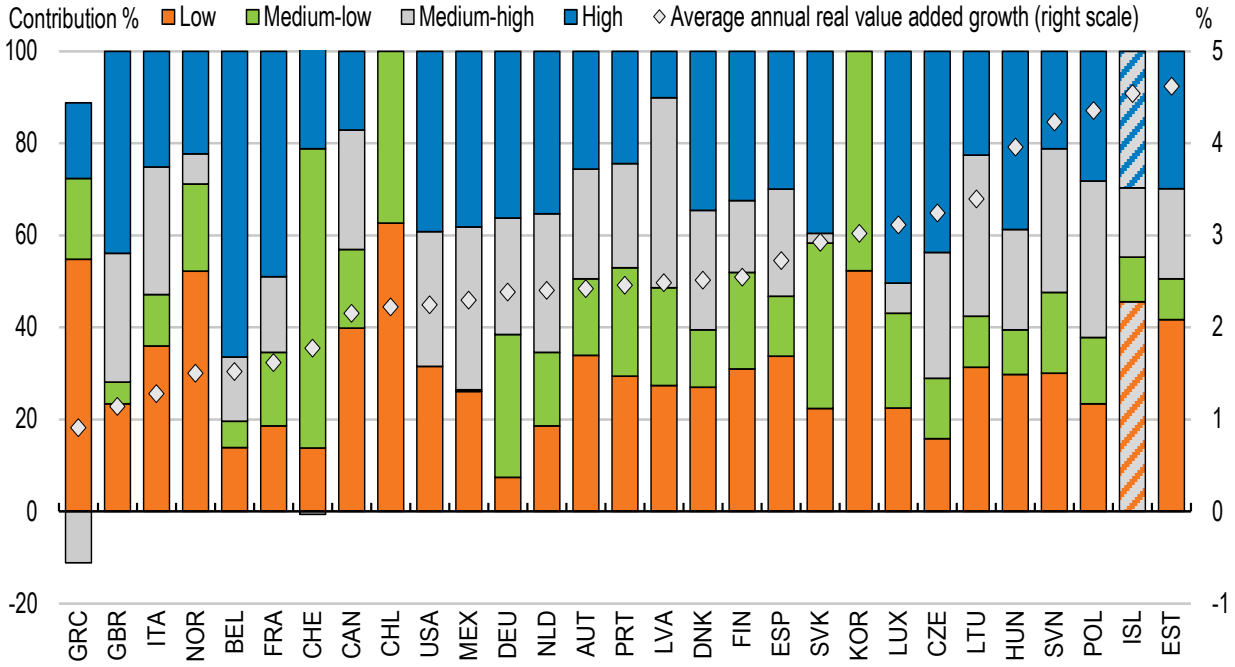
Going forward, Iceland needs to ensure effective support for business R&D, building on past achievements. Seizing the opportunities of new technologies is essential. Digital-intensive sectors (high and medium-high) contribute less to growth in value added than the average of OECD countries (Figure 4). Wider adoption of advanced technologies by firms would strengthen innovation, while yielding productivity gains (OECD, 2020[3]; Sorbe et al., 2019[4]). Scale matters and a small country like Iceland cannot be expected to contribute to genuine innovation and push the technology frontier as much as large countries. Adopting advanced technologies is thereby particularly important for Iceland, helping to explore and make the most of innovation niches. To this end, framework conditions for innovation in the private sector need to be improved. In the public sector, further developing digital government could have a positive societal impact. The provision of appropriate skills is a prerequisite for becoming more innovative and staying competitive in the digital era. To make the most of research outcomes, knowledge exchange between industry and research sectors needs to be strengthened. Deepening the benefits of international co-operation in research would bring additional gains in terms of knowledge flow. The government innovation strategy ("The Innovative Iceland"), currently under implementation, addresses many of these challenges (Box 1), but reform efforts need to continue.

The paper discusses the innovation-related challenges Iceland faces in a digital age and potential areas of further reforms, focussing on: government schemes to support business R&D; options for overcoming barriers to firms' adoption of digital technologies; further development of digital government; education and

adult training policies for the provision of relevant skills; and policy levers to strengthen business-research sector collaboration on innovation. The main findings and recommendations are summarised in a table at the end of the paper.

Figure 4. The contribution of digital-intensive sectors in added value is comparatively low

Digital-intensive sectors' contribution to value added growth, as a percentage of average annual growth in real value added 2015-18, chain-linked volumes (reference year 2015)



Note: "High" identifies sectors in the top quartile of the distribution of the values underpinning the "global" taxonomy, "medium-high" the second highest quartile, "medium-low" the second lowest, and "low" the bottom quartile. Digital-intensive sectors comprise high- and medium-high sectors. 2015-17 data for Germany, Latvia, Lithuania, Norway, Portugal, and Switzerland. 2015-2019 data for Iceland and Greece. Digital intensity is defined according to the taxonomy described in: Calvino, F., C. Criscuolo, L. Marcolin and M. Squicciarini (2018), "A taxonomy of digital-intensive sectors", OECD Science, Technology and Industry Working Papers, No. 2018/14, OECD Publishing, Paris. Factors that define digital intensity of sectors include: ICT tools; human capital needed for their effective use; ICT tangible and intangible (i.e. software) investment; purchases of intermediate ICT goods and services; stock of robots; and turnover from online sales.
Source: Going Digital Toolkit. https://goingdigital.oecd.org/en/indicator/08/.

Box 1. Iceland's Innovation Policy: main features

A new 10-year Innovation Policy, "The Innovative Iceland", launched in 2019, aims to prepare Iceland for future technological changes and related economic and societal challenges. It focuses on three broad challenges associated with the "Fourth Industrial Revolution", the environment and climate change, and demographic changes.

In brief, the Policy is based on five main pillars:

- Mind set: an attitude that is prevalent in the community towards innovation, research, development and start-up activities. Ingenuity of individuals is seen as the most important source of innovation. The essence of the mind set pillar is that innovation is not only the basis of economic success, but rather the key to solving the tasks people face, both today as well as in the coming decades. To this end, innovation will be a part of education policy to ensure that students acquire the necessary skills to thrive in an innovative environment, knowledge derived from innovative projects will be communicated publicly, while emphasis will be placed on improving society's understanding that innovation outcomes tend to take time to materialise.
- Finance: funding of research, development, and innovation and start-up activities. The amount, source and distribution of funds in the innovation environment have a significant impact on the scope and nature of innovation.
- Market access: access by Icelandic entrepreneurs and investors to markets needs to be enlarged to enable more diverse innovation activities.
- The framework, in the form of support agencies, the legal framework, infrastructure and social structure. The support for innovation, along with the general rules of the game regarding innovation and business operations, must always be competitive on a global scale.
- Human resources available to innovative companies: Iceland must develop relevant skills and attract specialized foreign professionals to face international competition.

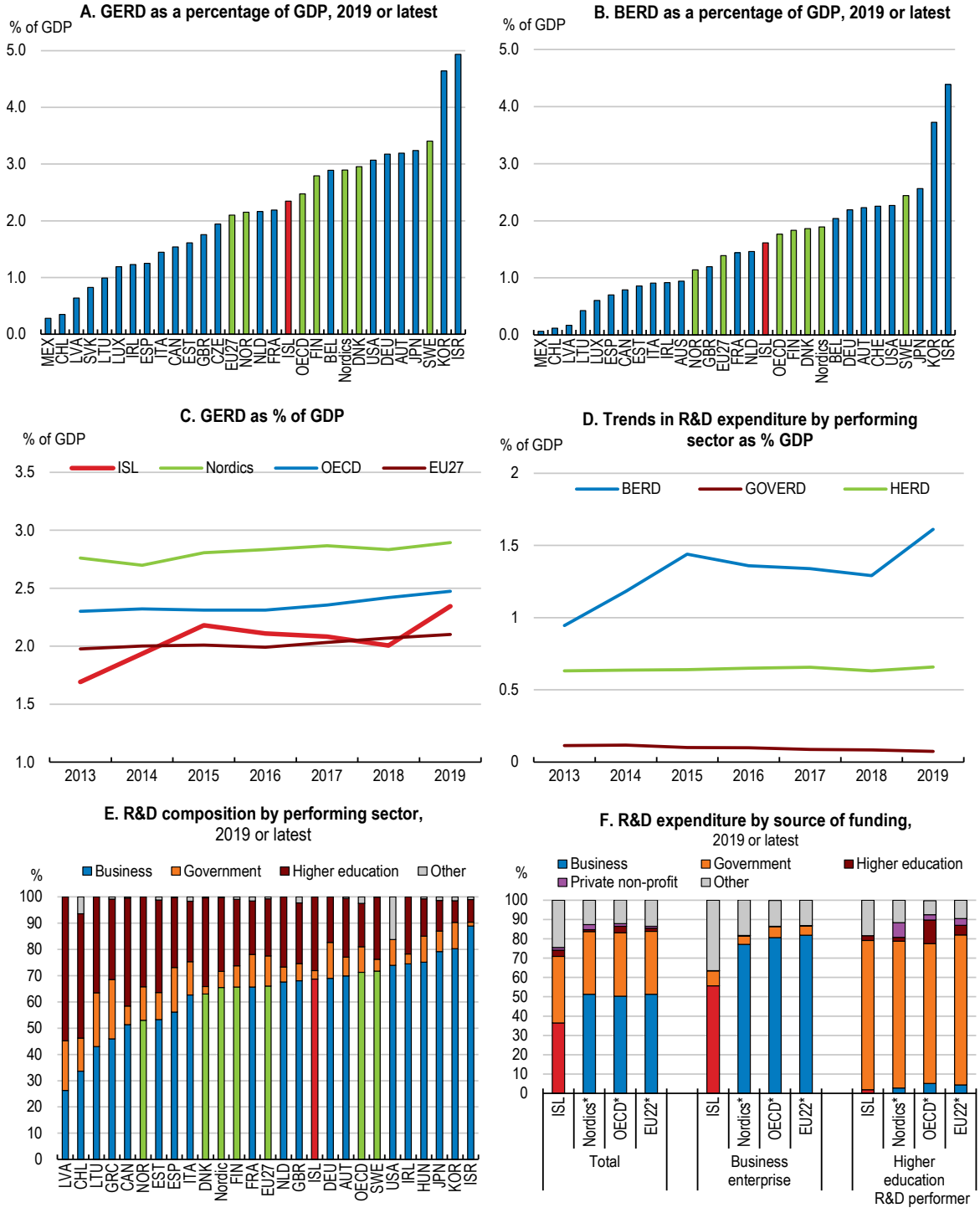
The Policy is currently under implementation. Recent initiatives include the establishment of Kría, a start-up and innovation fund (discussed below), and provision of funds to entrepreneurs, start-ups and institutions in the fields of innovation through increased contributions to the technical development and research funds and specific funding to stimulate entrepreneurship in the countryside. Special focus has been placed on green innovative solutions and innovative solutions in health technology. At the same time, government support to innovation infrastructure is being reorganised to enhance efficiency. Initiatives under the Policy further include the establishment of a new Technical Centre whose main role is to support and stimulate academia-business collaboration in high-tech innovation. Efforts also are being made towards opening access to data from public institutions (discussed below).

Source: (Government of Iceland, 2019[5]); (Government of Iceland, 2020[6]); (OECD, 2020[7]).

Improving R&D support for businesses

Iceland invests approximately 2.3% of GDP on R&D, close to the OECD average (Figure 5). Effective government support will help to increase this share further, not least by mobilising private investment, given that the business sector accounts for around two-thirds of overall R&D (Figure 5, Panel E). Solid framework conditions and closer business-university collaboration (both discussed further below) are also vital.

Figure 5. Iceland has scope to raise R&D spending



Note: GERD stands for Gross domestic expenditure on R&D and BERD for Business enterprise expenditure on R&D. In panels A, B, C, and E OECD, EU27 and Nordics refer to weighted averages of the member countries for which the data is available. Nordics include Denmark, Finland, Iceland, Norway and Sweden. In Panel F, country aggregates that are marked with "*" refer to simple averages of member countries for which data are available.

Source: OECD, Main Science and Technology Indicators database; and OECD, Research and Development Statistics database.

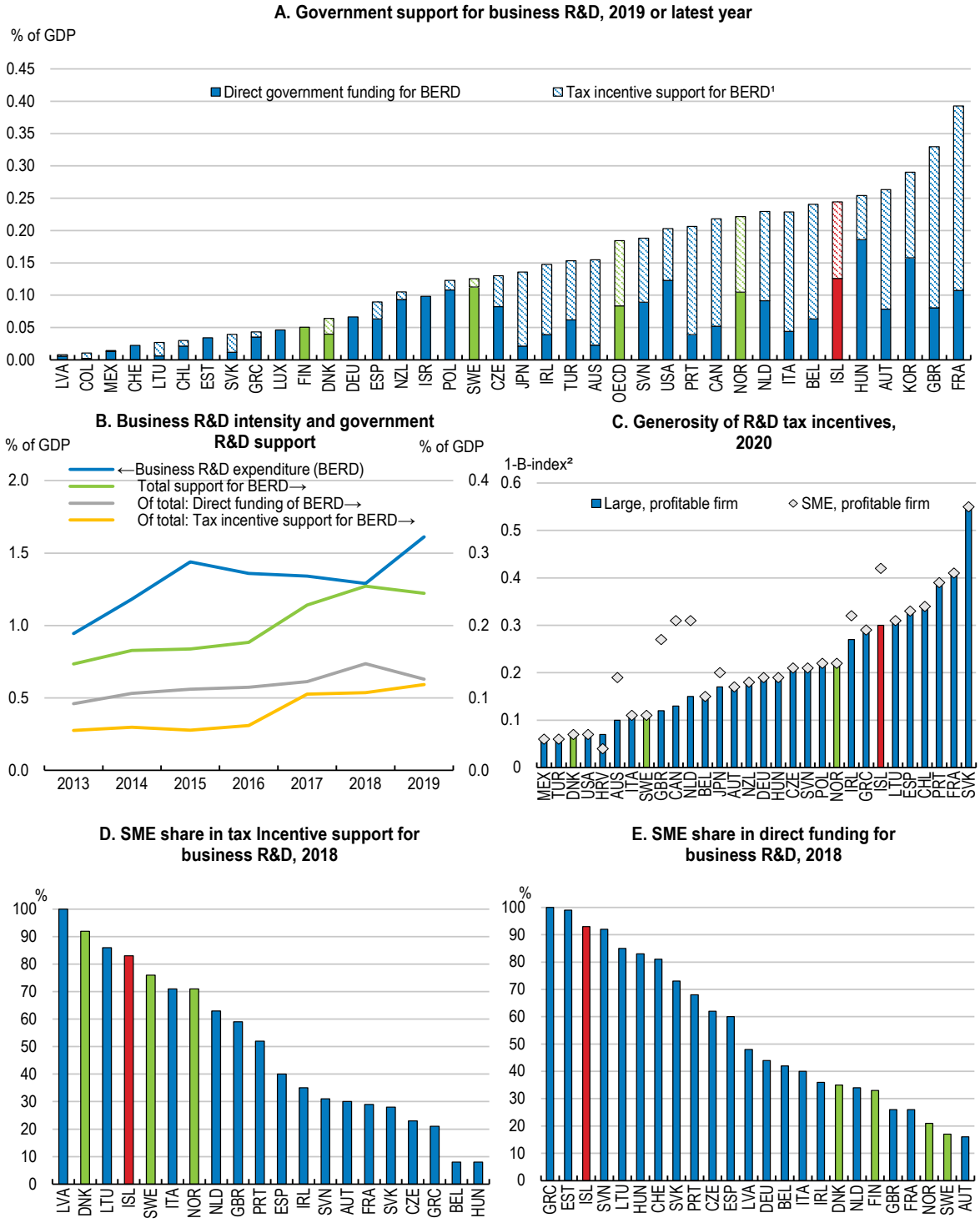
Unlocking innovation potential through R&D support

Iceland's R&D tax incentive scheme is generous by international comparison. Public support for business R&D has increased as a share of GDP in recent years to above OECD and Nordic averages, with tax incentives growing faster than direct support (Figure 6). The R&D tax credit scheme is volume-based, allowing companies to claim a tax rebate on qualifying R&D expenditures up to a ceiling (OECD, 2021[8]). A minimum level also applies to R&D projects. In case of insufficient tax liability, firms are entitled to an immediate refund of unused credits. Changes in 2020, as part of a broader package to counter the impact of the COVID-19 crisis, raised the annual ceiling on qualifying R&D expenditure and introduced different tax credit rates for SMEs and large firms, at 35% and 25%, respectively, from a common rate of 20% previously. These changes increased the generosity of the R&D tax credit (OECD, 2021[8]).

