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BOOSTING PRODUCTIVITY IN NEW ZEALAND BY UNLEASHING DIGITALISATION

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ABSTRACT/RÉSUMÉ

Boosting productivity in New Zealand by unleashing digitalisation

This paper overviews structural reforms that promote the diffusion of digital technologies and investment in intangible capital that maximises the potential of these technologies in New Zealand. Effective use of digital technologies enables New Zealand citizens to participate in society in a more inclusive way, firms to strengthen competitiveness and better integrate into the global economy, and the government to offer better services. New Zealand has room to boost its relatively low productivity level by removing the structural bottlenecks holding back the expansion of its digital sector and digital innovation. There are severe shortages of specialised ICT skills owing to COVID-19-related border restrictions and a weak domestic pipeline of these skills that partly results from school students' poor mathematics achievement. Some regulations have not kept pace with technological change and risk constraining digital innovation while failing to prevent harmful activities. More intensive use of digital tools is also held back by the low availability of high-speed Internet connections in rural areas and a lack of financial support for small businesses. Weak coordination between export promotion and innovation support prevents young firms investing in digital innovation from reaping high returns through exporting. New Zealand should rigorously implement its new national digitalisation strategy so that government agencies and social partners can advance digital transformation

This Working Paper relates to the 2022 OECD Economic Survey of New Zealand (http://www.oecd.org/economy/new-zealand-economic-snapshot/)

JEL Classification: O33, O38, O43, O56

Keywords: Digital transformation, productivity, intangible capital, skills, regulation, Internet, New Zealand

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Stimuler la productivité en Nouvelle-Zélande en libérant la numérisation

Ce papier passe en revue les réformes structurelles qui favorisent la diffusion des technologies numériques et l'investissement dans le capital immatériel qui maximise le potentiel de ces technologies en Nouvelle-Zélande. L'utilisation efficace des technologies numériques permet aux citoyens néo-zélandais de participer à la société de manière plus inclusive, aux entreprises de renforcer leur compétitivité et de mieux s'intégrer dans l'économie mondiale, et au gouvernement d'offrir de meilleurs services. La Nouvelle-Zélande a la possibilité d'augmenter son niveau de productivité relativement faible en supprimant les goulots d'étranglement structurels qui freinent l'expansion de son secteur numérique et l'innovation numérique. Il existe de graves pénuries de compétences spécialisées en TIC en raison des restrictions aux frontières liées à la COVID-19 et d'un faible réservoir national de ces compétences qui résulte en partie des mauvais résultats en mathématiques des élèves. Certaines réglementations n'ont pas suivi le rythme de l'évolution technologique et risquent de limiter l'innovation numérique sans pour autant empêcher les activités nuisibles. L'utilisation plus intensive des outils numériques est également freinée par la faible disponibilité des connexions Internet à haut débit dans les zones rurales et le manque de soutien financier aux petites entreprises. La faible coordination entre la promotion des exportations et le soutien à l'innovation empêche les jeunes entreprises qui investissent dans l'innovation numérique d'obtenir des rendements élevés grâce à l'exportation. La Nouvelle-Zélande devrait mettre en œuvre rigoureusement sa nouvelle stratégie nationale de numérisation afin que les agences gouvernementales et les partenaires sociaux puissent faire progresser la transformation numérique.

Ce Document de travail a trait à l'Étude économique de l'OCDE de la Nouvelle-Zélande, 2022 (http://www.oecd.org/fr/economie/nouvelle-zelande -en-un-coup-d-oeil/).

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Mots clés : Transformation numérique, productivité, capital immatériel, compétences, réglementation, Internet, Nouvelle-Zélande

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By Naomitsu Yashiro, David Carey and Axel Purwin[1]

Better use of digital technologies can deliver productivity gains

Digital technologies have transformed the economy and social interactions in recent decades, with the COVID-19 pandemic accelerating this trend. Digital technologies have considerable potential to boost productivity growth and improve wellbeing. For instance, a wider use of online platforms lowers transaction costs by matching sellers and buyers more efficiently and reducing information asymmetries. Big Data analysis and Artificial Intelligence enhance innovation by helping firms to exploit large and timely data in their R&D activities or introduce novel digital solutions to reduce costs and improve efficiency (OECD, 2020[1]). Digitally-enabled innovations often exert strong economies of scale as they can be replicated with little additional cost (Brynjolfsson et al., 2008[2]). Despite the ongoing digital transformation, many OECD countries, including New Zealand, are struggling with low productivity growth. This is partly because economic statistics do not capture fully the benefits of digital technologies, not least when digital services are provided for free. But a more import reason is that diffusion of digital technologies is still underway and is not fast and broad enough to significantly raise productivity growth (Brynjolfsson, Rock and Syverson, 2021[3]).

Historically, general-purpose technologies have generated significant productivity gains only after a long time lag, and might even have contributed to a productivity slowdown in the short run as resources have had to be diverted for adoption and learning (Hornstein and Krusell, 1996[4]). Countries need to accumulate intangible capital that complements digital technologies, such as new work organisation, digital and managerial skills and valuable (big) data (Brynjolfsson, Rock and Syverson, 2021[3]; Corrado et al., 2021[5]).Investment in such intangible capital is costly and time consuming, as well as risky, involving substantial trial-and-error. It requires good access to a skilled workforce and risk capital, as well as flexible and competitive regulatory settings that encourage digital innovation. Availability of high-quality digital

[1] Naomitsu Yashiro, David Carey and Axel Purwin are members of the OECD Economics Department. The authors acknowledge valuable comments and inputs received from Vincent Koen, Alvaro Pereira, Isabell Koske, Patrick Lenain, Nikki Kergozou, Timo Leidecker (OECD Economics Department), Dirk Pilat, Fernando Galindo-Rueda, Verena Weber, Jeremy West, Laurent Bernat, Sara Calligaris, Galia Daor, Alexander Himbert, Andreas Molnar, Maximilian Reisch (OECD Directorate for Science, Technology and Innovation), Francesca Casalini, Guillaume Gruère (OECD Directorate for Trade and Agriculture), Richard May, James Mancini (OECD Directorate for Financial and Enterprise Affairs), Patricia Mangeol, Andreea Minea-Pic (OECD Directorate for Education and Skills), Glenda Quintini (OECD Directorate for Employment, Labour and Social Affairs), Ganesh R. Ahirao, Lynda Sanderson and other members of New Zealand's Productivity Commission, Stuart McNaughton (New Zealand Ministry of Education), Garrick Wright-McNaughton and other members of New Zealand's Ministry of Business, Innovation and Employment, members of New Zealand's Commerce Commission, Nick Manning (Crown Infrastructure Partners), as well as Elena Avery and Emily Gray. Special thanks are due to Sisse Nielsen and Gemma Martinez (OECD Economics Department) for editorial assistance.

infrastructure, like ultra-fast broadband, also underpins faster diffusion of advanced, data-intensive digital technologies (Sorbe et al., 2019[6]; OECD, 2021[7]).

The effective use of digital technologies and data would enable New Zealanders to participate in society in a more inclusive way, firms to boost productivity and exports and the government to offer better services. However, reaping these benefits requires seizing the opportunities digital technologies bring, judicious investment in digital technologies and infrastructure, as well as better risk management against heightened digital security threats, and strong trust in digital environments (OECD, 2019[8]). Social institutions including laws, regulations, education and innovation policies will need to adjust while ensuring that all citizens enjoy access to good, affordable communication infrastructure, opportunities to acquire skills to thrive alongside the digital transformation of the workplace, and means to protect themselves against data theft and other harmful online activities.

In many OECD countries that underwent prolonged periods of lockdown, the COVID-19 pandemic accelerated the use of digital technologies among businesses, notably through changes in work arrangements and moving activities online (OECD, 2021[9]). The stringent lockdown in April 2020 raised awareness among New Zealand businesses of how effective use of digital tools can improve their performance. However, they may not have seized the opportunity to press ahead with the digital transformation as much as their peers in other OECD countries as economic activities reopened rapidly (OECD, 2022[10]). The next section assesses the diffusion of digital technologies in New Zealand from several angles including ICT industries, digital innovation and the use of digital tools by firms, households and the government. The following one discusses various policies to enhance the diffusion of digital technologies.

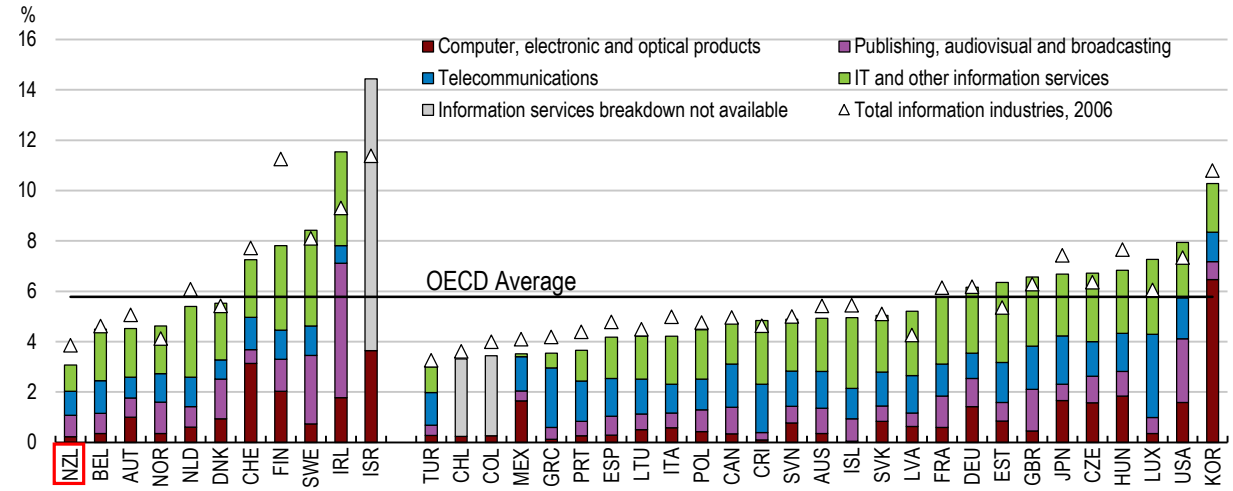
There is scope to enhance the diffusion of digital technologies in New Zealand

The digital sector is small

The digital sector, defined here as the ICT sector and digital services, is small in New Zealand by international comparison. For instance, value added shares of information industries (defined as the ICT sector plus the content and media sector) have decreased since 2006 and are among the smallest in the OECD (Figure 1). New Zealand especially stands out in comparison with other Small Advanced Economies (SAEs), which are defined in this paper as the 11 OECD countries with populations between 1 million and 20 million and with per capita incomes above USD 30 000 (PPP exchange rates). This definition is in line with the one employed by the Productivity Commission (2021[11]) and Skilling (2020[12]), except that they also included two non-OECD economies (Singapore and Hong-Kong). This paper compares New Zealand with other SAEs not only to control for their smaller domestic product and factor markets, but also to identify areas of digitalisation where New Zealand has substantial room to catch up to its peers through policy reforms.

Figure 1. ICT industries account for a low share of value added

Value added by information industries as a percentage of total value added, 2016[1, 2] or latest



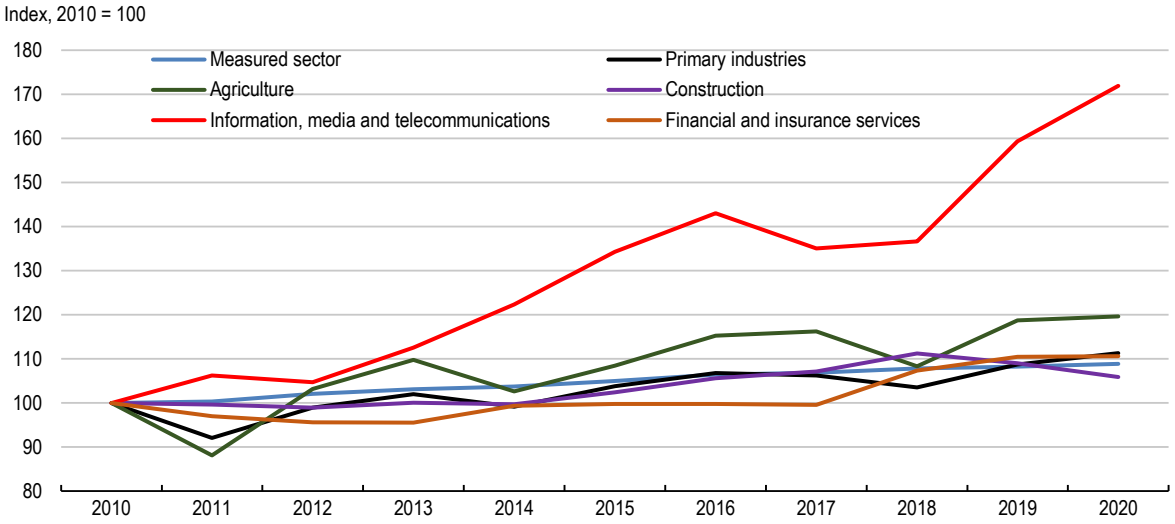
1. Values for Colombia, New Zealand, Poland, Portugal, Spain, Sweden and Turkey are for 2015 and values for Canada are for 2014.
2. Small advanced countries are defined as the OECD countries with populations of 1-20 million and with per capita incomes above USD 30 000.

Source: OECD (2021), STAN database, Inter-Country Input-Output database and national sources.

Productivity growth in the ICT sector outpaces that in other sectors (Figure 2), but its contribution to New Zealand's aggregate productivity growth is muted by its small weight. Chronic shortages of ICT skills (Figure 3) have contributed to high wage levels in the digital sector (Figure 4). Firms in the ICT sector are by far the most advanced users of digital technologies, such as big data and cyber security technologies (OECD, 2020[1]). Innovation in the ICT sector exerts positive spillover effects on productivity in other industries, through backward and forward linkages (Han et al., 2011[13]). Industries that are more ICT intensive benefit most from such spillover effects, which materialise over time. While the weight of ICT intensive sectors in New Zealand is small compared with many other OECD countries (Figure 5, Box 1), it is growing, with their contribution to employment growth around the OECD average during 2006-16 (Figure 6).

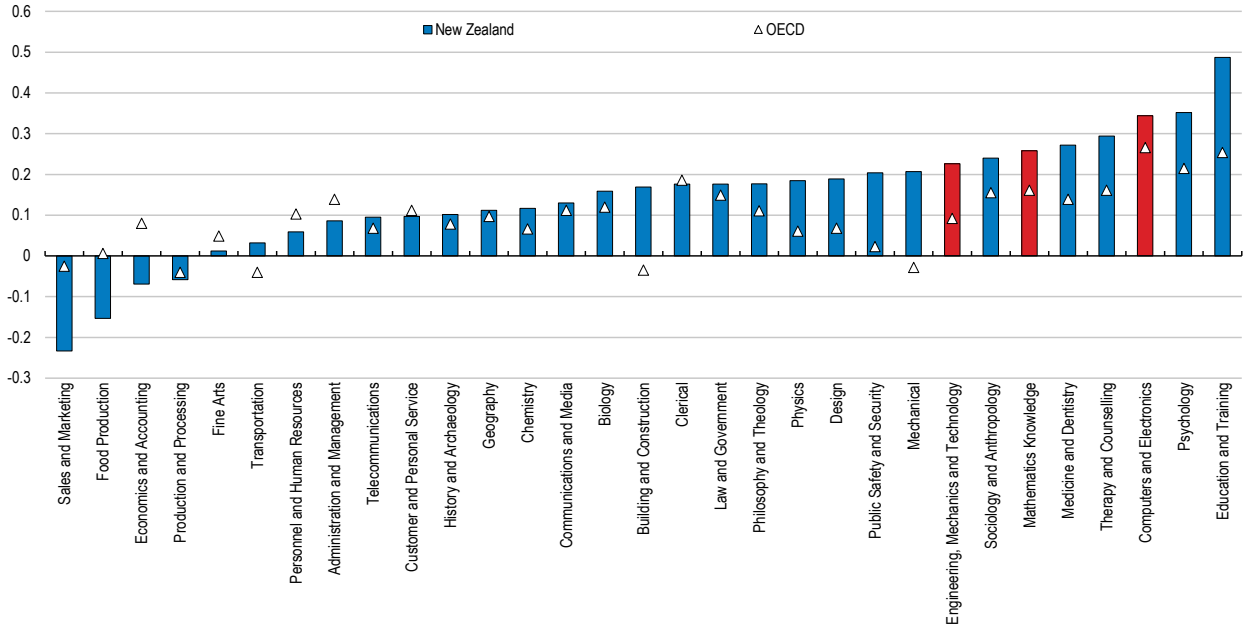
Figure 2. Labour productivity has grown fast in the ICT sector

Hourly labour productivity



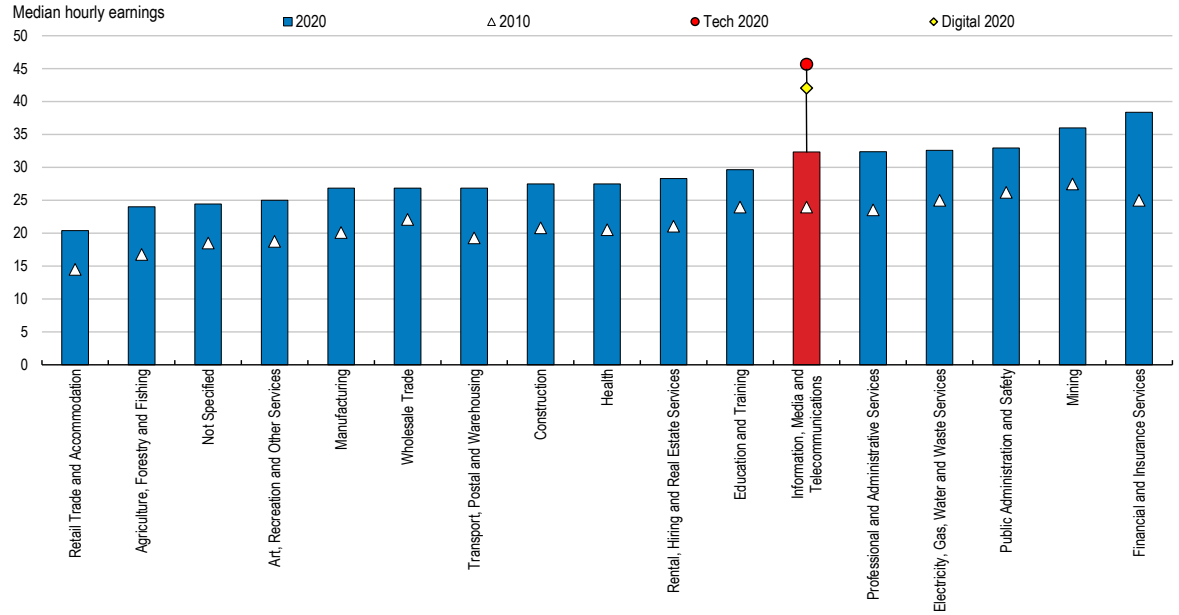
Source: Stats NZ.

Figure 3. Shortages of ICT skills are among the most pronounced in New Zealand, 2015



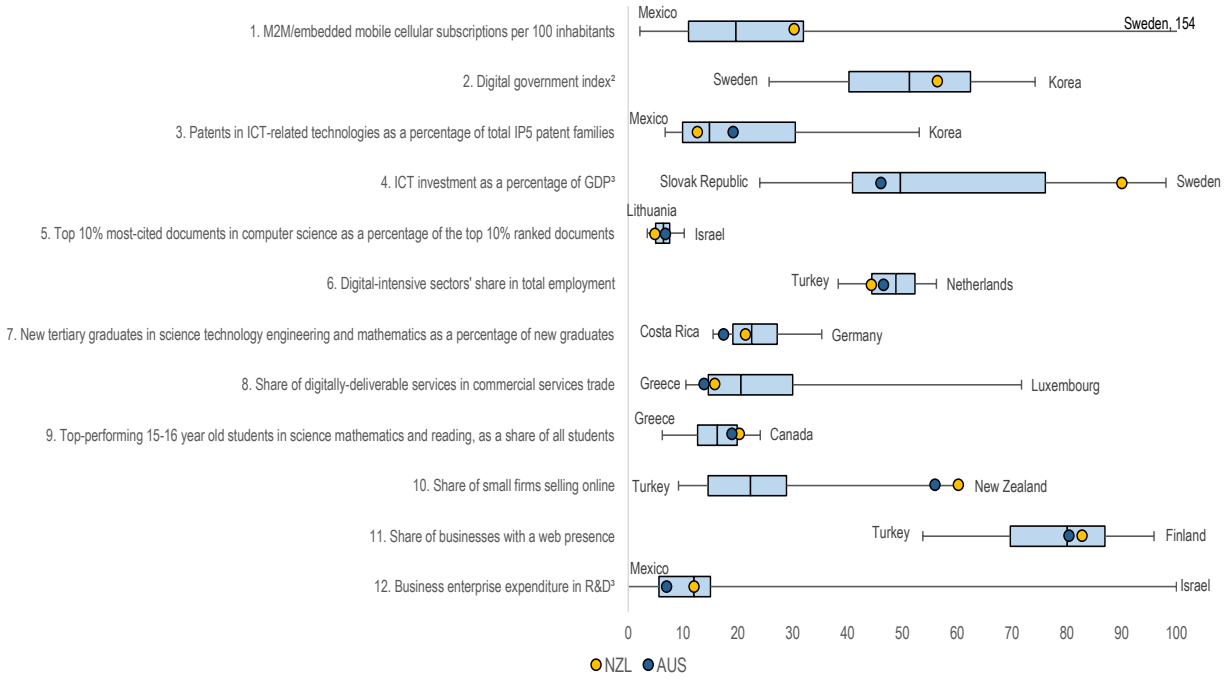
Note: The OECD Skills for Jobs indicator captures skills shortages and surpluses. Positive values indicate skills shortages while negative values point to skills surpluses. The larger the absolute value, the larger the imbalance. Results are presented on a scale that ranges between -1 and +1. The maximum value reflects the strongest shortage observed across OECD countries and skills dimensions.
Source: OECD, *Skills for Jobs* (database).