Government tax support for business R&D could be more effective. Business R&D intensity does not match the rapid increase in government support in recent years, especially tax incentives, although the uptick in 2019 is encouraging (Figure 6, Panel B). While the take-up of tax incentives has increased, especially among SMEs, it remains low by international comparison, despite relatively generous provisions (OECD, 2020[9]). The structure of the economy with large natural resources and service sectors, where firms tend to be less likely to undertake R&D-based innovation, and a preponderance of small firms, needs to be accounted for in designing R&D policies. Innovation outcomes of smaller firms, which are the main beneficiaries of government tax support for R&D, remain relatively weak and the gap between small and large firms is non-negligible (Figure 7). Whereas innovation outcomes can be influenced by other factors as well, ensuring effective tax support for business R&D is very important. R&D tax incentives should better target smaller innovative firms through more generous provisions for young innovative firms, on the basis of carefully designed eligibility criteria. Such firms face most difficulties to access finance. Some countries such as France, the Netherlands and Portugal specifically target young firms and start-ups. Reform options include the provision of a higher tax credit rate for young innovative firms or more generous refund conditions for such firms in the case of insufficient tax liability (Criscuolo et al., 2016[10]). This could be financed, for instance, by a reduction in the tax credit rate for larger firms or a reduced ceiling, to make the reform revenue neutral. When targeting young innovative firms, it is important to avoid incentives to split parts of a company just to meet the age criteria, for example, through restrictions on associated enterprises and mergers (Ognyanova, 2017[11]).

The cost-effectiveness of R&D tax incentives needs to be assessed regularly to inform policy choices and further reforms. The government aims to evaluate the tax credit scheme since its introduction in 2011 (Government of Iceland, 2020[6]). The assessment is of high priority and will focus on the uptake, utility and efficacy of the R&D tax credit and its impact on stimulating private investment and improving the competitive position of innovative firms. The review is welcome and should be completed as scheduled. Crucial to this assessment is input additionality, or the extent to which public support prompts R&D over-and-above the amount that would be undertaken without it. This requires comprehensive information on R&D investment, including matched R&D activity and tax relief data. Initiatives in this area in other OECD countries, including the Netherlands and Norway, are instructive and suggest that introducing a limitation (e.g. threshold or ceiling) beyond which the rate of R&D tax credit will be reduced can do much to encourage additionality (OECD, 2020[12]). Consideration could also be given to output additionality, or the outputs from R&D activities which would have been achieved without public support, as well as assessments of wider economic and social impacts (Appelt et al., 2016[13]).

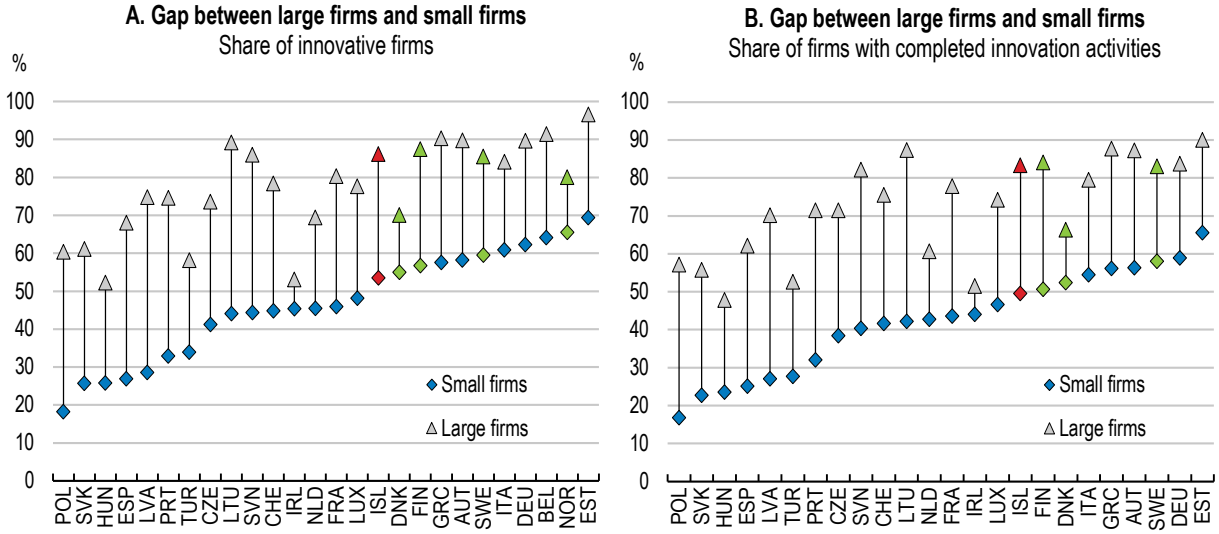
Figure 6. Support to business R&D is comparatively generous



Note: BERD stands for Business enterprise expenditure.1. Subnational tax support for BERD is included in tax support for BERD. 2. The B-index specifies the pre-tax income needed for a "representative" firm (typically defined for convenience as one with sufficiently large profits to be able to fully make use of earned tax credits in the reporting period) to break even on a marginal, monetary unit of R&D outlay (OECD, 2020). It is customary to present this indicator in the form of an implied subsidy rate, namely one minus the B index.
Source: OECD R&D Tax Incentives database. http://oe.cd/rdtax.

Figure 7. Innovative outcomes of smaller firms could improve

2018



Note: 1. The enterprise is considered as innovative if during the reference period it introduced successfully a product or process innovation, had ongoing innovation activities, abandoned innovation activities, completed but yet introduced the innovation or was engaged in in-house R&D or R&D contracted out. 2. Firms with completed "innovation activities" are those which implement product and/or process innovation and at least one innovation activity, such as R&D and acquisition of equipment or software, during 2016-18. For further methodological details, refer to Community innovation survey 2018 (CIS2018) (inn_cis11) (europa.eu).
Source: Eurostat, the Community Innovation Survey 2018.

The effectiveness of tax incentives in promoting collaboration between businesses and research institutions also deserves attention, because this type of collaborative projects tend to have closer links to basic research and, as a result, provide the basis for disruptive innovations (Appelt et al., 2016[13]). Iceland provides explicit incentives for R&D collaboration, but businesses finance only a very small share of the R&D performed by higher education institutions (Figure 5, Panel F). The R&D tax credit scheme, in particular, foresees an increase in the ceiling on qualifying costs in the case of collaborative projects, but it does not discriminate between collaboration among firms, and between firms and research institutions (OECD, 2020[14]). A higher R&D tax-credit premium could therefore be considered for business-research collaborative projects than for other collaborative ventures that do not include research institutions. For example, in Japan, the credit-tax rate rises to 30% for joint or contracted R&D with universities and national research institutes from 20% in the case of collaboration among qualifying companies (apart from venture companies where the applied rate is 25%) (OECD, 2020[15]). In France, expenditures on subcontracted R&D count double if the R&D is outsourced to certain approved research institutions. Reform to the R&D tax-credit scheme would in any case need to be complemented by action in other areas (discussed below) to strengthen collaborative research.

Moreover, R&D tax incentives need to keep adapting to evolving conditions, especially in a digital era. Regular assessments of the scheme's key parameters, such as the scope of eligible R&D and the ceiling for qualifying R&D expenditure, are crucial to ensure cost-effectiveness. In the United Kingdom, for instance, reforms are under way aiming to broaden the scope of qualifying expenditure under the tax credit scheme to include data and cloud computing (OECD, 2020[16]). R&D tax incentives may apply to R&D expenditure or to the income generated from business R&D and innovation.

Patent boxes, also referred to as intellectual property (IP) regimes, provide preferential tax treatment to income generated from intellectual property, even though such regimes could lead to wasteful tax competition without a concomitant increase in innovation activity (Gaessler, Hall and Harhoff, 2018[17]).

OECD countries agreed on a "modified nexus approach" for IP regimes in 2015 restricting the scope of qualifying IP assets and requiring a link between R&D expenditures, IP assets, and IP income (Asen, 2019[18]). Most countries have by now amended or abolished their regime to ensure compliance with the nexus approach (OECD, 2020[19]). Also, by favouring patent holders, patent boxes reduce incentives to innovate through risky experimentation, which is an important driver of R&D dynamics and innovation in the digital era (OECD, 2015[20]). Moreover, young firms that have particular strengths as R&D performers (e.g. in creating radical innovations) are unlikely to benefit from the patent box given the long lags that characterize the patenting process. Instead, large, often multinational, corporations are the main beneficiaries. A careful assessment of the benefits and costs of this type of tax incentive would be required.

A balanced mix of indirect support (tax incentives) and direct funding for business R&D is essential to spur innovation, given their complementarity (OECD, 2020[12]). Indeed, R&D tax incentives are more likely to stimulate short-term applied research and boost incremental innovation, whereas direct funding is more suited for longer-term, high-risk research and for targeting specific areas with long-term research and radical innovations (Appelt et al., 2016[13]); (OECD, 2020[12]). It will be important, in this context, to maintain direct funding to achieve balanced support for business R&D as the economy recovers from the COVID-19 crisis (Figure 6). Such funding also forms the basis for applications by Icelandic firms to international funds that can improve knowledge transfers and innovation (Government of Iceland, 2020[6]). As a welcome step, the current government fiscal plan provides for a significant increase in direct funding for R&D, including for the Tech Development Fund and Research Fund budgets. Evaluation of the supported projects on the basis of rigorous cost-benefit analysis and systematic impact assessments are vital to ensure that government spending on business R&D is prioritised to private sector innovation with disruptive potential.

Greater coordination will strengthen the innovation system

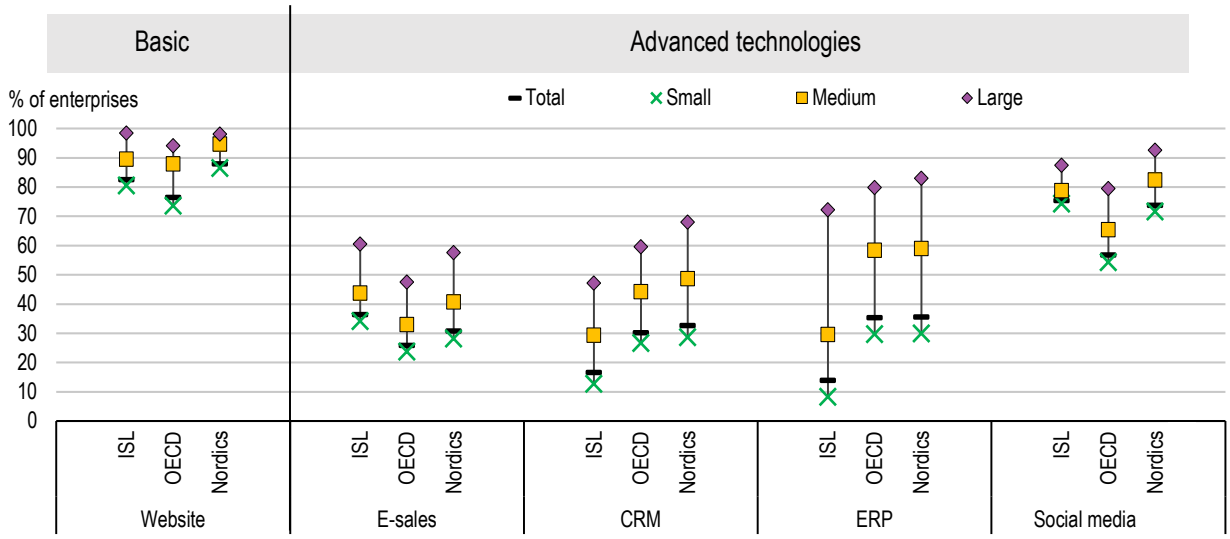
Fragmentation and an insufficient focus on implementation are key shortcomings of Iceland's science and innovation system, with several initiatives in recent years aiming to address these weaknesses. An international peer review of the system in 2014 highlighted, in particular, the scope for enhancing horizontal co-ordination and to clarify and strengthen the role of the Science and Technology Policy Council (ERAC, 2014[21]). It also stressed the need for a more evidence-based policy-making in science and innovation. Since 2014, the Science and Technology Council has been issuing a policy and action plan, which has led to a greater transparency in the implementation of the policy (The Prime Minister's Office, 2020[22]). In addition, the Council's connections with the ministries' functions were strengthened as the directions set by the action and policy plan are incorporated in the government's five-year fiscal strategy.

Efforts need to be stepped up to enhance coordination and strengthen policy design. A task force, set up in 2018 to review the legal framework of the Science and Technology Policy Council, proposed a new organisational structure based on international experience, which is currently under consideration. Central to the proposed reforms is the establishment of a new statutory ministerial committee with a strategic role, which would replace the existing Science and Technology Policy Council alongside a new Council (the Science and Innovation Council) with an advisory role (The Prime Minister's Office, 2020[22]). The Council would provide feedback to the ministerial committee based on solid analysis and operate as an independent body. The task force has also proposed to transfer the policymaking responsibilities in the science and innovation area to individual ministers in order to ensure ownership. The ministerial committee would be in charge of policy coordination. The proposed changes go in the right direction. Important to success, if the government goes ahead with these reforms, is that the policies developed at the ministerial level have clear objectives and are effectively coordinated. Efforts in this area need to be complemented by the development of a comprehensive database for analysis and policy evaluation.

Encouraging firms to adopt advanced technologies

Firms that effectively use digital technologies tend to be more innovative and productive (European Investment Bank, 2020[23]; Gal et al., 2019[24]; OECD, 2016[25]). Iceland fares well in some areas, such as social media use by businesses and e-sales, but it lags behind in others such as the use of enterprise resource planning software (ERP) and customer relationship management (CRM), which enable firms to digitalise and optimise processes and integrate deeper in digital market (Figure 8). As in other countries, there is a digital gap between large and small enterprises. Small firms face barriers to adopt new technologies related to the availability of finance to make the necessary investment, and a lack of requisite human resources and management expertise (OECD, 2019[26]). They may also be more vulnerable to cyber threats.

Figure 8. Icelandic firms, especially smaller ones, have scope for greater adoption of digital technologies



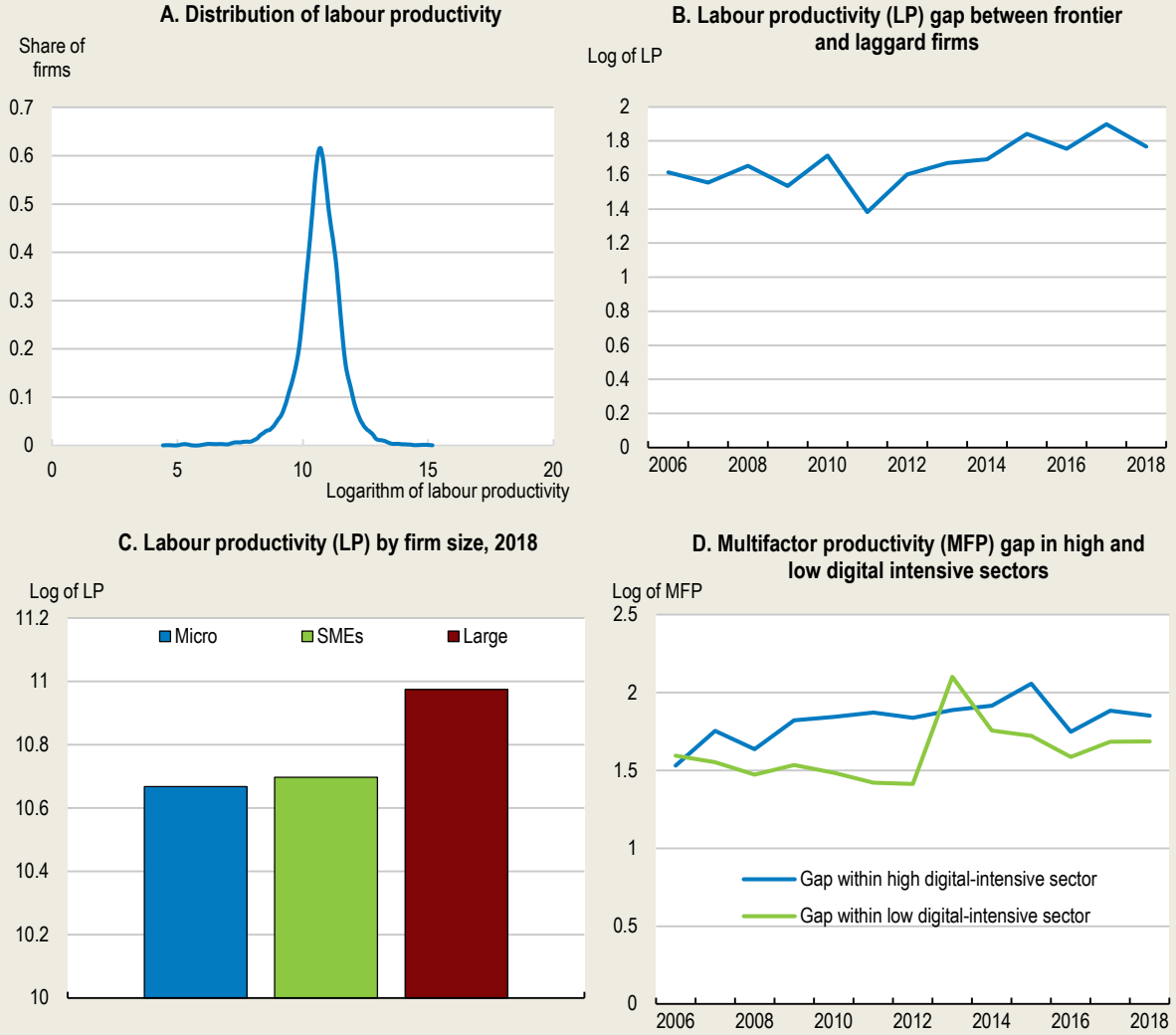
Note: Data for Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) refer to 2017, data for website refer to 2018, data for social media refer to 2019 and data for e-sales refer to 2020. In the figure, “OECD” is the simple average across all OECD countries for which data are available. "Nordics" refers to the simple average of the latest values for Denmark, Finland, Iceland, Norway and Sweden. “Small" stands for enterprises with 10-49 employees, "Medium" for enterprises with 50-249 employees and “Large” for enterprises with 250 employees and over. Total refers to the enterprises with at least 10 employees.
Source: OECD, ICT Access and Usage by Businesses database.

Illustrative OECD scenarios suggest that policy reforms can encourage firms to adopt digital technologies, with associated productivity dividends (Sorbe et al., 2019[4]). This would also help shorten the tail of low-productivity firms (Box 2). For example, increased take-up of high-speed broadband and improved skills (discussed further below) can sharpen the incentives of firms to take advantage of new technologies, but the largest productivity gains are associated with improvements in framework conditions, in particular by reducing regulatory barriers, and easing access to finance for young innovative firms (Figure 11). To enhance the impact, pro-competitive regulations need to be combined with insolvency regimes that do not over-penalise entrepreneurial failure. At the same time, the labour market should remain flexible, while safeguarding workers (OECD, 2021[2]). Sufficiently flexible employment protection regulations encourage experimentation with new technologies and organisational changes. The sections below discuss these policy enablers.

Box 2. Digitalisation and productivity: some empirical findings

Firm-level analysis of labour productivity conducted for this *Survey* reveals a relatively large tail of low-productivity firms in Iceland (Cho and Koutsogeorgopoulou, 2021[27]) (Figure 9). In addition, the labour productivity gap between top- and bottom-performing firms has increased in recent years from already high levels. Digitalisation is a possible contributor to this widening gap, as more productive firms are more likely to adopt advanced digital technologies and benefit from production process reorganisation than their less productive counterparts (Gal et al., 2019[24]). This is because the required digital skills for the adoption of advanced technologies are more likely to be found in highly productive firms. In addition, labour productivity varies according to firm size, with smaller firms underperforming their larger counterparts.

Figure 9. Productivity dispersion remains large

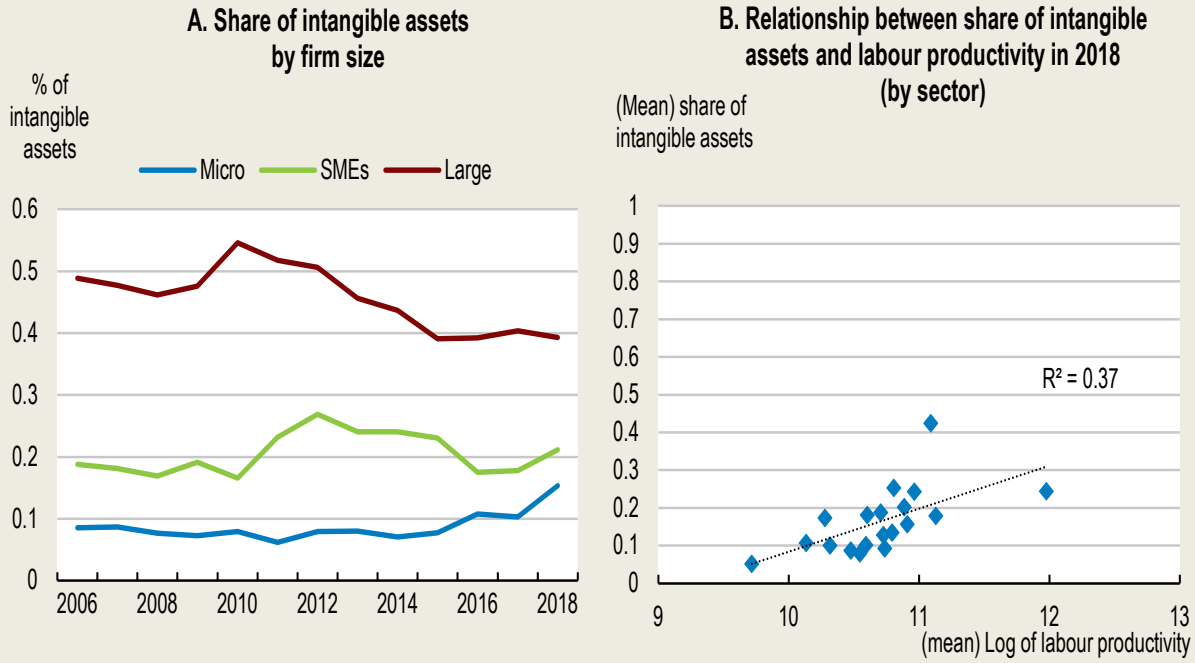


Note: Labour productivity is computed as the ratio of real value added to number of employees. Multifactor productivity measurement is based on the Wooldridge (2009) method. The "frontier" is measured by the unweighted average of the logarithm of productivity for the top 5% of firms with the highest productivity levels in each 2-digit industry and year. "Laggard firms" are measured by the unweighted average of the logarithm of productivity of remaining firms. "Micro" enterprises comprise fewer than 10 employees; small and medium-sized enterprises (SMEs) 10 to 249 employees; and large enterprises more than 250 employees. Sectors are classified as having "high" of "low" digital intensities following the taxonomy by (Calvino et al., 2018[28]). The analysis covers 2-digit industries NACE Rev.2 10 to 82 (excluding 64 to 66).
Source: OECD calculations based on ORBIS data.

At a more aggregate level, the analysis also shows that the productivity gap (measured in terms of multifactor productivity) between top- and bottom-performing firms is larger in more digitally-intensive sectors, such as ICT (Figure 9, Panel D).

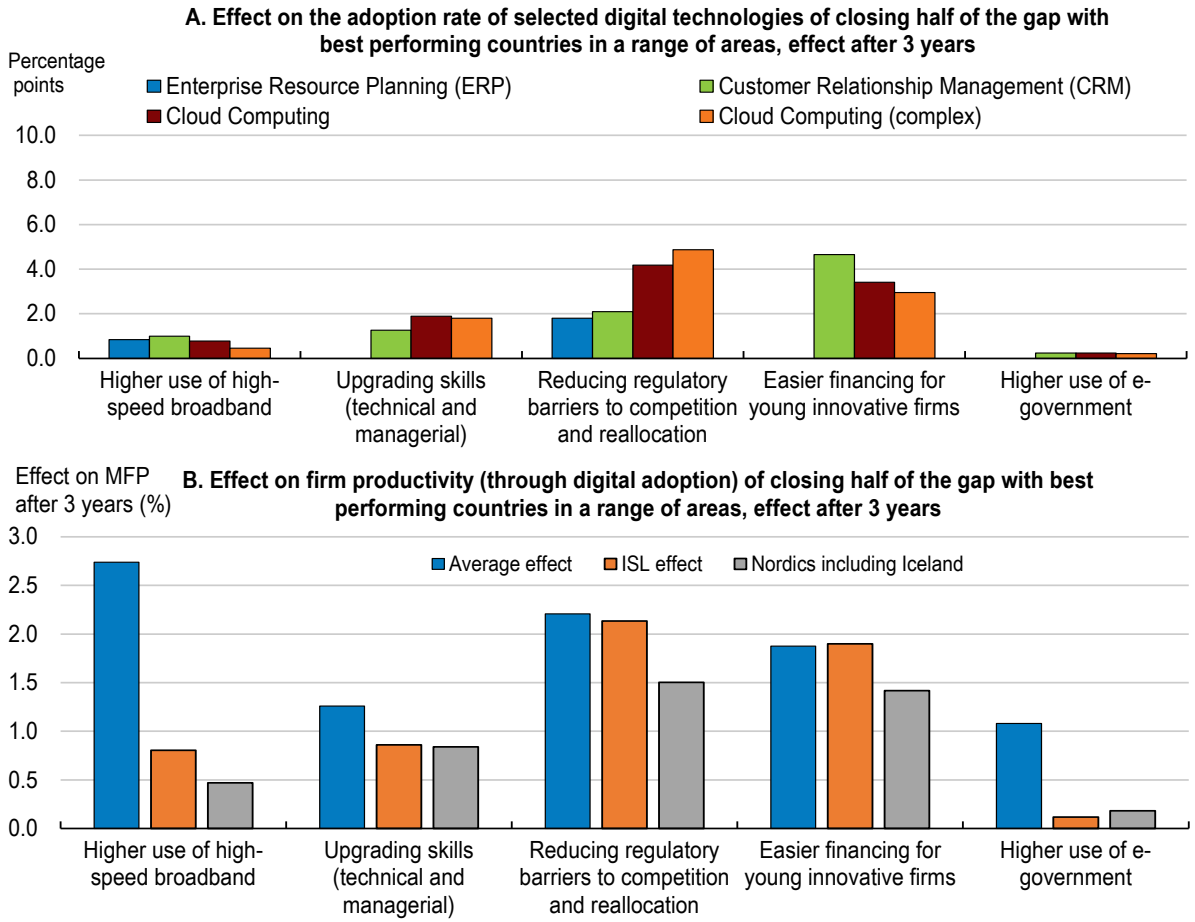
These productivity disparities can be related to differences in investment in intangible assets, given the complementarity that exists between of such investment and adoption of digital technologies (Andrews, Nicoletti and Timiliotis, 2018[29]). Smaller firms, in general, tend to have lower shares of intangible assets compared to larger ones, which can affect their ability to adopt increasingly sophisticated technologies (Figure 10). The results of the sectoral analysis further reveal a positive correlation between productivity performance and intangible investment. The findings suggest, in particular, that more digitally-intensive industries tend to have a higher share of intangible assets and record higher overall productivity compared to their less digitally intensive peers.

Figure 10. Investment in intangibles can boost productivity



Note: Labour productivity is computed as the ratio of real value added to number of employees. The analysis covers 2-digit industries NACE Rev.2 10 to 82 (excluding 64 to 66). "Micro" enterprises comprise fewer than 10 employees; small and medium-sized enterprises (SMEs) 10 to 249 employees; and large enterprises more than 250 employees.
Source: OECD calculations based on ORBIS data.

Figure 11. Adoption of advanced technologies has much productivity potential



Note: Estimated effect on the average digital adoption rate (Panel A) and the multi-factor productivity (MFP) of the average firm (Panel B) of a range of policy and structural factors. The effect of "Higher use of high-speed broadband" on productivity combines the direct and indirect effects. "Upgrading skills" covers quality of management schools. "Reducing regulatory barriers to competition and reallocation" includes lowering administrative barriers to start-ups, relaxing labour protection on regular contracts and enhancing insolvency regimes, where Iceland is the best performer. "Easier financing for young innovative firms" covers the development of venture capital markets and the generosity of R&D tax subsidies. For each of the underlying indicators, it is assumed that half of the gap to the best performing country in the sample is closed. It is also assumed that policy factors in each group are largely independent from each other.
Source: Sorbe et al., 2019.

High-speed broadband could be utilised more by firms

Iceland has an advanced fibre-optic network infrastructure (ITU, 2020[30]). Reforms over the past decade, guided by the Electronic Communication Plan (2011-2022), have increased connectivity and the speeds experienced by users (Figure 2, Panel A). Iceland currently ranks at the top of European countries in terms of fibre deployment, with a penetration rate close to 80% (FTTH Council Europe, 2021[31]). Ensuring an effective use of high-speed broadband by firms, especially the smaller ones, is vital for a wide adoption of digital technologies.