Figure 4. Wages in the digital sector are relatively high



Note: Data on wages for tech and digital jobs come from absolute IT. Tech jobs include roles such as software engineer, scrum master and data analyst. Digital jobs include roles such as web developer, SEO manager and digital marketing specialist.
Source: Stats NZ; Absolute IT (2021), *Tech & Digital Remuneration Report, July 2021*

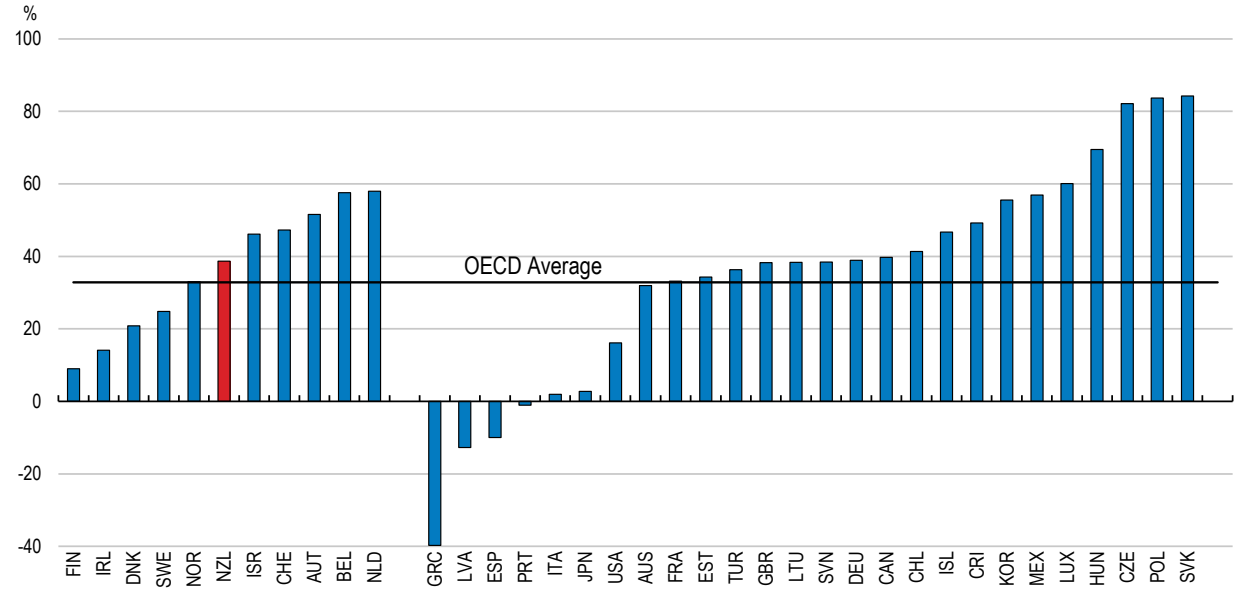
Figure 5. Overall, New Zealand scores around the OECD average on the available digital indicators[1]



1. The box shows the second to fourth quintile, the vertical line indicates the median and the whiskers show minimum and maximum values.
2. The OECD Digital government index assesses the adoption of digital technologies by public sector organisations. The index takes values from 0 (lowest digital maturity) to 1 (highest digital maturity). In this chart, index values have been multiplied by 100.
3. Not actual values, but relative ranking by OECD Going Digital.
Source: OECD (2021), *Going Digital Toolkit*

Figure 6. The contribution of digital-intensive sectors to employment growth is around the OECD average

As a percentage of total absolute changes in employment in 2006-16



Note: Digital intensity is defined according to the taxonomy described in Calvino et al (2018). See the source for more details.
See Figure , note 2 for the definition of small advanced economies.
Source: Calvino et al. (2018), *A taxonomy of digital intensive sectors*, OECD Science, Technology and Industry Working Papers, No. 2018/14.

Box 1. The OECD Going Digital Toolkit indicators

The OECD Going Digital Toolkit includes 42 key indicators for benchmarking OECD countries' digital transformation. The indicators, capturing a wide range of aspects of a digital economy, are categorized into seven policy dimensions: Access, Use, Innovation, Jobs, Social, Trust and Market openness.

The *Access* dimension measures components that lay the foundation for the digital transformation, such as access to communication infrastructure, data and services. The *Use* dimension captures the extent to which digital technologies are actually used, for instance for selling and buying products online or interacting with authorities. The *Innovation* dimension gauges both how much resources are put into innovation and the actual output, in terms of academic research and start-up firms. The *Jobs* dimension captures the weight of the digital sector and the readiness of workers to thrive in a digital workplace. The *Society* dimension captures inclusiveness in the digital economy and society. The *Trust* dimension captures individuals' and firms' confidence in the digital environment. For instance, this dimension includes an indicator on the extent to which national health data may be shared with domestic and international stakeholders. The *Market Openness* dimension captures the weight of the digital sector in trade and the openness to trade and investment in digital services.

Many indicators in the Toolkit are missing for New Zealand, making it difficult to identify the aspects of its digital transformation that require the greatest attention (Table 1). Improving data should be a priority in the national digital strategy currently being developed (see below).

Table 1. Many of the Going Digital Toolkit indicators are missing for New Zealand

Dimension	Indicator	New Zealand data not available	Underperforming the OECD average	Outperforming the OECD average
Access	Fixed broadband subscriptions per 100 inhabitants			Med.[1] quintile
	M2M (machine-to-machine) SIM cards per 100 inhabitants			X
	Mobile broadband subscriptions per 100 inhabitants		Med.[1] quintile	
	Share of households with broadband connections	X[2]		
	Share of the population covered by at least a 4G mobile network		X	
	Broadband speed			X
	Disparity in broadband uptake between urban and rural households	X		
Use	Internet users as a share of individuals	X		
	Share of individuals using the Internet to interact with public authorities	X		
	Share of Internet users who have purchased online in the last 12 months	X		
	Share of small businesses making e-commerce sales in the last 12 months			X
	Share of businesses with a web presence			X
	Share of adults proficient at problem-solving in technology-rich environments			X
	Share of businesses purchasing cloud services	X		
Innovation	ICT investment as a percentage of GDP			X
	Share of start-up firms (up to 2 years old) in the business population			X
	Top 10% most-cited documents in computer		X	

	science, as a percentage of the top 10% ranked documents			
	Patents in ICT-related technologies, as a percentage of total IP5 patent families		X	
	Business R&D expenditure in information industries as a percentage of GDP		X	
	Venture capital investment in the ICT sector as a percentage of GDP	X		
Jobs	Digital-intensive sectors' share in total employment		X	
	Workers receiving employment-based training, as a percentage of total employment			X
	New tertiary graduates in science, technology, engineering and mathematics, as a percentage of new graduates		X	
	Public spending on active labour market policies, as a percentage of GDP		X	
	ICT task-intensive jobs as a percentage of total employment	X		
Society	Percentage of individuals who live in households with income in the lowest quartile who use the Internet	X		
	Disparity in Internet use between men and women	X		
	Top-performing 15-16 year old students in science, mathematics and reading			X
	OECD Digital Government Index			X
	Percentage of individuals aged 55-74 using the Internet	X		
	Women as a share of all 16-24 year-olds who can program	X		
	Percentage of individuals who use digital equipment at work that telework from home once a week or more	X		
Market openness	Digitally-deliverable services as a share of commercial services trade		X	
	OECD Digital Services Trade Restrictiveness Index		X	
	OECD Foreign Direct Investment Regulatory Restrictiveness Index		X	
	ICT goods and services as a share of international trade	X		
	Share of businesses making e-commerce sales that sell across borders	X		
Trust	Health data sharing intensity	X		
	Percentage of businesses in which ICT security and data protection tasks are mainly performed by own employees	X		
	Percentage of individuals not buying online due to concerns about returning products	X		
	Percentage of individuals not buying online due to payment security concerns	X		
	Percentage of Internet users experiencing abuse of personal information or privacy violations	X		

1. Median.
2. After 2018.

Source: OECD (2021) *Going Digital Toolkit*.

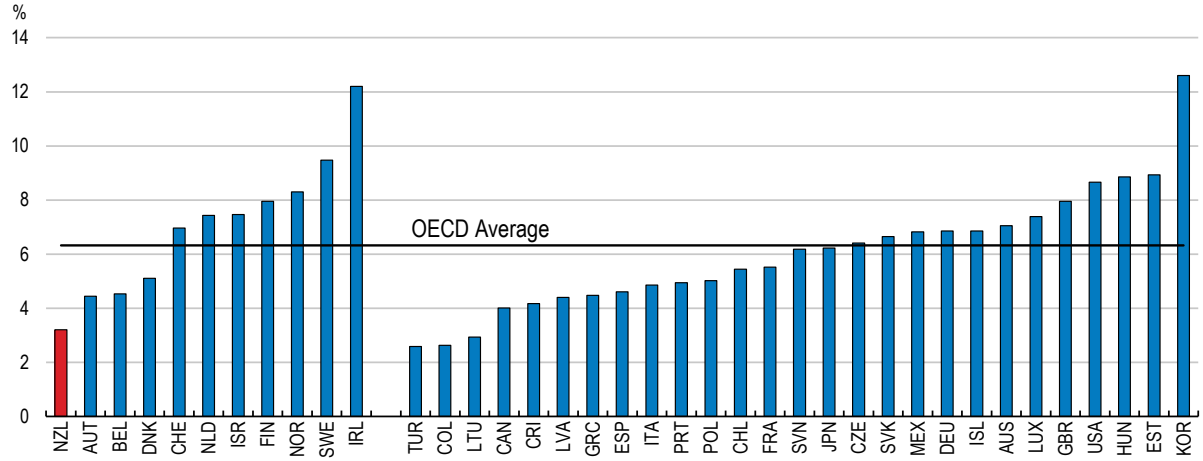
The use of advanced digital technologies is limited among NZ firms

The use of advanced digital technologies by NZ firms appears to be low compared with other OECD countries. For instance, the information industry supplies only 3.2% of intermediate inputs used in New Zealand's production, the lowest share among SAEs and one of the lowest in the OECD (Figure 7). The small size of information industries (Figure 1) also indicates that the use of digital services by New Zealand firms is lower than in many other OECD countries, either due to smaller demand or limited supply. In particular, IT and other information services, the main providers of digital services including cloud computing that provide firms on-demand access to ICT services, comprise only 1% of value added in New Zealand, half the OECD average. Although ICT investment as a share of GDP is relatively high (Figure 5), this may reflect the weak use of ICT services, notably cloud computing, which requires New Zealand firms to build up their own digital capabilities.

Surveys conducted of New Zealand firms also suggest that their use of advanced digital technologies is limited. For instance, only 16% of 852 small businesses surveyed by the Small Business Council (2019[14]) used cloud computing in 2019. Intezari et al. (2019[15]) found that two thirds of managers in predominantly large and medium-sized companies expressed only limited confidence in big data analysis, with one quarter having only rudimentary knowledge of big data. Few New Zealand firms integrate a digital strategy into their corporate strategy (PwC, 2017[16]). While the shutdown of non-essential businesses during the COVID-19 pandemic highlighted the difference in performance between firms that exploited digital tools and those that did not, it did not result in a significant increase in the use of sophisticated digital tools. Among 2 280 NZ firms interviewed by the Ministry of Business, Innovation and Employment (MBIE), the share of firms that took up communication tools like Skype or Zoom increased from 29% to 50% during the pandemic, but the use of cloud-based collaboration tools increased by a mere 5% (Better for Business, 2020[17]).

Figure 7. New Zealand makes little use of digital inputs in its production

The share of information industry products in intermediate consumption, 2015



Note: See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD (2021), *Going Digital Toolkit*

New Zealand is advanced in using some digital technologies. For instance, New Zealand firms make good use of some ubiquitous digital technologies, like online sales. Some 60% of SMEs sell online, the highest share in the OECD (Figure 5). Nevertheless, the weight of online sales in total sales is relatively low - some 62% of the companies reported that their internet sales account for 10% or less of total dollar sales in 2020 (Stats NZ, 2021[18]) – although smaller firms and firms in more ICT-intensive sectors sold relatively more

online. The share of firms owning a website is above the OECD average (Figure 5), although it is lower than many other SAEs. The COVID-19 pandemic resulted in a dramatic rise in online shopping. While the number of people shopping online continues to increase, the average number of transactions, as well as the average size of each transaction, has decreased since the second quarter of 2020 (NZ Post, 2021[19]). New Zealand also has a high number of M2M (machine-to-machine) SIM cards issued per 100 inhabitants (Figure 5), which suggests an advanced use of the Internet of Things (IoT). In the aforementioned survey of 2 280 firms, 62% responded that they have or use IoT technologies (Better for Business, 2020[20]).

Diffusion of digital technologies generates positive productivity spillovers. For instance, Gal et al. (2019[21]) found that higher industry-level adoption of digital technologies increases the productivity of European and Turkish firms, particularly firms with initially high productivity levels. A wider use of cloud computing by small and credit-constrained firms would allow them to experiment with digital technologies without investing in their own digital facilities or hiring technicians, thereby boosting innovation and productivity.

Digital innovation could be stronger

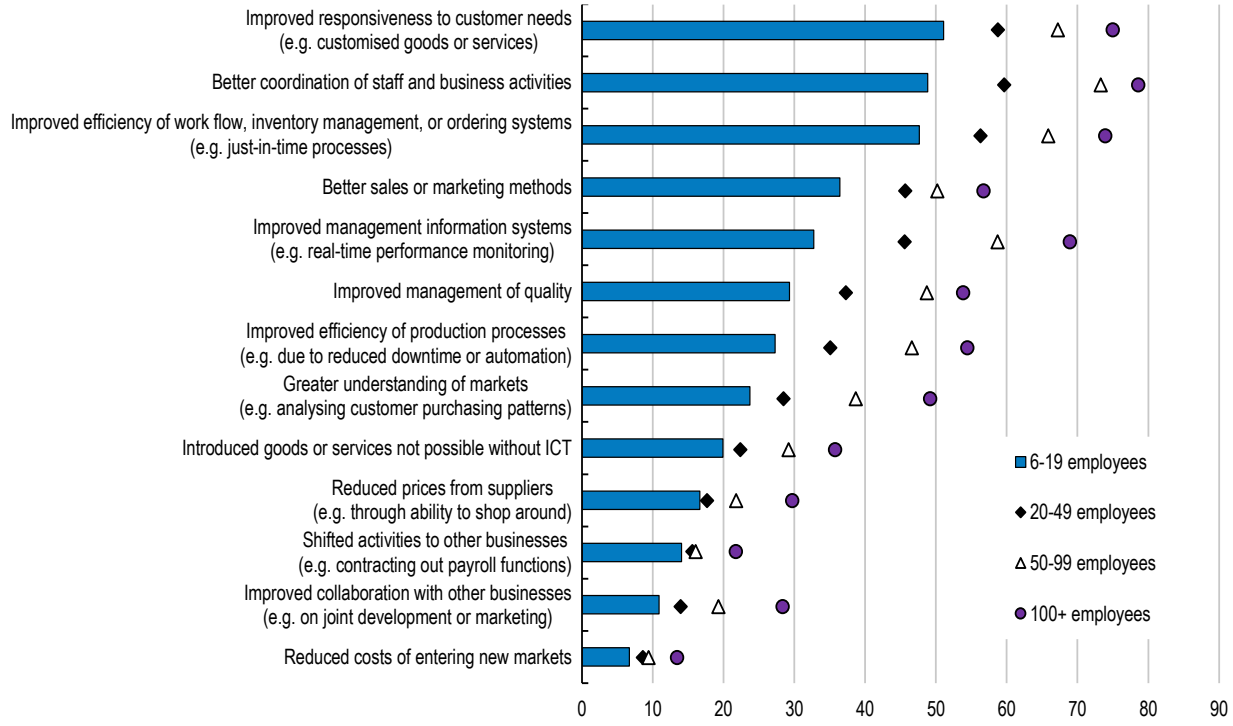
New Zealand's digital innovation is moderate overall. For instance, R&D spending by information industries was about 0.3% of GDP in 2018, which is slightly lower than the OECD average (about 0.4%) but slightly higher than Australia (about 0.2%) (OECD Going Digital Toolkit). Furthermore, only 13% of IP5 patents (patents filed in at least two patent offices worldwide, including one of the five largest IP offices) filed by New Zealand entities were on ICT-related technologies, a share that is again lower than the OECD average (20%) or in Australia (19%) (Figure 5).

Large firms are not obtaining transformative outcomes using digital technologies

Digital innovation does not only concern R&D or patent application by information industries. It encompasses the introduction of novel products, production or delivery processes, as well as organisational and marketing changes enabled by digital technologies. However, New Zealand firms' relatively low overall investment in R&D (0.8% of GDP as opposed to the OECD average of 1.8% in 2019) and in other intangible capital (OECD, 2017[22]), together with relatively poor management quality (see below) risk holding back New Zealand firms in achieving strong productivity gains. Indeed, while a high share of New Zealand firms self-reported that they improved customer relations and work efficiency by using digital technologies, only a small share managed to reduce the cost of entering new markets, introduce new products or collaborate with other businesses on innovation (Figure 8). Small firms are less likely to improve information management, coordination of staff and business activities or marketing than mid-sized firms, possibly because they invest much less in intangible capital (Figure 9).

Figure 8. Few New Zealand firms are successful in achieving transformative outcomes using ICT

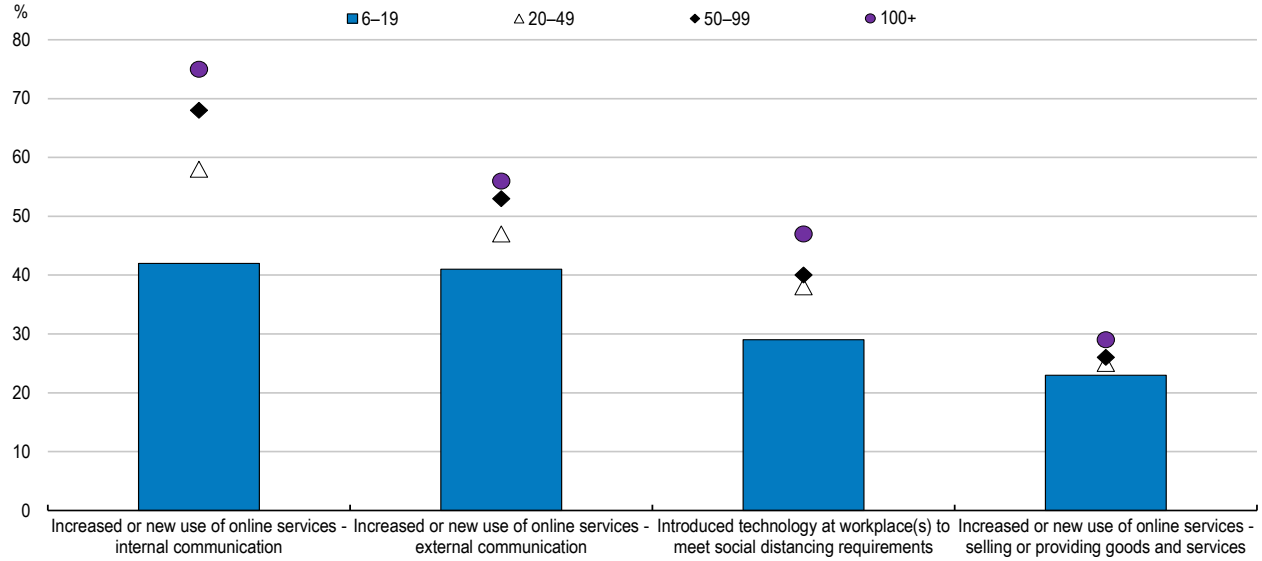
Outcomes achieved using ICT, percentage of firms by size, 2020



Source: Stats NZ (2020), *Business Operations Survey*

Figure 9. Large firms were not much better than smaller firms in expanding online sales during the pandemic

Firms using digital technologies in response to COVID-19, share of total respondents in each size class



Note: Businesses were surveyed from August to December 2020 about how they responded to the COVID-19 pandemic in 2020.
Source: Stats NZ (2020), *Business Operations Survey*

Weak digital innovation is holding back productivity growth in the agricultural sector

Agriculture accounts for a large share of New Zealand's economy and exports (OECD, 2022[10]). It exports over 90% of its products and is highly exposed to global competition; with virtually no producer support, prices are in line with the world market (OECD, 2021[23]). It has also been historically agile in adopting new technologies (Ministry of Business Innovation and Employment, 2020[24]).

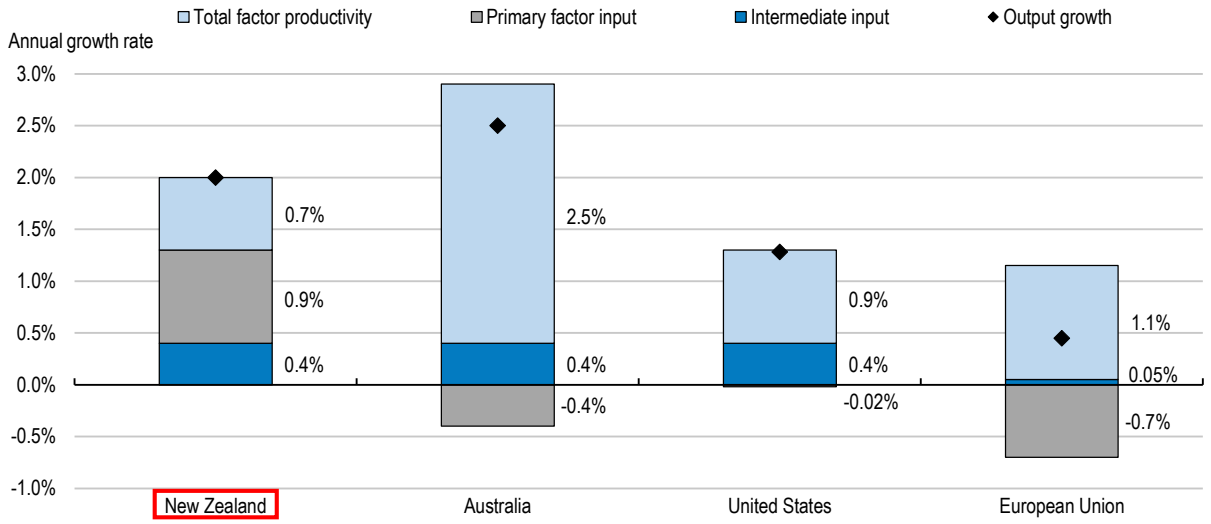
Despite its strong export performance, New Zealand's agricultural sector faces several structural challenges. Its annual average total factor productivity (TFP) growth during 2007-16 was only 0.7%, lower than in Australia, the United States or the European Union (Figure 10). This points to a slow adoption of new technologies and innovation, partly resulting from -heavy reliance on low-skilled migrant labour. With the inflow of migrant workers curtailed by border restrictions and unlikely to return to pre-COVID levels owing to immigration policy becoming more restrictive, faster technology adoption will be needed to cope with labour shortages.

The agricultural sector also faces other issues, such as a significant shift in global consumer preferences towards sustainable farming and healthy food. The emergence of new production technologies like plant-based or laboratory-produced meat and dairy products may eventually reduce demand for products from pastoral farming (Ministry of Business Innovation and Employment, 2020[24]). New Zealand's farmers and food production firms need new technologies and business models that enable them to provide quality assurance to final consumers and communicate their environmental commitment more effectively (Baragwanath, 2021[25]). The agricultural sector also faces stricter regulations on fresh water pollution and will need to reduce its greenhouse gas emissions (OECD, 2022[10]). The natural hazard risks farmers have to cope with are also likely to be heightened by climate change (Casalini, Bagherzadeh and Gray, 2021[26]).

Better use of digital technologies would help the agricultural sector to respond to these challenges. Digital innovation can unlock strong productivity growth. Intelligent and digitally connected machinery (the Internet of Things) would facilitate precision farming, helping farmers improve the accuracy of operations and optimise the use of inputs including fertilisers and pesticides (Paunov and Planes-Satorra, 2019[27]). It would also help farmers determine nutrient loss based on their application of fertiliser onto pasture, which is critical for implementing environmental regulations at the farm level. Increased use of robots would help to address labour shortages and boost productivity in horticulture, which often involves labour-intensive harvesting and packing processes; New Zealand has already developed some successful robotics for horticulture and pastoral farming (GOFAR, 2021[28]). Agritech New Zealand (2020[29]) estimates that the effective use of these technologies could boost the agricultural sector's output by 21% in the long run. Digital tools can also help the government to better manage natural hazards and biosecurity risks and provide quick responses in the case of an animal disease outbreak or flooding emergency.

Figure 10. Growth in agricultural output is driven less by innovation and more by growth in primary factor input

Composition of agricultural output growth, 2007-16



Note: Primary factors comprise labour, land, livestock and machinery.
Source: OECD (2021), *Agricultural Policy Monitoring and Evaluation 2021: Addressing the Challenges Facing Food Systems*, OECD Publishing, Paris.

Nevertheless, the take-up of digital technologies has been slow. For instance, only 16% of businesses in the agricultural sector were using fibre broadband in 2020, compared with an average of 64% across all sectors (Stats NZ, 2021[18]). Furthermore, less than 10% of over 4 000 farmers responding to the 2017 Survey of Rural Decision Makers (Manaaki Whenua, 2017[30]) made use of precision agriculture, while only 3% indicated uptake of automation or robotics.