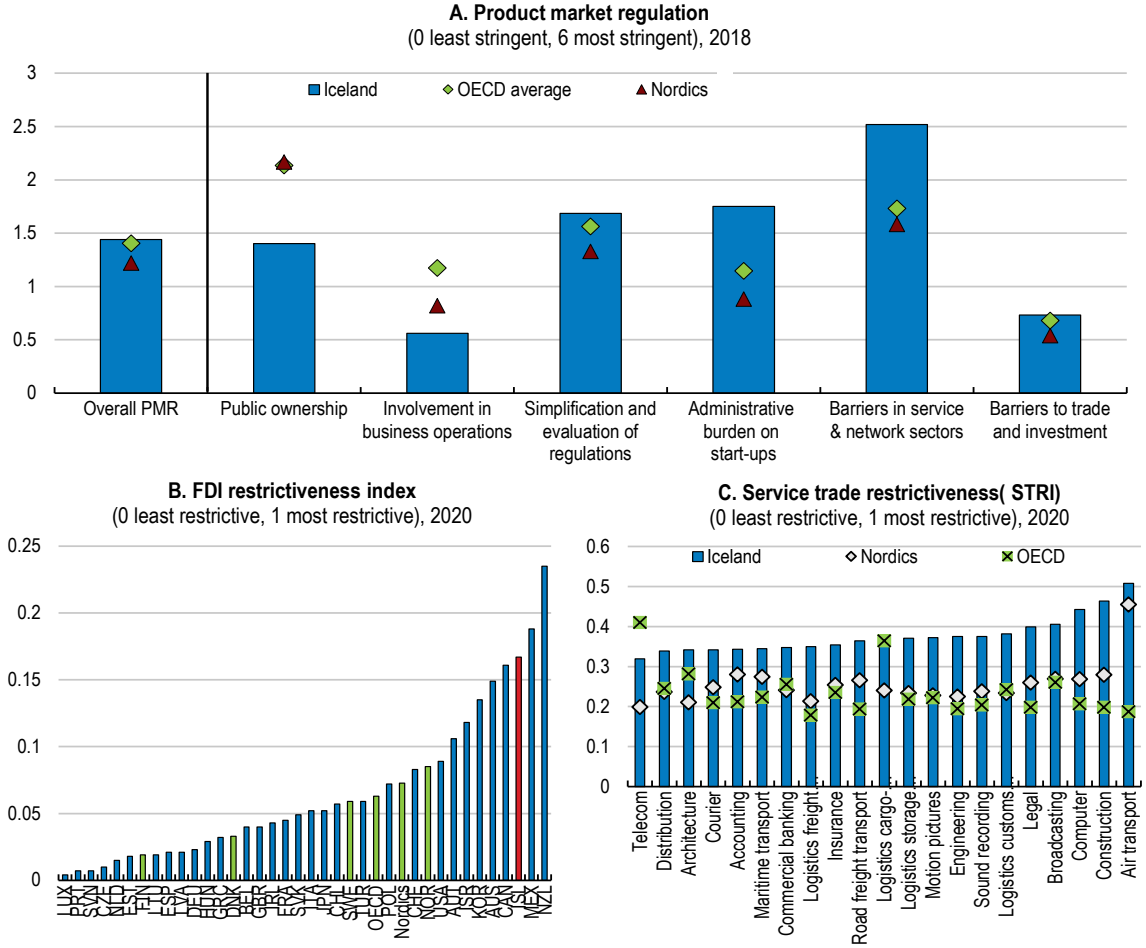
Ongoing efforts focus on expanding fibre networks to rural areas. The aim is to secure universal access to optical fibre by end-2021, facilitating access to 100 Mb/s fixed line connections (ITU, 2020[30]). Deployment of 5G is also a policy aim. In May 2018, Iceland signed a declaration of intent for a cooperation on 5G with other Nordic countries (European Commission, 2018[32]) and 5G coverage already reaches half of the population. In addition to its focus on accelerating the development of 5G, the declaration also identifies

areas in which Nordic cooperation needs to be strengthened. Further use of high-speed broadband and the deployment and take-up of 5G will allow businesses to face the increasing data demand in near future, stemming from the digital transformation (OECD, 2019[33]). Helping firms, especially the smaller ones, to reap the benefits of fast connection also matters. To this end, the adoption of high-speed broadband needs to be combined with complementary organisational investment (Fabling and Grimes, 2016[34]).

Improving framework conditions

A more competition-friendly regulatory framework could also foster innovation. Iceland's overall regulatory framework for product markets is as competition-friendly as the OECD average, but more stringent than those of Nordic peers (Figure 12). While public ownership and government involvement in business operations are low, regulatory barriers in network industries and professional services are particularly high. Administrative requirements for start-ups are burdensome (OECD, 2021[2]). Complex regulatory procedures affect many sectors of the economy, including construction and tourism, which account for almost 18% of GDP (OECD, 2020[35]). Stringent market regulation holds back innovation by hampering the entry of young firms, which are an essential part of the digital innovation landscape (OECD, 2015[36]); (OECD, 2020[3]).

Figure 12. The regulatory burden on businesses should be eased



Source: OECD, Product Market Regulations Statistics database; OECD, FDI regulatory restrictiveness index; and OECD, Services Trade Restrictiveness Index.

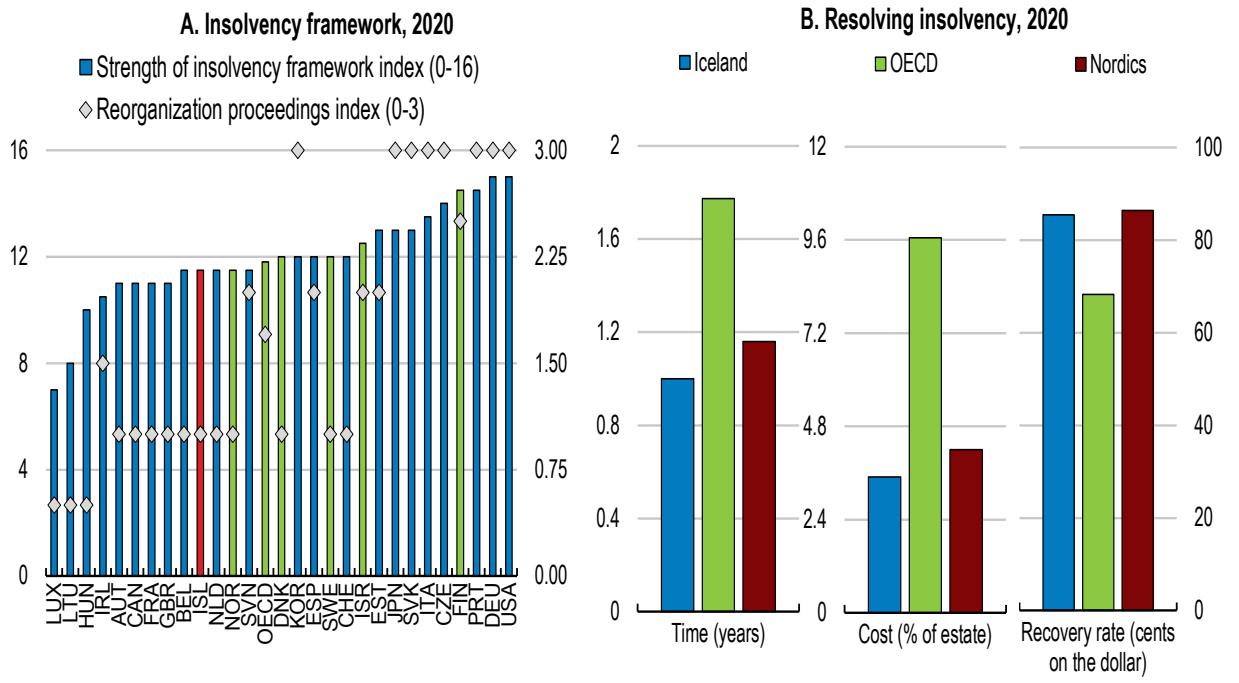
Efforts to create a more business-friendly regulatory environment should continue. The 2020 OECD Competition Review for construction and services points to areas of possible reform, including streamlining land-use requirements and simplifying the process for obtaining building permits and, as far as tourism is concerned, an alternative airport ownership and operating model to open a competitive tender for the management (OECD, 2020[35]). Carrying out thorough competition assessments in other sectors, particularly energy, would be advisable.

Lowering restrictions to foreign direct investment (FDI) and service trade should be a policy priority. Horizontal restrictions, including labour market tests for temporary service suppliers from countries outside the European Economic Area (EEA) and restrictions on land ownership by non-EEA residents create barriers for foreigners to do business or seek employment in Iceland, weakening international capital and knowledge transfer (OECD, 2018[37]). Moreover, half of the board members and management of corporations must be resident in Iceland or the EEA. In addition, legislation, going back to the 1990s, limits investment of foreign companies domiciled outside of the EEA in the fishing, energy and aviation industry. The government should go ahead with plans to streamline the application process for work permits for specialists from outside the EEA, meeting the set timeframe. Opening up professions is also important. Product market regulations for architects and lawyers, for instance, are more stringent than the OECD and Nordic averages (Figure 12). Conducting regulatory impact assessments on an ex-ante and ex-post basis to identify and remove unnecessary restrictions to competition should be a central element of regulatory reform.

The digital transformation raises new challenges for competition policy. Digitalisation promotes competition in many product and service markets through the increased use of data and cross-border mobility. This can benefit consumers through lower prices, and wider choice of products. However, the impact of technologies and data is not always evenly spread across firms, with the risk of market concentration (OECD, 2020[3]). Concerns also relate to the potential harm to firms that are reliant on digital platforms to deliver services, as the possibility to achieve scale without mass in such markets can enhance the market power of dominant firms (OECD, 2020[16]). As digitalisation continues to influence competition, it may pose some new challenges, requiring the regulatory policy framework to adapt. In the United Kingdom, for instance, a new council was introduced to advise on rules and regulations that may need to change to keep pace with technology (OECD, 2020[16]). In Spain, the new digital strategy introduces a number of initiatives to improve the business environment in the context of digital transformation, including measures relating to tax and social security aimed at both start-ups and investors (OECD, 2021[38]).

The insolvency regime can be further improved to encourage the restructuring of companies, sharpening incentives for disruptive innovation and the adoption of advanced technologies. Iceland compares favourably with other OECD countries with regard to the speed of finalising insolvency procedures and in terms of costs (Figure 13). Moreover, the recovery rate is relatively high, which can stimulate entrepreneurship. There is scope, however, for facilitating enterprise restructuring to reduce the cost of entrepreneurial failure (Adalet McGowan, Andrews and Millot, 2017[39]). Creditors in Iceland may file for liquidation, but for not restructuring, as opposed to debtors. Good international practice includes clear rules for the commencement of restructuring procedures by allowing creditors to initiate restructuring (World Bank, 2020[40]). A predefined period for enforcement action is important for the restructuring process to take place in a swift manner. Temporary authorisation was given to companies in operational difficulties due to the COVID19-crisis to restructure their operations through agreements with creditors. During the restructuring, the companies are in a payment shelter. These measures have been extended until end-2022.

Figure 13. The insolvency framework can be more innovation-friendly



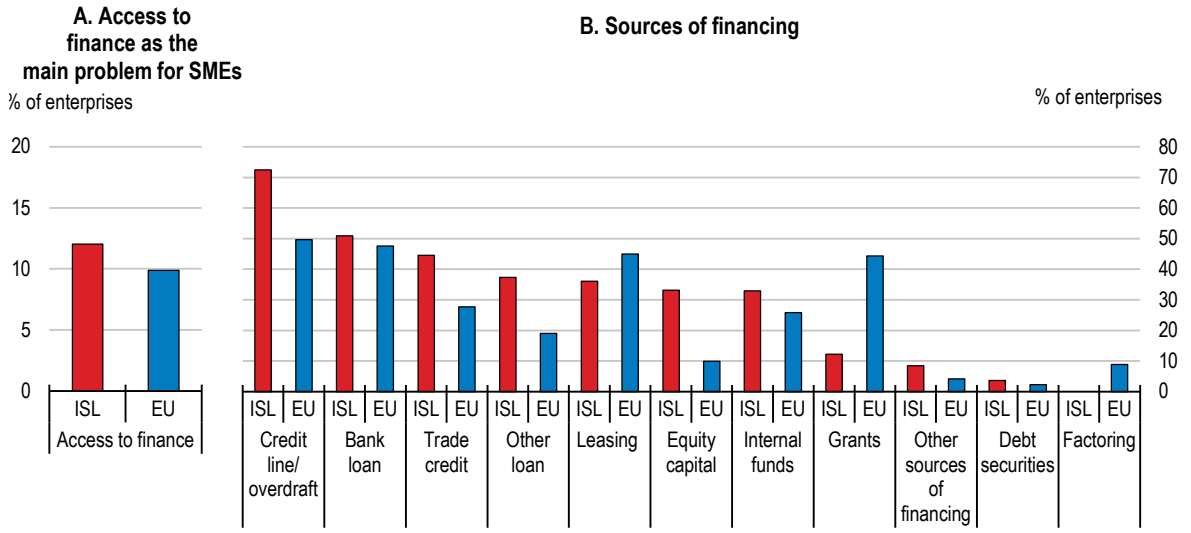
Note: The strength of insolvency framework index is a composite index comprising the commencement of proceedings index, management of debtor's assets index, reorganisation proceedings index and creditor participation index. The reorganisation proceedings index has three components: (i) whether the reorganisation plan is voted on only by the creditors whose rights are modified or affected by the plan; (ii) whether creditors entitled to vote on the plan are divided into classes, each class votes separately and the creditors within each class are treated equally; and (iii) whether the insolvency framework requires that dissenting creditors receive as much under the reorganisation plan as they would have received in liquidation.
Source: World Bank, Doing Business Indicators.

Improving access to finance for young innovative firms

Smaller firms in Iceland have alternative financing options, but many consider access to finance as an important concern (Figure 14). As in other countries, firms facing financial constraints are often young innovative SMEs, which lack the necessary track record to signal their prospects to potential investors. The information asymmetry problem is exacerbated by the difficulty to collateralize intangibles, whose share of assets tends to be high in innovative, digitally-intensive firms (Calvino, Criscuolo and Menon, 2016[41]); (Demmou and Franco, 2021[42]).

Figure 14. Bank lending is an important source of financing for smaller firms

2020

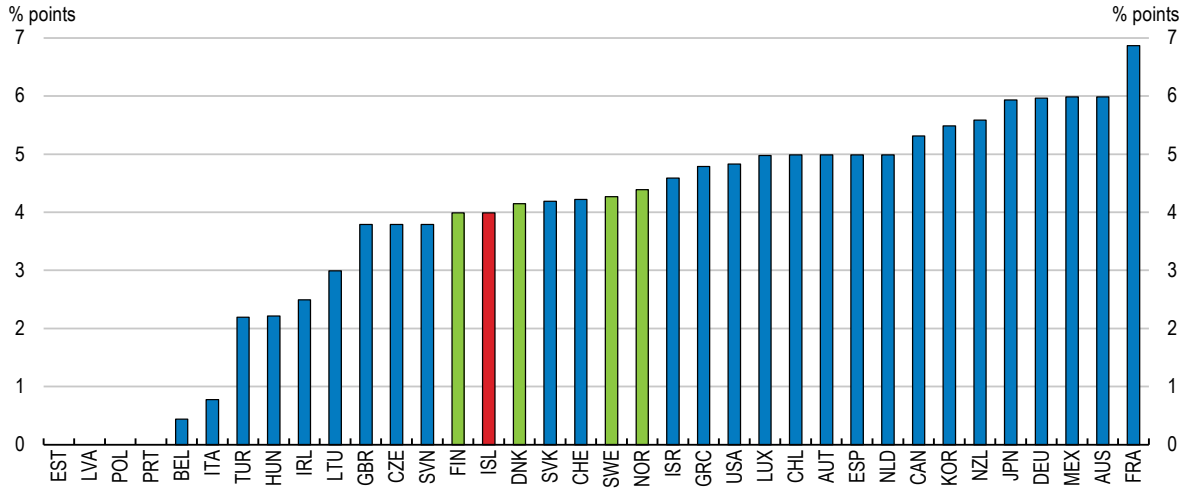


Note: EU refers to 27 EU member countries in 2020.
Source: European Commission, Survey on the Access to Finance of Enterprises (SAFE).

There is scope to develop equity finance for innovative firms. While many Icelandic SMEs consider equity capital to be an important source of finance, they tend to resort more to bank lending (Figure 14). This may reflect the more favourable treatment for tax purposes of debt, as oppose to equity, finance, like in many OECD countries (Sorbe et al., 2019[4]) (Figure 15). Granting an appropriate allowance for corporate equity (ACE), subject to fiscal space, could make equity finance more attractive (Demmou et al., 2021[43]). Some countries, such as Belgium and Italy, have introduced ACE and their experience is instructive (Box 3). Indeed, initiatives in this regard have the added advantage in the post-pandemic era to provide support for firms without creating potential debt overhang problem that can stymie the recovery (Demmou et al., 2021[43]).

Figure 15. The debt-bias in the Icelandic corporate tax system could be lowered

Differences in effective tax rates for equity and debt financing, 2019



Source: OECD, Corporate Tax Statistics.

Box 3. Allowance for corporate equity: international experience

Corporate income tax systems generally favour debt finance over equity finance by allowing deductibility of interest expenses, while equity finance is not deductible. This makes equity financing comparatively costly. Some countries, including Belgium, Italy and Portugal, have introduced an allowance for corporate equity (ACE) to address this asymmetry, while several others countries have experimented with it in the past (Demmou et al., 2021[43]). ACE can partially or totally offset the tax advantage of debt financing, making equity financing more attractive. Implementation requires the specification of the equity base for the computation of ACE and how it evolves over time, as well as setting a "risk-free" rate of return on equity (e.g. the rate on medium-term government bonds) (OECD, 2019[44]).

Evaluations of existing systems suggest that ACE systems, if well designed, reduce leverage at the firm level. Recent empirical evidence for Italy suggests, for instance, that the introduction of incremental ACE has substantially reduced the leverage ratio of its beneficiaries, with a larger effect for smaller enterprises and for mature firms (Branzoli and Caiumi, 2020[45]). The impact of ACE was found to be higher for vulnerable and risky firms than sound ones. Evidence for other countries, including Belgium, Austria and Turkey, also suggests that ACE is associated with a significant decrease in financial leverage (Demmou et al., 2021[43]).

Addressing financing and potential abuse issues is important for the successful implementation of ACE. The design should ensure, in particular, that multinationals do not exploit ACE for tax planning (Demmou et al., 2021[43]). Coordinated ACE implementation across countries would also help to tackle the issue. Granting ACE to new equity capital only can reduce the fiscal costs of the measure.

Venture capital (VC) is growing, but not yet well developed. Iceland still scores poorly in international comparison in this regard (IDM, 2020[46]), even though the relatively small size of the market needs to be taken into account. The New Business Venture Fund, established by the government in 1997, was the main source of financing until the mid-2000s. It provides start-up capital and invests in early-stage and expanding companies in return for an ownership stake in the firm. Currently there are a few more VC funds, which are financed mainly by the pension funds. Early-stage financing is further provided in Iceland through the Technology Development Fund, the Research Fund as well as a number of other funds (of various size and scope) in the form of grants, with a variety of private funding schemes also contributing. A matching fund to protect COVID-ridden start-ups has recently been established.

A new publicly-owned VC fund, Kría, started operating in March 2021. Its purpose is to boost liquidity and activity in the VC market by investing in other, privately-owned funds to promote innovation and bring more foreign capital and expertise to the country (Iceland Chamber of Commerce, 2020[47]). The fund is expected to invest around 0.3% of GDP over the next five years. Kría will be financed by the state budget and its dividends. The government move to engage indirectly, through privately-owned venture funds, rather than directly in VC activity is in line with international experience. Most OECD countries have moved progressively towards co-investment funds and funds-of-funds that aim to leverage private investment (Demmou and Franco, 2021[42]). This is because government funding is most effective when disciplined by private management.

To be successful, Kría should invest in viable privately-owned VC funds with large potential to promote start-ups and innovation companies. Setting up the appropriate conditions for the participation of privately-owned venture is also vital. Additional incentives might be needed to attract foreign funds. International experience, such as the Yozma Initiative, can provided guidance in this regard. A regular impact assessment of the success of Kría is necessary. The authorities also need to assess carefully the benefits of operating the New Business Venture Fund in parallel with Kría. As the domestic VC market grows and matures, the government can gradually phase out its equity involvement.

Business angel investment can play a more important role to support start-ups. The creation of more formal business angel networks is important for matching supply of and demand for equity. The government could consider, in this context, providing support (logistical/and or financial) for the establishment of such networks, in line with practice in other countries (OECD, 2016[48]). Several OECD countries provide tax incentives, for instance, as preferential tax treatment or tax relief on capital gains, to promote business angel lending (Demmou and Franco, 2021[42]). As an example, the "tax shelter" scheme in Belgium provides a tax reduction of 45% in the personal income tax for investors in a start-up (OECD, 2016[49]). In Italy, capital gains realised by business angels, not engaged in a business activity to which the participations are effectively connected, are tax-exempt. The angel industry can be further shaped by crowdfunding techniques that enable business angels finding investment opportunities in wider geographical areas (Box 4). Crowdfunding is utilised in Iceland through platforms such as Kickstarter and Icelandic Karolina Fund (ICLG, 2020[50]).

Box 4. Crowdfunding: a potential financing tool for young innovative firms

Crowdfunding provides a new source of finance for business. Peer-to-peer lending can be particularly attractive for young innovative firms that lack of credit records or collateral for bank loans. In addition to addressing at least in part the financing needs of young firms, crowdfunding entails marketing advantages, as it tends to raise public attention to the company and its investment opportunities, with the potential of helping to develop the business angel industry.

There are four models of crowdfunding: i) the patronage model, i.e. financing undertaken by not-for-profits organisations; ii) the reward-based model, according to which investors receive a reward for their commitment either in the form of a donation or of preferential access to and prices for the new product; iii) the lending model, which resembles peer-to-peer lending: investors receive just a promise of repayment after a predefined period of time of the capital loaned plus interest; and iv), the equity model, in which investors receive a share of the company and become effectively shareholders.

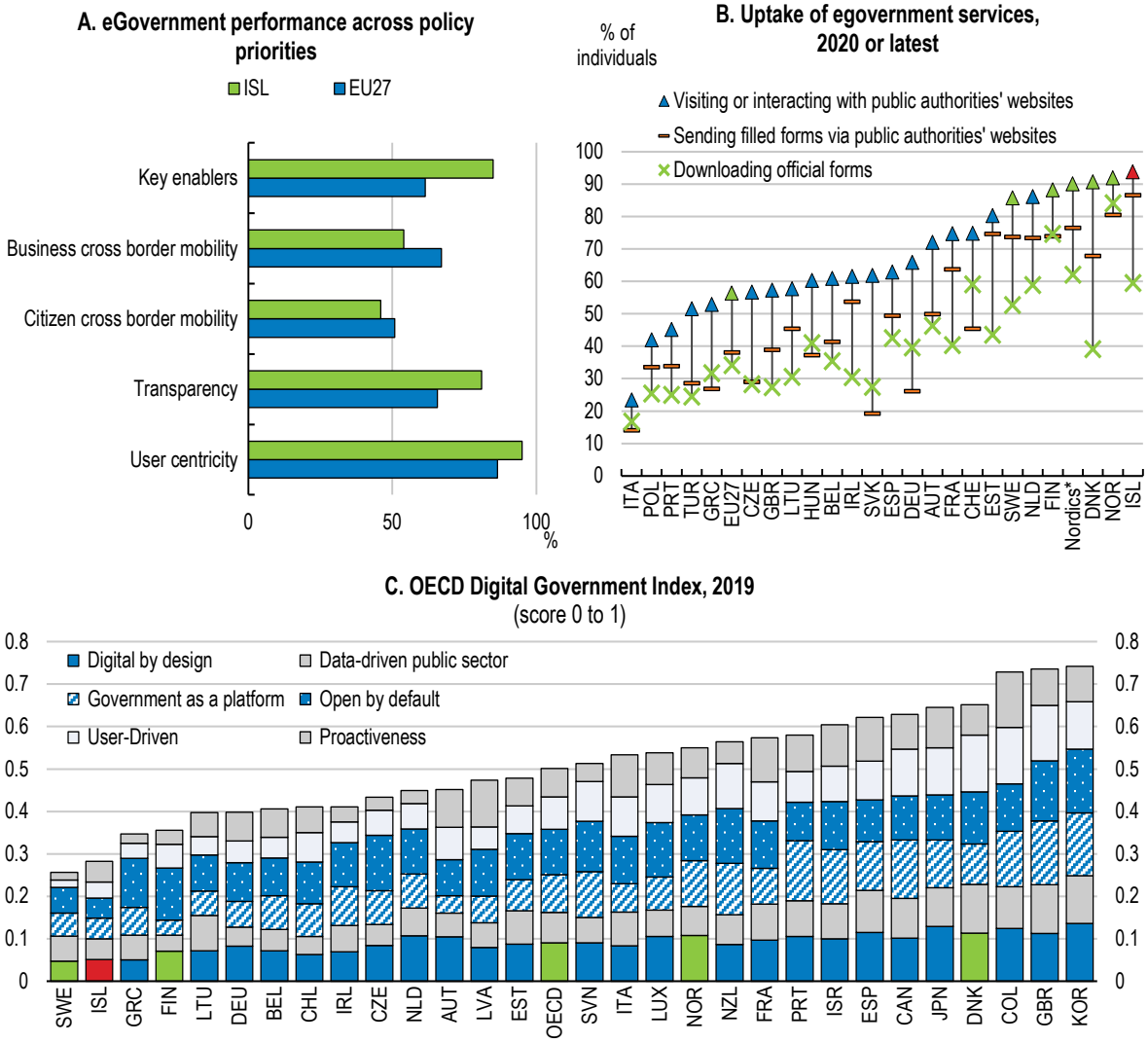
Overall, crowdfunding is still developing and is still relatively modest, and crowdfunding platforms seem to have a growing appeal among individual investors. The effectiveness of such initiatives to help firms raise funding, and the appropriate underlying procedures and employed models need to be assessed further.

Source: (Demmou and Franco, 2021[42]).

Developing digital government

Iceland has applied ICT technologies to some government operations, which is an important step towards developing e-government capabilities. However, it has yet to reap the full potential of digital government. While a relatively large share of the population uses the Internet to interact with the government and e-government services are well developed (Figure 16, Panels A and B), Iceland lags behind in the use of data to anticipate the needs of users and deliver better services, as well as in evaluating government's own performance based on the OECD's Digital Government Index (OECD, 2019[51]) (Figure 16, Panel C). Progress in this area is important to foster stronger innovation and digital transformation across the economy.

Figure 16. E-Government indicators fare well but there is room to improve digital government



Note: In Panel A, User Centricity, indicates the extent to which a service is provided online, its mobile friendliness and usability of the service. Transparency refers to the process of service delivery, responsibilities and performance of public organisations and personal data processed in public services. Cross-Border Mobility, indicates the extent to which users of public services from another European country can use the online services. Key Enablers indicate the extent to which technical and organisational pre-conditions for e-government service provision are in place. In Panel C, data are not available for Australia, Hungary, Mexico, Poland, Slovak Republic, Switzerland, Turkey and the United States. For detailed information on the methodology of Digital Government Index, please refer to OECD Digital Government Index (DGI): Methodology and 2019 results | en | OECD.

Source: European Commission, Digital Public Administration factsheet 2020 Iceland; OECD (2019), Going Digital: Shaping Policies, Improving Lives and OECD ICT Access and Usage by Households and Individuals Database (http://oe.cd/hhind); and OECD Survey on Digital Government 1.0.

The initiative Digital Iceland is a positive step forward. It sets the framework for the projects carried out under the leadership of the government in cooperation with agencies, municipalities and enterprises. The Digital Iceland taskforce, under the Ministry of Finance's purview, coordinates digital matters in the public sector, manages the implementation of digital projects and provides support to public entities with regard to digital matters. Steps are under way to connect agencies to the national data exchange platform and develop service processes both for the general public and businesses.

The implementation of a national strategy on open data should be stepped up. Compared to other European countries, Iceland lags behind in this area (Open Data Maturity, 2019[52]). While a national open data portal is available, there is limited information on data use and the value it generates, as there are no monitoring mechanisms in place (European Commission, 2020[53]). The government is currently working towards a national strategy on open data (Government of Iceland, 2020[54]). At the same time, a new cyber security strategy was approved in 2019 to prepare Iceland to detect and respond to cyber threats, tackle cybercrime, and the abuse of personal and commercial data. The Cyber Security Council, established in 2015, plays a key role in implementing strategy the strategy. The Cyber Security Forum, also established in 2015, acts as a platform for cooperation between the public and private sectors.

Relevant skills are needed to foster innovation in the digital era

Boosting innovation and reaping the benefits of digitalisation hinges upon the development of relevant skills that respond to rapid technological change and evolving labour market needs. Indeed, official estimates suggest that 28% of the labour market in Iceland is likely to undergo radical changes or elimination of jobs because of automation, similar to other Nordic countries (Government of Iceland, 2019[1]). Successful adaption requires not only ICT skills, but also literacy, numeracy and problem solving competencies, as well as creative thinking and management practices (OECD, 2020[3]). However, skills and qualification mismatches, especially in occupations requiring high skills, were already present before the pandemic, as highlighted by the previous OECD *Economic Survey* (OECD, 2019[55]). While the crisis might have alleviated pressures, longer-term challenges remain to be addressed.