Digital technologies can help reduce the "tyranny of distance"

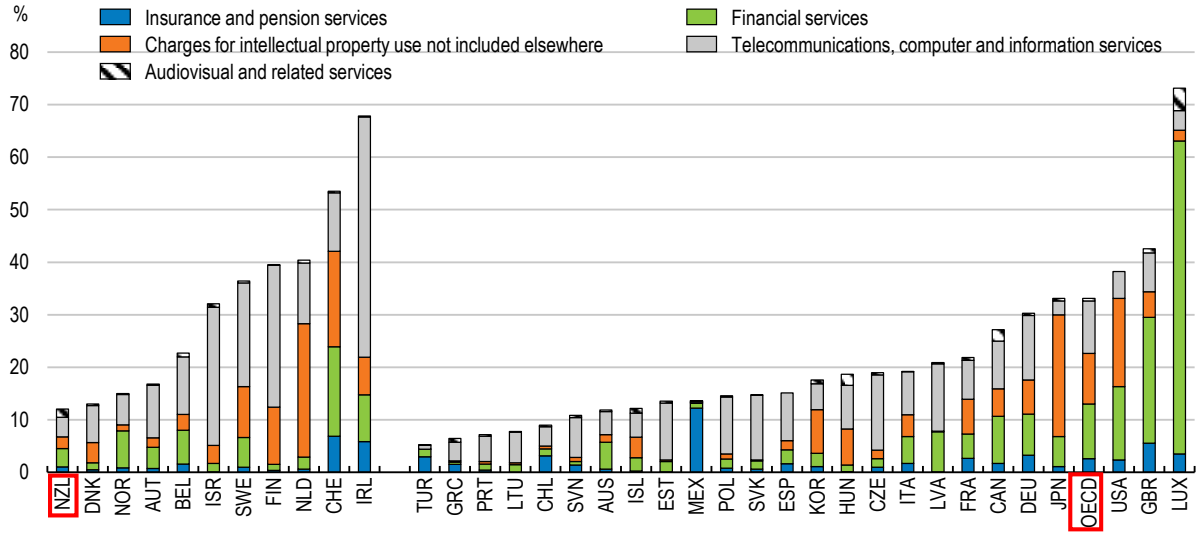
New Zealand's exports are constrained by its geographical remoteness from large markets and suppliers of intermediate inputs (Fabling and Sanderson, 2010[31]; de Serres, Yashiro and Boulhol, 2014[32]). This remoteness increases shipment costs, which holds back the competitiveness of New Zealand exports, and information frictions, which make it harder for New Zealand exporters to penetrate foreign markets and establish export relationships. This "tyranny of distance" not only holds back New Zealand's exports, but also the adoption of digital technologies. Without export sales, New Zealand firms may not be able to capture sufficiently large returns to justify risky investments in new technologies and intangible capital. An effective use of digital tools like websites or online platforms can help to reduce the tyranny of distance by facilitating export entry via reduced search costs and information asymmetries in international transactions (see Box 2).

If digital take-up enables more New Zealand firms to start exporting or expand their export markets, this would, in turn, accelerate the adoption of digital technologies and intangible investments (Box 2). This interaction between digital take-up and exporting is an important driver of diffusion of digital technologies. Firms that export and adopt digital technologies become more productive and competitive, thereby expanding their domestic market shares and attracting resources like labour. This reallocation of resources toward digitalised exporting firms boosts aggregate productivity (Melitz, 2003[33]). Exporting also provides firms with opportunities to learn advanced technologies and management practices from foreign buyers (De Loecker, 2007[34]), which would help New Zealand firms to catch up to the global productivity frontier (New Zealand Productivity Commission, 2021[11]).

Another way of reducing the tyranny of distance is to increase exports by the weightless sector, such as digital services that can be delivered predominantly online. The share of predominantly digitally deliverable services in New Zealand's service exports is relatively low compared with the median of OECD countries (Figure 5) or other small advanced economies (Figure 11). There are opportunities to increase exports of digital services, particularly for the digital gaming industry, which has already established a strong track record in New Zealand. However, the competitiveness of digital services is constrained by a severe skills shortage, which has been greatly aggravated by COVID-related border restrictions (OECD, 2022[10]) and a weak domestic pipeline of skilled digital workers (see below). Furthermore, distance can hold back competitiveness in other ways besides increasing shipping costs. For example, some digital services delivering highly tailored products require intensive face-to-face interactions (Australian Productivity Commission and New Zealand Productivity Commission, 2019[35]). The lack of agglomeration of innovation activities in New Zealand also limits competitiveness in knowledge-intensive services. New Zealand's export-oriented digital start-ups often seek to establish their presence in large foreign markets to better serve foreign customers and tap into local knowledge sources (Sim, Bull and Mok, 2021[36]).

Figure 11. Exports of predominantly digitally deliverable services are relatively low in New Zealand

As a percentage of total services exports, 2017



Note: For Chile, Mexico, New Zealand and Switzerland, Audiovisual and related services include Other personal, cultural and recreational services. See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD, *International Trade in Services Statistics*; WTO (2018), *Trade in Commercial Services*

Online platforms can help small firms in particular to export as they often struggle to cover the sizable entry costs of exporting related to finding foreign buyers and establishing distribution channels (Melitz, 2003[33]). In 2020, 31% of New Zealand firms with 20 to 49 employees that sold online also exported online, well above the overall share of exporters in this size cohort (23.5%), implying that firms using traditional trade channels were much less likely to export (Figure 12). In contrast, for firms with over 50 employees, the two shares are about the same, implying that larger firms were equally likely to export online or through traditional channels, possibly because they can bear traditional export entry costs.

Even though small firms selling online enjoy reduced export entry costs, the low share exporting online suggests that barriers to exporting remain high even with the use of digital tools. One such barrier is the lack of intangible capital that underpins export competitiveness. For example, established brands and reputation among foreign consumers are important for expanding sales, particularly from online platforms (Box 2). A lack of brand recognition in foreign markets has been the most common challenge acknowledged by New Zealand's exporters (Sim, Bull and Mok, 2021[36]). Another potential barrier is limited capabilities by small firms to make an effective use of digital tools. Joint research by the OECD and MBIE

finds that the adoption of ultra-fast broadband, which supports an extensive use of digital technologies, increases the chance that New Zealand firms start exporting, particularly for those that are making effective use of digital tools. Indeed, New Zealand firms that export use Internet more for enhancing communication and business collaboration than non-exporting firms do, and also deploy websites equipped with more functions (Box 3). This underscores the importance of support measures that help firms develop capabilities to leverage digital tools for capturing new business opportunities and boosting profits.

Figure 12. Smaller firms are more likely to export online than via traditional channels

Share of exporting firms in each size cohort, online versus general exports, 2020

Note: The share of firms exporting online is computed as the share of firms with non-zero sales via Internet that sell abroad over all firms with non-zero sales via Internet. The general share of exporting firms is the share of firms reporting non-zero exports.
Source: Computed by the Secretariat based on Stats NZ (2020), *Business Operations Survey*

Box 2. Can digital technologies overcome the tyranny of distance?

Digital technologies facilitate trade but do not make distance less important

Digital technologies facilitate trade between countries by reducing transaction and information costs through faster and cheaper communication. One might expect that they partially offset the well-documented negative impact of distance on trade flows. However, empirical evidence is mixed.

On the one hand, Freund and Weinhold (2004[37]) reported that a 10 percentage point increase in the growth of the number of web hosts in a country led to a 0.2-percentage point increase in service export growth during 1995-1999. Osnago and Tan (2016[38]) reported that higher Internet adoption (defined as the number of individuals using the Internet per 100 persons) by both the exporting and the importing countries boosts bilateral exports: a 10% increase in Internet adoption in the exporting (importing) country increases bilateral exports by 1.9% (0.6%). On the other hand, these trade-promoting effects coming from increased Internet use do not necessarily mean trade has become less sensitive to distance. On the contrary, Disdier and Head (2008[39]) reported that the impact of distance on bilateral trade has increased since the 1970s, despite the development and diffusion of ICT. Akerman, Leuven and Mogstad (2022[40]) found that roll-out of broadband Internet made international trade by Norwegian municipalities more sensitive to distance and the economic size of partner countries. Furthermore, digital services trade, which does not involve shipment costs, still seems to be negatively affected by distance. For instance, Blum and Goldfarb (2006[41]) showed that US imports of digital services consumed over the Internet fell with the distance between the US and the exporting countries.

Digital technologies help more firms to start exporting

Although digital technologies cannot nullify the impact of distance on trade, effective use of digital technologies can help firms to start exporting or enter new foreign markets by reducing the costs associated with searching foreign buyers or gathering information on foreign markets (Freund and Weinhold, 2004[37]). Osnago and Tan (2016[38]) found that higher Internet usage by the exporting country increases bilateral exports mainly through a larger number of exported products. However, the low entry cost to online platforms like AliExpress results in a large number of firms competing for consumers' attention, congesting consumers' search process and thus causing serious information frictions (Bai et al., 2020[42]). As a result, firms with sizable past sales, established reputation or recognisable brands are more likely to capture larger sales, thanks to their higher visibility on online platforms.

Exporting encourages adoption of digital technologies

Exporting encourages firms to adopt digital and other technologies that improve productivity because it increases the return to investment by allowing firms to capture larger sales from both foreign and domestic markets (Bustos, 2011[43]). Across OECD countries, including New Zealand, exporting firms are found to innovate more than non-exporting firms (Baldwin and Gu (2004[44]) for Canada; Damijan, Kostevc and Polanec (2008[45]) for Slovenia; Sin et al. (2014[46]) for New Zealand; and Peters, Roberts and Vuong (2020[47]) for Germany). In some cases, the decisions to adopt digital technologies and export can be made in tandem. For instance, some firms are not sufficiently productive and thus cannot capture sufficient export revenue to cover trade costs. They have an incentive to adopt new technologies to boost productivity so that they can start exporting (Lileeva and Trefler, 2010[48]).

Box 3. Does fast Internet increase exports by New Zealand firms?

Joint research by the OECD and the Ministry of Business Innovation and Employment (Sanderson, Wright-McNaughton and Yashiro, 2022[49]) explores the role of ultra-fast broadband (UFB), such as fibre, in promoting exports by New Zealand firms. It investigates whether adopting UFB increases the probability that a firm will start exporting.

UFB supports a more intensive use of digital tools like websites or online platforms, as well as adoption of advanced digital technologies that require transmitting large data instantaneously, such as Cloud Computing or the Internet of Things. As discussed in Box 2, digital tools can help firms find foreign buyers and establish export relationships by reducing search and information costs, which are often considered as key barriers to export entry (Melitz, 2003[33]). Furthermore, UFB can also improve the productivity of New Zealand firms that use it to support their production and management processes (Fabling and Grimes, 2021[50]). This enables them to compete in overseas markets despite the increased costs and competition associated with exporting (Melitz, 2003[33]; Fabling and Sanderson, 2013[51]).

However, UFB may not boost firms' export capabilities to the same extent: it can be more effective when firms are making strategic use of the Internet or more sophisticated digital tools. This is in line with the view that good management practices and organisational changes condition the productivity gains from the adoption of digital technologies (Box 7).

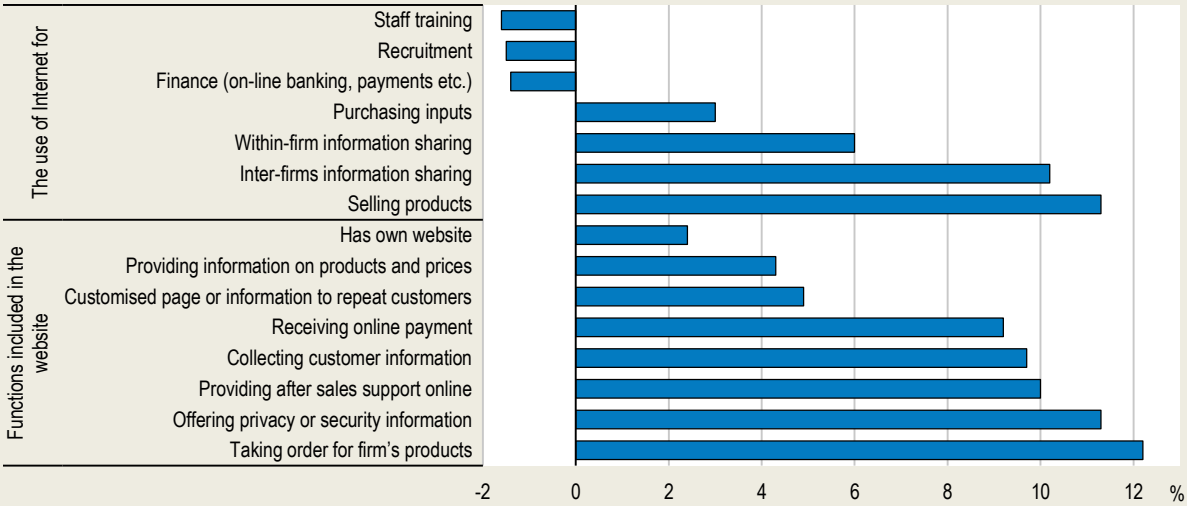
Exporting firms are making greater use of the Internet

It is found that New Zealand firms that export not only use the Internet more extensively, but also use the Internet more for communication and collaboration purposes. For example, the probabilities that exporting firms use the Internet to share information with business partners or sell products online are more than 10 percentage points higher than for non-exporters (Figure 13). Exporters also own websites

with more functions. They are significantly more likely to own websites equipped with functions like placing an online order or after-sales support.

Figure 13. Exporters use digital tools more intensively

Exporters' advantage over non-exporters in specific Internet uses or website features



Note: The chart displays how much exporters are more likely than non-exporters to use Internet for a given purpose or to have the specific function in their websites, after controlling for differences in firms' size and industry.
Source: Sanderson, Wright-McNaughton and Yashiro (2022[49]).

UFB adoption increases the probability of export entry

To identify the impact of UFB on exports, the probability of export entry by a New Zealand firm is estimated as a function of UFB adoption. The exercise exploits the rich information on ICT take-up and export activity by New Zealand firms included in several waves of the Business Operations Survey (BOS), which are linked to broader firm-level information contained in the Longitudinal Business Database and Integrated Data Infrastructure. The BOS includes an ICT module that surveys ICT take-up every two years.

The empirical analysis focuses on two cohorts of firms that were not exporting nor using UFB in 2010 and 2012 and tracks whether these firms started exporting over the following four years. In particular, it estimates the extent to which non-exporting firms that adopted UFB in the two years between ICT modules were more likely than other non-exporters to start exporting either during this period (time t) or two years later (t+2). In order to assess whether the impact of UFB is more important for firms that have been making more intensive use of digital tools, an indicator that summarises the information on a firm's use of Internet and its website functions overviewed in Figure 14 (*ICT intensity*) is included in the model. The indicator is lagged two years, so that it captures how intensively firms were using digital tools when they adopted UFB. Another indicator of ICT use, which captures the extent to which firms are using the Internet for enhancing efficiency of internal operations, such as their internal communication and human resource management (*ICT-process focus*), is also included.

After controlling for a wide range of firm characteristics that are likely to affect export entry and intensity of ICT use, the results suggest that firms that adopted UFB enjoy a higher probability of export entry both this period and two years later (Table 2, columns 1 and 2). While both the contemporaneous and future effects are statistically significant, the future effect is larger and more statistically significant. For instance, firms that adopted UFB were 6.3 percentage points more likely to export two years later. While past indicators of ICT use do not predict export entry by themselves, the coefficients on their interactions

with UFB take-up are positive and significant (columns 3 and 4), implying that the impact of UFB in promoting export entry is stronger for firms that were using digital tools more intensively or for improving internal efficiency.

Table 2. Estimated coefficients on the probability of export entry by initial non-exporters

Firms in export-intensive industries

	(1)	(2)	(3)	(4)
	Export at t	**Export at t+2**	**Export at t**	**Export at t+2**
Adopts UFB	0.036*	0.063**	0.039*	0.063**
	(0.022)	(0.028)	(0.022)	(0.028)
ICT intensity	-0.000	0.003	-0.004	-0.003
	(0.005)	(0.008)	(0.005)	(0.007)
ICT - process focus	0.002	-0.000	-0.000	-0.009
	(0.006)	(0.009)	(0.007)	(0.010)
Adopts UFB#ICT intensity			0.019*	0.027
			(0.010)	(0.017)
Adopts UFB#ICT process focus			0.009	0.035*
			(0.015)	(0.020)
R-squared	0.045	0.045	0.048	0.054
Number of observations	1080	810	1080	810

Note: The table reports the estimated coefficients of a linear probability model of export entry by initial non-exporters. The numbers in parentheses are standard errors. ** and * represent statistical significance at 5% and 10% respectively. The model includes control variables such as firm size, capital intensity, human capital, inward and outward foreign direct investment, and R&D, as well as ANZSIC 1 digit industry and year dummies (all at t-2). The indicators *ICT intensity* and *ICT process focus* are principal components capturing the intensity of Internet use described in figure 2.13 and the extent to which the Internet is used to enhance internal efficiency. They are lagged so as to capture these features prior to fibre adoption (at t-2). The estimation sample is firms in five export-intensive industries, which are: Agriculture, forestry and fishing; Manufacturing; Wholesale trade; Information media and telecommunications; and Professional and technical services.
Source: Sanderson, Wright-McNaughton and Yashiro (2022[49]).
Disclaimer by Stats NZ: These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD) which are carefully managed by Stats NZ. For more information about the IDI and LBD please visit https://www.stats.govt.nz/integrated-data/ The results are based in part on tax data supplied by Inland Revenue to Stats NZ under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

Entry costs of exporting are more burdensome for small firms, which lack scale to disperse the sizable fixed costs. By reducing entry costs (Box 2), fast Internet may thus benefit small firms disproportionally. At the same time, small firms may lack the capabilities to exploit fast Internet effectively to advance their internationalisation strategies. Sanderson, Wright-McNaughton and Yashiro (2022[49]) find that while UFB adoption increases the probability of export entry by smaller firms, the magnitude of this effect depends importantly on the intensity of ICT use prior to the adoption. Especially, the UFB adoption increases the probability that smaller firms start exporting two years later only if they were making more intensive use of digital tools.

Policy implications

The importance of strategic use of digital tools in export entry indicates the need to combine financial or technical assistance with effective business strategy advice on how to exploit digital technologies to expand market reach. Policies to promote exports and digital take-up by New Zealand firms should include measures to build up their managerial capabilities in exploiting digital technologies, as is done in Germany (see below).

Internet use by individuals is high, but some groups have been left behind

In 2020, 96% of individuals comfortable with using the Internet used it daily at home (InternetNZ, 2020[52]), one of the highest shares OECD-wide. On average 65% of Internet connections at home are fibre, but this share varies across regions, ranging from 74% in Auckland to 48% in the West Coast region (Ministry of Business, Innovation and Employment, 2021[53]). Despite very high Internet access, some population groups have been left out. For instance, 31% of individuals living in social housing and 27% of disabled individuals have no access to Internet and students from certain minority groups, particularly Pasifika, have lower access to Internet at home (Grimes and White, 2019[54]). Shares of individuals without Internet access are also higher among those living in towns with a population less than 25 000, older persons, particularly those aged over 75 years, the unemployed and inactive. Lack of Internet access limits people's social relations, interactions with public authorities and ability to receive public services, lowering subjective wellbeing (Grimes and White, 2019[54]). InternetNZ (2018[55]) has estimated that the gains from closing the digital divide, and allowing more people to save time, communicate online and increase their employability, could amount to NZD 280 million per year. Before the pandemic, only about one-third of individuals used the Internet to interact with the government, far below the 60% OECD average. This partly reflects the limited digitalisation of government services, which is mostly at the stage of digitising existing processes (see below). COVID-19 has exacerbated the costs of the digital divide as those with poor access to Internet could not access government services, such as education services that were provided online during the lockdown.

As became clear at the onset of the pandemic, access to the Internet is, by itself, not enough for full digital inclusion. Other aspects, such as skills, trust and motivation matter as well. In fact, it is estimated that one in five New Zealanders falls short on at least one of these dimensions (New Zealand Digital Government, 2020[56]). For older people, who are more likely to be digitally excluded, the main barrier is not access to the Internet but other factors like skills, trust, cost and disabilities. In particular, lack of trust is an important factor preventing the elderly from using the Internet at all (Lips et al., 2020[57]). Only one third of New Zealanders aged 65 or above can easily access information on how to keep personal information secure online, and close to 50% of those over 70 would not know who to contact in the case of online security incidents, such as password theft (InternetNZ, 2020[52]; Bank of New Zealand, 2021[58]). As digital technologies evolve, older people who did not acquire digital skills at school or at work are exposed to higher risks of digital exclusion (Lips et al., 2020[57]). Among Māori and Pasifika, the cost of the Internet and devices is one of the primary barriers to digital inclusion. Other barriers are lack of skills and English-only digital platforms.

In response to the digital difficulties faced by older New Zealanders, the government earmarked NZD 600 000 in its 2019 Wellbeing Budget for digital literacy programmes for seniors to be spent over three years. It was found that elderly who had attended programmes such as "Pacific Senior CONNECT" and "Better Digital Futures" significantly improved their digital communication skills, learnt how to communicate through video and use email more often (The Government of New Zealand, 2020[59]). Some programmes also helped seniors to get affordable Internet access at home. To facilitate the use of digital services by disabled persons, the government has introduced a "web accessibility standard", which lays out guidelines on how to ensure that webpages are accessible to people with, for instance, low vision or hearing loss. However, many agencies fail to meet this standard.

The Covid-19 pandemic has accelerated the trend toward increased teleworking. In 2020, 73% of New Zealanders who could work from home did so for some or all of the time (InternetNZ, 2020[52]). In addition, half of the respondents who worked partly from home under the pandemic expressed a desire to work from home even more frequently in the future. However, slow Internet speed has been recognised as a major barrier to teleworking (InternetNZ, 2020[52]). In remote areas, some 44% of New Zealanders are concerned or very concerned about poor Internet connections.

The government could become more agile through better use of digital technologies

Digital technologies can transform the internal processes and operations of government and, consequently, how public services are designed and delivered. Extensive use of digital technologies and data enables governments to be more efficient, agile and responsive, and even anticipate people's needs. The early adoption of digital technologies referred to as e-government focused on increasing efficiency and transparency in the public sector through the digitisation of existing processes. Indeed, New Zealand's government has achieved some back-office efficiencies and some more user-friendly interfaces through its e-government efforts. For instance, the myIR system for reporting income tax in New Zealand provides online tax forms with much of the relevant data pre-filled, reducing the scope for erroneous or missing information and the compliance burden on taxpayers. Also, companies can be registered online, and thanks to a data-sharing arrangement between the Australian Securities and Investments Commission (ASIC) and the New Zealand Companies Office (NZCO), firms expanding across the Tasman can register easily in the other country. More recently, the government has been seeking to systematically improve user experience or approach system design from the perspective of customers. For instance, it launched the Business Connect platform in 2019, an online one-stop shop for firms to apply for and renew licences and permits. This platform has been evolving incrementally and will soon allow firms to manage their data held by the government and re-use the information they previously submitted to the authorities.

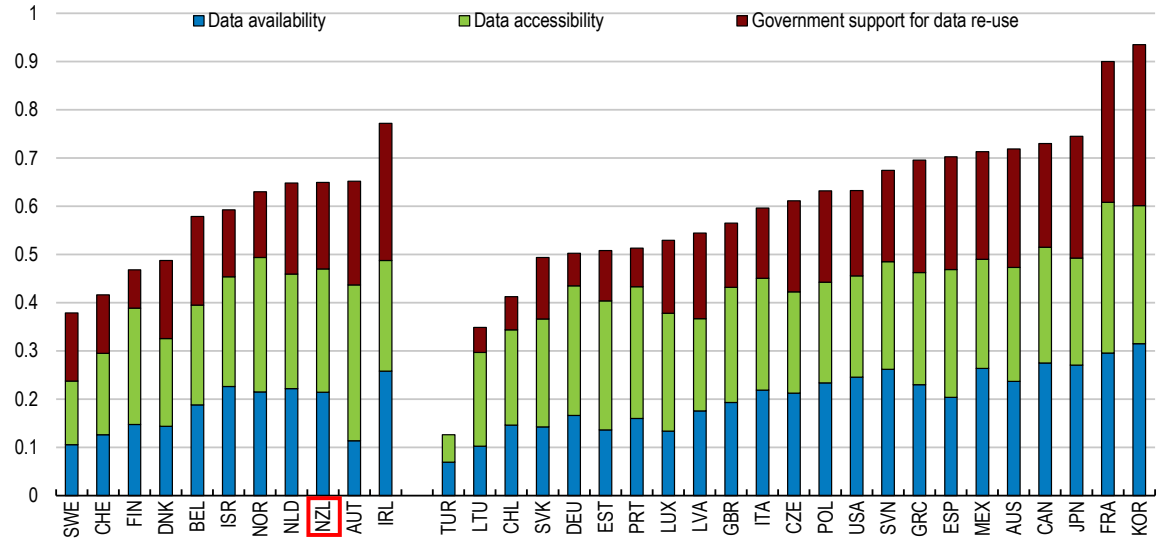
Governments across OECD countries are now aiming to upgrade their e-government efforts into the so-called digital government, which entails digitalisation of policy making and implementation processes as well as collaboration across public sector organisations, with the aim of delivering more integrated and seamless, as well as user-driven and proactive, services (OECD, 2020[60]). New Zealand ranks relatively high in the OECD Digital Government Index 2019, which captures progress toward digital government (Figure 5). In 2020, the government introduced a strategy for a Digital Public Service, which set broad objectives for the digital transformation of public services, with a programme of work.

New Zealand is relatively advanced in terms of opening government data and systematically releasing government policies and decisions online. It ranks relatively high among SAEs when it comes to availability, accessibility and re-usability of government data (Figure 14). The statistical office has been leading and coordinating New Zealand's data strategy across agencies since 2017. The strategy aims to increase availability and accessibility of government data by, for instance, enhancing government data visibility, identifying data gaps and implementing an "open by design" culture, whereby data are released in a format that facilitates wider use by the public (Government Chief Data Steward, 2018[61]). One area with some room for improvement is promoting the re-use of the government data outside the public sector, for instance through long-term partnerships with open data communities (OECD, 2020[62]). Efforts are underway, such as GovHack, a large annual Australasian event that involves dialogues between stakeholders and a two-day hackathon in which participants use open government data to propose innovative solutions to the challenges facing government and communities.

New Zealand has a good base for ensuring coherence in the use of digital technologies across policy areas, thanks to initiatives like the Digital Government Partnership, which brings together agencies from across the public service to support the goal of an all-of-government digital system. The function of this partnership is mostly advisory and does not involve decision-making on ICT investment across government agencies or evaluation of their ICT projects. The Partnership, however, annually disburses NZD 5 million to foster digital and data innovation by public sector organisations. There is room to strengthen the authority of the coordination body over government agencies in moving digitalisation forward (see the next section).

Figure 14. New Zealand is advanced in making government data open, useful and re-usable

OURdata Index scores, 2019



Note: OURdata Index is a composite index with a maximum value equal to "1" corresponding to the best practices. See Lafortune and Ubaldi (2018) for more information. See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD (2021), *OURdata Index on Open Government Data*

New Zealand's government trails behind other OECD countries in terms of pro-activeness, defined as grasping citizens' changing needs and improving digital services accordingly in an anticipatory way (OECD, 2020[62]; New Zealand Productivity Commission, 2021[11]). One way of improving this is to enhance the participation by experts and stakeholders in the early stages of designing digital services (OECD, 2020[60]). The strategy for Digital Public Service aims for a more agile and adaptive digital public service. Frontrunners in digital government, such as Estonia and Korea, demonstrate what could be done to enhance and expand the scope of digital services in New Zealand. For instance, Estonia has leveraged digital IDs and a state-of-the-art data sharing technology (the X-Road) to deliver all but three public administrative services (marriage, divorce and real estate transactions) online and provide secure, transparent and traceable encrypted communication between public and private service providers and citizens (OECD, 2019[63]). Its digital ID framework is built on trust between the government and citizens, underpinned by legislation such as the amended 2018 Personal Data Protection Act, which for instance stipulates that citizens be informed when and for what purpose their data are being used by the government as well as contact information of the officials in charge of this use. Korea introduced mobile ID cards that allow people to use government services from their smartphones and enabled citizens to download personal information held by public institutions and submit them directly to public authorities and banks through MyData portal (OECD, 2020[64]). The government also plans to increase the provision of personally customised digital services related to health check-ups, national scholarship applications, civil defence education or tax payments. Although Korea is already the frontrunner in the openness of public data (Figure 14), it will facilitate the use of public data even further to strengthen cooperation between the public- and private sectors and to promote new industries, such as autonomous driving and health care. The government is also investing in digital infrastructure and innovation in the public sector, for instance expanding 5G wireless networks and building a security control system using artificial intelligence.

A significant impediment to an extensive use of digital technologies by the government has been the absence of data companies based in New Zealand. This has been a barrier because any data stored, processed or transmitted by cloud services could be subject to legislation and regulation in the countries where data are stored. The decision by Microsoft and Amazon Web Services to establish datacentres in New Zealand is likely to address this data sovereignty issue, enabling the government to use cloud computing more intensively and adopt other data-intensive digital technologies.

Policies for faster diffusion of digital technologies

Advancing the new national Digital Strategy and enhancing coordination across all policy areas

New Zealand has recently embarked on the preparation of a comprehensive national digitalisation strategy, following up on the 2017 Building a Digital Nation report. Policy initiatives on digital transformation have been fragmented and subject to unstable budgeting. In 2020, the Digital Government Partnership (see above) put forth a strategy on delivering high-quality digital public services. Also, Industry Transformation Plans for digital technologies and agritech industries have been produced. However, a national digital strategy encompassing a wide range of policy areas such as education, labour market and social affairs was missing, making it difficult for government agencies to work in a coherent way toward New Zealand's digital transformation. The new national strategy is to strengthen coordination of digitalisation policies under three pillars: (1) trust in the digital environment, which includes sound data privacy; (2) digital inclusion, such as endowing New Zealanders with the right skills to thrive in digital workplaces; and (3) growth, which involves promoting the adoption of digital technologies among small businesses (New Zealand Government, 2021[65]). It is important that this strategy cover all relevant policy areas and set a clear roadmap and action plans. Furthermore, these action plans have to be implemented rigorously, on the back of strong political support.

The new national strategy is the responsibility of the Minister for the Digital Economy and Communications, appointed in 2020 to enhance the coordination of digitalisation policies. At the moment, various digitalisation strategies co-exist, including the one for Digital Public Service mentioned above and initiatives developed by the so-called government functional leads. For example, the Digital Government Partnership is led by the Government Chief Digital Officer, who is also the Chief Executive of the Department of Internal Affairs. The digital technologies Industries Transformation Plan is produced jointly by the Ministry of Business, Innovation and Employment and NZTech, a prominent social partner. Examples of the governance of national digital strategies in other OECD countries indicate that high-level leadership and a centralised mandate for strategic coordination, often above ministerial level, are important in advancing a holistic digital strategy (Box 4). While this does not necessarily imply that New Zealand needs a single government body overseeing all digitalisation policies, it highlights the importance of a clear hierarchy and a strong political mandate for the coordination body.

Monitoring and evaluation are essential to ensure effective implementation of a national digital strategy. However, New Zealand has not set transparent targets against which progress is assessed or the effectiveness of existing strategies evaluated. A lot of data and indicators used by OECD countries to capture the progress in digitalisation are missing for New Zealand, making it difficult to benchmark New Zealand against best performers to identify room for catch up. For instance, many of the indicators in the OECD's Going Digital Integrated Policy Framework (OECD, 2020[66]), which help identify complementary policies to boost wellbeing through digitalisation, are not available for New Zealand (see Box 1). These data need to be collected to provide the basis for a national digital strategy and to monitor progress against this strategy.

Box 4. High-level strategic coordination is needed for a national digital strategy

The effectiveness of a national digitalisation strategy hinges on good coordination among government agencies and social partners. In order to ensure this, some OECD countries assign high-level leadership and centralised responsibility for strategic co-ordination above ministerial level. In these countries, a coordination office under the president, prime minister or chancellor usually drafts the national strategy backed by a strong political mandate. The office involves key ministries and stakeholders in the process, and also often leads strategic co-ordination. For instance, in Mexico and the Slovak Republic, the Prime Minister holds a strong mandate for digital issues, including for the

drafting of the strategy, executed through a dedicated co-ordination office. In other countries like Chile, Estonia, Korea and Luxembourg, certain functions are ensured by the Prime Minister, notably for strategic co-ordination, but ministers still play an important role both in providing input to strategy development and in implementing the strategy.

The central co-ordination office may also be a centre within the government. The centre usually supports the highest level of the executive branch of government. Examples include the German Chancellery, the UK Cabinet Office and the White House Executive Office. Each government agency implementing the strategy often has a focal point, such as a chief digital officer, who ensures operational co-ordination. These agencies also monitor implementation and report to the co-ordinating office.

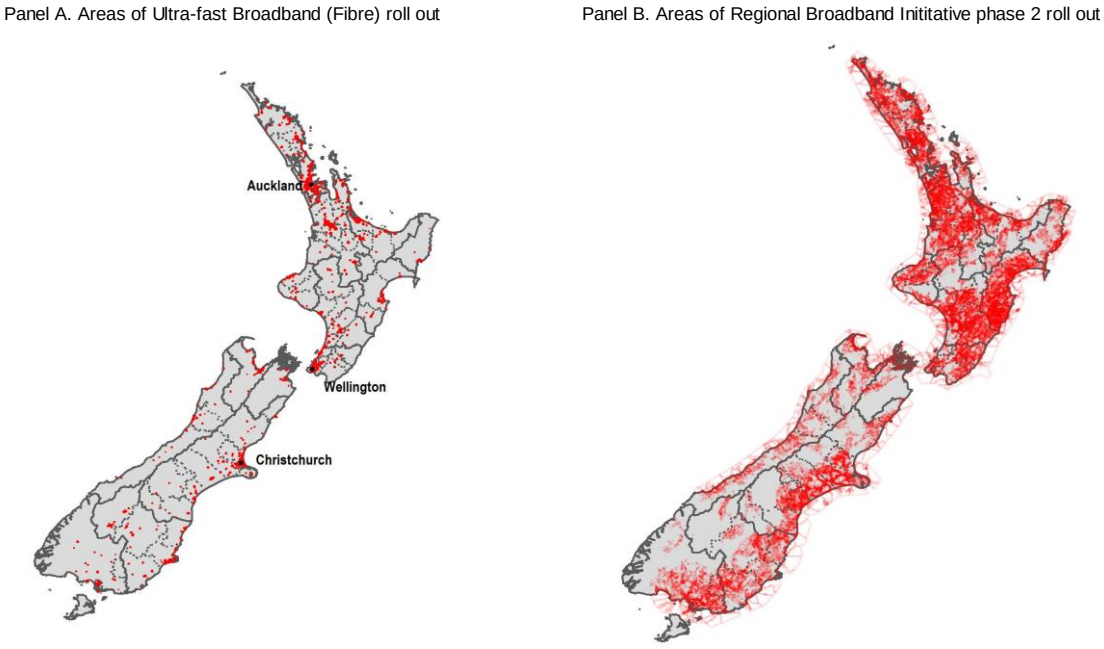
In other countries where political support is not as strong, the responsibility of strategic coordination of the National Digitalisation Strategy is allocated to a lead ministry often dedicated to digital affairs (as in Belgium, Japan, Poland, Portugal and New Zealand). In some countries, this ministry has responsibility for several policy areas including a digital portfolio and, in a few countries, there is not one but several ministries in charge.

Source: OECD (2019), *Going Digital: Shaping Policies, Improving Lives*, OECD Publishing, Paris.

Enhancing access to high-quality communication infrastructure

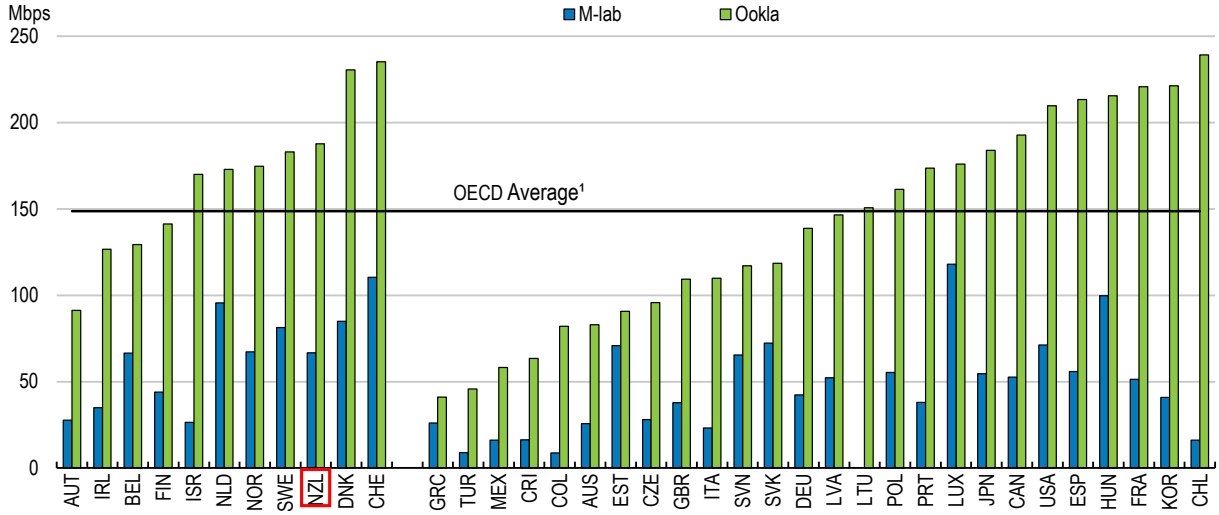
Access to fast and reliable connectivity is a prerequisite for the diffusion of digital technologies. New Zealand has been rolling out high speed broadband, with a target to provide 99.8% of its population with access to improved broadband by end-2023. In particular, the Ultra-Fast Broadband (UFB) programme has been rolling out fibre connections mainly in the urban areas, namely large cities (Figure 15, Panel A). It aims to provide access to fibre to 87% of the population in over 390 towns and cities by end-2022. As of July 2021, 85% of New Zealanders could already access fibre, and 65% had taken it up (Crown Infrastructure Partners, 2021[67]). In rural areas, where UFB roll-out is too costly, the second phase of the Rural Broadband Initiative (RBI) aims to provide high-speed broadband, primarily through wireless technologies such as 4G (Panel B). The government has also allocated NZD 10 million over two years to free up radio spectrum suitable for providing 5G technology in rural communities. Furthermore, more than NZD 46 million has been allocated to reducing network congestion on mobile networks in rural areas where data use has reached capacity constraints. These initiatives are expected to put New Zealand's broadband speed, which is already higher than the OECD average (Figure 16), on a par with the top performers.

Figure 15. New Zealand is rolling out high speed broadband



Note: Red dots in Panel A are areas covered by funding from the Crown Infrastructure Partners to build ultrafast fibre broadband (UFB) service to premises within those areas. Red dots in Panel B are areas covered by Fixed Wireless Access or wireless broadband service under the Rural Broadband Initiative Phase 2.
Source: New Zealand Crown Infrastructure Partners.

Figure 16. New Zealand's broadband speed is higher than the OECD average

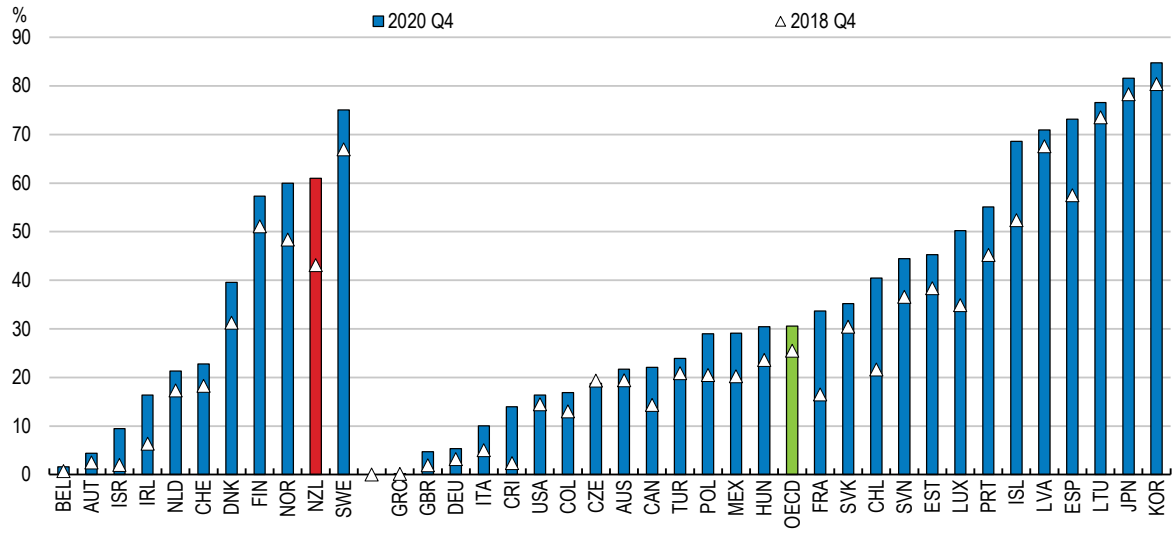


1. Sample average. See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD, based on Ookla, November 2021 and M-Lab (Worldwide broadband speed league) as measured between July 2019 and June 2020.

The high share of fibre in broadband implies that New Zealand's communication infrastructure will be able to support the use of new digital technologies that require transmitting large quantities of data rapidly (Figure 17). The number of companies using fibre-to-the-premise has risen rapidly in recent years, especially among smaller firms. The overwhelming reason why some companies are still not using fibre-to-the-premise is unavailability in their location (Stats NZ, 2021[18]). One notable feature of the fibre roll-out

in New Zealand is that it has prioritised schools. Because almost all state schools had fibre connections by 2016, New Zealand's schools are equipped with some of the best digital tools in the OECD (Figure 18). Grimes and Townsend (2017[68]) report that access to fibre broadband increased the proportion of students who achieved or outperformed the National Standard in mathematics, writing and reading by a small, but statistically significant margin. However, communication infrastructure and digital tools tend to be used in less educationally relevant manners by students from poorer and less privileged communities.

Figure 17. The share of fibre connections in total fixed broadband is relatively high



Note: See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD (2021), *Broadband Portal*

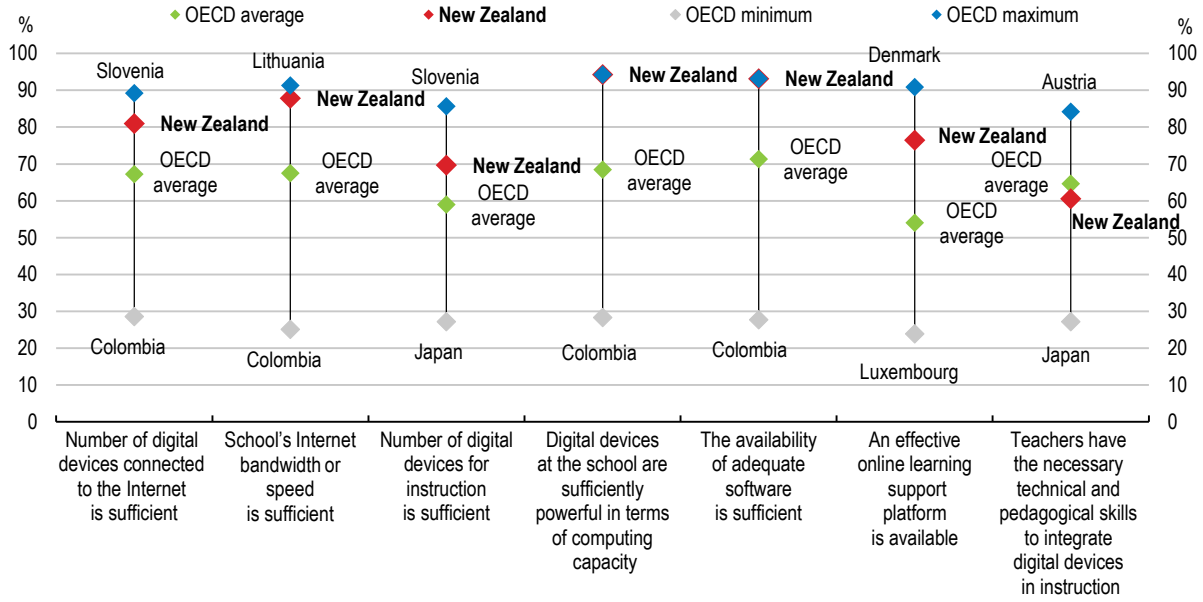
New Zealand's mobile network infrastructure serves over 95% of the population, but covers only half of the territory. Moreover, download speeds are between 32 to 44% slower in rural areas than in urban areas, constraining the use of data-intensive digital tools in rural areas. The Mobile Black Spot Fund (MBSF) aims to provide greater mobile coverage on approximately 1 400 kilometres of state highway and in 168 tourism locations where no coverage currently exists. To expand mobile coverage in remote regions in accordance with the MBSF and the RBI Phase 2 Initiative, New Zealand's three major mobile network operators, Spark, Vodafone and 2degrees, have formed a joint venture, the Rural Connectivity Group (RCG). Funded by both the RBI, the MBSF and the three mobile companies, the RCG builds communications infrastructure that can be used by all three operators. The MBSF has, however, so far progressed slower than the UFB and RBI programmes, holding back the use of digital technologies in remote areas.

Low-income households may be deterred from using advanced digital tools to improve their wellbeing if broadband service costs are too high. This also risks excluding them from accessing various online tools that connect them to government services, jobs and training opportunities as well as housing, limiting their social mobility. The monthly price of the unlimited broadband package, which 85% of Internet users subscribe to, averages NZD 73 (Commerce Commission, 2021[69]), corresponding to 4.5% of the median household income of the lowest income quantile. The share of New Zealanders concerned about the cost of Internet has declined over the past five years, and is considerably smaller than shares of those concerned with other issues like inappropriate online content (InternetNZ, 2020[52]). Instead, a more relevant issue that can lead to digital exclusion of disadvantaged individuals is the cost of digital devices, which has surged due to COVID-related increases in transportation costs and disruptions in global supply chains. During the COVID-19-induced lockdowns, the government distributed free devices to students from disadvantaged households in addition to providing Internet connections and paying usage fees to prevent them from being excluded from online school courses. The government could consider providing subsidies for the comprehensive costs of accessing fast Internet, which include broadband subscription and digital

devices. For instance, the United States subsidised broadband access by low-income households during the pandemic through the Emergency Broadband Benefit Program. Households qualifying for the programme received up to USD 50 per month to pay for Internet service and a USD 100 discount if they bought a computer, laptop or tablet. This temporary measure was extended into the permanent Affordable Connectivity Program in December 2021. Subsidised broadband access by disadvantaged households improves their employment prospects and earnings (Zuo, 2021[70]), contributing to inclusiveness. It would also allow the government to advance its e-government initiatives by moving a wider range of public services online without endangering access to these services by disadvantaged households.