The education system needs to remain attuned to changing skills needs

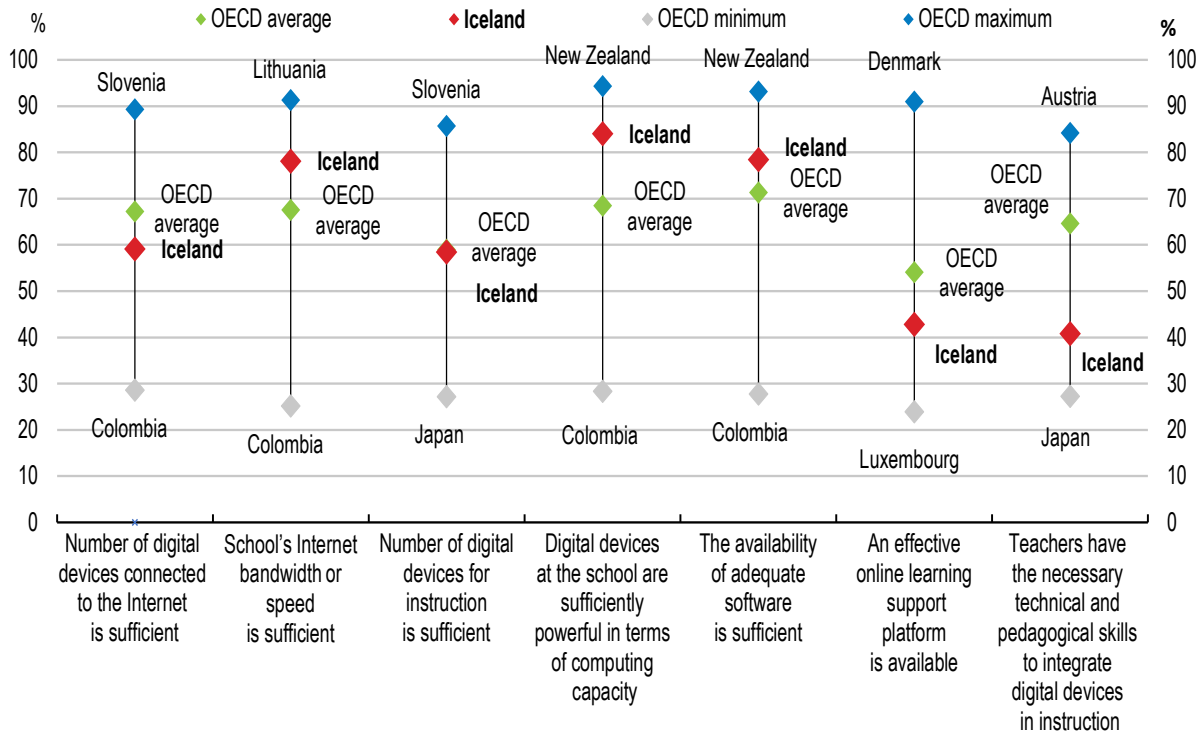
Ensuring strong foundational skills for school and VET students

Many students in Iceland lack solid core skills and competences at the end of compulsory education, according to PISA results (OECD, 2021[2]). This is especially the case of students with an immigration background. The 2018 PISA scores suggest, in particular, a performance gap in reading of 55% in favour of non-immigrant students, regardless of socio-economic background. The development of strong foundational skills should continue to be a policy priority for school education, given their importance for continuous learning. The government's focus on the reform of the school system, as one of the main pillars of its Fourth Industrial Revolution strategy, is therefore welcome (Government of Iceland, 2020[54]). The envisaged measures aim to reduce the learning gap between immigrant and native students, including through a more co-ordinated government approach, enhance the professional development of teachers and, overall, improve the capacity of schools to promote critical thinking. Reform implementation should go ahead, and outcomes be closely monitored.

Solid teacher skills in using ICT tools effectively in schools are essential for helping students to make the most of new technologies and develop skills for the future. Iceland fares better than the OECD average when it comes to the adequacy of digital devices available to schools, but the skills (technical and pedagogical) of teachers to integrate such devices in instruction are comparatively low (Figure 17). This is also likely to make learning from home less efficient. Teleworking and distance learning have increased with the outbreak of the COVID-19 pandemic and are expected to remain above pre-crisis levels. As education moves to a "new normal", where traditional teaching in the classroom will be complemented by some distance learning, strong teacher ICT skills become even more important (OECD, 2020[56]).

Figure 17. Iceland lags in teachers' ICT preparedness

Percentage of students in schools whose principal agreed or strongly agreed with statements about the school's capacity to enhance learning and teaching using digital devices, 2018



Source: OECD calculations based on PISA.

ITC training for teachers needs to be stepped up. Adoption of innovative classroom practices by teachers depends to a large extent on the training they receive in ICT for teaching (OECD, 2020[56]). However, the 2018 TALIS survey reveals large unmet training needs in this area (OECD, 2018[57]). Novice teachers also need to be better prepared to implement innovative practices in classrooms. Only 26% of the Icelandic teachers in the survey reported to be well-prepared for the use of ICT for teaching, as against a 43% OECD average. Strengthening pre-service programmes that include ICT for teaching would therefore be advisable. Countries across the OECD have introduced a range of policies to foster teacher ICT skills, including self-assessment tools enabling teachers to assess their digital competences (Box 5).

Box 5. Policies to foster teacher ICT skills: some international practices

OECD countries have introduced various policies to foster teacher ICT skills, ranging from the development of national plans to the introduction of compulsory training, national accreditation standards and national certification for teachers. In some countries, including Chile, Korea, Italy, and Spain, ICT training for teachers constitutes a part of a broader strategy to promote ICT in schools.

Standardisation is one way OECD countries seek to improve teacher ICT skills. Denmark, for instance, has developed a voluntary Pedagogical ICT Licence that combines pedagogical knowledge of ICT and basic ICT skills training. Such an approach was first implemented for in-service training and was then expanded to initial teacher education and general upper-secondary education. Even though it is not mandatory, the licence is integrated into the curriculum of teacher education colleges.

Some countries have developed self-assessment tools. In France, for instance, teachers can assess their digital competences through an on-line tool and receive an authorised certificate. In Finland, teachers can measure and analyse their use of information and communication technologies in teaching through an online self-assessment tool which provides teachers, schools and municipalities information on their ICT usage. In the United Kingdom and Switzerland, on-line self-assessment tools were mainly designed for the identification of professional development needs for teachers and policy priorities in this area. Such tools can also help teachers to identify areas of improvement.

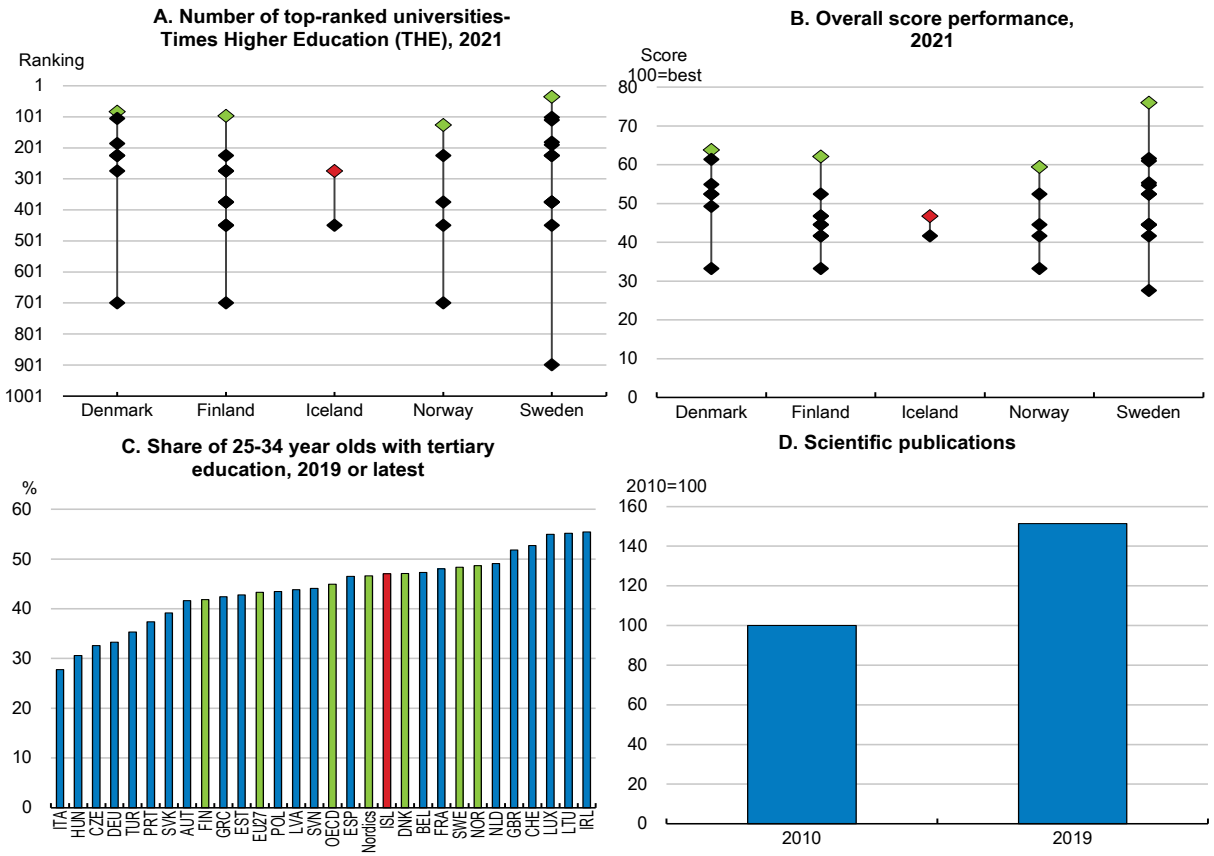
Source: (OECD, 2016[58]); (OECD, 2019[59]); (European Commission, 2019[60]).

Improvements are also needed in vocational education and training (VET). Occupation-specific skills can quickly become outdated in view of rapid technological change; as a result, VET programmes should focus on skills that are considered to be increasingly in need and are transferable across occupations. A better integration between school- and work-based learning components of VET is important to equip students with solid practical skills (OECD, 2021[2]); (OECD, 2019[55]). Up until now, schools in Iceland have not provided work-based places; rather, VET students had to search for them and apply to companies. As a result, the two components of VET tended to be disconnected (Eiríksdóttir, 2020[61]). To address this issue, a regulation was adopted in early 2021 which makes schools responsible for work-based training of VET students by providing students with appropriate positions at companies and integrating the school and work-based parts of the students' training. As a positive step towards improving the quality of work-based learning, the digital logbook, under development, will entail a description of skill and competence requirements that a VET student must have acquired upon completion of training (CEDEFOP, 2020[62]).

Fostering skills for knowledge-driven innovation

Iceland's two, out of seven, domestic universities rank among the world's top 500, and almost half of the young people in the country have a tertiary degree. However, there is a need for greater focus on quality and outcomes (Figure 18). A planned reform of university funding, to be completed by 2025, aims to help address these challenges. This is welcome, because current funding provides an incentive for universities to focus on enrolment, rather than performance: funding is allocated across institutions on a per-student basis, prompting a bias towards inexpensive courses and popular studies (OECD, 2019[55]) (Box 6). The large weight attached in the funding formula to the number of students also limits differentiation of institutional profiles.

Figure 18. Tertiary innovation performance can improve



Note: The Times Higher Education World University Rankings are the only global performance tables that judge research-intensive universities across all their core missions: teaching, research, knowledge transfer and international outlook. In panels A and B data refer to 2021.
Source: THE 2021; OECD, Education at a Glance database, and SCImago, SCImago Journal & Country Rank Database.

Box 6. Tertiary education: main features

The Icelandic tertiary education sector comprises 7 universities (4 public and 3 private) and caters to 18000 students in total. All tertiary institutions have the status of universities. There are no specialised VET institutions at the tertiary level, but some are more oriented towards VET programmes than others. Examples include the art academy and the agricultural university. The minimum requirement for admission to universities is a matriculation examination (*stúdentsprófi*) or the equivalent level of study.

The main source of income for universities is public funds. Around two-thirds of the allocation is for teaching and is based on a funding model that takes into account the number of students (approximately 95%) and to a much lesser extent the number of those who graduate (approximately 5%). Both are calculated on the basis of price categories for different fields (15 categories for exams). One-third of the public funds allocated to each higher education institution is determined on a historical basis. No criteria exist for research activity.

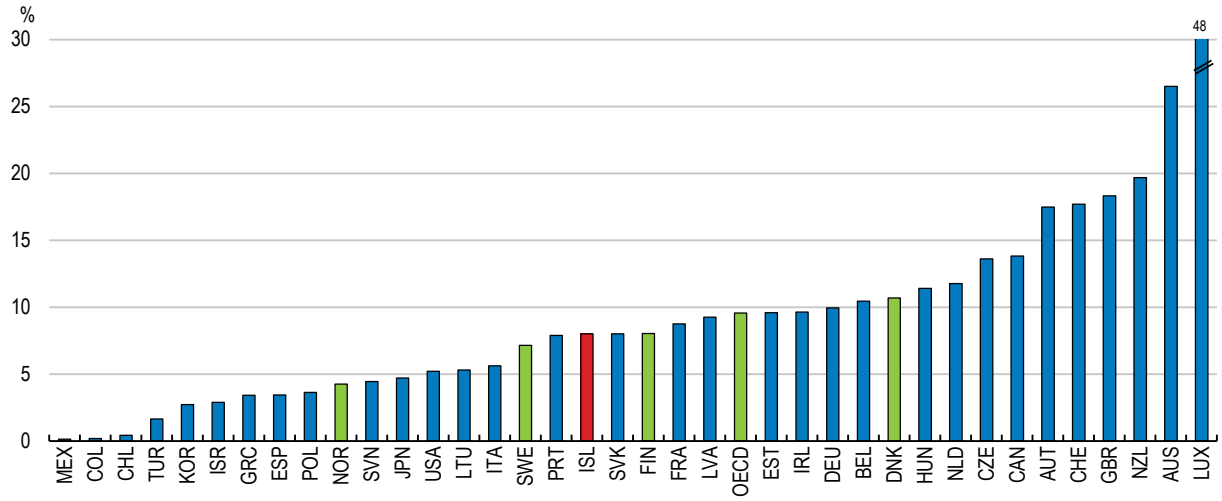
The funding system is currently under review, based on the findings of a 2019 Green Paper. Efforts focus on the development of indicators to measure the quality and efficiency of universities. The new funding system is to be introduced in 2025.

Source: Ministry of Education, Science and Culture; (Government of Iceland, 2020[54]).

To better support quality and performance, less emphasis should be placed on quantitative criteria based on enrolment in the funding mechanism for higher education. This can be done by broadening the set of indicators considered for allocating funds to institutions to include, for instance, international exchange of students, given the importance of mobility of highly educated individuals for knowledge circulation, and research performance (both in terms of outcomes and laboratory/equipment intensity) where there are currently no criteria (Box 6). Both Denmark and Norway include mobility indicators in their funding models. Iceland could benefit from such a reform (Figure 19). Gender balance objectives could also be pursued through financial incentives. Attaching a higher weight in the funding formula to the institutions' track record in graduations is also important. Official data suggest that only a third of students who entered to university in 2011 completed their undergraduate studies three years later, while 23% dropped out (Ministry of Education, Science and Culture, 2020[63]). It is essential that the set of indicators employed are clearly defined, and based on rigorous data and analysis.

Figure 19. The share of international students in tertiary education is low

International student enrolment as a percentage of total tertiary enrolment, 2018



Note: International students are those students who moved from their country of origin (defined as the country of prior education or of usual residence) for the purpose of study.
Source: OECD, Education at a Glance database.