Figure 18. Many of New Zealand's schools are equipped with good digital tools

Percentage of students in schools where the principal agreed or strongly agreed with the statement



Source: OECD calculations based on *PISA 2018 Results (Volume V)*

Alleviating shortages of digital and management skills

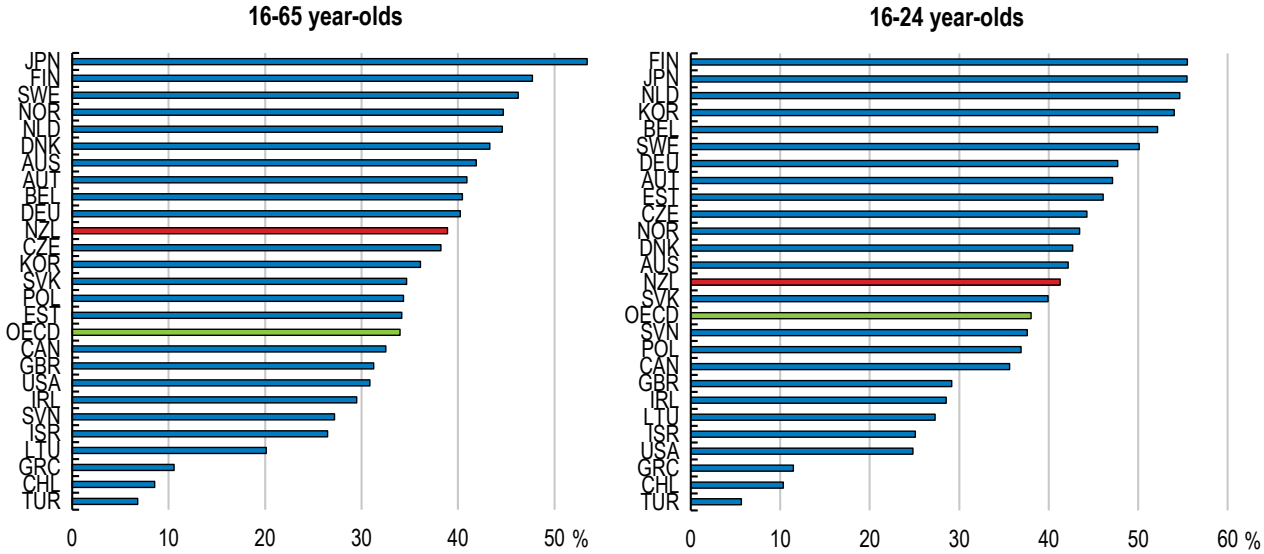
Strengthening foundational skills

To thrive in the digital workplace, workers need strong cognitive skills - literacy, numeracy and problem solving in a technology-rich environment – and socio-emotional skills (OECD, 2019[71]). A well-rounded skills set is the key that allows people to unlock all the benefits of Internet use and use the Internet in diversified and complex ways rather than just for information and communication (ibid). People with strong cognitive skills are better able to adapt to labour market changes, such as workplace reorganisation to use digital technologies more productively.

The share of the working-age population (aged 16-65 years) with a well-rounded skills set is above the OECD average (Figure 19) and the share lacking basic skills is one of the lowest (Figure 20), albeit with performance in numeracy lagging that in literacy and problem-solving in a technology-rich environment. However, the younger age group's (16-24 years) skills compare less favourably with those of their peers in other countries than do the skills of older age groups. A factor that contributes to mediocre skills of the younger age group is that achievement increases less beyond lower secondary education than in most other countries. When comparing the literacy achievement of the cohort of individuals who were 15-year-old students in 2000 (2003 for New Zealand and three other countries to which the OECD PIAAC study was extended in 2015) and 26-28-year-old adults in 2012 (2015 for New Zealand and the other three

countries), literacy achievement in New Zealand grew by 5 points on the PIAAC scale, which was less than the OECD average growth of 13 points (OECD, 2021[72]). Achievement growth for high performers in PISA was one of the lowest among participating countries (ibid, Figure 3.9). On the other hand, engagement in adult learning, which can reduce the loss of foundation skills owing to ageing, is high in New Zealand, which may help to explain the relatively strong performance of older age groups. The proportion of adults who do not participate in adult learning and report being unwilling to participate in the learning opportunities that are currently available to them (i.e. they are disengaged from adult learning) is 28%, far below the OECD average of 50% (OECD, 2021[72]). Workers who obtained a tertiary qualification are 14 percentage points less likely to be disengaged than workers without a tertiary qualification, a difference that is less pronounced than it is on average among OECD countries (ibid).

Figure 19. New Zealand has a high share of adults with a well-rounded skills set despite relatively weaker outcomes for the younger age group

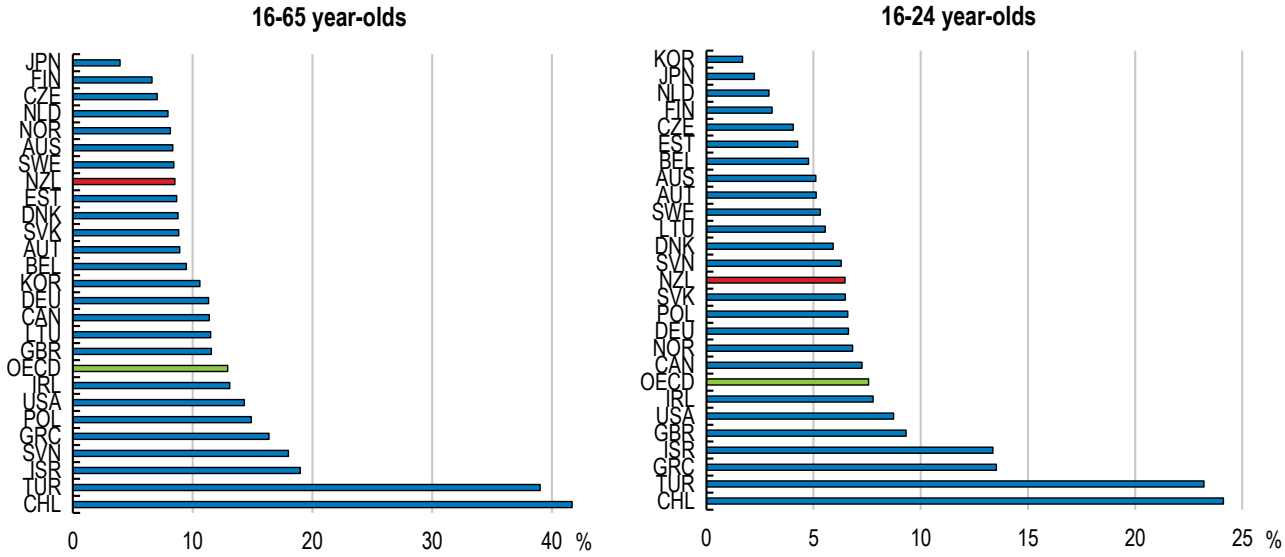


Note: Individuals with a well-rounded skill set score at least Level 3 (inclusive), out of 5, in literacy and numeracy and at least Level 2 (inclusive) in problem solving.

Source: Calculations based on OECD (2012) and OECD (2015), *Survey of Adult Skills* (PIAAC).

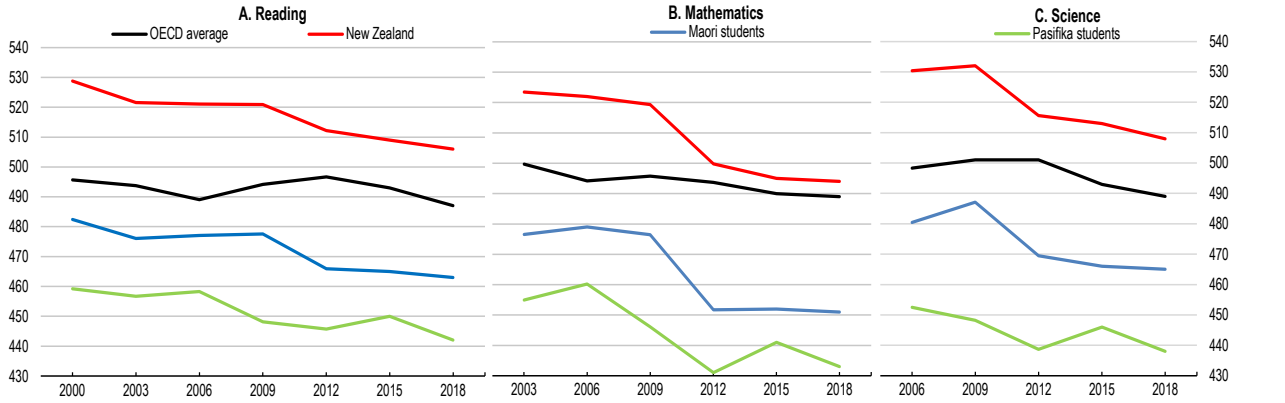
The corner stone for building information-processing skills and the foundations for lifelong learning is initial education. One indicator of the progress made by students at 15-16 years of age is achievement scores in the OECD PISA study, which are correlated with PIAAC scores and are a strong predictor of success at the tertiary level of education (OECD, 2016[73]). Achievement has been declining since PISA tests began (the average three-yearly trend is negative and statistically significant), although New Zealand scores remain above the OECD average and still rank relatively highly (6th – 12th rank range) amongst OECD countries in reading and science (Figure 21). The decline since 2009 reflects an increased share of low performers (below Level 2) and a reduced share of high performers, albeit to levels that are similar to those in countries with average scores that are not significantly different from New Zealand's (Figure 22). The increased share of low performers, which is over 20% in mathematics, is serious as they do not demonstrate the competencies that are needed to participate effectively in life as continuing students, workers and citizens. Similarly, the decline in the share of top performers is a problem as this group has acquired the foundation skills at an early stage of their education that are needed to be well equipped in the digital era (OECD, 2020[1]). Māori and Pasifika achievement has also declined since PISA tests began and continues to lag well behind that of the rest of the population. The influence of socio-economic background on scores is similar to the OECD average but is higher than in the other English-speaking countries except the United States, for which the difference is not statistically significant (Figure 23).

Figure 20. New Zealand has a low share of adults lacking basic skills despite relatively weaker outcomes for the younger age group



Note: Individuals lacking basic skills score at most Level 1 (inclusive) in literacy and numeracy and at most Below Level 1 (inclusive) in problem solving (including failing ICT core and having no computer experience).
Source: OECD calculations based on OECD (2012) and OECD (2015), *Survey of Adult Skills* (PIAAC).

Figure 21. New Zealand's average PISA scores have declined

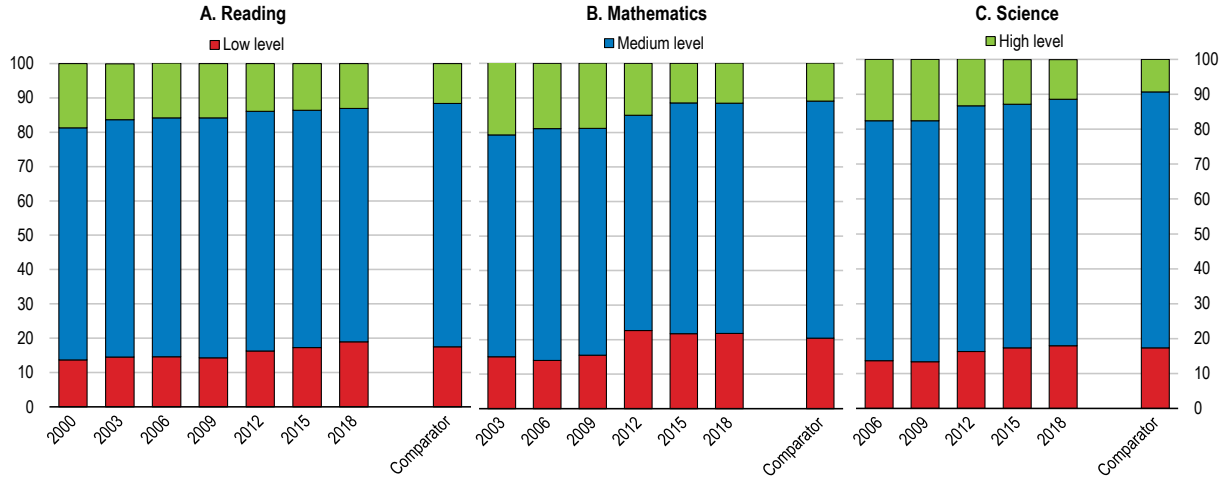


Source: OECD, *PISA database* ; (May, Jang-Jones and McGregor, 2019[74]), PISA2018, *New Zealand Survey Report*

Achievement issues are most pronounced in mathematics, where the average PISA score is only just above the OECD average and there is a larger tail of low performers than in the other subjects. Weakness in mathematics is corroborated in the TIMSS study by Mullis et al. (2020[75]), which tests mathematics knowledge and assesses students' ability to use it and apply mathematical reasoning in a range of problem-solving situations. New Zealand scores at Grades (referred to as years in New Zealand) 4 (year 5 in New Zealand with students aged around 10 years) and 8 (year 9 in New Zealand with students aged around 14 years) are lower than in other English-speaking countries and indeed lower than in all other participating OECD countries except Chile and, at Grade 4, France (Figure 24), and have fallen significantly at Grade 8 since New Zealand first participated in the TIMSS study in 1994. New Zealand's National Monitoring Study of Student Achievement (Darr et al., 2018[76]) showed that in mathematics most children were achieving at the curriculum level expected of them in year 4, but by year 8 only 45% were doing so.

Concomitantly, less than half of students at year 8 are on a trajectory to reach the required level at year 12 to continue their education at the tertiary level in any field requiring mathematics competence.

Figure 22. The share of high performers in PISA has declined and the share of low performers has increased

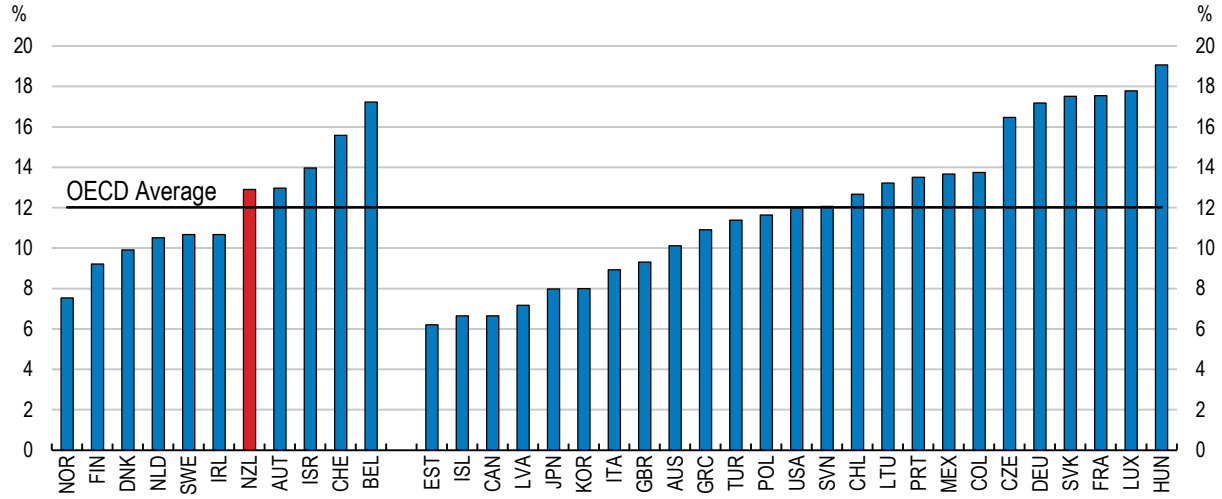


Source: OECD, *PISA database*

A key reason for New Zealand's poor equity and achievement outcomes is that, since the *Tomorrow's Schools* reforms in 1989, schools have predominantly operated as autonomous, self-managing entities, loosely connected to each other, and with a distant relationship with the centre (Ministry of Education, 2019[77]). This has left schools to operate largely on their own and without sufficient support. Moreover, School Boards of Trustees, which are largely composed of unpaid elected parents, have often struggled to perform the wide range of complex roles required of them, including appointment and performance reviews of principals. This has been a greater problem in more disadvantaged communities than others. In light of these problems, the government decided in 2019 to strengthen support networks in the school system and to make them more responsive to the needs of students and their families. The first plank of the government's reform to the *Tomorrow's Schools* framework is to rebalance the Ministry of Education towards more regional and local support, through the establishment of a separately branded business unit within the Ministry of Education, the Education Service Agency (ESA), which will lead a programme of substantial service level transformation. The second plank is to strengthen the arrangements that underpin principal leadership of schools. This includes inviting the Teaching Council to establish a Leadership Centre, a new role of Leadership Advisor, and the establishment of eligibility criteria for appointments to school principal roles so that all schools have leaders with the right skills and expertise. The government also plans to strengthen incentives for the most capable principals to work in schools with the greatest challenges, which tend to be schools where children predominantly come from disadvantaged backgrounds. Third, the Ministry of Education will reduce the burden on school boards by simplifying or removing infrastructure management and maintenance responsibilities and centralising key services, such as planned and preventative maintenance.

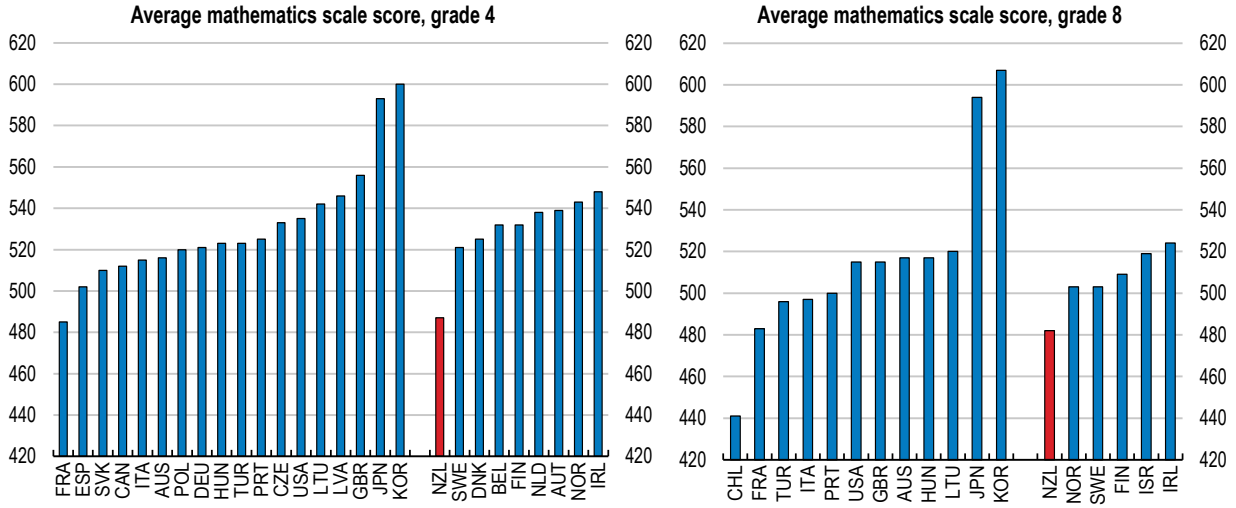
Figure 23. The influence of socio-economic background on PISA scores in literacy is greater than in many other countries

Variation in student performance explained by socio-economic background[1], 2018



1. PISA index of economic, social and cultural status. See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD, *PISA database*

Figure 24. New Zealand primary and lower-secondary school students' mathematics knowledge is poor



Note : See Figure 2.1, note 2 for the definition of small advanced economies.
Source: Mullis et al. (2020), *TIMSS 2019 International Results in Mathematics and Science*

In mathematics, there also appear to be a number of problems with the way it is taught in New Zealand that have contributed to poor achievement. First, since the introduction of the Numeracy Project in 2000, teachers have been trained to put more emphasis on teaching children a range of strategies for solving mathematics problems and less on basic mathematics knowledge. Direct instruction and explicit teaching can yield better results than enquiry-based learning, although in science the negative correlation between enquiry-based teaching and achievement is greatly attenuated when lessons are delivered in disciplined science classes (Mostafa, Echazarra and Guillou, 2018[78]). Equipping children with basic mathematics knowledge enables them to proceed to higher levels of mathematics reasoning without becoming cognitively overloaded. Second, many teachers lack the skills needed to teach mathematics effectively

(Education Review Office, 2021[79]). There is a severe shortage of specialist mathematics teachers at both primary and secondary levels of education – only 53% of Year 9 mathematics teachers have a degree with a maths major according to Mullis et al. (2020[75]) − and teacher education courses devote little time to mathematics (or any other subject-specific) teaching. There is too little guidance for schools on the teacher training best suited to bring teachers' skills up to the required level. Third, the curriculum does not give schools clear enough guidance on what should be covered; it was deliberately designed to be generic so that schools could adapt it to the interests and needs of their local community. The Education Review Office (2021[79]) finds that in the absence of strong direction and clarity, reinterpretations of the National Curriculum have become embedded over time in the mathematics and statistics learning area - there is evidence of a slippage of expectations and a focus on numeracy to the exclusion of other strands.

Key elements of reforms to overcome these problems include: putting more emphasis in teaching strategies on children acquiring basic mathematics knowledge and less on enquiry-based discovery; raising teacher education quality and entry standards (current minimum entry standards for teaching programmes are relatively low) and improving incentives for teachers to gain specialisation in mathematics and to attract graduates into mathematics teaching; supporting professional learning and development that lifts the capability of current teachers in mathematics, ideally with greater programme direction from the Ministry of Education; giving stronger direction and clearer guidance on what is required to achieve the standards in the National Curriculum for mathematics; and supporting school leaders to lead a collaborative, data- and evidence-informed teaching culture that emphasises all aspects of the mathematics curriculum. Consideration should also be given to estimating value added by teachers and schools (i.e., increase in student achievement) controlling for factors such as students' socio-economic background, as in Hernandez (2021[80]), so as to identify and diffuse best practice and to provide greater incentives for better teaching; obviously, such a reform is potentially relevant for all disciplines, not just mathematics. The government has commissioned The Royal Society Te Apārangi to produce an independent academic paper by end-2021 on what mathematics knowledge and skills learners need to know and by when and what needs to change in the New Zealand Curriculum and in how mathematics is taught for more students to reach these levels.

Foundational skills now include general digital skills. New Zealand students perform well in critical literacy, which is taught in English classes. Up to 80% of 15-year-old students report learning about aspects such as the consequences of making information public online, judging whether to trust information from the Internet or comparing different webpages and deciding the relevance of information (Medina and Mcgregor, 2019[81]). In addition, 61% of 15-year-old students answered correctly when asked to distinguish fact from fiction (one item only), which was higher than the international average (47%) and similar to the results for Canada, Australia and the United Kingdom (Medina and Mcgregor, 2019[81]). Another strength is general collaboration skills. New Zealand 15-year-olds rank very highly on collaborative problem solving on computers (working with others to solve a problem through shared understanding and group focus) in a game-based format − only Singapore, Japan and Hong Kong China had significantly higher average scores (May, 2017[82]). This strength may also be related to PISA data that show that New Zealand students score relatively highly in evaluating and designing scientific enquiry.

New Zealand started implementing digital technologies through the Technology curriculum in compulsory education from 2020, with all schools now expected to include digital technologies in their curriculum. This curriculum area aims at fostering critical thinking in cyber space and digital fluency and involves a focus on both computational thinking (i.e., the ability to frame problems in ways that computers can help solve them) and designing and developing digital outcomes. The impact of the new curriculum is being assessed for years 4 and 8 as part of the National Monitoring Study of Student Achievement (NMSSA) in 2021. Take-up of the new curriculum has been slow, as many schools were not ready or lacked the capabilities needed to implement it. The Ministry of Education should ask schools to self-review readiness and capability to implement the curriculum so that support can be directed to where it is most needed.

There is a need to provide high-quality training to teachers on how best to integrate technology in their pedagogical practices. In the 2018 PISA study, mathematics scores were lower for New Zealand students who used devices during classes than for who did not (Sutcliffe, 2021[83]). Conversely, the best readers used devices with their teachers for more than an hour per week (Sutcliffe, 2021[83]). Many New Zealand teachers were deemed to lack the time, incentives, or expertise to build their capability for effective digital integration for learning (Sutcliffe, 2021[83]). To properly integrate ICTs in the classroom, teachers need not only basic digital skills that allow them to use a computer but also more complex digital skills that enable them to tailor the use of technology to their own teaching (OECD, 2019[71]). Following the Education Review Office (2019[84]) report, which found that teachers in only 7% of schools in 2019 reported having enough knowledge and skills to implement the digital technologies curriculum, additional professional learning development for 34 000 teachers was made available through 2021. Consideration should also be given to including digital education in the early learning curriculum to enhance the effectiveness of school-level digital education.

Increasing the domestic supply of specialised digital skills

The diffusion of digital technologies is increasing demand for workers with advanced digital skills, such as software programming, managing and analysing big data, managing digital hardware and networks, and cyber security. As in other countries, there are shortages of experienced workers with these skills in New Zealand, especially in data science and machine learning. In all sectors across OECD countries, wage returns to ICT skills are twice as high as those related to numeracy skills (OECD, 2019[71]). ICT jobs are well paid in New Zealand - the median base wage for ICT workers in 2021 was 73% higher than the median base wage across all occupations (Absolute IT, 2021[85]).

New Zealand firms have preferred to recruit experienced workers with advanced digital skills rather than offering career paths to existing employees or ICT graduates that lead to these posts (New Zealand Digital Skills Forum, 2021[86]). Employers have sourced most such employees through immigration: for example, 3 683 ICT workers entered New Zealand on work visas in 2019, which is equivalent to 75% of all ICT jobs created that year (ibid). Given that global demand for such workers is also high and growing fast, such heavy reliance on immigration is risky, as the COVID-19 border closure in New Zealand has highlighted. Very few visas have been issued for ICT workers since the beginning of the pandemic and employers report losing experienced high-skilled staff who have returned to their countries (ibid), often because they could not bring family members to New Zealand.

While a rapid easing in immigration restrictions on hiring experienced, high-skilled ICT workers from abroad is vital for the development of firms requiring such workers over the next few years, there also needs to be a greater focus on strengthening the domestic pipeline of IT skills both to reduce the risk of shortages and to give more New Zealanders the opportunity to develop high-paying IT careers. For this to occur, IT employers will need to develop efficient, ongoing upskilling processes. Providing experienced senior staff with new skills may be more efficient in the long term than continual recruitment activity in a high-cost competitive market (New Zealand Digital Skills Forum, 2021[86]). Unfortunately, the domestic pipeline is narrowing, partly as young New Zealanders seek to avoid a dead-end pathway where employers prefer to recruit experienced workers with high digital skills rather than to offer career paths to existing employees or ICT graduates. The share of upper-secondary students participating in National Certificate of Education Achievement (NCEA) Technology standards has been slowly declining in recent years as have the shares participating in mathematics and science standards, which are pathway subjects for computer science. Very few (20% in 2019) Year 13 students who pass NCEA technology courses go on to some form of IT tertiary education, of which only one half take an IT degree-level course in the following year, although most of these standards (26/36) at Level 3 are not Digital Technologies standards; the Review of Achievement Standards proposes to create fewer, larger standards for each subject and to split Digital Technologies into two subjects to create clearer pathways. Enrolment in tertiary technology courses has been declining in recent years, despite a solid increase in enrolments in degree-level courses, reflecting a

sharp decline in sub-degree-level courses (New Zealand Digital Skills Forum, 2021[86]). However, growth in degree-level enrolments has been almost entirely attributable to international students, most of whom do not stay in New Zealand once they have finished their studies (New Zealand Digital Skills Forum, 2021[86]). The total number of domestic students graduating with degree-level IT qualifications (1750 in 2019) is less than half the number of new jobs created each year that require such qualifications.

Better information about the skills in demand could feed back into improvements in education pathways, making graduates more attractive to employers. The reform of vocational education underway aims to make the tertiary education system more responsive to the skill needs of industry. Six Workforce Development Councils were established in May 2021, one of which covers technology, to identify future skills needs and provide industry with greater influence over the training system. Collaboration across Workforce Development Councils where the needs of the different industries they represent align provides an opportunity for the IT industry to shape the provision of teaching, learning and skills across different areas and ensure that programmes at NCEA Levels 3-7 (excluding degree level) meet the needs of employers and learners.

Digital apprenticeships, as in the United Kingdom, would provide opportunities for people who may have the capabilities but not the resources to undertake a digital technology education by enabling them to earn while they learn; introducing such work-integrated learning would conform with Objective 4 in the Tertiary Education Strategy, which includes a review of the tertiary education investment system to introduce a stronger focus on work-integrated learning across a broader range of disciplines. This opportunity would be especially valuable to Māori and Pasifika students who are grossly underrepresented in digital careers and often have to renounce fulltime education, including before finishing secondary education, to earn a living (New Zealand Digital Skills Forum, 2021[86]). It could also provide a clear pathway for people returning to work or looking to move to a digital career. In addition, apprenticeships would provide better integration of employers, education and job opportunities. Industry and providers working through the Technology Work Development Council (and potentially supported by the Tertiary Education Council) should co-design and pilot some sub-degree pathways, as recommended by the Digital Skills Forum, and, depending on the results, extend the concept to degree-level pathways if that appears to be promising.

Internships also provide a valuable opportunity for students to gain relevant work experience and for employers to provide feedback on the skills acquired through education programmes as well as helping employers to identify promising candidates for recruitment. The Employer Engagement function within the Ministry of Education is focused on transitions for learners between schooling and further education and/or employment and has worked with schools and employers to develop a number a number of Work Integrated Pathways in technology (Fusion Networks and Tamaki College; IBM P-Tech and Aoere College and Manurewa High School). However, most IT firms are unwilling to offer internships because they find them too costly. As a result, student demand for internships far exceeds supply. For Summer of Tech, which is New Zealand's largest technology internship, the supply of interns has consistently outstripped places available. Less than 20% of students who apply manage to get an internship each year, but of those that do, 70% end up being employed. Where grants have been provided for internships, via the Callaghan Innovation R&D Experience Grant, there has been a large increase in uptake. As recommended by the Digital Skills Forum (2021[86]), broadening this grant beyond R&D to something more general like innovation or software development and simplifying the process by allowing Callaghan to provide bulk funding to accredited or preferred providers so they can provide the intern and the funding in a single process could be effective ways to increase the supply of IT internships. The Forum also recommends that consideration should be given to creating specific roles within an agency to help small firms that do not have human resource staff develop work plans for interns. The Unified Funding System for vocational education and training, which is to be rolled out in 2023, will support and incentivise more work-integrated learning. The Career Connect programme in Washington State could provide a role model for expanding career-connected learning opportunities (Box 5).

Box 5. Expanding career-connected learning: the example of Career Connect Washington

The Career Connect Washington programme aims to significantly expand the scale of career-connected learning opportunities in the state through a system-wide approach. The Career Connect Task Force identified opportunities to expand the provision of career-connected learning at both secondary and post-secondary levels, including:

- career exploration programmes, such as career fairs or courses proposing work-based problem solving;
- career preparation programmes, which include short internships or concentration of vocational courses in secondary education ("Career and Technical Education concentrators");
- career launch programmes, such as registered apprenticeship and programmes requiring work-based learning in two- and four-year institutions.

Career Connect Washington is funded through the Washington Workforce Education Investment Act 2019, which calls for:

- cross-sector co-ordination through a cross-agency work group across the state;
- resources to K-12 and higher education partners to support enrolment in career launch and registered apprenticeship programmes, as well as other career-connected learning opportunities;
- regional leadership and co-ordination to facilitate connections between industry and education;
- creation of a grant programme tailored to the local needs of students and employers, and designed for students to receive dual credit; this includes supporting career-connected learning programme intermediaries working within and across regions.

The programme is supported by close to USD 40 million in 2019-21. The funding supports the creation of new career-connected learning opportunities through competitive funding allocated to programme intermediaries, regional networks and education district co-ordinators; increased enrolment in existing career-connected programmes; supports for low-income students and those in underserved areas to participate, including for transportation; as well as start-up and capital funding.

As part of Career Connect Washington, funding has been allocated to the development of new registered apprenticeships in non-traditional fields such as information technology (USD 2 million), health care (USD 1.6 million), and advanced manufacturing.

Source: (OECD, 2020[87]).

The Industry Transformation Plan with the Digital Technologies sector has developed a new Digital Skills Plan (replacing the previous Digital Skills Forum). This includes actions to develop pathways between education and work – including digital apprenticeships, and greater emphasis on internships and micro-credentials. Implementation planning is underway.

Despite being the largest employers of IT graduates, most public-sector organisations recruit individually and few take on interns (New Zealand Digital Skills Forum, 2021[86]). The central government has a small but successful GovTechTalent graduate programme in place, where IT graduates spend 24-months rotating through three of the participating agencies, spending eight months in each. This programme, or similar programmes, should be opened to all public-sector organisations to enable them to engage with digital technology graduates and better coordinate internships. The same mechanism should also be expanded to provide internships for digital technology students to help them gain work experience while studying. This would improve the quality of graduates and support the difficult transition from education to employment.

There is also scope to strengthen the digital skills pipeline by encouraging underrepresented groups – women, Māori and Pasifika – to pursue digital careers, which would help to reduce the wellbeing gaps for these groups highlighted in the 2019 *OECD Economic Survey of New Zealand*. By the final year of secondary school (Year 13), the proportion of women taking NCEA Technology Standards is much lower than for men (Table 3). Moreover, smaller shares of women, Māori and Pasifika than men and the rest of the population, respectively, are enrolled in mathematics, which is an important pathway subject to a digital career; however, more women than men are enrolled in science, which can also be an important pathway subject depending on the scientific field concerned. Gender and ethnic inequality is greater again at the tertiary education level, with women, Māori and Pasifika comprising only 25%, 5% and 3%, respectively, of IT-degree graduations (2019 data). Respondents to the 2020 Digital Skills Survey indicated that only 27% their digital teams were women, 4.1% Māori and 2.8% Pasifika. Public-private partnerships, such as those in Washington State, that focus on promoting interest in STEM fields, particularly among under-represented groups, could help to close these gaps (Box 6).

Table 3. Female, Māori and Pasifika secondary students are underrepresented on pathways to digital careers

Funding Year Level Year 13 enrolments, 2020, %					
	Share of students enrolled in the subject and in total			Share of total enrolments in the subject and in total	
All ethnicities	Female	Male	Total	Female	Male
Technology Standards	25.6	47.9	36.3	36.8	63.2
Mathematics	69.5	81.2	75.1	48.3	51.7
Science	81.2	76.4	78.9	53.7	46.3
Total	52.2	47.8		52.2	47.8
Māori					
Technology Standards	24.0	43.9	33.4	6.1	10.0
Mathematics	53.0	59.1	55.9	6.5	6.5
Science	55.5	48.3	52.1	6.5	5.0
Total	52.9	47.1		9.2	8.2
Pasifika					
Technology Standards	21.9	48.2	34.5	3.6	7.3
Mathematics	61.0	62.7	61.8	4.9	4.6
Science	48.9	41.0	45.1	3.7	2.9
Total	52.3	47.7		6.0	5.5

Source: Ministry of Education, Secondary Subject Enrolment and July Roll Return total response ethnicity data.

Box 6. Public-private partnerships in Washington State to help socially disadvantaged students access high-demand, high-earning fields of study

Washington STEM

Washington STEM is a state-wide, independent non-profit organisation comprised of STEM experts whose role is to identify and foster innovative STEM programs and partnerships. It seeks smart and scalable solutions that lead to opportunities for students underserved and under-represented in STEM fields. Washington STEM supports policymaking through advocacy, identifies areas of focus on which it collects data (such as early math achievement), and supports regional STEM networks. These 11 regional STEM networks bring educators, business leaders, STEM professionals, and community leaders together to build student success and connect them with STEM career opportunities in their communities.

The Washington State Opportunity Scholarship (WSOS)

The WSOS was created in 2011 to address needs in sectors including aerospace, engineering, technology and health care and rising tuition costs at Washington institutions. The programme consists of scholarships for low- and middle-income students to pursue these fields of study at baccalaureate level and in Career and Technical Education programmes; funds are provided by industry and philanthropic organisations and are matched dollar-for-dollar by the state. This initiative has served close to 20 000 students and outcomes are promising: 61% of students served are women, 64% are students of colour and 65% are first-generation college students. While the average family income of the most recently awarded cohort of baccalaureate scholars was just over USD 41 000 at the time of acceptance into WSOS, the average salary of recent WSOS graduates employed full-time was USD 62 297. Almost 95% of WSOS Baccalaureate graduates are employed or in graduate school, and most (81%) live in Washington state.

Washington Mathematics, Engineering, Science Achievement (MESA)

Washington's MESA programme aims to improve diversity and retention with an emphasis on traditionally under-represented students in STEM fields, including African Americans, Native Americans, Hispanic/Latinos, Pacific Islanders, and women. This programme is one of eleven state programmes co-ordinated by a national body. It benefits from industry sponsorship to fund various supports in schools, community colleges and engineering programmes. These supports are diverse, including teacher training, academic tutoring/counselling, internships, field trips, and recognition events to support both student access and retention into STEM.

Source: (OECD, 2020[87]).

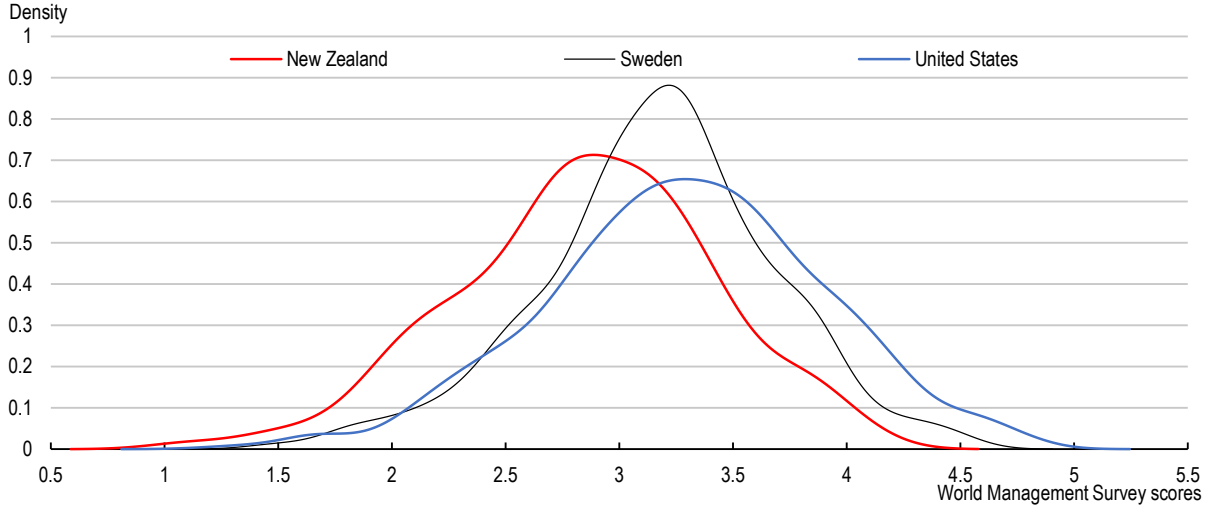
The NCEA Change Programme seeks to address inequity in qualifications. By giving equal status to Māori knowledge, the Programme aims to help Māori learners see themselves studying these subjects. The Review of Achievement Standards also aims to enhance equity by applying quality criteria from four critical perspectives (Māori learners, Pacific learners, pathways and accessibility) to each Standard developed to help ensure that it is as suitable as possible for a diverse range of students.

Enhancing management skills

Managerial practices in New Zealand lag behind other advanced OECD economies, holding back the adoption and effective uses of digital technologies. Management practices have been lagging partly owing to weaker competitive pressure in New Zealand's small, geographically isolated market (de Serres, Yashiro and Boulhol, 2014[32]; OECD, 2017[22]). Indeed, New Zealand underperforms in the distribution of managerial quality against the United States and Sweden (Figure 25). Smaller New Zealand firms, especially family-owned firms, trail behind larger firms in managerial quality (Green and Agarwal, 2011[88]).

Figure 25. New Zealand lags behind in managerial practices

Distribution of management quality, Kernel distribution



Note: The figure depicts the Kernel distribution of scores in the World Management Survey conducted against firms in New Zealand, Sweden and the United States. The Survey captures the quality of management practices in operations management, performance monitoring, target setting, leadership management and talent management (see the source for more information). The longer left tail in New Zealand's distribution indicates the existence of firms with a very low score (poor managerial practices), which are less frequent or not found in Sweden and the United States.

Source: *The World Management Survey Database*

Weakness in management skills has prevented managers from recognising the return from digital take-up and identifying which digital technologies they should adopt (Better for Business, 2020[20]). It is also an important barrier to unlocking productivity growth through digital transformation, considering that reaping the full benefits of digital take-up requires investing in complementary organisational changes (Box 7). The deficit in management skills results in low dynamic capabilities, which is holding back New Zealand firms from grasping changes in business environments and investing in strategic intangible capital to capture new business opportunities or respond to threats (Teece and Brown, 2020[89]). Management boards in New Zealand's firms are often more focused on preserving existing value and regulatory compliance than on growth strategies that involve productivity-enhancing investments and international expansion (Smith and Garden, 2020[90]). In particular, there is a shortage of board members with rich managerial experience as opposed to a preponderance of those from accounting and legal backgrounds. In addition, tolerance by shareholders towards failed ventures is low.

Box 7.Digital transformation requires good management and organisational changes

The benefits of digital technologies are conditional on complementary investment in organisational change (Garicano, 2010[91]; Cardona, Kretschmer and Strobel, 2013[92]; Corrado et al., 2021[5]). These changes include new organisational processes and structures, knowledge sharing, and redesigned monitoring, reporting, and incentive systems (Brynjolfsson, Hitt and Yang, 2002[93]). Investment in such organisational changes is often risky and typically costs more than the direct financial costs of adopting digital tools like fast broadband or digital services like cloud computing (Brynjolfsson, Rock and Syverson, 2021[3]). However, a successful combination of digital technologies and organisational capital acts as a source of competitive advantage, which competitors find difficult to replicate (OECD GFP, 2019[94]).

Although it is difficult to capture the exact organisational changes made by firms during their digital transformation, some aspects have been documented. For instance, (Bloom, Sadun and Van Reenen,

2012[95]) reported that US multinational enterprises operating in Europe use digital technologies more intensively than European firms and reap higher productivity from ICT capital. They find that higher productivity of ICT capital is mostly explained by superior human resource management by US multinationals, suggesting that better people management practices boost the benefits of digital technologies. (Black and Lynch, 2001[96]) estimated the contribution of various workplace practices to US firms' productivity and found that a higher share of non-managerial workers using computers is associated with higher plant-level productivity, while, interestingly, a higher share of managers using computers is not. Their finding that the usage of computers by mid- to low-level workers improves firm performance is in line with findings that lower costs in gathering information enabled by digital tools increase the value of more decentralised decision making (Bloom et al., 2014[97]).

While the government cannot intervene in corporate boards nor change their risk-averse culture, it can promote the diffusion of good managerial practices that so far are concentrated among the most productive firms (Fabling, 2021[98]). For instance, the government could provide or subsidise the use of in-firm management consulting services, which are found to improve managerial practices in a relatively short time and have lasting impacts (Bloom et al., 2020[99]; Bruhn, Karlan and Schoar, 2018[100]). Classroom-based training programmes for managers could also be provided, although their effectiveness is found to hinge on the quality and intensity of training (McKenzie, 2021[101]). The government could also experiment with various approaches to effectively diffuse good management practices, by involving social partners, academia, and public sector organisations. For example, in 2018 the United Kingdom launched the Business Basics Programme, which provides competitive funds to projects testing innovative ways to encourage SMEs to adopt existing technologies and management practices to improve their productivity. Academic research on management science, especially on advanced management techniques for exploiting digital technologies and dynamic capabilities, should be strengthened as well. Despite their relatively large presence in academia, business scholars are under-represented in panels in the Marsden Fund, which distributes the government's research grants, and are less successful in raising research funds (Godfrey and Freeman, 2019[102]).

To prevent strong risk aversion from biasing management decisions, the government should reform the insolvency regime to facilitate timelier restructuring of non-viable businesses and lessen the penalty for failed entrepreneurs. Although the efficiency of New Zealand's insolvency regime is middle of the range for OECD countries, there is room to make it more conducive to resource reallocation and entrepreneurial risk-taking, as discussed in the 2017 *Economic Survey of New Zealand*. For instance, the government could consider reducing the debt discharge period in personal bankruptcy from three years to less than one year, as in the United States, the United Kingdom and Canada. This would encourage small business owners to experiment with new work organisations that leverage digital tools.

Reducing regulatory barriers to digital innovation

Making regulations more agile and accommodative to digital innovation

Product market regulations need to be agile and responsive to digital innovation in order to accommodate disruptive innovation and avoid killing off technology development while preventing harmful digital activities. New digitally-driven business models often challenge regulations by transcending existing administrative and market boundaries. This creates a void where new businesses are unbound by regulations applied to incumbents, generating unwarranted competitive advantage, and may expose consumers to risks. However, if regulations are too restrictive or prescriptive, they risk deterring digital innovation and its contribution to the economy and society. Regulations that are not technology neutral also prevent the use of more efficient technologies that would have allowed for better compliance.

The government can make its regulations more agile by identifying emerging key technologies and anticipating reform needs arising from these technologies (World Economic Forum, 2020[103]). Having good

foresight prevents risks of ill-timed interventions that fail to maximise the potential of digital innovation or mitigate risks to consumers. Several OECD countries have units in place that advise regulators on technological innovation and potential reform needs. For instance, Sweden's Committee for Technological Innovation and Ethics (Komet) helps the government identify policy challenges regulators would face from Fourth Industrial Revolution technologies, and proposes solutions to promote responsible use of these technologies. New Zealand would benefit from having a similar body of experts and social partners in place. Although the production process of Industrial Transformation Plans involved identifying sector-specific challenges and policy priorities, it did not provide holistic insights on how regulations should adapt to technological change.

The government can increase its capacity to accommodate new technologies by shifting from prescriptive rule-based regulations toward goal- or principle-based regulations. Goal-based regulations stipulate objectives that need to be achieved but do not define technologies and activities that are permitted or forbidden (OECD, 2021[104]). Several OECD countries are adopting this regulatory approach, especially in areas where there is great uncertainty about technological progress (Box 8). Goal-based regulations are future-proof because the principles behind them are unlikely to become obsolete even if new technologies blur the boundary of regulated activities. For example, the goal of road safety regulations, preventing accidents, will not be obsolete in the face of new modes of transport, like electric scooters.

New Zealand's copyright regime is one area where a goal-based approach would be effective. Due to the lack of principles that define "fair use" exceptions of copyright, New Zealand's copyright law has been progressively patched with narrow exceptions that are soon overtaken by the development of new technologies (Australian Productivity Commission and New Zealand Productivity Commission, 2019[35]). For example, current exceptions in New Zealand's copyright law limit ordinary uses of cloud services (InternetNZ, 2018[105]). It also does not allow some activities that underpin machine learning and artificial intelligence technologies, such as data and text mining, and other non-expressive uses of copyright material (Deloitte, 2018[106]). Copyright protection should be made future-proof by defining its objectives while allowing for the use of various technologies so long as they are consistent with these objectives.

One concern for moving from a prescriptive- to a goal-based regulatory approach is that it can increase regulatory uncertainties if firms cannot assess correctly whether their compliance efforts will be considered sufficient in achieving regulatory objectives. This can lead to over- or under-compliance, especially for younger or smaller businesses with limited capacity to interpret regulatory objectives. In case of the copyright regime above, moving away from prescriptive copyright exceptions (referred to as "fair dealing") to principle-based regulation risks ending up in case-by-case determination of "fair use" by the court, which would increase uncertainties and transaction costs. These regulatory uncertainties can be reduced by complementing goal-based regulations with guidelines or non-binding standards like codes of conduct. These guidelines should be produced and revised regularly in partnership with social partners with information on the latest technologies and new business models that could challenge existing regulations (OECD, 2020[107]). Such a co-regulation process could work well in New Zealand given that policymakers benefit from constructive relationships with social partners. However, it will be important for the government to reach out to market participants that are not well represented by existing organisations, such as start-ups.