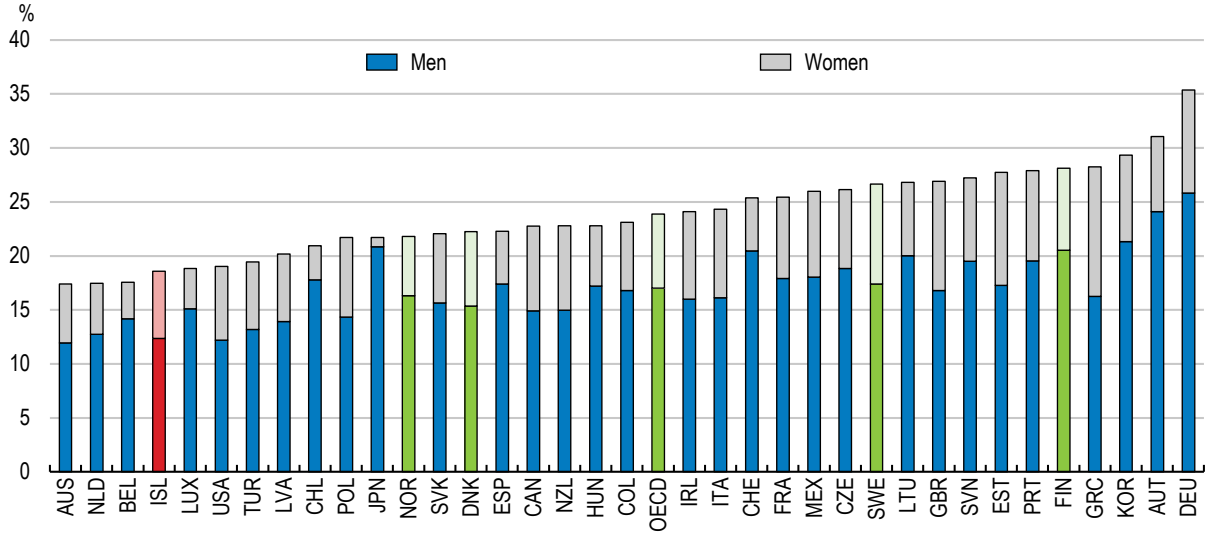
Tertiary funding should also be more tightly linked to labour market and future skill needs. Large qualification- and field-mismatches were evident before the COVID-19 crisis, indicating scope for more relevant skills (OECD, 2017[64]; OECD, 2019[55]). Labour market features, such as the compressed wage distribution in Iceland, can weaken the response of skills to labour market needs. Tertiary funding mechanisms, however, may also play an important role in this regard. The additional funding to universities for the provision of teacher qualifications at post-graduate level to address shortages is a welcome recent initiative. Introducing incentives into the funding formula by linking university funding partially to the success of tertiary courses in providing skills corresponding to labour market needs, as recommended in the previous OECD Economic Survey (OECD, 2019[55]), would be advisable. For example, specific courses, such as certain subjects within STEM (science, technology, engineering, and mathematics) that provide skills for innovation and are essential for embracing the digital era, could be rewarded more.

The proportion of tertiary graduates in STEM courses remains lower than the OECD average, especially among women (Figure 20). Policy should focus on the STEM disciplines with strong demand but also go beyond and build an innovation-rich skills base. In addition, effective career guidance in schools and universities, quality information on graduates' labour outcomes and on the competencies of students

entering universities are also important factors in improving skill matching. A national database of skills imbalances can help. Recent progress on this front is welcome, with the first set of skill forecasts due to be published in the course of 2021 (The Prime Minister's Office, 2020[22]).

Figure 20. Relatively few students graduate in STEM fields

STEM in % of all tertiary graduates, 2018



Source: OECD, Education at a Glance database.

The government could also encourage collaborative research when allocating funds to tertiary institutions, to facilitate knowledge transfer (see below). Several countries, including Australia, Denmark, Estonia, Finland and Ireland, have established performance contracts between universities and ministries that put emphasis on the role of higher education institutions in supporting business innovation based on indicators such as IP licences, spin-offs and industry-funded R&D (Borowiecki and Paunov, 2018[65]). Linking university funding to collaborative activity and commercialisation of research would help to disseminate the benefits of government-funded research. Increased funding from industry through collaborative research would also provide additional revenue for universities. The experience of the United States suggests that the source of funding (public or private) of university research has important implications for how research outputs are commercialised, with public-funded research entailing larger knowledge spill-overs (Babina, 2020[66]).

The skill mix at the tertiary level should be broadened. Iceland does not have a tertiary VET sector, and instead some universities offer vocational programmes (Box 6). The government should go ahead with plans to strengthen the provision of VET at post-secondary/tertiary education level based on the outcomes of a pilot project. Students from tertiary VET programmes should be allowed to enter a post-graduate course, so as to make such programmes more attractive. The development of skill assessments, currently in progress, for students who have not yet passed the matriculation examination will make it easier for universities to assess the applicants (Ministry of Education, Science and Culture, 2020[63]). More solid pathways from secondary to vocational tertiary education are also necessary. The provision of entrepreneurship programmes at higher education, as well as lower levels, is important as such programmes can equip students with broader competencies (OECD, 2019[55]; OECD, 2019[67]). Efforts in this domain should continue, while ensuring an appropriately trained teaching staff.

Overall, the tertiary education system has to deliver the appropriate skills for the digital age and also adapt to it. A prerequisite, beyond a quality-oriented funding scheme, is that higher education institutions have the capacity to embrace the constantly evolving ICT technologies. Moreover, students and teaching staff

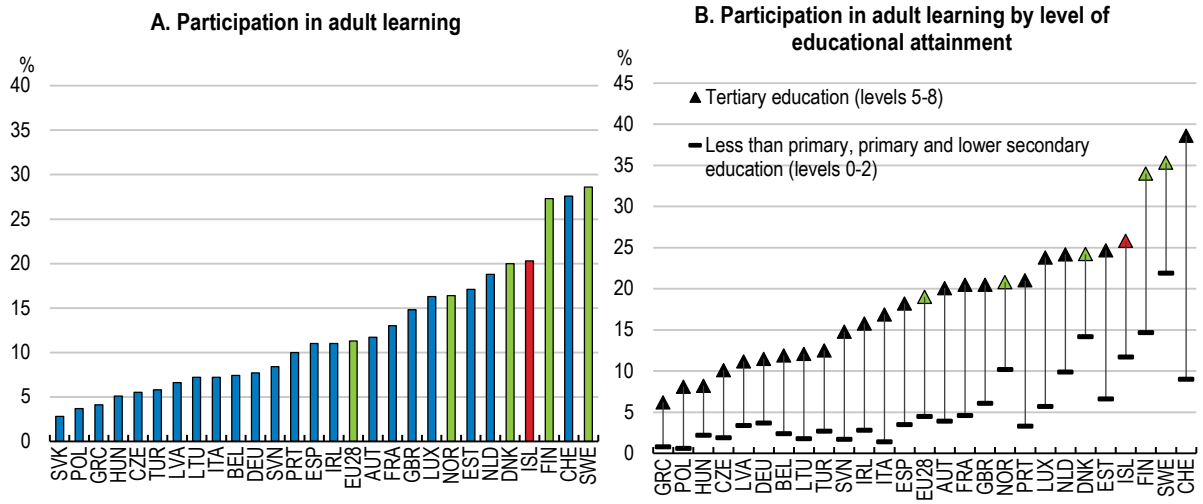
also need to be familiarised with digital technologies. This is even more important, as mentioned earlier, as on-line teaching, which accelerated with the COVID-19 crisis, may become more of a norm in the future. Effective mechanisms to monitor higher education outcomes and respond to poor performance are essential. As a positive move, the Quality Board safeguards the standards of Icelandic higher education, through the implementation of the Quality Enhancement Framework, conducting evaluation reviews. The second evaluation cycle is underway.

Encouraging participation in adult learning programmes

Iceland compares well internationally in terms of participation in adult learning, though it still needs to catch up with some of its Nordic peers (Figure 21). Around one in five adults take part in lifelong learning, access to continuing education and training is set out in collective agreements, and funding is available for those participating (Andersen, Hougaard and Ólafsson, 2011[68]); (OECD, 2019[69]). Icelandic workers have the flexibility of entering and re-entering the education and training system, which provides plentiful lifelong learning possibilities. Re-skilling and up-skilling through adult learning programmes are key to develop digitalisation further (Andrews, Nicoletti and Timiliotis, 2018[29]).

Figure 21. Participation in lifelong learning remains relative low for some groups

25 to 64 years, 2020 or latest



Note: Adult learning is defined as participation in education and training (last 4 weeks) of people aged between 25 and 64.
Source: Eurostat Labour Survey.

There are gaps in participation in adult learning. Special attention is given to adults who have not finished upper-secondary education. The 2010 Adult Education Act provides a legal basis for improved financial support for programmes targeting this group and for access to study and counselling (European Commission, 2015[70]). Preparatory programmes are currently available for people to return to the educational system to complete their upper-secondary education, which are delivered throughout the country through a network of lifelong learning centres. The less educated, however, are still less likely to participate in adult learning programmes than those with tertiary education, even though they are most at the risk of seeing their prospects worsen during downturns, as evidenced by the COVID-19 crisis, and/or to suffer from shifts in demanded skills related to technological change (Figure 21). Moreover, adult learning has a stronger impact on digital adoption in the case of low-skilled workers compared to those who are already highly skilled (Andrews, Nicoletti and Timiliotis, 2018[29]). Lack of time due to work and family obligations, financial constraints, lack of support by employers or limited information about lifelong

learning programmes have been identified as barriers to the participation in learning of the low-skilled adults (OECD, 2017[71]).

Iceland should move towards a more comprehensive approach to lifelong training. The government Action Plan for the Fourth Industrial Revolution includes adult learning among its main pillars (Government of Iceland, 2020[54]). The plan entails, in particular, three broad objectives: a simplified system of continuing education, improving information on learning, and strengthening the links between adult learning and the education system through the development of skills assessments schemes. The strategy goes in the right direction and should be implemented swiftly. The focus on the groups most exposed to rapid technological change, namely less educated workers and immigrants, is appropriate. As a positive step, the development of skills assessment schemes is under way and can facilitate re-entry into the formal school system for workers that lack upper-secondary qualifications by evaluating work experience and acquired skills. Overall, the recognition of prior learning can help to re-engage individuals in training and limit time and costs (OECD, 2019[72]). To ensure a high take-up of the skills recognition programmes, procedures should be simple. To broaden the use of these programmes among adults with low qualifications, France and Portugal for instance have put in place guidance services that support the recognition of the skills for such groups (OECD, 2019[72]; OECD, 2019[73]). It is important that the skills assessment processes are harmonised.

Access to funding for adult learning needs to be simplified. While there is considerable funding in Iceland to support lifelong learning activities, the system is fragmented with numerous funds, reducing the ease of access. Streamlining would be advisable. In addition, financial incentives can be provided to encourage participation among under-represented groups (Box 7). Incentives should be carefully designed to ensure appropriate targeting and reduce deadweight costs. Encouraging participation also calls for raising awareness about lifelong opportunities and longer-term benefits from re-skilling, for example through individualised advice and guidance-counselling services, as provided by Lifelong Learning Centres (OECD, 2019[69]). A regular assessment of these services in improving the incentives for re-skilling is nevertheless needed. Overall, to be attractive to low-skilled, adult education schemes need to lead to certification and be accompanied by clearly defined career pathways.

Box 7. Financial incentives to boost participation in lifelong learning: international experience

To encourage participation in adult learning of under-represented groups, a variety of financial incentives are provided across OECD countries. This is justified, as workers and firms may not fully internalise the need for further investment in skills.

The financial incentives provided in OECD countries include subsidies, such as vouchers and grants, and tax incentives in the form of allowances or tax credits. In Sweden, for instance, an education entry grant was introduced in mid-2017 with a focus on the low-qualified unemployed aged 25-56. In the United Kingdom, low-skilled adults have access to digital programmes that are fully-funded. The United States grants vouchers to unemployed low-skilled adults for training programmes that respond to in-demand sectors.

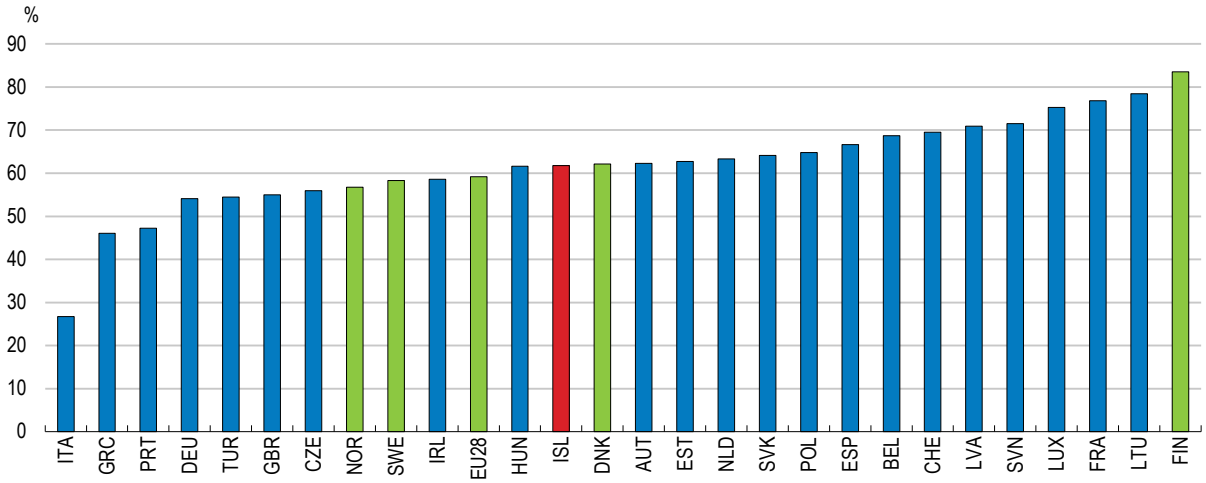
Some countries, for instance France and the Netherlands, have introduced individual learning accounts. Such schemes attach training rights to individuals, rather than jobs, to fund future education and training, and include accounts where time and/or savings for training are accumulated over time. They have received increasing attention in recent years as they allow for the portability of training rights between jobs and also employment statuses, facilitating career transitions.

Source: (OECD, 2019[72]); (OECD, 2019[74]).

Reaping the benefits of digitalisation also requires upgrading management skills. This would improve the ability of firms to develop new business models and adopt advanced technologies (Andrews, Nicoletti and Timiliotis, 2018[29]). The share of managers in Iceland with tertiary education compares well with the EU average but it falls below the best performers (Figure 22). Providing more entrepreneurship programmes at tertiary level (as discussed earlier) and encouraging management training would help enhance managerial skills. As a positive step, MBA programmes are organised around working students with an emphasis on innovation and digital transformation. Moreover, the Strategy for Public Leadership, implemented by the government in 2019 puts emphasis on leadership, results and communication. Innovation and foresight are among the focal points of the strategy, supporting the emphasis on knowledge and innovation among public leadership in the Innovative Iceland Policy (Box 1). The improvement of management skills in SMEs is also important in the digital era. The Training Action (Formação-Ação) model in Portugal is an example in this regard (OECD, 2018[75]). Training under the model focuses on areas such as boosting the efficiency of production processes and marketing and sales, with the consulting services aiming to help employers develop training plans.

Figure 22. Managerial skills can improve further

Share of managers with tertiary education, 2020 or latest



Note: Data refer to managers (group1) based on the International Standard Classification of Occupations 2008 (ISCO-08) and tertiary education (levels 5-8) based on the International Standard Classification of Education (ISCED 2011).
Source: Eurostat, Labour Force Survey database.