Goal-based regulations may not be feasible if the government lacks capacity to assess whether firms' use of digital technologies is consistent with regulatory goals or to hold businesses accountable where this is not the case. An alternative way of making regulations more flexible is experimentation. Several OECD countries have adopted regulatory sandboxes, which enable selected firms to test innovative products or services with minimal regulatory requirements. Regulatory sandboxes were initially used mainly in fintech, but have since expanded to other industries, including transport (drones, autonomous vehicles), energy (smart meters), health (mobile health apps) and ICT (5G) (Attrey, Lesher and Lomax, 2020[108]). New Zealand has not adopted regulatory sandboxes for fintech to date because the Financial Market Authority's broad power enables exemptions that reduce disclosure and licensing obligations on a case-by-case basis.

However, this measure is not intended to promote experimentation of new technologies. The government should consider introducing regulatory sandboxes or similar measures to encourage experimentation across industries. For example, Italy introduced in 2020 a legal provision allowing firms and research institutions to request a temporary derogation from regulations that inhibit new products or business models. Upon approval, innovators are granted a "Right to Innovate" exemption for a specified period.

Box 8. Japan's goal-based regulation on autonomous (self-driving) cars

In the near future, traditional cars will be replaced by partially-autonomous cars with automated functions like acceleration and steering, which nevertheless require drivers to remain engaged and monitor the environment, and eventually by fully autonomous cars performing all driving functions under all conditions.

To keep up with technological progress, Japan's Ministry of Land, Infrastructure, Transport and Tourism has built an agile goal-based regulatory framework. It established in 2018 the Basic Safety Guidelines for Self-Driving Vehicles, which define the safety goal to be met by automated cars as: "automated vehicle systems, under their operational design domain, shall not cause any traffic accidents resulting in injury or death that are rationally foreseeable and preventable." The Guidelines further provide more detailed goal-based requirements in areas including the safety of automated driving systems, compliance with the safety standards, human machine interface, installation of data recording devices, cyber security, safety requirements under autonomous driving modes, and so on. All of these requirements are qualitative and do not include numerical objectives or negative lists of specific technologies. This approach allows companies to experiment with a wide range of technologies to meet these safety requirements. The Ministry will also co-develop voluntary technical requirements with industry for experimenting with autonomous vehicles.

Because the safety of autonomous vehicles is governed primarily by the controlling software, which has to be updated regularly, the Ministry also requires automakers to obtain permits from the Ministry on such updates before they are installed in cars. This provision can be regarded as an example of agile safety regulation that evolves with the digitalisation of vehicles.

Source: Ministry of Land, Infrastructure, Transport and Tourism (2018[109]); Ministry of Economy, Trade and Industry (2020[110]); World Economic Forum (2020[103]).

Digital technologies are allowing firms to capture a larger share of revenue from online commerce and to develop business models that combine the most promising aspects of both traditional and e-commerce (OECD, 2020[1]). However, regulations have not always adapted to evolving business models in the retail sector and often impose artificial distinctions between online and offline commerce. Although many New Zealand firms sell online (see above), New Zealand only ranks 12th among OECD countries for the ease of doing digital business on e-commerce platforms (Chakravorti, Chaturvedi and Filipovic, 2019[111]). A factor in New Zealand's relatively poor showing is that retailers must have a bricks-and-mortar shop to be allowed to sell some goods and services online (OECD 2018 Product Market Regulation Indicator). The government should remove this barrier to online sales.

Establishing a consumer data right

Data are a key resource for digital innovation. Because data can be used simultaneously by multiple parties without engendering scarcity or diminishing their value, the benefits of data are maximised when they are widely shared and re-used across many entities insofar as this does not infringe any individual's privacy or corporate secrets. For instance, effective use of customer data can reduce search and switch costs, allowing consumers to shop around for the best services, or firms to introduce new services that respond to consumers' unmet demand. The possibility of transferring customer data across digital services or platforms allows consumers and businesses to change more easily to new and potentially better data-

driven services and platforms, fostering greater user choice, competition and innovation (OECD, 2019[112]). Data portability is a promising way to promote re-use of personal and business data, where a firm that collected an individual's data provides data in a commonly used, machine-readable format to the individual, or to a third party he or she has chosen (OECD, 2019[112]). A consumer data right provides a legal basis for data portability by establishing the rights of individuals or businesses to the data they generate. It gives them stronger control of their data and ensures that their data are only shared for their benefit, with their consent. Australia enacted legislation on consumer data rights in 2019, which enabled consumers in designated sectors to have certain information disclosed to them or to accredited third parties. It was applied first to the banking sector and is to be extended progressively to energy and telecommunications. New Zealand's current regulatory settings embody some barriers to consumers gaining access to their data from data holders (New Zealand Productivity Commission, 2021[11]). The government is preparing legislation rolling out a consumer data right on a sector-by-sector basis that should be presented to Parliament in 2022. Further decisions need to be made concerning the implementation of consumer data rights, including how to enforce them or in which sectors they should first be applied.

Safeguarding competition in digital services markets

Digital services are often characterised by large economies of scale and network effects that lead to entry barriers, winner-take-most dynamism and strong market concentration. Market dynamism, especially entry and growth by start-ups introducing new technologies, disruptive innovation and business models, is important as they can help break up concentrated markets or force less efficient incumbents to improve or exit. An eventual acquisition by large incumbents is often an important motivation for digital innovation by these start-ups. However, problems arise with regard to technology diffusion when incumbents decide not to commercialise technologies acquired from nascent firms, for instance because they cannibalise their existing services. In some cases, large incumbents seek to snuff out competition by acquiring nascent competitors holding valuable digital technologies, and discontinue their development (a case referred to as a killer acquisition) (OECD, 2020[113]). The competition authority should therefore be able to thoroughly scrutinise mergers and acquisitions (M&A) that potentially curb competition in digital markets, in particular acquisitions of nascent competitors.

In New Zealand, the Commerce Act prohibits mergers and acquisitions that have an effect, or likely effect, of substantially lessening competition. However, parties can apply to the New Zealand Commerce Commission (NZCC) for clearance on a voluntary basis. If the NZCC grants clearance, this provides immunity from prosecution under the Commerce Act for the transaction for 12 months. The NZCC can also decline to give clearance, if it is not convinced that the transaction will not have an effect, or likely effect, of substantially lessening competition. The voluntary notification regime, also adopted in the United Kingdom and Australia, contrasts with the ones in most OECD countries, where notification is obligatory for mergers that result in turnover or other criteria exceeding stipulated thresholds. On the one hand, this can prevent the NZCC from reacting to M&A that lessen competition in a timely way if the Commission is not aware of the transactions. On the other hand, New Zealand's regime can be more flexible, because it allows the competition authority to investigate smaller M&A that do not exceed stipulated thresholds, unlike most of the mandatory pre-merger notification regimes (OECD, 2020[113]).

If the merging parties do not notify the NZCC prior to the merger but the NZCC subsequently forms the view that the merger undermines competition, it can prosecute the parties and seek divestment remedies and pecuniary penalties against firms and/or individuals. The NZCC also has the ability to file to the court for an injunction to prevent transactions that it is aware of that may affect competition from completing. If prosecuting a transaction under the Commerce Act, the so-called burden of proof lies with the NZCC, that is, in order to prohibit or prosecute specific M&A, the NZCC needs to convince the court of the anti-competition effects of the merger. However, anticompetitive impacts of mergers in digital services are often hard to prove due to their dynamic markets, rapid innovation and complex business models. Anti-competitive effects of nascent acquisitions are harder to prove, since this involves comparing the degree of market competition against the counterfactual where the nascent firm was allowed to grow. Such

difficulty in reversing potentially anti-competitive M&A underscores the importance of ensuring that the NZCC thoroughly scrutinises them in advance.

This provides a case for equipping the NZCC with "call-in" power to order merger parties to apply for its clearance, whenever it sees a risk of substantially lessened competition. For example, the United Kingdom is consulting on introducing a new merger regime applied to firms with specific market status that allows the competition authority to intervene based on a realistic prospect that the merger or acquisition is expected to reduce competition. Germany, in its amended Competition Law, endowed the Federal Cartel Office with the power to order companies with worldwide revenue and a domestic market share exceeding stipulated thresholds to notify all acquisitions if it holds objective concerns that they significantly impede effective competition in Germany (Herrlinger et al., 2021[114]). This call-in power should be complemented with power to halt the integration of merger parties and require businesses to be run separately until the NZCC completes its investigation. Also, the NZCC currently lacks the powers to order merger parties based overseas to produce information or documents for its investigation, unlike the Australian competition authority. The NZCC therefore has to enter into agreements with foreign competition authorities to obtain these, which can be time-consuming. Equipping the NZCC with such power would help it make better and more timely decisions.

Strengthening trust in Internet environment and preparation against digital security risks

Preventing online extremism and algorithmic biases

Low trust in online security and digital privacy deters people from engaging more in the digital economy (OECD, 2019[115]). Ensuring a safe internet environment is thus key to reaping the benefits from new digital technologies. In 2020, almost 60% of New Zealanders chose at least once not to use an online service because of security or privacy concerns, and 46% of the New Zealanders were very or extremely concerned about the online security of their personal data (InternetNZ, 2020[52]). The top online privacy concerns are fear that credit card details get stolen and that private companies and public agencies share personal details without permission (Office of the Privacy Commissioner, 2020[116]). Other aspects of the Internet that concern New Zealanders, particularly the elderly and women, are cyber bullying and the possibility that young people get access to inappropriate content (such as hate speech or politically extremist material) (InternetNZ, 2020[52]). Following the 2019 terrorist attack in Christchurch, New Zealand, together with France, launched the "Christchurch call", an action plan to combat online extremism. So far 55 countries and 10 tech companies, including Google, YouTube and Facebook, have joined in, committing to measures including improved transparency in the removal of online content and ensuring that algorithms do not direct users towards violent extremist material. New Zealand also supports the OECD Voluntary Transparency Reporting Framework, aimed at improving the evidence base on terrorist and violent extremist content (TVEC) online by facilitating transparency reporting on TVEC by online content-sharing services within a common framework.

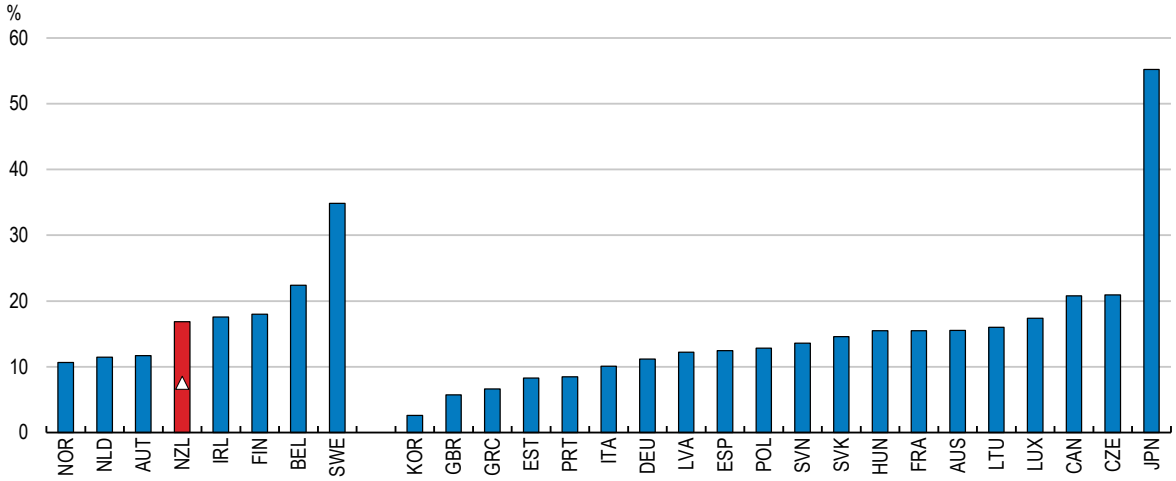
New Zealand is among the first countries in the world to develop of a set of standards to guide the use of algorithms by government agencies and as such a pioneer in pursuing the "Ethical Algorithm", which seeks to correct bias embodied in algorithms that leads to unfairness. In New Zealand, public agencies such as the Department of Corrections, the Accident Compensation Corporation and the Police use algorithms to estimate inmates' risk of re-offending, process insurance claims and identify faces or car number plates. There is a risk, however, that algorithms perpetuate biases or prejudices if the dataset used to develop them reflects historical injustices or fails to properly represent the larger population. In such cases algorithms might, for example, overestimate the risk of recidivism for certain groups. In 2018, Government Chief Data Steward and the Government Chief Digital Officer published an "Algorithm Assessment Report" (Department of Internal Affairs, 2018[117]) that reviewed the use of algorithms by 14 government agencies. It recommended that public agencies be transparent about the role of algorithms in their decision making and carefully review their algorithms for any "unintended or adverse effects". In 2019, The New Zealand Law Foundation (2019[118]) issued a report stressing that algorithms might suffer from biases even though

they are supervised by humans and suggested the creation of an independent regulatory agency to scrutinize the algorithms used by public agencies. In 2020, New Zealand became the first country in the world to establish an "Algorithm Charter" to be used by government agencies. Agencies that have signed the charter pledge to be transparent about how their decisions are informed by algorithms, to peer review algorithms to avoid biases or other unintended consequences and to provide a channel for people to appeal against decisions informed by algorithms.

Strengthening digital security risk management

Concerns about cyber security and fraud are holding back more extensive use of digital technologies. For instance, 40% of firms seeking to adopt AI consider privacy and data security as the main barriers (The AI Forum of New Zealand, 2018[119]). The share of firms experiencing IT security breaches in New Zealand is indeed higher than the OECD average (Figure 26). The number of cyber-attacks has risen markedly worldwide since the Covid-19 pandemic, as firms increased their online activities (OECD, 2020[120]). In New Zealand, the total number of reported cyber-attack incidents rose by 65% between 2019 and 2020 (CERT, 2020[121]). The two most common types of cyber-attack, phishing and fraud, increased by 76% and 11% respectively, whereas reported malware incidents rose by a staggering 2008%, largely due to a surge in the Trojan malware Emotet. Many of the cyber-attacks that have increased drastically during 2020 were directed at business employees. According to Stats NZ's Business Operation Survey, the most common security measures taken by New Zealand firms in 2020 were virus protection, anti-spyware software, spam filters and regularly back-ups of critical data. However, fewer firms made use of authentication software for external users or secured communication between clients and servers. Also, few firms educated staff on cyber security or put in place digital security policies.

Figure 26. A relatively high share of businesses report ICT incidents (security breaches), 2019



Note: Data for New Zealand come from Stats NZ (2020), Business Operations Survey and cover 2018 (bar) and 2020 (triangle). See Figure 2.1, note 2 for the definition of small advanced economies. These data only measure reported ICT incidents and not the actual number of incidents, which is likely to be higher.

Source: OECD, *ICT Access and Usage by Businesses database*; Stats NZ (2020), *Business Operations Survey*

There is an urgent need to raise awareness about cyber-attack threats and to promote sound digital security risk management, especially among small businesses. The government could for instance encourage firms to conduct digital risk assessment practices, which are found to increase digital security measures by European SMEs (OECD, 2020[1]). It could also disseminate innovative safety measures undertaken by firms in other OECD countries (Box 9).

The government's capabilities to cope with digital security risks have been strengthened. In 2017, it established a Computer Emergency Response Team (CERT), which collaborates with its international

counterparts, the Police and agencies such as the National Cyber Security Centre (NCSC) to keep abreast of the latest cyber threats. It also provides businesses with best practice guides on ICT security and help in case they have been subject to an attack. Moreover, the NCSC, which protects New Zealand's nationally significant organisations, has set up a specific Covid-19 page to advise firms who start working remotely on sound digital practices. In August 2021, the government laid out a Cyber Security Emergency Response Plan, which stipulates roles of government agencies and a coordination framework to respond to a cyber security emergency.

Box 9. IoT security labelling in Finland and the United Kingdom

Nascent digital industries sometimes suffer from adverse selection, as consumers struggle to tell which new products are secure and which are not. Customers then tend to choose products based on factors such as price and usability, which are sometimes at odds with digital security. Companies thus have incentives not to devote more resources than absolutely necessary to improve cyber security measures in their products. In more mature markets, such as those for laptops and smartphones, the fact that consumers most often bear the costs of cyber-attacks and that companies sometimes deliberately shorten their products' lifecycles could also lead to companies neglecting digital safety in their devices.

To deal with these market failures, OECD countries are increasingly taking measures to increase product transparency and reduce information asymmetries. In 2019, the Finnish security firm F-Secure found that IoT products, such as smart TVs and watches, sometimes lacked secure-by-default features and were increasingly targeted by cyber criminals. At the same time, a survey from the Finnish Transport and Communications Agency Traficom showed that Finnish consumers worried about cyber security and wanted smart devices to clearly display information on their information security. In the same year, Finland became the first country in Europe to launch a voluntary security label for IoT products. Companies can apply for the Cybersecurity Label at the Finnish Transport and Communications Agency (Traficom), which examines the product to determine if it meets the cyber security requirements set by Traficom's cyber security centre. The requirements are based on the European standards organisation ETSI EN 303 645, ensuring that products can be easily modified to comply with other international requirements.

The United Kingdom provides another example on how to deal with vulnerabilities in new IoT devices. In 2018 it published a "Code of Practice for Consumer IoT Security", setting out guidelines that summarise good practice in IoT security. In early 2021, the United Kingdom announced plans to put three IoT requirements into law. To comply with the planned new law, IoT devices must inform customers when security software will no longer be updated, not use pre-set universal default passwords, such as "password" or "admin" and provide a point of contact so that the customer can report vulnerabilities. Australia adopted a similar, but voluntary, code of practice in 2020 and is currently considering making the guidelines mandatory. In response to the code of practice, Australian firms said that they preferred guidelines based on international standards.

Source: OECD (2020[1]), Traficom (2021[122]).

Enhancing digital transformation by small firms

Promoting the adoption by small firms of digital technologies is central to their diffusion, given that 90% of New Zealand's enterprises were firms with five or less employees in early 2020 (Stats NZ Business Demography Statistics). Managers and owners of small businesses are often constrained in terms of time, skills and capital in adopting the latest digital technologies and investing in complementary organisational capital. Small New Zealand firms, especially family-owned firms, trail behind larger firms in managerial quality (Green and Agarwal, 2011[88]), which constrains their ability to benefit from digitalisation (see above). Small firms are also less prepared against cyber-attack (see above). The first important step is

therefore to raise their awareness of opportunities and threats presented by digital technologies. This should be followed by accessible and highly practical support schemes that enhance their capabilities to exploit and benefit from digital technologies while implementing up-to-date security measures. These schemes include hands-on technical assistance and financial support for efforts to exploit digital technologies in developing new products and business models, or to improve management practices. The government should also support small innovative firms that leverage digital technologies to grow faster by enhancing access to growth capital and providing opportunities for them to capture larger demand.

As a part of the massive fiscal policy response to COVID-19, the government announced a package of NZD 20 million aimed at promoting digital capabilities in small businesses and tourism operators through training and consultation. Half of this fund was used to launch the Digital Boost initiative, which provides free digital skills training and consultation to small businesses online. This welcome step should be followed up with reforms of existing policy schemes to bolster the digital transformation of small businesses.

Raising awareness of the benefits of digital technologies

Managers of small businesses in New Zealand rely mainly on their peers, friends or business advisers (like accountants) for advice on digitalisation and less on government agencies or business organisations (Better for Business, 2020[20]). Therefore, actual cases of small businesses thriving through digital take-up should be disseminated through peer learning and trusted intermediaries. The Digital Boost initiative includes a Spotlight Series where small business owners share their experiences in transforming their business through digital take-up. The government should also work with business partners of small businesses like regional financial institutions as well as regional bodies such as regional economic development agencies to raise digital awareness of small businesses through their daily interactions.

Strengthening technical assistance and knowledge transfer

There is a strong need for an organisation that is specialised in supporting digital take-up by small businesses with weak digital capabilities. Research institutions in New Zealand, such as universities or Crown research institutes, do not have strong channels to provide technical support to these firms. There are organisations facilitating technology transfer and commercialisation of innovation by connecting research institutions and firms, such as the Kiwi Innovation Network (KiwiNet), which manages the innovation outputs of 18 universities and research institutes receiving public funding. However, the collaboration projects proposed by these organisations involve advanced technologies, which only concern a handful of firms with high technological capabilities. The lack of effective channels to help firms with weak capabilities makes it harder for research institutions to inform them of opportunities and risks digital transformation brings, or to assist their digital take-up. Callaghan Innovation, the Government's business innovation agency, brokers technologies and innovation for firms and provides in-house R&D services. It is possibly the most promising provider of hands-on technical assistance to small businesses. In the year ending in June 2020, 63% of its customers were firms with five or fewer employees (Callaghan Innovation, 2020[123]). Yet, it may have little incentive to divert its resources from R&D services that generate an important share of its revenue and yield higher value added than technical assistance. While the launch of the Digital Boost Initiative in 2020 is welcome as the first measure targeting small businesses, both the scope and depth of support for the digitalisation of small firms should be stepped up, possibly through a new organisation that offers hands-on support. For example, Germany has set up 26 Mittelstand 4.0 Centres of Excellence that offer a wide range of services focused on digital take-up by SMEs, which include demonstration factories that reproduce corporate operations to provide managers with real-life examples of how digital technologies could transform their operations and opportunities to try out their own technical solutions. In Latvia, the Latvian Investment and Development Agency operates a one-stop shop that dispatches groups of researchers (technology scout teams) stationed in universities across the country to firms to help them deal with technological issues.

Technical assistance on digital take-up needs to be coupled with advice on management practices and organisational changes, in order to increase the likelihood that small firms achieve significant benefits from

digitalisation, as do larger firms (see Figure 8). Small business owners in New Zealand often struggle to find digital advisers who are not only technically savvy but can also provide practical business advice highly specific to each firm (Ministry of Business Innovation and Employment, 2019[124]). New Zealand's research institutions do not have the capacity to offer advice on managerial practices or business strategies. The Competence Centres in Australia, Lithuania and Sweden not only disseminate knowledge on digital technologies but also provide tailored management counselling services (OECD, 2020[1]). Turkey's Competence Centre provides tailored advice on regulations relevant to new business models enabled by digital technologies with responses co-ordinated across the government. Germany's Mittelstand 4.0 Centres of Excellence help SMEs assess their own digital efforts, develop a digitalisation roadmap tailored to their individual needs, and support them as they select and implement specific actions, while providing advice as to whether a certain technical solution makes good economic sense. New Zealand's Digital Boost initiative provides one-on-one consultation online. It is important that such consultation provides extensive support to strengthen firms' managerial capabilities to leverage digital tools for their business strategy and organisational changes. The government should boost the capacity of the Digital Boost Initiative to meet diverse needs by small businesses in advancing their digital transformation. It should also ensure that this scheme receives stable funding, by reconfiguring some of the existing resources allocated to innovation support, if necessary.

Providing financial support for digital transformation

Several OECD countries provide financial support to small businesses, such as grants or tax credits, for adoption of digital technologies aimed at improving their product and management processes (Box 10). This is because benefits of adopting digital technologies can extend beyond the firms adopting digital tools. First, across OECD countries, there are considerable gaps in the take-up of the latest digital technologies between large productive firms and smaller less productive firms, which leads to wider productivity dispersion. This in turn results in larger wage dispersion across firms (OECD, 2021[9]). Promoting the diffusion of digital technologies among small, less productive firms thus helps reduce income disparities. Second, the adoption of digital technologies by a firm generates knowledge spillovers to other firms (Gal et al., 2019[21]). That is, it reduces the costs of digital adoption by other firms through demonstration effects. This positive spillover could be particularly strong in New Zealand, where small firms mainly refer to the experience of their peers when mulling their digitalisation strategy (see above). At the same time, the user cost of digital tools is considered by managers in New Zealand as one of the most important determinants of digital take-up (Better for Business, 2020[20]). The costs of adopting some digital technologies may be prohibitive for some firms, especially when added to the time and cost required to acquire the skills to use digital tools effectively. Introducing financial support to boost digital take-up by small firms would thus allow New Zealand to unleash these positive externalities.

Box 10. Grants and tax incentives for digital take-up

Some OECD countries provide direct financial support such as grants to help targeted companies cover the costs of accessing digital technologies and tools. For example, Korea provides grants for the use of cloud computing services. Portugal offers direct financial support for website development and maintenance, e-commerce, online marketing and big data. Denmark, Slovenia and Germany provide financial support to help businesses devise digitalisation strategies or augment digital capabilities and skills. Japan provides SMEs with indirect financial support for digital take-up, such as subsidies on digital tools like cloud computing and tax credits on ICT investment in both software and hardware.

Source: OECD (2020[1]).

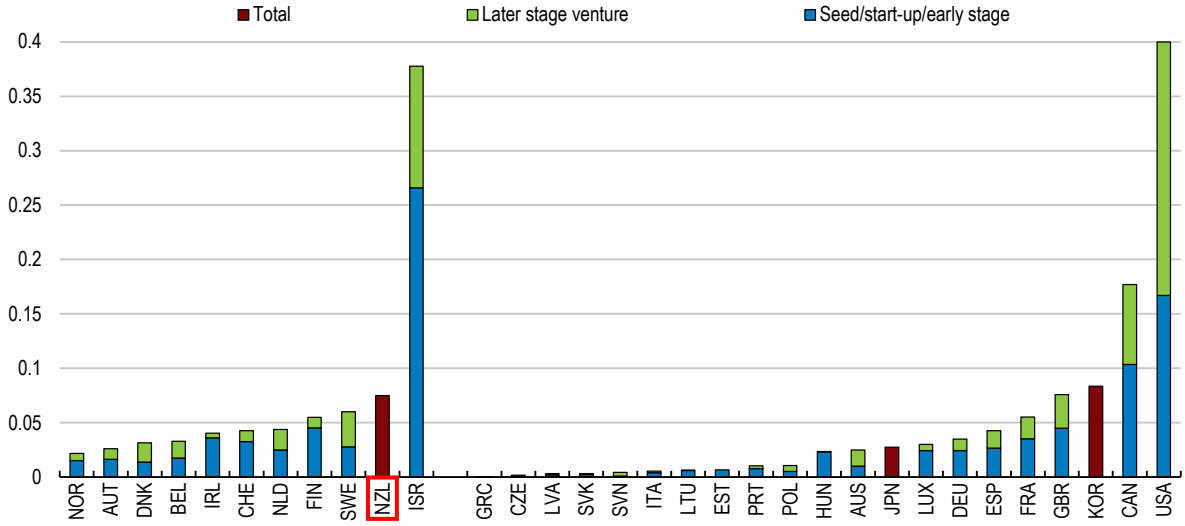
Enhancing access to growth capital

Good access to early-stage funding allows start-ups introducing novel digital solutions to expand in the market, and is thus essential for the diffusion of digital technologies. Seed and venture capital investment in New Zealand has been growing since the early 2000s, with the establishment of the government Venture Investment Fund (NZVIF) in 2002 and the Seed Co-Investment Fund in 2006 that developed early stage markets and a pipeline for the Venture Investment Fund (OECD, 2020[125]). The size of venture capital investment is comparable to that of the United Kingdom as a share of GDP (Figure 27). Nevertheless, a large funding gap in early-stage funding, namely in the venture series A and B funding that follows seed funding stage, is preventing many start-ups and high growth firms from reaching significant scale. Indeed, only 10% of New Zealand firms that raised seed funding can transition into venture capital Series A funding, a conversion rate that is considerably lower than in the United States, where the rate is about 40%, Australia or Singapore (New Zealand Treasury, 2019[126]).

The Treasury foresees an annual funding gap of NZD 150 million in Series A and B funding over the next five years, equivalent to 70% of foreseen demand (New Zealand Treasury, 2019[126]). Furthermore, venture capital supply is highly dependent on foreign sources. Only NZD 53 million Venture Capital was raised domestically while NZD 122 million was funded from abroad during 2012-17. The lack of sufficient early-stage funding prevents New Zealand's venture capital market from maturing and the ecosystem for commercialising digital innovation, which is much needed for the export competitiveness of digital services (New Zealand Productivity Commission, 2021[11]), from developing. It also encourages start-ups with high growth potential to relocate abroad in order to acquire the capital to scale up.

Figure 27. The venture capital market is relatively large compared with the size of the economy

Venture capital investments as a percentage of GDP, 2017 or latest available year



Note: Data for Japan refer to 2016 values and data for Israel refer to 2014 values. See Figure 2.1, note 2 for the definition of small advanced economies.
Source: OECD (2018), *Entrepreneurship at a Glance Highlights*

The government launched the Elevate NZ Venture Fund (the Elevate Fund) in March 2020, a fund of funds programme that will allocate up to NZD 300 million into venture capital firms over the next five years, to increase investment in Series A and B funding high-growth tech businesses. The venture capital firms are required to raise matching capital from other investors that is at least equal to the commitment from the Elevate Fund, and are required to invest at least 75% of the fund into Series A and B funding. The

establishment of the Elevate Fund may stimulate a larger supply of funds in this domain, in the same way as the Seed Co-Investment Fund has helped develop a vibrant angel investment industry.

The Elevate Fund is required to invest at least 70% of its capital in venture funds in New Zealand while it may invest the remaining 30% alongside offshore funds, provided that they invest this capital in New Zealand entities. However, considering that foreign investors fund more than twice as much large venture capital as domestic investors (see above) and that there are urgent needs for Series A and B funding, the government should allow some flexibility in this requirement in the near term. This would allow the Elevate Fund to collaborate more intensively with foreign venture capital firms to bring in more Series A and B funding in the short run, while achieving the 70% domestic capital share in the medium run. Access to the global network of foreign investors can provide start-ups with not only a deeper pool of funds but also opportunities to absorb advanced managerial knowledge and expand in foreign markets. In bringing in foreign venture capital, the government should ensure good coordination between the NZ Growth Capital Partners (previously the NZVIF) that manages the Elevate Fund and the New Zealand Trade and Enterprise (NZTE), which has been connecting New Zealand firms seeking to raise growth capital for international expansion with international investors.

The government should address several structural challenges that are holding back the domestic supply of venture capital. They include incentives that encourage banks to favour loans for housing purchases over loans to businesses, limited exit options for venture capital, which is due to an absence of large domestic tech firms that seek to adopt new technologies through acquisition of tech venture firms, overall low recognition by large foreign tech firms despite some recent high profile acquisitions, and limited opportunities for high-growth firms to list on the stock market (New Zealand Treasury, 2019[126]).

There is also a need to strengthen the capacity of start-ups to raise funding both domestically and internationally. Start-ups that leverage digital technologies and invest intensively in intangible capital can struggle to communicate and sell their value proposition to investors, compared to those investing in tangible capital (OECD, 2013[127]). The government can for instance set up a scheme where experienced managers coach start-up owners on how to promote their project to investors and match promising start-ups with investors by leveraging their connections (Smith and Garden, 2020).

Boosting exports by firms leveraging digital technologies

On the one hand, exporting encourages firms' technology adoption, and this will in turn strengthen their export competitiveness, leading to more exports (Box 2). On the other hand, an effective use of digital technologies increases the chance that firms start exporting (Box 3). This interaction between export and digital take-up can be unleashed through stronger coordination between export promotion and innovation support measures. The government should provide seamless support for small firms leveraging digital technologies that seek to grow larger through exporting. In order to establish strong competitiveness and capture high value added from exports and participation in global value chains, New Zealand's firms need to specialise in highly differentiated and knowledge-intensive goods and services that are hard to replicate. However, competitiveness in these goods and services is founded on strong innovation capabilities and accumulation of intangible capital (OECD, 2013[127]). This underscores the importance of innovation support that is closely tied to export promotion.

New Zealand's export promotion is not strongly oriented toward increasing new exporters. The NZTE provides export promotion services, including support for using digital tools like online sales platforms to sell abroad. However, the NZTE uses around 80% of its financial resources to support intensively around 700 exporting firms with strong export competitiveness and growth orientation (New Zealand Trade and Enterprise, 2019[128]). Firms seeking to enter export markets are given lighter support, such as knowledge transfer on foreign markets and export strategy planning. A digital portal was launched in 2019 to reach out to more potential exporters and provide practical information and advice. While the strong focus on established exporters may help boost New Zealand's export performance more efficiently under a resource constraint, it may fail to identify and support innovative young firms that seek to internationalise at their

early stages. There is also a risk of deadweight losses where intensive support is provided to the most competent firms that would have gained export market shares without the support. The government should reserve a part of the resources for export promotion measures to identify potential exporters of knowledge-intensive, hard-to-replicate goods and services and to promote their successful sales in foreign markets. Close cooperation between the NZTE and Callaghan Innovation would be crucial to identify such firms. Indeed, the draft version of the government's Research, Science and Innovation Strategy states as one of the priorities: "providing integrated support and advice services to start-ups through Callaghan Innovation and NZTE to make it easier for them to access global markets and global customer insights, and to go global from day one of business."

Using government procurement to foster the growth of digital services

Public procurement is an important industry policy tool that provides strategic sectors with an opportunity to develop faster by tapping into large demand. As New Zealand's government progresses toward digital government (see above), it will need to invest in a wide range of digital infrastructure and systems in order to offer user-centred digital services. The government should actively use its ICT procurement to promote the growth of New Zealand firms introducing novel digital solutions.

The public procurement rule requires government agencies to seek opportunities to increase New Zealand businesses' access to government procurement. Nevertheless, MacLennan (2021[129]) reports that the government's ICT procurement that was publicly advertised in the Government Electronic Tender Service amounted to only 2% of annual government ICT expenditure in 2020. This indicates that most ICT procurement was made through exemptions to the procurement rule, namely through secondary procurement, where the procuring agency purchases from a panel of pre-approved suppliers (OECD, 2022[10]). Panel members are often large incumbent firms and the window of opportunity for new firms to join these panels is limited, effectively excluding them from public procurement. This practice is particularly harmful for the procurement of digital services that can play a large role in the growth of digital firms and diffusion of digital technologies. In 2018, the government opened the Marketplace, a digital procurement channel that connects registered government agencies and suppliers of innovative products and services. About 80% of suppliers applying for registration are domestic firms, often SMEs. Currently, the Marketplace is open for four types of digital services including Software as a Service (SaaS) and Consultancy and Professional Services. The government intends to shift away from the secondary procurement to this new scheme, which reduces barriers for suppliers doing business with government and time and costs spent by agencies. It should pursue this by increasing the scope of ICT products and services traded in the Marketplace. The government's Chief Digital Officer has been coordinating to streamline procurement processes for ICT products and services across agencies and establish a common set of procurement agreements. Such a common guideline should include abstention from secondary procurement.

Unleashing digital innovation in the agricultural sector

Digital innovation in the agricultural sector is held back by low awareness of the benefits of technology adoption as well as by shortages of skills for implementing transformative changes in production systems. A lack of access to fast speed Internet in rural areas also hampers the use of data-intensive digital technologies. Further issues relate to digital tools. For instance, the platforms for managing irrigation, fertilisers and tracking animals are fragmented, and are not necessarily cross operational and do not produce data that can be easily combined with those produced by other systems (Ministry of Business Innovation and Employment, 2020[24]). Such fragmentation inhibits the use of sophisticated digital tools that require large integrated data. Data sharing by farmers adopting digital technologies is also limited by a lack of clear governance concerning data ownership and appropriation of economic value generated by data, curtailing the opportunities for data-driven innovation (Ministry of Business Innovation and Employment, 2020[24]). Moreover, the growth of New Zealand's agritech exports has been weak, in contrast to agricultural exports (Agritech New Zealand, 2020[29]). Many agritech firms are competing in the small domestic market without reaching sufficient scale to become internationally competitive. Technological

innovations in New Zealand's agricultural sector are often based on the pastoral model, which are often not applicable to other countries employing different farming systems. Also, large players in the agricultural innovation ecosystem are often focused on addressing domestic production issues and have limited capabilities or interest in proposing innovative solutions to global agricultural problems (Ministry of Business Innovation and Employment, 2020[24]).

Enhancing competition

While agriculture is more exposed to global competition in New Zealand than in other OECD countries (see above), maintaining and strengthening healthy competitive pressure and low barriers to market entry are key to promoting technological adoption (Nicoletti, von Rueden and Andrews, 2020[130]). The dairy industry, New Zealand's largest export industry, has undergone large structural changes since the Dairy Industry Restructuring Act 2001 (DIRA) that established Fonterra, a giant farmer-owned cooperative that controlled 96% of milk production in New Zealand. The DIRA, however, included provisions allowing farmers to exit the Fonterra Cooperative to supply other dairy processors and re-enter the Cooperative freely. It also stipulated that other dairy processors could obtain the raw milk necessary for them to compete in dairy markets (OECD, 2021[23]). Furthermore, the DIRA effectively deregulated dairy exporting by permitting all dairy processors to sell their products on international markets. These reforms led to entry by new dairy processing firms that introduced innovative business models and specialised in high value added niche products (New Zealand Productivity Commission, 2021[11]). The 2020 amendment to the DIRA will remove the open-entry provision from June 2023 that mandated Fonterra to take back any farmers who had left it to supply another milk company. This risks locking farmers into Fonterra's supply chain, thereby curbing competition and dynamism in the dairy processing industry, which is still dominated by Fonterra. Reduced competitive pressure could hold back diffusion of digital technologies. Fonterra would have less incentive to innovate and take up digital technologies to enhance its cost efficiency. Younger and more agile firms that are more likely to introduce disruptive digital innovation will be put at a disadvantage. The government should carefully consider the implications of this DIRA amendment on market dynamism and innovation in New Zealand's most important industry, and reverse it if necessary.

Building the capacity to exploit digital technologies

Policy support is needed to help farmers identify technologies and knowledge needed to address market and environmental challenges and to ensure that the agricultural workforce is endowed with the digital and management skills needed to exploit digital tools and adjust their work organisation in a way that maximises the effectiveness of digital tools. Previously, the New Zealand government provided proactive technology transfer through extension services in the 1970s and 1980s, which contributed to fast technology adoption by farms. Such direct support to farmers was removed in the late 1980s as part of wider public sector reforms, and government extension services were eventually privatised in 1996. Government support for agriculture has since focused on R&D while promoting the uptake and extension of new technologies has largely been left to other actors in the sector. However, the importance of accessible, up-to-date extension programmes is greater than ever, particularly in face of tighter environmental constraints and fast technological change. The Ministry of Primary Industries has recently re-entered the extension services space to help farmers make decisions that support sustainable land use and improve farming outcomes. Some NZD 35 million was allocated until June 2023 to support up to 2 200 producers. While this is welcome, ensuring the success of this new extension programme will require strong involvement by industry groups and other trusted parties to secure buy-in from farmers. It will also require close and highly effective collaboration with farmers and researchers to co-produce knowledge and effective solutions (Casalini, Bagherzadeh and Gray, 2021[26]) given that policy resources available are much smaller than in the 1970s and 1980s.

Another promising new channel of technology transfer and capacity building is the Centre of Vocational Excellence (CoVE) for Food and Fibre, launched in March 2021 by a Consortium of 54 organisations including industry associations, tertiary education providers, Māori, employers and employees. The Centre

is one of three prototypes that will receive funding of NZD 18 million over four years, and is tasked to identify excellence in vocational education in the area of food and fibre and drive innovation by funding specialised projects testing new ideas. It will also share applied research with firms and provide training support for firms. While the detailed activities of the CoVE for Food and Fibre are still being developed, the government should leverage the CoVE as an effective tool to diffuse digital innovation and managerial practices that complement digital technologies.

Improving interoperability and open data

The government should take the initiative in setting uniformly recognised or adhered-to standards for agritech products and services in order to ensure interoperability across digital tool platforms. It should require agritech players to converge to specific standards, while letting them choose the most suitable standards compatible with their commercial interests. Such standards may be some of the established standards in the world's agritech markets, which would facilitate agritech exports by ensuring interoperability with foreign systems. Access to valuable data underpins the effectiveness of digital innovation in providing solutions to the agricultural challenges. The government should propose a governance framework for agricultural data that balances protecting data privacy and confidentiality with farmers' economic interests in data they generate, while promoting wide access to these data to leverage their potential for the sector's growth and innovation (Jouanjean et al., 2020[131]). One way is to establish property rights over these data, for instance by extending the framework for the consumer data right (see above). Lastly, the government should also share the data collected for regulatory purposes in an easily usable format to support farmers' efforts to exploit digital tools to better comply with environmental regulations. The government should address the lack of consistency across councils' measurement and reporting requirements, particularly for environmental standards, which is reducing the usefulness of government data for agritech (Ministry of Business Innovation and Employment, 2020[24]). The government should also respond to unmet data needs of farmers and agritech by collecting useful data, such as those that help farmers prepare against natural disasters (Casalini, Bagherzadeh and Gray, 2021[26]).

Fostering the growth of agritech through exports

Agritech will be key to the diffusion of digital technologies in the agriculture sector. It will provide technologies and business solutions that allow the agricultural sector to boost productivity and capture a larger share of value added from global food value chains. The innovation ecosystem of agritech is developing, supported by the establishment and expansion of Agritech New Zealand, a consortium of large agri-businesses and start-ups, research institutions, government agencies and tech companies. The government's recent measure to boost early-stage venture capital funding (see above) would support further development of this ecosystem. The agritech industry was also selected as one of the strategic industries by the government, and received a NZD 11.4 million fund to develop the Agritech Industry Transformation Plan laying out strategies for the growth and scaling of agritech.

Nevertheless, agritech needs stronger exports to grow further. It is important that agritech researchers and firms shift their focus from domestic agricultural needs to international challenges and explore export opportunities, in order to capture larger returns from their innovation. However, there are so far no specific support measures for promoting agritech exports. In July 2020, the government launched Fit for a Better World, a ten-year roadmap designed to boost agriculture sector export earnings by NZD 44 billion over the next decade (Ministry for Primary Industry, 2020[132]). However, agritech has not been given a prominent emphasis in this roadmap. The government should define agritech exports as an integral part of the agriculture exports and allocate innovation support and export promotion measures accordingly. Furthermore, it should leverage the enactment of the Regional Comprehensive Economic Partnership (RCEP), which accounts for more than half of New Zealand's agro-food exports and imports, as an opportunity for promoting agritech exports.

Main findings and policy recommendations

FINDINGS	POLICY RECOMMENDATIONS
Implementing a comprehensive digitalisation strategy	
New Zealand embarked on the production of a national digitalisation strategy, which aims to promote trust, inclusiveness and growth in the digital economy and society	**Advance the national digitalisation strategy by providing a strong mandate for strategic coordination across all relevant policy areas and by collecting the data needed to support it.**
Improving access to high quality communication infrastructure	
High-speed broadband is being rolled out rapidly, but there are unserved areas in rural areas, holding back the use of data-intensive digital technologies in agriculture	Accelerate the mobile network infrastructure investment funded by the Mobile Black Spot Fund.
The cost of digital devices has surged due to COVID-related increases in transportation costs and disruptions in global supply chains, which risks excluding poor households from accessing the Internet.	Consider providing subsidies to low-income households for the costs of accessing high-quality connectivity, which includes broadband subscription and digital devices.
Strengthening digital skills and management quality	
The domestic pipeline of advanced ICT skills is weak. Poor mathematics achievement limits the proportion of school students who can obtain the university qualifications needed for ICT careers.	**Improve mathematics and science teaching in primary schools, including by putting more emphasis on inquiry plus guided teaching using well-articulated knowledge bases for both the student and the teacher.** **Develop digital apprenticeships and internships and expand the GOVTechTalent graduate programme to all public sector organisations.** **Develop programmes to help Māori and women pursue digital careers**.
Weakness in management skills is preventing digital take-up and investment in complementary organisational changes needed to unlock productivity growth through digital transformation.	Promote diffusion of good managerial practices through in-firm management consultancy, training programmes or other innovative approaches. Strengthen academic research on management science.
Reshaping regulations for the digital age	
Some of New Zealand's regulations lack flexibility to accommodate disruptive digital innovation, a framework to support data portability, and agility to prevent anticompetitive mergers and acquisitions in digital services.	**Move toward goal-based regulations that stipulate regulatory objectives while allowing flexibility in technologies used.** **Equip the NZ Commerce Commission with powers to order merger parties to apply for its clearance. Also endow it with the powers to halt integration between parties during its investigation and order the merger parties which are overseas entities to produce information for its investigation.**
Ensuring a safe digital environment	
Cyber-attacks have increased in the wake of the COVID-19 lockdown but few firms have adopted more robust security technologies, educated staff on cyber security or put in place digital security policies.	Raise awareness about cyber-attack threats and the need for sound digital security management, especially among small businesses. Encourage firms to conduct digital risk assessment practices.
Promoting the digital transformation of small businesses	
Research institutions do not have strong channels to provide technical support to small businesses with weak digital capabilities or advice on organisational changes needed to make best use of digital technologies.	Boost the capacity of the Digital Boost Initiative to provide both technical and managerial advice to small businesses. Ensure its stable funding.
A wider adoption of digital technologies by small firms facilitates the digital take-up by other small firms which learn from their peers, but is held back by its financial costs.	Consider introducing financial support for digital take-up by small firms.
The lack of sufficient early-stage funding is holding back the commercialisation of digital innovation. The government launched the Elevate NZ Venture Fund that co-invests with venture capital funds in Series A and B funding, but the Elevate Fund is required to invest at least 70% of its funds in New Zealand's venture capital funds, which have been providing only a minor fraction of early-stage funding so far.	Allow the Elevate Fund to invest more than 30% of its capital in offshore funds in the short run provided that they invest this capital in Series A and B funding for New Zealand companies. Aim to achieve the 70% share in the medium to long run.
Policy support for digital innovation and export promotion measures are not well linked.	**Provide seamless support to innovative digital start-ups for their early global expansion through better coordination between Callaghan Innovation and New Zealand Trade Enterprise.**

Government procurement through panels of pre-approved suppliers (secondary procurement) is depriving young innovative firms of an opportunity to grow faster by tapping into this large market.	Move away from secondary procurement in the procurement of ICT products and services by making greater use of the Marketplace.
Unleashing digital innovation in the agricultural sector	
The 2020 amendment to the Dairy Industry Restructuring Act (DIRA) 2001 will remove the open-entry provision that mandated Fonterra, the giant farmer-owned cooperative, to take back any farmers who had left it to supply another milk company. This risks undermining competition and innovation in the dairy processing industry by providing an unwarranted advantage to Fonterra over younger and more agile firms that are more likely to introduce disruptive digital innovation.	Carefully monitor the impacts of the DIRA amendment on market dynamism and innovation in the dairy sector, and reverse it if necessary.
Digital innovation in the agricultural sector is held back by low awareness of the benefits of technology adoption as well as shortages in skills for implementing transformative changes in production systems.	Ensure the effectiveness of the new extension programme through strong involvement by industry groups and other trusted parties. Leverage the Centre of Vocational Excellence for Food and Fibre to diffuse digital innovation and managerial practices that complement digital technologies.
The digital platforms for managing irrigation, fertilisers and tracking animals are not necessarily inter-operational, nor do they produce data that can be easily combined.	**Ensure interoperability across digital tool platforms by requiring agritech players to adopt common standards, while letting them choose the most suitable common standards to converge to.**
Many agritech firms are competing in the small domestic market, without reaching sufficient scale to exert strong competitive pressure.	Promote agritech exports as a part of wider agricultural exports. Support innovation collaboration with foreign firms and research institutions.

Note: Policy recommendations in bold are key recommendations highlighted in the 2022 Economic Survey of New Zealand (OECD, 2022[10]).

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