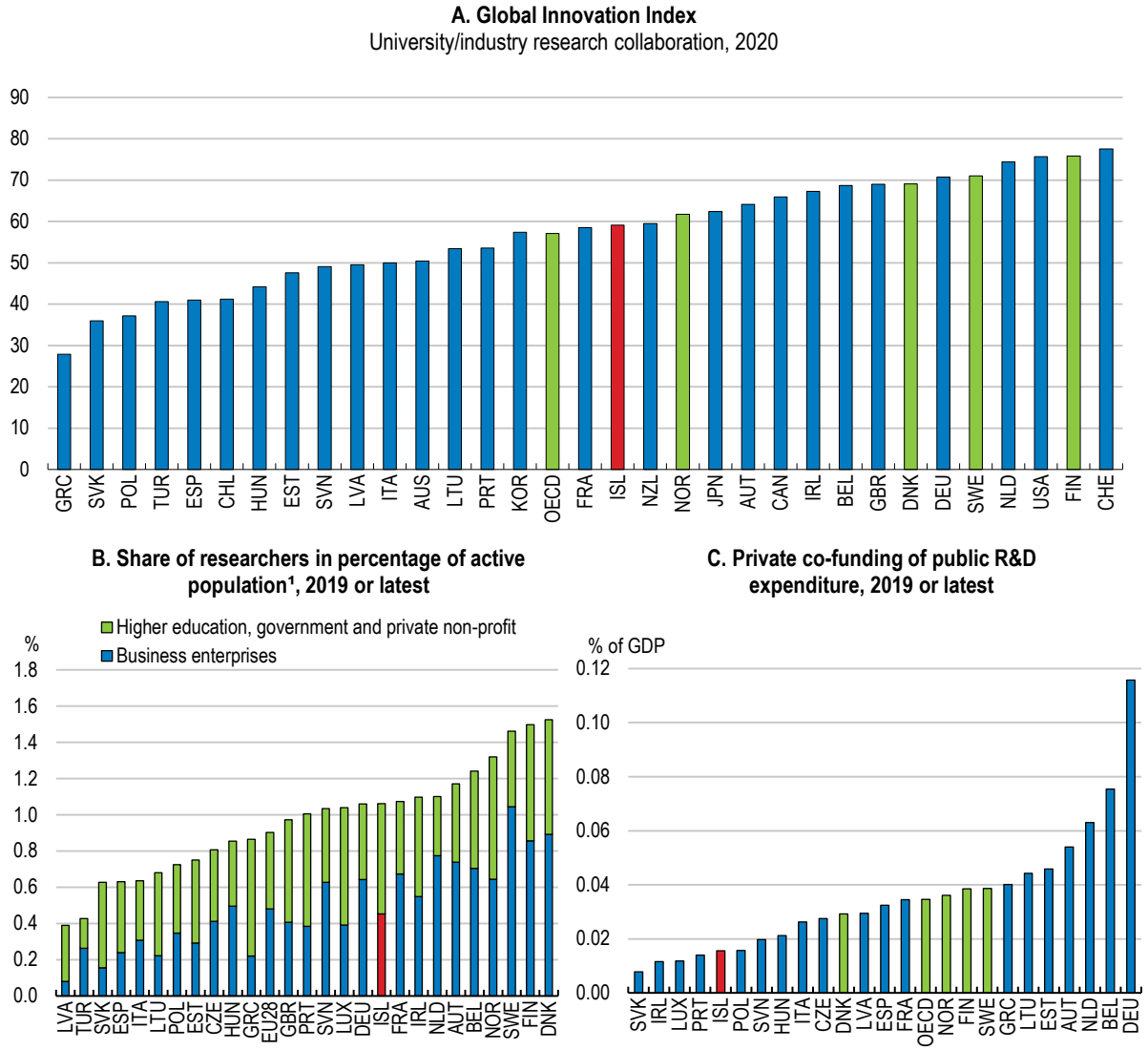
Enhancing knowledge transfer to strengthen inovation

Despite achievements, business-university collaboration remains weak

For public research outcomes to unleash their potential for innovation, business-university collaboration needs to strengthen. Such partnerships can spur innovation by facilitating knowledge transfer, which can boost firm-level productivity (Andrews, Criscuolo and Gal, 2015[76]). Business-research partnerships are especially important in the digital era, because of the need to adapt knowledge to specific applications (Guellec and Paunov, 2018[77]). Collaboration also allows research institutions and businesses to share the costs and risks of investment in digital innovation (OECD, 2019[78]), and it is particularly beneficial for small firms, as they often lack the equipment and skilled personnel needed to innovate (Hewitt-Dundas, Gkypali and Roper, 2017[79]). Moreover, business-research cooperation would help universities raise

revenue through "valorisation" activities, including commercialisation of R&D and academic entrepreneurship (University-Business Cooperation in Europe, 2017[80]). There are many examples of successful business-research collaboration in Iceland. These include the co-operation agreements between universities and various partners (for example, high-tech companies, the fishing industry, energy industry, medical industry and tourism and transportation services). However, businesses and universities in Iceland collaborate less than in several other European countries, including the Nordic peers, as is also reflected in the relatively low share of private co-funding of public R&D (Figure 23). Moreover, the number of researchers in the business sector is comparatively low, suggesting low mobility between the two sectors.

Figure 23. Collaborative research remains weak



Note: 1. Researchers are presented in full-time equivalent unit.
Source: Global Innovation Index, 2020; Eurostat; and OECD, Research and Development Statistics database.

Obstacles to business-research collaboration are well known. They range from differing priorities and cultures in universities and businesses to more structural factors, such as the historical lack of technology transfer services and infrastructure in Iceland. Academics consider a lack of private and public funding for collaborative research, including from universities themselves, and limited awareness among businesses of university research activities as the main barriers to collaboration (University-Business Cooperation in Europe, 2017[80]). Collaboration may also be discouraged by a perception among academics that there is a trade-off between research excellence and cooperation with businesses. The comparatively low absorptive capacity of Icelandic firms could also act as a barrier to collaboration (Cornell University, INSEAD, and WIPO, 2020[81]).

Policy levers for strengthening business-research collaboration

Iceland would benefit from a more comprehensive approach to business-research collaboration. Research partnerships rely mainly on informal linkages rather than formalised programmes (The Prime Minister's Office, 2020[22]). The introduction of carefully-designed policy initiatives that encourage business and academic partnerships, based on international experience (OECD, 2019[78]), should be considered, while making sure that existing measures, such as tax incentives for collaboration under the R&D tax credit scheme, are effective. As discussed earlier, the programme's outcomes have not met expectations, and a close monitoring and regular evaluation of the collaboration-enhancing schemes is crucial.

Innovation vouchers is a promising policy tool that the government could explore. These are small lines of credit to SMEs to purchase services from public knowledge providers, with a view to introducing innovations in their business operations. Innovation vouchers are currently used in several OECD countries (OECD, 2019[78]; Backer-Gonzalez-Salido, 2019[82]); for example, the experience of the Netherlands shows that innovation vouchers can have an impact over time as they change firms' behaviour and business strategy towards collaborative research (Roelandt and van der Wiel, 2020[83]). Innovation vouchers also tend to encourage output additionality, given that beneficiary businesses would not undertake innovation projects without public support (The Innovation Policy Platform, 2010[84]). Administrative simplicity, continuity, regular evaluation and clearly defined eligibility criteria are vital for innovation voucher schemes to succeed.

Dissemination of information also helps to raise awareness among eligible businesses and ensure high take-up rates. Likewise, it is important to develop a network of services to assist firms to reach into the right expertise in the research sector, while strengthening incentives for engagement. The Technology Transfer Office in Iceland (discussed below) is tasked to help the industry find required expertise within the scientific community, facilitating interactions between academia, industries and investors. The innovation incubators, through which the government supports the creation of small firms, also play a role in this area (OECD, 2015[85]). An additional initiative towards strengthening university-business collaboration involves the establishment of the University of Iceland Science Park. This also aims to create facilities for innovators. Moreover, a new Technical Centre has been established, as part of the governmental Innovation Policy (Box 1), to support and stimulate university-business collaboration in high-tech innovation. These initiatives are welcome. The authorities should also consider boosting collaboration through specific programmes that connect SMEs with researchers, based on the experience of other OECD countries (Box 8).

Box 8. Connecting businesses with researchers: international practices

To facilitate collaborative research, some countries have introduced initiatives to connect SMEs with research and talent in post-secondary institutions. Examples include:

- Australia's Innovation Connections. The programme involves a network of research facilitators who provide practical advice and mentorship to SMEs, assess their research needs and direct them to research expertise. It also provides funding for collaborative projects through grants (CSIRO, 2020[86]). The duration of Innovation Connections projects ranges between two and 12 months. An eligible firm can: i) place up to two of its own research employees in a publicly-funded research organisation or an Australian university, to work collaboratively on a project and/or access specialised equipment and research infrastructure; ii) employ a graduate or postgraduate student to undertake a research project for 6-12 months; or iii) place a researcher in the firm to work collaboratively on a project to develop and implement a new idea with commercial potential. Evidence suggests the programme tends to encourage longer-term partnerships between SMEs and research institutions (Watt, 2015[87]).
- The Canadian Technology Access Centres (TAC) Grant programme focusses on enhancing the innovative capacity of SMEs through collaborative access to specialised talent, expertise, equipment and technology from Canadian colleges (OECD, 2019[78]). The programme provides financial support to a network of 30 TACs throughout the country. TACs are specialised, applied R&D centres affiliated with publicly-funded colleges located across Canada (Hampel and Doyle, 2019[88]). Each TAC focuses on strengthening an industrial sector of significance to that region but they are networked with one another.
- The Patent Commercialisation Platform (PCP) in Korea connects researchers from 24 universities and more than 8 000 SMEs, with its experts providing advice to SMEs and matching SMEs with university technologies to support technology transfer (OECD, 2019[78]). It also provides follow-up financing for commercialisation of these technologies by SMEs.

Collaborative research could also be encouraged by the university funding system, which is under review. In particular, as discussed above, more weight could be attached to collaborative research. Greater recognition of collaborative activities with industry in other funding parameters, notably the appointment and promotion of academics, could also provide incentives for mobility. As in other countries, teaching experience and publications tend be the dominant criteria for tenure and promotion, rather than engagement in business-research cooperation. Mobility is indeed important, and the government provides short-term grants for summer internships to university students to work in R&D projects undertaken by businesses or universities/research institutes. Options for enhancing mobility could focus on higher-degree research students and longer-term financial support for firms to strengthen incentives for them to hire students. Canada's Mitacs-Elevate is instructive in this regard. The programme consists of a two-year research management training scheme for postdoctoral students that deploys leading talent into the private sector, where they have the opportunity to lead industrial R&D projects and gain business experience. The programme subsidises more than 80% of the salary (OECD, 2019[78]).

The transfer of public sector knowledge is improving

In 2018, Iceland established a technology transfer office (Aunda TTO) to facilitate the commercialisation of public research. The main roles of TTO include the analysis and support of IP rights, as well as mentoring and advising on spin-off creation. It also seeks to improve IP awareness and value creation of scientific research. The digital era reinforces the need for effective IP management as the IP system is confronted with new challenges related to the importance of data as input and output of digital innovation and AI created patentable inventions (Guellec and Paunov, 2018[77]). At the same time, it is important to ensure simplified IP licensing processes to promote collaborative research. It is still early to assess the effectiveness of TTO, but it is important that TTO is well resourced, and its staff has strong skills and expertise in the management of IP. The receptiveness of university departments to TTO services and business-oriented management of TTO are important determinants of success (Muscio, 2009[89]).

Current efforts focus on open access policies. The aim is to promote access to public data from universities, research institutions and data generated through grants in the field of research and innovation (Government of Iceland, 2020[6]). This is welcome, given the benefits of opening up access to public data to encourage research in institutions and companies, as well as increasing the social returns of public investment in this area (OECD, 2007[90]). Open access data also poses challenges, including those related to incentives for making research data available openly and the necessary digital infrastructure to make it accessible (OECD, 2015[91]). Privacy and enforcement of IP rights are other important considerations. The government should go ahead with its plans to conduct a detailed analysis of the barriers and costs in opening access and develop an action plan for implementation. The OECD principles for access to research data from public funding (OECD, 2007[90]), and updated guidelines (OECD, 2021[92]) in terms of scope and areas that are crucial for enhancing access to research data, provide an overarching framework for policy in this area.

International research collaboration is another important channel of knowledge transfer. Iceland participates in a number European cooperation programmes, such as Horizon 2020 and Erasmus+, outperforming its Nordic peers in terms of EU grants received (Government of Iceland, 2020[6]). It also ranks highly in terms of international scientific co-publications (Figure 2, Panel A). The government is currently working on a roadmap for research infrastructure. This is welcome and essential for deepening the benefits of international collaboration in terms of knowledge flow and access to quality infrastructure in all fields, especially for a small country like Iceland.

Table 1. Recommendations for fostering innovation for the digital era

Improving R&D support for businesses	
Business R&D intensity does not match the rapid increase in tax support for R&D in recent years and innovation outcomes of smaller firms, which are the main beneficiaries of such support, are relatively weak.	**Ensure that R&D tax-incentives better target smaller innovative firms.**
The tax credit scheme has not been evaluated since its introduction in 2011, with the first evaluation set to be completed by 2023.	Regularly assess the cost-effectiveness of R&D tax incentives to inform policy choices and further reform.
Tax-incentive support for business R&D grew faster in recent years than direct support.	Continue to boost direct funding to business R&D, ensuring a balanced mix of support.
The science and innovation system is fragmented and solid evidence-based policy-making is lacking in this area.	Move to a new organisational structure of the innovation system that ensures greater policy co-ordination. Develop a comprehensive database for analysis and policy evaluation.
Encouraging firms to adopt new technologies	
Restrictions to foreign direct investment are high, holding back innovation.	Proceed with plans to streamline the application process for work permits for foreign specialists.
The insolvency framework ranks below the OECD average in terms of re-organisation proceedings, weakening the incentives for disruptive innovation and adoption of new technologies.	Reform the insolvency regime to facilitate further enterprise restructuring, including through clear rules for the commencement of the procedures by allowing creditors to initiate restructuring and a predefined period for enforcement action.
Venture capital, an important source of financing for young and innovative firms without collateral, is not yet well developed.	**Ensure that the new publicly-owned venture capital fund invests in privately-owned venture capital funds with large potential to promote start-ups and innovation companies.**
Developing digital government	
The Administration lags behind in the use of data to anticipate the needs of users and deliver better services, as well as to evaluate government's own performance.	Accelerate progress towards digital government and a data-driven public sector.
Relevant skills for fostering innovation in the digital era	
School teachers lack solid skills to integrate ICT tools in instruction.	Increase in-service and pre-service training in ICT for teachers.
The funding system for tertiary education provides an incentive for universities to focus on enrolment, rather than performance, and it is not linked to labour market needs. The tertiary system does not provide sufficiently broad skills.	Proceed with the reform of the tertiary funding system, broadening the set of indicators considered for allocating funds to institutions. Link university funding partially to the success of tertiary courses in providing skills corresponding to labour market needs. **Increase the provision of vocational education programmes at the tertiary level and of entrepreneurship programmes.**
Workers with a lower education level participate less in adult training programmes.	Encourage participation in lifelong training of under-represented groups, including through carefully-designed financial incentives and simple procedures for skills recognition programmes.
Enhancing knowledge transfer to strengthen innovation	
Collaboration between research institutions and the business sector is weak, limiting knowledge transfer. Open access to public data created by universities and research institutions, including in the field of research and innovation, is still constrained.	**Introduce carefully-designed policy initiatives to encourage business-research collaboration on innovation, including specific programmes that connect smaller firms with researchers.** Conduct a detailed analysis of the barriers to, and costs of, in opening access to public data and develop an action plan for implementation.

Note: Key recommendations are in bold.

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